THE ECONOMICS OF TRADE SECRETS: EVIDENCE FROM THE ECONOMIC ESPIONAGE ACT

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The Economics of Trade Secrets: Evidence from the Economic Espionage Act

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Academic

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Abstract

This thesis reports on the economic analysis of trade secrets via data collected from prosecutions under the U.S. Economic Espionage Act (EEA.) Ratified in 1996, the EEA increases protection for trade secrets by criminalizing the theft of trade secrets. The empirical basis of the thesis is a unique database constructed using EEA prosecutions from 1996 to 2008. A critical and empirical analysis of these cases provides insight into the use of trade secrets.

The increase in the criminal culpability of trade secret theft has important impacts on the use of trade secrets and the incentives for would-be thieves. A statistical analysis of the EEA data suggest that trade secrets are used primarily in manufacturing and construction. A cluster analysis suggests three broad categories of EEA cases based on the type of trade secret and the sector of the owner. A series of illustrative case studies demonstrates these clusters.

A critical analysis of the damages valuations methods in trade secrets cases demonstrates the highly variable estimates of trade secrets. Given the criminal context of EEA cases, these valuation methods play an important role in sentencing and affect the incentives of the owners of trade secrets. The analysis of the lognormal distribution of the observed values is furthered by a statistical analysis of the EEA valuations, which suggests that the methods can result in very different estimates for the same trade secret.

A regression analysis examines the determinants of trade secret intensity at the firm level. This econometric analysis suggests that trade secret intensity is negatively related to firm size. Collectively, this thesis presents an empirical analysis of trade secrets.

Key Words: Intellectual Property, Trade Secrets, Economic Espionage Act, Damages, and Firm Size

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Chapter 1: Introduction

> We have among us men of great genius, apt to invent and discover ingenious devices; and in view of the grandeur and virtue of our city, more such men come to us every day from diverse parts. Now, if provision were made for the works and devices discovered by such persons, so that others who may see them could not build them and take the inventor's honour away, more men would then apply their genius, would discover and would build devices of great utility and benefit to our commonwealth.[1]

Patent Statute by the Venetian Republic, 1474

Innovation stems from human endeavours and drives technological progress. Innovation also allows society to overcome the myriad of challenges found in medicine, agriculture and virtually every aspect of human life. Encouraging this innovation and allowing innovators to reap the rewards of their work are key economic policy challenges. The Venetian Republic recognized the importance of protecting innovation and enacted a patent statute as a policy solution in 1474. Since then, the means of protecting innovation have evolved into a complex network of economic policy, law, business strategy and competition. Central to this network is the legal system of Intellectual Property Rights (IPR), which includes patents, trademarks, copyrights and trade secrets. This thesis examines trade secrets as a key element of economics and Intellectual Property (IP) with an in-depth empirical analysis of the role in trade secrets.

The central focus of this thesis is an analysis of the strategic role of trade secrets as a legal and business response to the challenge of protecting innovation through secrecy. As this thesis will argue, by maintaining important aspects of an innovation secret, the owner of the trade secret is able to reap the rewards of innovation and maintain a competitive advantage. However, as will be discussed, trade secrets are susceptible to loss through competing innovations, breach of contract and theft. A policy response to vulnerability of trade secrets to theft has been the United States Economic Espionage Act (EEA) of 1996. The

[1] Printed in Nard (2007) from the Guilio Mandich, "Venetian Patents", *Journal of the Patent Office Society*, 1948:30:166, 176-177.

EEA criminalized the theft of trade secret and unified trade secret law in the United States at the federal level. Prosecutions under the EEA form the empirical basis of this thesis and provide a hitherto unexplored data source on the use of trade secrets.

This thesis details the construction of a database stemming from these prosecutions and examines the data for evidence of the use of trade secrets. Due to their inherent secrecy, little empirical information is available for trade secrets. Thus, the stylized facts stemming from the composition of defendants, the types of trade secrets and the industries involved in EEA cases all represent new evidence of the use of trade secrets. Illustrative case studies developed in this work demonstrate the strategic use of trade secrets at the firm level and their role in appropriating the returns to innovation. Another area explored throughout the thesis is the valuation of trade secrets, which points to the underlying value of innovation but is a challenging process due to the intangible nature of trade secrets. The distribution of the values of trade secrets in EEA cases further develops the understanding of the underlying process of the growth of innovation and the value to the firm of protecting innovation. Finally, the thesis examines the determinants of the use of trade secrets, as measured by the intensity of the use of trade secrecy. Collectively, these analyses paint a picture developed throughout the thesis of the important role of trade secrets in providing innovators with incentives to innovate, and the means to appropriate the rewards of innovation.

1.1 Terms of Discussion

A number of concepts occur throughout the thesis and merit explanation at this point in the analysis. These terms of discussion set the stage for the economic analysis of the legal policies that form the infrastructure in which the incentives to innovate are developed.

1.1.1 Intellectual Property

Intellectual Property (IP) is property in information (Cooter and Ulen, 2004), or, more specifically, “an intangible asset… which has been granted legal protection and recognition."[2] It includes the Intellectual Property Rights (IPR) of trademarks, patents, trade secrets and copyrights. A specific area of law, IPR creates legally defined property rights over innovations. It allows the creators of innovations and creative material to exercise control over, and appropriate the returns to, the fruits of their labour. IP, and its economic role with a focus on trade secrets, is the central theme of this thesis.

1.1.2 Patents

As noted in the opening quote, patents are a form of IP with a long history. They also represent a ripe area for exploration due to their relatively easy to quantify nature.

In order to obtain a patent, an innovation must typically meet four requirements: it must be novel, it must have an industrial application, it must be a patentable subject matter and it must be non-obvious. The novelty requirement means that the innovation must advance the state of the "prior art"; i.e. it must be a novel contribution to the state of knowledge before its creation. The industrial application and patentable subject matter requirements vary between patent regimes. These requirements are a way of preventing innovations protected under other IPR, such as copyright, from also achieving patent protection. The non-obvious requirement means that the innovation must have some form of creative spark and not be an obvious extension of an existing innovation.

The patent granting process itself starts with an application to an official government body (Scotchmer, 2005.) This application is reviewed and, if successful, the applicant is granted a legal monopoly over the innovation for twenty years. This allows the applicant the right to exclude others from producing or using the innovation without consent. It also gives the applicant the ability to sue for damages in infringement cases.

1.1.3 Trade Secrets

[2] Anson and Suchy (2005), p. 16.

Trade secrets are often referred to as confidential information or industrial secrets (Dessemontet, 1998; Satija, 2009.) However, for the purposes of the analysis of IP, it is important to define trade secrets more strictly. Trade Related Aspects of Intellectual Property (TRIPS) is an international agreement that provides the minimum level of protection for trade secrets for members of the World Trade Organisation (WTO.) The definition found in TRIPs Section 7 Article 39 is a commonly used definition and defines trade secrets as information that is:

A) Secret in the sense that it is not … generally known
B) Has commercial value because it is secret
C) Has been subject to reasonable steps … to keep it secret

It is important here to emphasize parts B and C, which distinguish trade secrets from know-how and confidential information. Know-how does not qualify for trade secrecy protection as it involves tacit knowledge embedded in human capital, which does not require secrecy (Jensen and Webster, 2006.) Furthermore, confidential information is kept secret but does not necessitate commercial value (Cross, 1991.) An example of confidential information with no commercial value is patient medical records. Trade Secrets derive economic value from being secret in the sense that they give the owner of the trade secret an advantage over competitors. In addition, trade secrets must be formally protected through "reasonable steps", which typically involve confidentiality agreements, password protection for electronic resources and non-compete clauses in employment contracts. Thus, a trade secret does not passively become one; the owner must take active steps in order to afford trade secret protection.

The classic example of trade secrets is the secret Coca-Cola formula, as noted in Hettinger (1989). This formula, which is subject to extensive protection measures, has been the source of a number of lawsuits over the years. The formula was initially kept secret as a marketing ploy but has evolved into a long-term strategy to keep the company ahead of competitors, such as Pepsi. As

Hettinger notes, "If competitors could legally obtain the secret formula for Coke, for example, the Coca-Cola Company would be severely threatened."[3]

Trade Secrets are used to protect internal information within companies. Customer databases, design plan and strategy are guarded carefully and only provided to those who need access, as will be discussed in Chapter 3. In Europe, the European Directive on the Legal Protection of Databases[4] protects databases. However, Europe is unique in having a *sui generis* right for databases, which are normally protected under trade secrecy laws. Trade secrets also played a large role in the software industry. Software comprises two types of code: source code and object code. The object code, essentially a processed version of the source code, can be protected through copyright; the source code can be protected through trade secret (Samuelson and Scotchmer, 2002.)

These terms, IP, patents, and trade secrets, will be employed throughout the thesis.

1.2 Intellectual Property and Innovation

A challenge for economics has been that of rewarding innovation. In order to encourage sustained innovation, economics has put forth restrictions on the use of innovations via IP. IP provides innovators with a means to control how their innovations are exploited. In order to encourage innovation, IP creates legal rights for innovators via legal monopolies over their innovations. As an example, trademarks, an IPR, prevents the unauthorized use of a trademarked brand. IP allows innovators to appropriate the returns from their innovation by providing legal monopolies over these innovations (Scotchmer and Green, 1990.) Thus, IP provides an important policy tool for encouraging and rewarding innovation.

First enacted in Venice in the 15th century, patents have emerged as a dominant form of IP. The vast policy, legal and business framework that rests on patent law has created ample opportunity for study and a rich empirical source.

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[3] Hettinger (1989), p. 47.
[4] Directive 96/9/EC on the legal protection of databases.

However, the study of patents has grown exponentially (Epstein, 2003), while other areas of IP, such as trademarks, copyright and, the subject of this thesis, trade secrets, have received relatively little attention. Yet in recent years, as detailed in Chapter 2, economists have turned their attention to look at the broader context of IP. Research has discovered that other methods of protecting innovation, such as trade secrets, form a much more important aspect of business strategy than has been previously understood (e.g. Arundel, 2000; Cohen, et al., 2001; Anton and Yao, 2006.) This thesis furthers this line of research and provides an empirical look into the use of trade secrets.

The study of intellectual property is inherently interdisciplinary. The economic need to encourage innovation is given structure by the legal framework that establishes IPR (Scotchmer, 2005.) These rights are then managed ideally through good business and management practices. Hence, using and understanding intellectual property involves a mix of economics, law and management, which is further complemented by philosophical discussions of its origins (e.g. Nard, 2007) and the accounting principles guiding its application (Oldham and Cummings, 1996.) For the purposes of this thesis, the review of the literature will concentrate on the legal and economic research. Within these broad disciplines, further development of Trade Secret valuation is achieved via forensic economics, the economics of crime, case law analysis, competition law and tort law.

Patents and trade secrets form two sides of the same coin. For patents, they represent a very strong, officially granted and publically available documentation and protection of the innovation (Scotchmer, 2005.) In recognizing the innovator's right to disclose the innovation, patents implicitly recognize the innovator's right not to disclose the innovation – the trade secret (Paine, 1991.) Legally weaker and secret, trade secrets offer innovators the right to maintain the confidentiality of their innovations (Scotchmer, 2005.) Thus, analyses of trade secrets necessitate an investigation of patents. This thesis incorporates a framework that contrasts the study and use of patents with that of trade secrets. This duality is a strong theme throughout the work.

1.3 The Economic Espionage Act (EEA)

Unlike patents, the nature of trade secrets, the sectors using them and their role as a strategic business decision remain little understood (Lerner, 2006.) Given the obstacles to their study, it is not surprising that trade secrets have remained relatively neglected in academic research, as mentioned in Lerner (2006). However, developments in U.S. criminal law have opened the door for further study. In 1996, amidst concerns of lack of legal protection against foreign economic espionage, the U.S. enacted the Economic Espionage Act (EEA.)[5] The act unified Trade Secret law at the federal level and criminalized the theft of trade secrets. The new law represents a policy response to the perceived threat of economic spies, the increasing vulnerability of confidential documents via computers, and recognition of the important role of trade secrets in protecting innovations (Carr and Gorman, 2001.) The EEA provides prosecutors in the U.S. with the means to criminally prosecute the misappropriation of trade secrets through theft.

In this thesis, data from 13 years of prosecutions (1996-2008) have been gathered which provides a rich source on the use, theft and value of trade secrets. Given the data collection challenges surrounding trade secrets, the EEA prosecution data represent a unique empirical source. This thesis provides insight into case studies and empirical relationships associated with the use of trade secrets.

From a policy perspective, the EEA represents a change in the protection of trade secrets in the United States (Poolely et al., 1997; Carr et al., 2000; and Uhrich, 2001.) Broad-reaching, the EEA significantly increases both the level of protection for, and the definition of, trade secrets (Carr et al., 2000.) Most importantly, the EEA makes the theft of trade secrets a felony. This is a significant increase in the criminal culpability of the theft of trade secrets as these thefts were previously treated as civil matters. For researchers, the

[5] 18 U.S.C. § 1831–1839.

introduction of this legislation allows for a unique insight into the use of trade secrets. Chapter 3 details the reasoning behind the development of the EEA and its major provisions. Illustrative case studies further emphasize the impact the EEA has on the use of trade secrets and provide insight into the use of trade secrets themselves.

This thesis' focus on the theft of trade secrets and their criminal prosecution is similar to studies of litigation (e.g. Lanjouw and Shankerman, 1997, 1999, 2001, and 2004; Shankerman and Scotchmer, 2001.) The civil equivalent of prosecutions, litigation also offers insight into the closed world of trade secrets (e.g. Lerner, 2006; Almeling et al., 2009.) However, the unique contribution of the use of prosecution data is that it brings in a different sample of trade secrets. Civil litigation is one party suing another party for a breach of contract or misappropriation of a trade secret. The data stemming from civil litigation differ from the data found in criminal cases (Cooter and Ulen, 2004.) Thus, this thesis provides a unique look at a different sample of trade secrets.

1.4 Outline of Thesis

This thesis is structured over seven chapters, including the introduction and conclusion. Chapter 2 provides a literature review, which is followed by Chapter 3 in which stylized facts from the EEA data are presented. Chapters 4 and 5 analyse the valuation of trade secrets in EEA cases, while Chapter 6 presents a regression analysis of the determinants of the use of trade secrets. Collectively, these chapters develop an analytical picture of the use of trade secrets in EEA cases.

Given the interdisciplinary nature of IP, Chapter 2 develops a literature review of the law, economics and management research in IP. Furthermore, the relationship between patents and trade secrets provides the framework for the review. As law provides the justification and legal infrastructure for IP, the academic research in law and its interaction with economics are a strong theme. However, given that the focus of this thesis is economics, the economic study of

IP is given special consideration. Current debates and policy issues surrounding IP, including cumulative innovation, harmonization and disclosure, are reviewed with respect to their economic analysis. These debates are then furthered by the body of theoretical models evaluating competing policy instruments and the decisions of firms with respect to the social surplus. Finally, the review examines the literature addressing patents and trade secrets, which is most closely related to this thesis.

The development of the EEA database is detailed in Chapter 3. The database, which involves the collection of 147 observations of 50 variables, is the empirical foundation of the thesis. The third chapter explains the development of the EEA and its policy implications in light of the summary statistics from the database. Surprisingly, it is found that the majority of trade secrets in the EEA cases were in the manufacturing and construction sector. Furthermore, the majority of trade secrets were not deemed potentially patentable, which suggests that trade secrets are highly important for the protection of innovations that fall outside the limits of patents. These stylized facts are examined further through a cluster analysis of the EEA cases that suggests that that the category of trade secret can be grouped with the owner's sector. The cluster analysis develops a structure for the subsequent case studies that illustrate the use of trade secrets in EEA cases.

Building on the analysis of the EEA database, Chapters 4 and 5 provide a critical analysis of the valuation of trade secrets in EEA cases. As an intangible asset, IP is notoriously difficult to value (Bloom and Van Reenan, 2002.) A trade secret is even more difficult to value as it often lacks the pre-determined life span and comparable market transactions that are used to value patents (Halligan and Weyland, 2005.) These characteristics obfuscate the true value of trade secrets and have hampered their study. Despite these obstacles to academic observation, trade secrets play an important practical economic role in protecting innovation and strategic business information. Unlike their more formal counterparts, patents, trade secrets offer innovators a means of protecting innovation without a formal approval process, disclosure or time limit, as noted in Scotchmer (2004).

However, the valuation of trade secrets has important implications for the owners of trade secrets (firms) and policy makers. Understanding the value of trade secrets will enhance the decision processes of IP stakeholders. Chapter 4 examines the various methods used in EEA cases to assess damages. Using illustrative examples, these methods are critically analysed. The underlying principles of these methods (i.e. income flows, cost analysis and market valuation) allow for the broad categorization of valuation methods. The wide variety of valuation methods means that a single trade secret can be assigned a wide range of values. As the valuations in EEA cases can determine whether a defendant faces incarceration, the diverse methods employed play an important role in the outcome of EEA cases.

Chapter 5 furthers the analysis of Chapter 4 by developing a statistical analysis of the values found in EEA cases. The EEA evidence suggests that the data follow a lognormal distribution and places the distribution of trade secrets in line with that of income[6] and patents.[7] Furthermore, Chapter 5 tests the different estimates of the value of trade secrets for statistical differences. As discussed in Chapter 4, the use of different valuation methods can result in different values for the same trade secret. The evidence suggests that, based on a range of low and high estimates for each trade secret, these estimates have statistically different means. Furthermore, the evidence suggests that the valuations reported in the media and argued by the parties in EEA cases have a statistically higher mean that those used in sentencing. This indicates that judges are departing from the argued values and using much lower estimates in sentencing. Overall, the evidence of the statistical differences suggests that the owners of trade secrets face uncertainty as to the value of their trade secrets. As Anson and Suchy (2005) argue, trade secrets are only worth the value that can be proven in

[6] Limpert, et al. (2001) discuss the lognormal distribution of income in their catalogue of the observance of lognormal distributions.
[7] Lognormal distributions for the values of patents are confirmed in Shankerman and Pakes (1986), Lanjouw (1992) and Shankerman (1998).

court. Thus, the evidence of uncertainty associated with valuations reduces the effectiveness of trade secrets as a means of protecting innovation.

The empirical analysis of trade secrecy is still developing and much current literature uses data from surveys and litigation. This thesis provides a unique look at the determinants of the use of trade secrets at the firm level. Using the valuations of trade secrets discussed in Chapter 5, Chapter 6 explores the characteristics that determine the firm's intensity of trade secret use. The main finding of this chapter is evidence that trade secret intensity is negatively related to firm size. Therefore, small firms are particularly dependent on trade secrets for protection of their innovations. This suggests that trade secrets are an important policy tool for the development of small businesses.

The interaction between the legal statutes and the economic imperative to protect innovation has generated a large policy infrastructure. However, the application of these policies at the firm level remains under-examined. This thesis analyses the EEA and its criminalization of the theft of trade secrets. The empirical evidence uncovered in EEA cases provides a unique look at the use of trade secrets at the firm level.

To summarize, Chapter 2 provides a literature review with a focus on academic research in trade secrets and patents. Chapter 3 analyses the role of the EEA in protecting trade secrets and furthers this analysis using illustrative case studies. Chapters 4 and 5 provide a critical analysis of the valuation methods used in EEA cases and a statistical analysis of the observed values. Chapter 6 develops a regression analysis of the determinants of trade secret intensity. Finally, Chapter 7 concludes.

1.4.1 Acronyms

DOJ	U.S. Department of Justice
EEA	Economic Espionage Act of 1996
EELV	Evolved Expendable Launch Vehicles
IP	Intellectual Property
IPR	Intellectual Property Rights
PACER	Public Access to Court Electronic Records
TRIPS	Trade Related Aspects of Intellectual Property
USAF	United States Air Force
UTSA	Uniform Trade Secrets Act

Chapter 2: Literature Review: Patent and Trade Secret Literature

2.1 Introduction

This chapter examines some key research in intellectual property, specifically in patents and trade secrets, economics, economics & law and related areas (e.g. management.) As trade secrets are often framed as an alternative to patents, this chapter is structured around a comparison of the patent and trade secret literature. As the weaknesses of patents become more apparent, researchers turn to trade secrets as a relatively unexploited research area. This literature review develops the history of the theory and empirics behind patents and trade secrets and points to the future development of the trade secret literature.

Given the somewhat unwieldy nature of IP systems (David, 1992), discussions of IP often begin with an overview of the historical context of IP (e.g. Scotchmer, 2005.) David (1992) develops a metaphor of IP institutions as being equivalent to the "thumb" of the Giant Panda, or "a striking example of evolutionary improvisation yielding an appendage that is inelegant yet serviceable."[8] As David highlights, the present state of IP systems is the result of an evolutionary process which has developed an "inelegant yet serviceable" means of protecting and encouraging innovation. Scotchmer (2005) further describes IP as "a tortured solution to the problem of providing a public good."[9] Thus, the evolution, historical context and justification of IP aids in the analysis of its current state.

Given the combination of economics and law that form the basis of IP systems, the study of IP is inherently interdisciplinary. Economics identifies the need for IPR and aids in the analysis of competing policy options (e.g. Cugno and Ottoz, 2006; Anton and Yao, 2006, etc.) The study of law and the legal profession provide the means of creating and understanding the implementation of the

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[8] David (1992), p. 5.
[9] Scotchmer (2005), p. 35.

structure of IP (e.g. Nard, 2007; Manderieux, 2007.) Furthermore, the management and business studies discipline allows for the understanding of the management and organization of IP (e.g. Liebeskind, 1997.) These three disciplines, economics, law and management, together provide a comprehensive academic perspective on IP. This thesis will focus primarily on the law and economics study of IP, while recognizing that the management literature often overlaps with these disciplines.[10]

Given the evolutionary nature of IP systems (David, 1992), research in IP faces a constant stream of policy issues and debates. Furthermore, in the debate over the role of IP in the global economy and economic development (as in Gold and Gruben, 1996; Lanjouw, 2002; Tansey et al, 2008), IP policy tools are often scrutinized. This chapter presents an overview of the current issues surrounding knowledge diffusion, limitations of patents, IP harmonization and cumulative innovations. These current debates set the agenda for the further empirical and theoretical analysis of IP.

As this literature review describes, economics has developed theoretical models to examine the value of IP (as in Bloom and Van Reenen, 2002,) the appropriateness of patent and trade secret policy mechanisms in light of cumulative innovation (e.g. Erkal, 2005) and firms' IP decisions under different policies (as in Anton and Yao, 2003 and Bessen, 2004; among others.) These models allow for the exploration of policy options and the better understanding of their relative advantages and disadvantages at the firm, consumer and overall social level. Furthermore, these models provide the theoretical basis for subsequent empirical analyses of their predictions.

Finally, this chapter turns to the empirical analysis of IP. Building on the theoretical models, the empirical analyses of IP use quantitative evidence to test IP policies. This thesis addresses the data arising from two main sources for patents and trade secrets: surveys (as in Scherer, 1977; Cohen et al, 2000; and

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[10] Indeed, many papers involve co-authors from management and law and/or management and economics. For example, Bosworth and Rogers (2001) and Hall et al (2003).

Arundel, 2000) and evidence from litigation (as in Lanjouw and Shankerman, 1997, 1999, 2001 and 2004; Lerner, 2006; and Almeling et al, 2009.) Furthermore, patents also have citations available as a data source (as in Breschi and Lissoni, 2004; and Montobbio, 2007.) These empirical studies analyse the real-world influence of IP and its use.

This literature review focuses on the law & economics research on patents and trade secrets. The first section addresses the historical rationale behind intellectual property systems with respect to patents and trade secrets, and, with respect to the current state of IP research, the economics, law and management coverage of IP. The second addresses applied and practical issues in the debate of IP. The third examines theoretical models of patents and trade secrets. The fourth section presents a review of empirical research, which is most in line with this thesis as a whole. Finally, the last section concludes.

2.2 The Study of Intellectual Property

The study of intellectual property originates in the development of the recognition and justification of the need for the protection of innovations (Scotchmer, 2005; and Nard, 2007.) These arguments date back to the 15th century Venetian patent system and are developed further and extended to other areas of IP by scholars in later centuries. This section details the foundations of the study of intellectual property and its modern scholarship in law, economics and management.

2.2.1 Basis of Intellectual Property Systems

Intellectual Property Rights are the application of property rights to intangible property. The innovator (or owner) is entitled to property rights over the fruits of their intellectual labours. Locke (1690) provides a theoretical justification for property rights applying the concept of labour theory of acquisition.[11,12] Locke

[11] Becker (1976) labels Locke's theory as "labor theory of acquisition" in his paper; however, other authors refer to Locke's theory as labour-deserve theory (as in Borghi (2007)), or merely labour theory.

argues that individuals have ownership of their own labour and, when that labour is applied to remove something out of its natural state, the result is also his property. "Whatsoever he removes out of the state that nature hath provided and left in it, he hath mixed his labour with, and joined it to something that is his own, and thereby makes it his property… He by his labour does, as it were, enclose it from the common."

Locke's reasoning provides the foundation for current patent regimes, which parallel his labour theory of acquisition. In order to qualify for patent protection, the invention must surpass the state of the "prior art." This prior art is merely the state of knowledge preceding the start of the innovative efforts and is akin to Locke's state of nature. Intellectual Property Rights are the appropriation of the result of an individuals' mental labour applied to the current state of knowledge; Locke's property rights are an appropriation of the result of an individual's physical labour applied to the current state of nature.

Adam Smith (1776) argues for property rights as a means to avoid the tragedy of the commons.[13] Smith encourages a laissez-faire approach to economic trade policies with the exception of intellectual property rights. The emphasis on property rights lends itself most naturally to Smith's capitalistic structure; however, IPRs are not excluded from the philosophical arguments of other economics regimes, such as communism and socialism. IP systems exist internationally and operate on a global level. From a de facto perspective, given that IP protection regimes are open to foreign applicants, the presence of IP rights in any regime means that no modern economic system can exclude IP rights. Thus, IP is found in capitalist, communist and socialist economic regimes.

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[12] Texts and notes selected by Borghi, "Rationales for Patent Protection", Bocconi Intellectual Property Transatlantic Summer Academy, June 25, 2007, include the relevant passages in Locke, Fichte and MacLeod.

[13] The tragedy of the commons is the scenario in which a public good is over-used because the individual receives all the benefits of additional use but only incurs a portion of the costs. The typical example is that of the common grazing area in which each farmer has an incentive to graze more sheep in the area. However, each additional sheep degrades the grazing area and this ultimately ends up with over-grazing. Division of the public good into individual property rights is a proposed solution to the tragedy. Nicholson (1998).

Having established the property rights justification for intellectual property rights, the contract between society and the owner of the intellectual property rights must be examined. Fichte (1791) notes the conflicts which IP systems address – rewarding innovation while increasing social surplus:

> It is not fair that the man who invested his money and years of hard work and effort should find himself robbed of the fruits of his labour as soon as he goes public with the results of his extensive work, results of which are of such a nature that anyone who sees them can appropriate them.[14]

Here Fichte notes the fairness aspects of rewarding innovation and the ease with which reverse engineering can be accomplished. This argument emphasizes how society should reward innovators and encourage further innovation.

Fichte also addresses the competing argument, which is concerned with increased social surplus. From this perspective, and incorporating the utilitarian argument of the greatest good for the greatest number of people,[15] Fichte (1791) recounts a parable in which an IP infringer of a medicine defends himself by arguing:

> The only true measure of the excellence of our actions is their utility … I sell the nostrum [infringed medicine] much more cheaply that the plaintiff; the lowliest man can thus afford to procure it, unlike at the high price demanded by the monopolist. What a service to humanity! Could I but paint a vivid picture for Your Majesty of the groans of the suffering, the rattling throats of the dying, who have been saved by the physic they bought from me![16]

In this case, the counter-argument to rewarding innovators with monopolistic rights is that the innovation, medicine in this case, would provide more total utility; i.e. increased social surplus, if it were not under the monopoly restriction. Fichte recognizes that the IP systems must be considered from the points of view

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[14] Fichte (1791), p. 8.

[15] While Locke and Smith support individual property rights, followers of utilitarian philosophies can present arguments against them. As noted in Rosen (2003), John Stewart Mill evaluates policies based on whether they result in the greatest good for the greatest number of people. This greatest happiness principle can be applied to reject property rights in that they may not maximize utility. For example, the farmer who grows oats would, under labour-deserve theory, own these oats and have rights to them. However, were the oats not the private property of the farmer, and instead available to hungry people, overall happiness could be increased. That is, the disutility the farmer suffers from losing the oats would be more than compensated for by the utility the oats provide to the hungry people. In this case, the utilitarian philosopher would argue against property rights, as they do not maximize overall utility.

[16] Fichte (1791), p. 10.

of both the innovator and society. Thus, IP protection systems provide a policy tool to maintain the delicate balance of the individual's property rights and the utilitarian perspective of social surplus.

Under the patent system, the individual reveals the innovation and is granted protection from appropriation, in the form of a temporary monopoly, which then results in higher prices and lower quantities of the good. In return, society benefits from the innovation and receives the innovative knowledge in exchange for paying higher prices. The underlying concept is that a static inefficiency (inefficiency at a point in time, in this case the temporary monopoly) is tolerated in order to achieve the dynamic efficiency (efficiency over time, in this case continued innovation.) As Macleod (2005) describes it, one aims not to kill the (innovative) goose that laid the golden egg (of new IP.)

The philosophical justification for Trade Secret protection is more problematic than that of patents and copyrights. From the Lockean perspective, trade secrecy is compatible with labour theory of acquisition. Bone (1998), however, notes that while the Lockean labour-deserve theory does allow for some rights over the fruits of labour, it says nothing about the need for secrecy.[17] Furthermore, from the utilitarian perspective, trade secrecy does not necessarily have the social surplus aspects required. As Hettinger (1989) notes, trade secrecy does not encourage the free flow of information and can limit the labour mobility of employees.[18] These difficulties in using the traditional justifications for IP in justifying trade secrets highlight some of the doubts raised by the law discipline with respect to trade secrets as a form of IP (as discussed in Lemley, 2008.)

[17] Bone (1998) notes that the Lockean argument cannot "explain two of the most basic features of trade secret law: its requirement of secrecy, and its concern with the way information is appropriated", p. 284.

[18] The labour mobility of employees can be hindered by "non-compete" or "non-disclosure" clauses in employment contracts that limit employee's ability to work for other employers. This also falls under the "inevitable disclosure" doctrine, which argues that, in the course of employment, a former employee will inevitably disclose confidential information even if they are contractually prevented from doing so.

However, from a practical perspective, these arguments are partially addressed by the relatively low level of protection afforded to trade secrecy in comparison with other intellectual property, as noted by Friedman et al (1991) and Lemley (2008.) In addition, like patents, trade secrecy offers incentives to innovate and develop ideas. In response to Hettinger's arguments, Paine (1991) argues that trade secrecy is justified on the basis that individuals should have the right to control initial disclosure of their ideas, respect for confidential relationships and that patents, by offering incentives to disclose, implicitly recognize the right of innovators not to disclose.

The combination of labour and utilitarian theories provides the main justifications for Intellectual Property protection. These arguments are typically applied to the justification of patents, but similar arguments are made in favour of trade secrecy.

Trade Secrets and Privacy

Further justification for trade secrecy can be found in the legal discussion surrounding privacy law. While privacy law focuses on privacy as it pertains to individuals, the extension of privacy to commercial activities provides further arguments in favour of trade secrecy. Posner (1983) addresses the relationship between privacy, which he defines as "the withholding or concealment of information,"[19] and secrecy, which is included in the broader definition of privacy. Posner argues that secrecy allows the innovator to choose when to disclose information. He notes that, when extended to commercial activities, "The purpose of a property right, or of according legal protection secrecy as a surrogate for an explicit property right, is to creative an incentive to invest in the creation of information."[20] Posner argues that privacy, and therefore secrecy, is sound in an economic sense in the commercial context because it reduces socially wasteful efforts to protect information (e.g. constant monitoring of former employees to insure secrets are not revealed.)

[19] Posner (1983) p. 231
[20] Posner (1983) p. 245

Posner (1983) also notes that the term 'privacy' is not often evoked in discussion of commercial activities:

> "The polemical character of the privacy debate is further illustrated by the arbitrary contraction of the term to exclude business privacy, despite the strong economic case for such privacy. Not only is the word privacy rarely used with reference to the private information of corporations or universities, but privacy interests are rarely thought implicated when information is concealed, even if by an individual, in the context of commercial activities."[21]

2.2.2 The Study of Intellectual Property

> The field of intellectual property is a growth industry that may involve an unintended consequence of Moore's Law in that the number of published articles in the field doubles on average every eighteen months. Most of that increased effort has been devoted to copyright and patents

Epstein (2003)

The literature on Intellectual Property spans three main areas: economics, law and management. As Epstein notes, patents are a popular research topic due to their clearly defined legal status, wealth of available information and easy to quantify nature. The literature follows Moore's Law, which predicts that the speed of computers doubles every two years; here, the quantity of literature doubles every two years. Economics allows for an analysis of innovation and property, while law creates and examines the policy tools to implement efficient systems. Management tends to approach IP from an organizational view. From a simplified perspective, economics can be seen as the architect of Intellectual Property, designing the purpose and general structure; law as the builder, creating the infrastructure of IP; and management as the building maintenance, optimizing the use of IP.

Law

[21] Posner (1983) p. 275

While the main focus of this research is the economics literature, thelaw and management literature is considerable and relevant. The three disciplines complement each other and often overlap in their functions.

Legal literature, unsurprisingly, focuses on the legal aspects of IP systems. As the tool of IP economic policy, law must account for the interests of both society and the owner of the IP. The theoretical and philosophical justifications noted earlier should be incorporated into the design and practice of law, as examined in Hettinger (1989). Analyses of these justifications and the performance of the current system can be found in law journals such as the *Buffalo Law Review*, the *Texas Intellectual Property Law Journal* and the *New York University Law Review*.

The legal profession is heavily involved in patenting in both practice and research. Legal professionals are involved in the bureaucratic patenting process from the beginning, when they perform patent searches, through to the final stages of licensing and litigation, etc. The relatively clear legal rights associated with patents make them an attractive subject for study. The focal areas of IP research overlap in law and economics, particularly with harmonization, justification, strategy and development. The legal research addresses patent law harmonization (as in Manderieux, 2007) and the associated difficulties with international legal jurisdictions and domestic interests. Nard (2007) addresses the history and justification of patent systems by tracing the creation of IP systems since the initial Venetian patent system. Economist and lawyers have much to discuss in strategic use of litigation and dispute resolution (as in Kowalchyk, 2006) and in IP and economic development (as in Lucchi, 2005), among other themes.

From a legal perspective, trade secrets suffer from a relative lack of clarity in terms of both rights and ownership when compared to patents. In fact, the legal status of trade secrets is often only determined once a conflict arises (as noted in Anson, 2005.) In order to enforce the rights of a trade secret, the existence of the secret must be proven. This is an obvious weakness when compared with the officially granted patent, where the burden of proof does not lie with the owner of the IP (Risch, 2007.) Trade secret disputes can arise as conflicts between employers, with their right to protect IP, and former employees, with their right to find employment elsewhere (Van Caegnegam, 2007.) The law literature probes trade secrets by examining the law, which is often case-based, and common structures and defences, as in Rissland and Ashley (1987), and inevitable disclosure, as in Lowry (1988).

Management

Management literature frequently overlaps with the economics literature in its analysis of the strategic use of IP (e.g. Bosworth and Rogers, 2001) and assessment of IP systems (e.g. Kawaura, 2005; Hall et al, 2003), but tends to focus on how the internal structure of the firm works with intellectual assets (e.g. Liebeskind, 1997.)[22] Patents are a relatively quantifiable measure of output (innovation) and thus make an appealing research topic and management tool. For example, Human Resources use patents as a means of measuring employee performance, as described in Oldham and Cummings (1996). When considering trade secrets, the management literature examines how to maintain them within the firm's internal organization, as in Rønde (2001). Thus, the management literature addresses areas not typically covered in economics by examining the function and strategic use of intellectual property within the firm.

Economics

For a long time, the economic literature has had a distinct bias towards the examination of patents as distinct from other forms of IP (Arundel, 2001; Epstein, 2003.) Economic research naturally gravitates towards subjects with good data sources and patents have long provided a rich source for the study of innovation, as noted in Arundel (2001) and Scotchmer (2005).[23] Given the large amount of searchable, systematic patents data, the literature bias towards patents over other forms of intellectual property is not surprising, as noted in Lerner (2006.) However, recent survey studies have indicated that patenting is

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[22] Note that while these examples include authors from Management and Business School, some of the papers could be considered interdisciplinary.
[23] Scotchmer notes that the study of patents goes back to Jacob Schmookler in the 1950s.

considered an inferior strategy by firms when compared to trade secrets, lead time and marketing etc., as in Cohen, Nelson and Walsh (2000). This new research has given some pause to the traditional, patent-focused line of research and generated interest in alternatives, such as trade secrets.

Patents and trade secrets are inextricably linked. In order to discuss the decision to use trade secrets fully, the decision to use patents must be explained, as discussed in Friedman et al, (1991). However, the economics literature sometimes works with the presumption in one direction; i.e. that using trade secrets reflects a decision not to use patents, but using patents does not necessarily reflect a decision not to use trade secrets (e.g. Mansfield, 1986; Arundel and Kabla, 1998; Erkal, 2005.) While the latter is perhaps implicit in the literature, discussions on trade secrets typically start with an explicit examination of the former (e.g. Friedman et al, 1991.) Patent discussions do not necessarily include trade secrets, but discussions on trade secrets necessitate the inclusion of patents. This may be cause for economists to revisit earlier patent literature to include the possibility of trade secrets, as noted in Arundel (2001.)

Many parallels exist between patenting research and trade secret research in the evolution of this research and the methodology used. Fundamentally, both lines examine the role and protection of intellectual property, as in Friedman et al, 1991. Strategic use by firms, diffusion of knowledge, social surplus effects, along with a host of other IP related issues, can be applied to both patents and trade secrets. The development of the economics literature in patenting and trade secrets follow similar lines. These parallels will be developed further later in this discussion, but it can be said that the research in trade secrets is in its adolescence and is following the same maturation process as patenting literature (Epstein, 2003.) This can particularly be seen in the use of litigation as a source of empirical evidence for trade secrets, which has only just been utilized, as in Lerner (2006) and Almeling et al (2009.) This literature review will take the research into patents and its associated limitations to explain the recent growth in trade secrets literature.

2.3 Policy Issues and Current Debates

IP is a widely debated policy on both the national and international levels. Some authors examine the reform of IP systems, as in Harhoff et al (2007); Menell and Scotchmer (2005); and Lévêque and Ménière (2006.) On the international level, there is much debate with regards to IP protection of pharmaceuticals (Lanjouw, 2002) and agriculture (Tansey et al, 2008; Marinova and Raven, 2006.) The issues surrounding these debates can be broken down into specific theoretical debates on knowledge diffusion, scope, harmonization and cumulative innovation. This section of the chapter details the current academic debates with respect to patents and trade secrets.

2.3.1 Current Policy Debates: Patents

Schumpeter (1934) defined our modern interpretation of innovation as an applied invention. Since then, researchers have sought to determine how innovation occurs, how it can be encouraged, how it affects economies and how firms interact in innovation. There are four main areas of research within patent policy, all of which have in mind the ultimate goal of maximizing social surplus. These areas are: cumulative innovations, knowledge diffusion, patent scope and breadth, and harmonization. Cumulative innovation and knowledge diffusion are aspects of encouraging innovation, which need to be accounted for in IP policy. Patent scope and breadth, along with international patent system harmonization, examine the design and implementation of policies.

Patents and Knowledge Diffusion

An important aspect of patent policy design is the disclosure incentive it incorporates. In return for being granted a legal monopoly, the innovator must disclose information related to the innovation (as in Scotchmer and Green, 1990.) The goal of this disclosure policy is to increase the spread of knowledge and encourage cumulative innovation, which subsequently increases social surplus. As Scotchmer and Green, (1990) argue, the "social goal" of disclosure allows for "shared technical information [that] would help other innovators in their own research, reduce redundancy, and hasten the time to subsequent innovation."[24] From the firm's perspective, disclosure may not be desirable as it can benefit competitors, as noted in Scotchmer (2005.) The disclosure surrounding patents reveals technological advances and can indicate the strategic plans of a company (Baker and Mezzetti, 2005.) With cumulative innovation, disclosure by one firm may allow a competitor to leapfrog (as in Fudenberg 1983.) This is one reason why trade secrets may be employed, as will be discussed later.

Breschi and Lissoni (2007) use patent data to study knowledge diffusion between researchers. Using patent data, they map knowledge networks and highlight the concept of technological gatekeepers, which are figures that sit at the centre of and link important research areas. Their findings, while inconclusive, point to the concept that social and physical distance may have greater influence on knowledge diffusion than the disclosure of knowledge through patenting. This suggests limitations to the effectiveness of patents as a mechanism for disclosure.

Patent Scope and Breadth

In addition to examining patent policies as a whole, examining patent duration and breadth was also a popular research topic in the 1990s. Patent duration has obvious research appeal (Gold and Gruben, 1996) as it is merely the length of the patent (typically 20 years). Additionally, patent duration is dependent on the owner of the patent paying renewal fees, which can indicate the value of the patent (Shankerman and Pakes, 1984; Shankerman, 1998; and Lévêque and Ménière, 2006.) However, this represents a simplistic view as patent duration may not be the same as the market duration of an innovation. Thus, the focus of research shifted to *effective* patent duration, as in Denicolo (1996), which is more difficult to measure. The concept of effective patent duration highlights the fact that a multitude of factors, including market conditions, type of innovation, industry and cumulative innovation, can affect the optimal policy.

[24] Scotchmer and Green (1990), p. 132.

A second focus of patent policy research is that of patent scope or breadth. This line of research examines how much a patent covered in terms of determining what similar innovations could be patented, what is considered infringement and how this is interpreted in the courts. From an economic perspective, breadth is the closeness of non-infringing substitutes; or, as Gallini (1992) identifies, the cost of inventing around a patent. This, however, presents an empirically challenging model as patent scope is a less tangible measurement and is often determined in court cases and practice rather than written policies (Chang, 1995.)

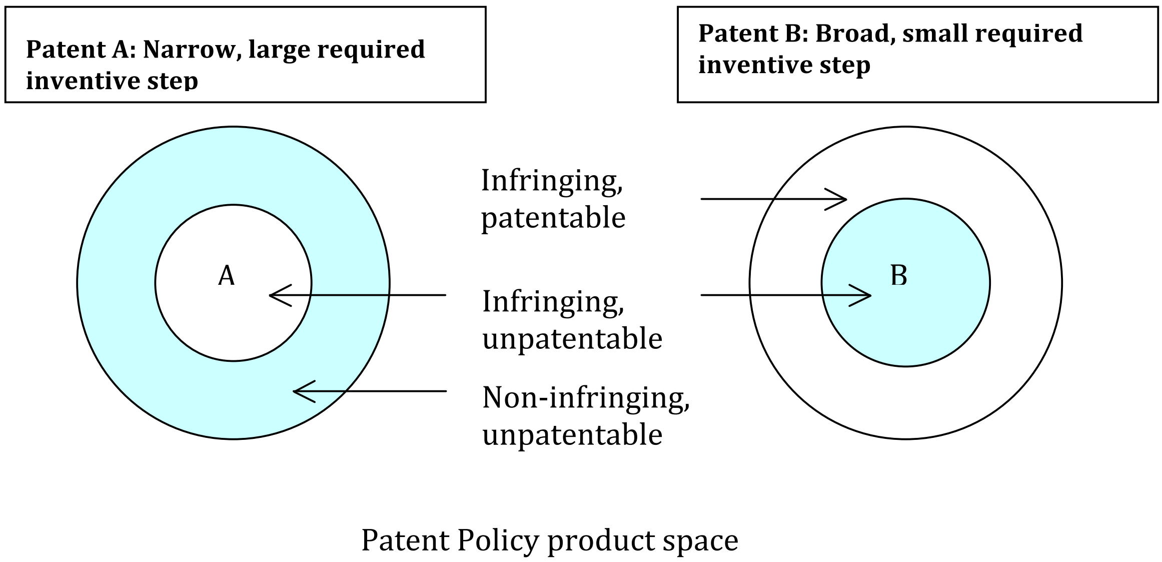
Patent length and breadth are two policy tools that counterbalance each other. Longer patents are typically balanced by having narrower patent breadth. This argument is developed by Klemperer (1990), who examines both infinitely lived, narrow patents and short-lived, broad patents looking at product differentiation. He argues that the market conditions of the demand side (consumer preferences) determine the ideal policy. However, in the same issue of the same journal, Gilbert and Shapiro (1990) develop a similar argument, assuming homogeneous products, which calls for infinitely lived patents offset by adjusting patent breadth. Yet both of these papers acknowledge the fact that they do not consider cumulative innovations, which could dramatically alter the results. Gallini (1992) furthers the Klemperer and Gilbert and Shapiro models by allowing for the possibility of costly imitation. Contrary to their papers, she argues that the ideal patent length is shorter because longer patent lengths encourage others to invent around patents and/or infringe. Furthermore, the consequence of a longer patent length may actually be decreased R&D expenditures as innovators face the increased likelihood of losing their monopoly as their competitors invent around the patent or infringe. Gallini concludes that the optimal policy is broad patents that limit imitation and adjustable patent lengths, which are adjusted to achieve the desired reward to the innovator.

Reid and Roberts (1996) focus on the scope of patenting as opposed to its duration by examining the patent width, defined as the technological coverage of the patent, and breadth, which they define as the scope for exploiting the market power which the patent rights confer on the innovator. They use this to analyse the patenting activity of the scientific instruments industry in the UK and conclude that patent-active firms are typically larger than non-patent active firms and suggest that the patent activity has a non-linear relationship with firm size characterized by diminishing returns.

Scotchmer (2005) refines the breadth argument further by making an important distinction when analysing patent policy. She separates patent breadth from the inventive step, whereas other authors treat them singly. Scotchmer notes that the breadth determines how different another innovation must be in order to avoid infringement. The inventive step determines what is patentable. The product space of these concepts is represented in Figure 2-1, where policy determines the infringement and patentability of products. For product A, the inner circle is infringing and unpatentable substitutes due to the narrow patent. The outer circle are substitutes that are not considered infringing, but do not meet the inventive step required. For product B, the inner circle is infringing due to the small inventive step, while the outer circle is considered infringing due to the broad patent.[25]

[25] Scotchmer develops an example of this concept using the laser. The maser, which had a broad patent, was a blocking patent to the laser. The maser would be product B in Figure 1, while the laser would fall in the outer circle. See Chapter 3 of Scotchmer (2004) for further information.

Figure 2-1: Scotchmer's Patent Breadth and Inventive Step



The concepts of patent length, breadth, scope and the inventive step are important policy tools available to IP regimes. However, as this section notes, no consensus has been reached on the ideal design of IP policy. Therefore, IP regimes often employ a mix of these tools and vary significantly across regimes.

Patent Law Harmonization

The movement towards harmonization of patent laws has also proven to be a fertile research ground. Harmonization seeks to standardize IP protection internationally, which is hoped to encourage investment in developing countries, promote innovation and reduce the costs of achieving IP protection (Pitkethly, 1999.) The signing of the Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) in 1994 created a natural experiment, which allows for researchers to observe the effects of harmonization. Authors such as Beath (1990) model the effects of TRIPS on developing countries, international trade, etc. While the effects may not be seen for some time, they call attention to the conflicts surrounding harmonization. The main points of contention are the enforcement of IP laws and the level of protection provided. On a more subtle note, the first-to-invent-rule[26] of the US versus the international standard of first-to-file and the patentability of business methods and organisms, provide examples of underlying ideological conflicts, as examined in Kotabe (1992) and Kawaura (2005.)

An example of the efforts to harmonize national systems and develop an international standard is the European Patent Convention. This agreement created an international filing system that reduces foreign filing fees and is developing a unified opposition system (Caldirini and Scellato, 2003.) Unlike trademarks and geographical indicators, which are internationally unified within the EU and fall under the jurisdiction of the Office for the Harmonization of the Internal Market (OHIM), patents enjoy no such consistency. However, the British Patent Office's Gowers Review (2006) of IP notes the high cost of translation fees associated with filing in multiple countries. Despite these costs, the fact remains that patent offices generate significant revenue for governments at the national level. The vested financial interests, national pride and ideological differences have created challenges to a unified system (Pitkethly, 1999.)

Patents and Cumulative Innovations

> If I have seen further, it is only because I am standing on the shoulders of giants.
>
> Newton (1676)

In his now clichéd phrase, Newton typifies the concept of cumulative innovation by stating that his advances were only possible due to the advances of other scientists before him. Innovations can thus be divided into two categories: independent (i.e. one-off or isolated) and cumulative (i.e. sequential), as in Scotchmer (2005.) Cumulative innovations are a series of innovations that build on each other, whereas independent innovations do not spawn subsequent innovations.

[26] The first-to-invent rule in the U.S. dictates that the first entity to invent the innovation should have the right to the patent. This differs from the first-to-file rule, in which the first entity to file the patent has the right to the patent.

There are numerous variations of cumulative innovations, as Scotchmer (1991) defines in her seminal paper on cumulative innovation. The first innovation may be a research tool without a commercial application. It may be a small or large innovation. The second innovation may be the commercially successful application of the tool, a great leap forward (a radical innovation), or merely a minor improvement (an incremental innovation.) For example, Percy Spencer invented the microwave oven when he realized that the magnetron he was working with melted the chocolate bar in his pocket; Spencer developed a hugely successful commercial application for the magnetron that had been used primarily for ship navigation.[27] However, the first innovation is a necessary predecessor to the second. Therefore, the first innovator is only appropriately rewarded once the profit and social surplus of the second is taken into account (Scotchmer 1991; Encaoua and Lefoulli, 2006.)

Scotchmer also notes the difficulty in rewarding each generation appropriately. In order to give the second innovator an incentive to invent, they must receive some of the surplus. However, the first innovator must also be rewarded with some of this surplus. This inherent conflict, referred to as a double marginalization,[28] makes the one-size-fits-all approach to patenting inefficient, as the surplus generated by the second innovation cannot be given to both innovators. One of her suggested solutions, also addressed by others (Cugno and Ottoz, 1991; Choi, 2004; and Anand and Kahnna, 2000), is to allow more collusion between firms through licensing and other means. This, however, poses anti-competition problems, as Chang (1995) also notes, due to the anti-competitive nature of collusion agreements. Chang examines collusion in the context of cumulative innovation and licensing and concludes that allowing collusion may attract inefficient entry by imitators who invent around the original. Even Thomas Edison recognized the process of cumulative innovation in his quote, "I start where the last men left off."

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[27] See Lemelson-MIT Program, 1996.
[28] Scotchmer (1991), p. 34.

2.3.2 Current Policy Debates: Trade Secrets

Trade secrets face many of the same debates as patents. Given their inherent secrecy, trade secrets can be particularly challenging when faced with demands for knowledge diffusion. Additionally, trade secrecy protection is not internationally homogenous, which leads to the discussion of harmonization.

Knowledge Diffusion: The Loss of Trade Secrets

Trade secrecy protection, as noted earlier, is less well defined as patent protection. Trade secrecy protection can be lost once the secret becomes public; this is the primary means of knowledge diffusion with trade secrets. Loss of trade secrecy occurs through two main channels: competitors and employees.

Competitors can obtain trade secrets through independent research, espionage and negotiations. Conducting R&D to either reverse engineer or discover an innovation independently are legitimate channels of independent research that can uncover trade secrets. Industrial espionage provides another, illegal, means of spying on another competitor in order to gain access to confidential information and uncover trade secrets. As Risch (2007) notes, a common example of industrial espionage is the 1964 DuPont case[29], in which a competitor hired a photographer to take aerial photos of a DuPont plant being built. DuPont argued successfully that this was a violation of their trade secrets as the plant construction revealed their methane-treating process, as noted in Friedman, et al (1991). Finally, trade secrets can be disclosed legitimately in interactions with potential business partners etc.; while this disclosure is lawful, the owner of the trade secret often has the right to prevent the other party from using the trade secret in practice through contracts (Dessemontet, 1998.)

Perhaps the most common form of trade secrecy loss is through employees, as noted in Almeling et al (2009.) Employees, particularly former employees, may

[29] Posner (1983) also cites this DuPont example as an example of the economic benefit of having commercial privacy. In the absence of the right to privacy, DuPont would be induced to expend resources to conceal the building of the plant. Commercial privacy, in this case, reduces the wasteful use of resources.

disclose trade secrets to others or new employers. While the disclosure of trade secrets by employees is illegal, this is a grey area as the right of the employee to work is important and can override the right to trade secrecy. Coleman (1992) notes this difficulty:

> … too tight a control on the right of employees and ex-employees to use or disclose information could have a detrimental effect on the employment market … On the other hand, without some form of post-employment protection to ensure that valuable developments or improvements remain in the exclusive control of employers, there would be less incentive to carry out research and development.[30]

Thus, policy makers face a delicate balance of taking into account the rights of employees to work, versus the rights of employers to maintain trade secrets.

Trade Secret Law Harmonization

The international harmonization of trade secrecy laws is also an issue as differing legal and cultural attitudes towards trade secrets pose problems for international business (Bone, 1998; Lemley, 2008.) In contrast to patents, trade secrecy has much more heterogeneous protection internationally and may fall under a variety of legal jurisdictions (e.g. tort law, criminal law and contract law, as noted in Bone, 1998; and Samuelson and Scotchmer, 2002.) This lack of consistency obfuscates the legal protection of trade secrets, particularly for firms operating in multiple countries. The public status of court proceedings can also have an impact on the protection of trade secrets, as firms will be reluctant to seek legal recourse if court proceedings are made public (Nasheri, 2005.) These public proceedings could result in the disclosure of the trade secret, as noted in Lerner (2006.)

Recent changes in the U.S. law, with the enactment of the Economic Espionage Act (EEA) of 1996, have highlighted the issue of harmonization. The EEA and the data associated with it form a central part of this thesis. The enactment of the EEA lead to significant harmonization of trade secret laws at the state level in the U.S. Authors such as Poolely et al (1997), Carr et al (2000) and Uhrich (2001) have examined the new law and its legal implications. As these authors note, the

[30] Coleman (1992) p. 53.

EEA has some extraterritorial provisions that are given particular attention in Effron (2003.) Chapter 3 of this thesis will develop these issues further.

Trade Secrets in Cumulative Innovation

One particular doctrine that varies internationally is the application of prior user rights, which allows an owner of a trade secret to continue to use the trade secret if another entity develops and patents the trade secret independently. Prior user rights also figure into the cumulative innovation debate as they allow for two independent innovators to incur the costs of developing the innovation and reap a portion of the rewards (Shapiro, 2006.) More precisely, Magri (1997, p. 4) defines them as, “Prior user rights allows one who is practicing the invention prior to the filing of a patent application by a later user to continue to practice the invention, even if a patent issues to the later user on the technology.” Denicolo and Franzoni (2004) examine the economic effects of prior user rights and conclude that prior user rights increase incentives for innovation but decrease the first innovator’s propensity to patent. As they argue that patenting is social surplus increasing, they argue that prior user rights are not socially beneficial. Prior user rights are not internationally harmonized, as noted in Menell and Scotchmer (2005.)

Given the discordance of international IP regimes, harmonization of trade secret laws internationally could prove beneficial to firms operating internationally. Magri (1997, p. 2) recounts an example of how this discordance affected the decisions of Coca-Cola. In 1977, Coca-Cola ceased its operations in India in order to protect its secret formula. At the time, the Indian government, by law, was demanding that Coca-Cola turn over 60% of its Indian operations to Indian-controlled enterprises. With this 60%, Coca-Cola was expected to hand over technological information, including the secret formula; Coca-Cola refused and chose to leave India. As the laws changed, Coca-Cola returned to the Indian market in 1993.[31] Harmonization of international trade secrecy laws could avoid costly situations such as the 1977 Coca-Cola case.

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[31] According to the Coca-Cola India website: http://www.coca-colaindia.com/about_us/coca-cola-introduction.asp.

Collectively, patents and trade secrets face similar policy and current debates, as discussed in Friedman et al (1990.) Knowledge diffusion, cumulative innovation and harmonization all factor into current academic and political topics. These debates will shape the future of policy and are thus central to academic investigations into theoretical models and empirical evidence. The next two sections of this chapter develop the theoretical and empirical themes in their academic context.

2.4 Theoretical Models in Economics

In addressing the policy issues and current debates surrounding IP systems, the economics literature has responded with economic models. These theoretical models weigh the relative merits of policy options and examine the impact of policy changes at various levels, including the firm and market levels. This section presents an overview of current models in IP with a focus on theoretical models incorporating trade secrets.

2.4.1 Patents

The literature developing theoretical models of patenting is vast and provides the foundations for later work in trade secrets. This section of the literature review will describe recent scholarship in patenting with particular attention to those models that are deemed relevant to trade secrets and the topic of this thesis.

Models of Cumulative Innovation and Disclosure

As noted in the previous section, a current debate surrounding patent policy is the appropriate rewards for cumulative innovation (e.g. Scotchmer, 1991; Chang, 1995; Choi, 2004; and Scotchmer, 2005.) Many authors note that, without adequate models for protecting cumulative innovations, the innovator of the first innovation may ultimately suffer from the success of the second innovation (as in Scotchmer, 1991; Green and Scotchmer, 1995; and Chang, 1995.) Erkal (2005) models cumulative innovation as a Bertrand competition between firms over two, cumulative innovations. Bertrand competition dictates that the two firms have the same marginal cost and compete with a homogenous product by adjusting price. The innovator of the first innovation may decide not to patent in order to capture more of the returns from the second, cumulative innovation. However, this makes the development of the second innovation more costly for competitors. Erkal examines the impact of government policy on the decisions by firms in cumulative innovation patent races.

Adapted from an earlier model by Denicolo (1996), Erkal models two sequential R&D races with free entry. The winner of the first race can participate in the second. If the winner of the second race is not the winner of the first, licensing or patenting occurs. The good is produced at zero marginal cost and R&D is successful following a Poisson process (a statistical method for modelling random events). Each innovation has market value v per time period and consumers are willing to pay v for the basic version and $2v$ for the improved version. The discount rate is r. The Erkal (2005) model brings together issues of cumulative innovation and disclosure as the disclosure of an initial innovation affects the development of a subsequent innovation.

The actions available to each firm are the decision to enter the race and, if successful, the decision to commercialize or not, and to patent or to keep secret the innovation. If they do not patent, the innovation is protected solely through secrecy and reverse engineering is assumed to be easy. The level of disclosure in patenting and commercialization is the same. Commercialization after the first innovation allows for the winner to collect interim profits.

In this model, the government has two variables of IP policy available in terms of the breadth of patents and the level of collusion allowed between firms:

Infringement (I) – second innovations are found to infringe the first.
No Infringement (N) – second innovations are not found to infringe, thus second innovations can be patented.
Collusion (NIC) – firms allowed to collude.
No Collusion (NINC) – firms are not allowed to collude.

An infringement means that the second innovation cannot be patented and that the second innovator will be liable for damages. Collusion is a competition policy instrument and, in this case, means that firms are allowed to work together in R&D. These policies are available in three combinations: I, NIC, NINC.

The sequence of the player's moves in the first patent race is as follows:

1. Govt announces policy (I, NIC, or NINC).
2. Firms decide how much to invest in R&D and engage in R&D process.
3. Race ends when one develops the innovation.
4. Winner decides whether to patent, and whether to commercialize.
    a. If not patented, reverse engineering assumed to be easy.
    b. Commercial use results in the same amount of information leakage as patenting.

In the second race, the race takes the same format as the first but begins when the firms decide to invest (i.e. government announcement of IP policy occurs only in the first race.) The winner of the second race is only able to patent under the NIC and NINC policies. Assuming different winners in each race, the expected payoffs for the two races are as follows:

Table 2-1: Erkal Model Expected Payoffs

Erkal Model Expected Payoffs		
	Assumes winner of the first race is not the winner of the second	
Policy Regime	Payoff to first winner	Payoff to second winner
I	(v/r)+(v/2r)	v/2r
NINC	0	v/r
NIC	v/2r	(v/r) + (v/2r)

Where v is the value of the first innovation, 2v is the maximum price of the second innovation and r is the discount rate. For example, the payoff to the first winner under regime I is the value of the first innovation discounted one period (v/r), plus damages payments (due to infringement by the second winner) found by the court equal to the value of the marginal value of the second innovation (2v – v = v) discounted two periods (v/2r). Depending on the relative effectiveness of secrecy, and the marginal benefit of the rival firm's R&D (e.g. spillovers), each firm will choose to disclose or not to disclose, depending on the government's IP policy.

As Erkal points out, the government IP policy affects the firms' payoffs and, hence, their behaviour. For example, if the policy is NIC (no infringement but collusion allowed), the winner of the first race will not invest in the second but collude instead with the winner of the second. If the policy is NINC and the first innovator loses the second race, the first innovator receives zero profit, as the winner of the second race will be able to patent the improved product but will have done so without colluding with the first. Furthermore, Erkal highlights the fact that the social benefit of an innovation should include the option value of subsequent innovations.

Like Scotchmer's (1991, 2005) analysis, the social surplus from innovation includes the value of subsequent innovations. Hence, if the first innovator chooses not to patent, the social surplus of the first innovation is delayed until the second innovation is commercialized. Erkal suggests that if early innovations are not likely to be patented, narrow patent protection coupled with allowing collusion may be ideal. Like Chang (1995), Erkal (2005) finds that collusion can be desirable in the case of cumulative innovation. Thus, government policy has important implications for rewarding first and second innovators. Furthermore, Erkal argues that if firms prefer secrecy for the first innovation, disclosure and subsequent innovations should be considered in the optimal design of patent and competition policy. His overall conclusion is that, "having broad patent protection increases social welfare by encouraging earlier disclosure of innovations."[32] The Erkal model is one example of a model that examines cumulative innovation. Other examples can be found in Scotchmer and Green (1990), Chang (1995), and Denicolo (2000).

Patent Options Analysis

One difficulty in the debates over IP systems is that the IP itself often lacks a

[32] Erkal (2005), p. 537.

precise valuation, as will be discussed in Chapters 4 and 5. Recent emphasis on intangible assets as contributing to firms' market value has further emphasized the need to apply monetary values to patents accurately (Bosworth and Rogers, 2001.) Options analysis presents both a theoretical model and the opportunity for an empirical analysis for examining patent data. Patents present a relatively tangible form of intellectual assets, as they are a legally defined right. As Bosworth and Rogers (2001) argue, "The issue of accounting for intangibles is a key issue facing accountants and policy makers, since inappropriate valuations may diminish incentives to invest in these important aspects."[33] Valuations are thus useful in determining a company's value and developing innovation strategies, and can be a strategic tool in negotiating (Arundel, 2001.) Thus, the literature has searched for means to value patents accurately.

Patents generating licensing revenue can be valued in a fairly straightforward manner using a discount cash flow analysis (Slottje et al, 2006.) Additionally, patents being licensed from others can also be incorporated easily into balance sheets (Anson and Suchy, 2005.) The analysis becomes much more difficult when patents are, or will be, exploited on a commercial basis. One method of performing this has been the application of real options analysis, as in Baecker (2006.) Using the financial principles of options, patents are modelled as options to license or produce the innovation. This method allows even inactive patents to be valued as noted below.

Bloom and Van Reenen (2002) present a model of using options analysis in which they distinguish between "embodied" knowledge, that which has been invested in, and "disembodied" knowledge, for which the firm has a patent but is not being utilized (e.g. not in production.) The authors describe patent options as "the value a firm places on its ability to choose the timing of its investment in patented technologies when this involves sunk costs."[34] Thus, they value the option value of the patent being the difference between the discounted profit flows and the sunk cost of embodiment.

[33] Bosworth and Rogers (2001), p. 324.
[34] Bloom and Van Reenen (2002), p. C105.

Applying this method to a database of British firms and using patent citation data, the authors conclude that patents have an economically and statistically significant impact on firm level productivity and market value. Furthermore, the impact on firm level productivity is delayed in contrast to the impact of market value, which is almost immediate. The authors also find that market uncertainty reduces the impact of patents on productivity, which is in line with the real options methodology. The Bloom and Van Reenen paper presents a useful combination of real options analysis and its empirical application.

Marco (2003) combines real options analysis with another trend in patent research, that of litigation (which is discussed in Section 2.5.) In his paper, the uncertainty of patents stems from the threat of litigation, instead of market forces. He argues that patent value also depends on the uncertainty of the IP itself and that a patent is actually a portfolio consisting of its profit flow and the option value of litigation. The litigation creates uncertainty because the standard defence is the validity defence, which could render the patent invalid, and the extent of damages arising from successful litigation varies. Marco's research provides an interesting twist on patent options analysis.

From an academic perspective, options analysis is an often-used method of patent valuation; however, there is no industry or accounting standard to evaluate disembodied IP. Bosworth and Rogers (2001) discuss the "anecdotal evidence that the accounting (book) value for intangible assets does not accurately reflect true investment levels."[35] This poses a potential problem, as one company recounted.[36] An external consultant valued one of their brands at one billion dollars, which the company chose not to incorporate into their balance sheets. Within a year, the brand had become obsolete due to a merger. Had the one billion dollars been incorporated into the company's accounts, the obsolescence of the brand would have meant a billion dollar loss. This anecdote demonstrates how inaccurate valuation of IP assets can have a significant impact

[35] Bosworth and Rogers (2001), p. 324.
[36] A participant in the EPO – Bocconi International Workshop in Industry and Innovation Management, held on July 10th and 11th, 2007 at the University of Bocconi, Milan, Italy.

on firms. Thus, the search for an international accounting standard of patent valuation is a future concern for the literature, as noted in Bosworth and Rogers (2001.) Patents are not alone in this difficulty as other intangible assets, such as goodwill, trade secrets and trademarks, all suffer from uncertainty in their valuation. Chapter 4 will develop these arguments further.

2.4.2 Economic Models of Trade Secrets

Further papers attempt to provide a stronger theoretical framework to the discussion of trade secrets by modelling either the decision not to patent and/or the decision to use trade secrets. I highlight the distinction because the former approach treats trade secrets as a catch-all strategy for actions other than patents, as discussed in Arundel (2001.) The implication is that using no IP protection at all fits into the same category as Trade Secrets; using Trade Secrets is a passive action. The second approach of modelling the decision to use Trade Secrets treats Trade Secrets as an active decision. This approach takes into account the "reasonable steps" required to protect Trade Secrets. However, this approach, while excluding using no IP from using Trade Secrets, fails to offer using no IP as a strategy. Arundel (2001) points out that a number of policy discussions model the decisions to use patents with the assumption that patents are an obvious decision or mutually exclusive from trade secrets; both assumptions, he argues, that are in conflict with the empirical evidence. This section of the chapter examines the literature's analysis of the firm's IP decisions with respect to the decision not to patent and the decision to use trade secrets.

Decision Not to Patent

The decision not to patent, as Arundel (2001) notes, is sometimes modelled as a default decision to use trade secrets. One example is that of Erkal (2005), discussed in Section 2.4.1, in which the author examines the impact of policy regimes on the behaviour of firms in two sequential R&D races. In the first round, depending on the regime, the winner may decide to maintain the first innovation secret in order to delay the progress of its competitors in the second round. Erkal suggests that strong trade secret protection should be accompanied by broad patent protection and that allowing collusion to encourage disclosure may be optimal. However, Erkal assumes reverse engineering to be easy and that commercialization results in the same amount of information disclosure as patenting. However, reverse engineering can be difficult and/or costly and, consequently, commercialization can result in only limited disclosure. Thus, these two assumptions are fairly strict and reduce the model's ability to make policy recommendations.

Decision to Use Trade Secrets

The active decision to use trade secrets presents a more complete analysis of the firm's strategic protection of innovation, as noted in Arundel (2001.) An example is that of Bessen (2004), where the author develops a three-stage model with two competing firms. The Bessen model also incorporates issues of disclosure and argues that diffusion of knowledge is not necessarily more likely with a patent system.

In the first stage of the Bessen (2004) model, the innovator decides whether to patent or use trade secrets; in the second, the follower decides whether to develop innovation independently or not (potentially by inventing around); and, in the final stage, the firms produce and compete in the market. The author assumes that patenting costs more than using trade secrecy and concludes that firms use patents when they reduce or eliminate imitation.

If the follower chooses not to imitate, then the innovator will receive monopoly profits under trade secrecy, or, under patent protection, monopoly profits followed by duopoly profits for both firms once the patent expires. (For simplicity, Bessen chooses not to incorporate discounting.) If the follower chooses to imitate or invent around, they will incur R&D costs and their efforts may not result in a successful imitation. If the follower is successful, then both firms will receive duopoly profits under both IP regimes. Unsuccessful imitation results in the innovator retaining monopoly profits. The decisions of each player are determined by the probability of diffusion. Bessen argues that firms use patents when they serve to reduce or prevent imitation and diffusion from imitation is, therefore, reduced under patents.

Bessen's analysis focuses on the decision to use secrecy and the subsequent diffusion of technical information. The author argues that technology is more diffused when it is profitable for the follower to imitate and that patent regimes slow down this diffusion. Bessen notes that firms can choose whether to protect inventions by patents or by trade secrecy and predicts that the diffusion of technical information of inventions is not improved by the patent system and may be delayed.

Trade Secret Models and Licensing

The licensing of trade secrets allows for extensions of simpler models and can affect the social surplus effects of trade secrecy.

Bhattacharya and Guriev (2006) develop a two-stage model in which a research unit develops an innovative idea, which is then licensed to a development unit to potentially develop into an innovation. The focus of their paper is how the units can use licensing strategically. In their model, licensing occurs either through an open sale, in which the knowledge is protected through patenting, or a closed sale, in which trade secret protection is used. The authors conclude that the closed licensing with trade secrecy is most often used if the knowledge is highly valuable, if intellectual property rights are not well protected and if negotiations involve substantial knowledge leakage.

The Bhattacharya and Guriev approach highlights an important aspect of using trade secrecy in that the leakage during negotiations is paramount. The authors also note that valuable, trade secret protected knowledge is more likely to result in an exclusive license that minimizes leakage. If the monopoly rents created by an exclusive license are high enough, the licensor has no incentive to sell the knowledge to a third party. As the licensing literature acknowledges, self-reinforcing mechanisms are crucial to successful licensing of knowledge.

The Bessen model is extended to include licensing and concludes:

> The extent of the market for licenses may actually be greater without patents. The intuition is simple: licensing occurs where there is a credible threat of imitation. Because imitation occurs in more restricted circumstances with patents than without patents, the extent of licensing is less with patents.

Cugno and Ottoz (2006) also develop a model detailing how the innovator's choice to use patents or trade secrets as protection affects social surplus, which they term social welfare. In their view, patents represent a temporary monopoly followed by perfect competition, whereas secrecy represents a long-term oligopoly. The introduction of licensing under the secrecy regimes allows for this oligopoly. Cugno and Ottoz conclude that social welfare is greater, ex post, when the innovator chooses secrecy given that transactions costs do not get too costly. Licensing avoids welfare wasting duplication costs (the cost of reinventing an existing innovation) as these are instead appropriated by the inventor via licenses.

Applying a ratio test, also used in Scotchmer (2005), Cugno and Ottoz (2006) examine the conditions of the deadweight losses and profits under different IP regimes. The ratio test provides an overview of the per-period deadweight loss with respect to the per-period profit. As Scotchmer notes, this test is used in Gilbert and Shapiro (1990) to argue that substituting lower prices for longer protection is socially beneficial."[37] The ratio examines the ratio of deadweight loss and profits; where the ratio of deadweight loss to profits is lower indicates the better policy.

In Cugno and Ottoz (2006), the authors evaluate this ratio under secrecy and patents. Primarily, they are interested in cases in which the deadweight loss to profit under patents (W_P) is greater than the deadweight loss to profit under secrecy (W_S):

[37] Scotchmer (2005), p. 109.

[2-1]

$$W_P \geq W_S$$

Where

$$W_P = \frac{\text{Deadweight Loss}_{\text{Patents}}}{\text{Profits}_{\text{Patents}}}$$

$$W_P = \frac{\text{Deadweight Loss}_{\text{Secrecy}}}{\text{Profits}_{\text{Secrecy}}}$$

Assuming that patent duration and secrecy are equally profitable for the innovator, the authors conclude that social welfare is greater under secrecy. The authors draw this conclusion because duplication costs under trade secrecy are converted into licensing fees. Thus, these duplication costs are not put towards the wasteful task of reinventing the wheel. The introduction of licensing makes trade secrecy a socially beneficial regime by increasing social surplus (which the authors refer to as social welfare.) However, this analysis ignores enforcement costs and the incentive to innovate goal of IP systems.

The licensing of trade secrets does, however, present some practical difficulties. Primarily, given the intangible nature of trade secrets, it is difficult to determine if the licensee has truly received the trade secret knowledge and difficult to determine if the licensee ceases to use this knowledge upon the license's expiration. Nonetheless, as numerous authors examine (Scotchmer, 1991; Cugno and Ottoz, 1991; Choi, 2004; and Anand and Kahnna, 2000), the introduction of licenses to trade secret models can allow for increased social surplus and diffusion of knowledge.

The Anton and Yao Model

However, one weakness of many of the previously discussed models is that they treat trade secrets and patents as mutually exclusive, which, as noted by Arundel (2001), is not necessarily true. An example of an exception to these models is the Anton & Yao (2004) paper. In "Little Patents and Big Secrets," Anton and Yao (2004) argue, as the title suggests, that firms should patent small innovations and use trade secrets to protect larger innovations. Furthermore, the authors allow for a mixing of trade secrecy and patent for medium-sized innovations. This widely cited paper provides a relatively comprehensive model in addressing the decision to use patents or trade secrets. Their argument is based on three fundamental assumptions that "innovation creates asymmetric information, innovation often has only limited legal protection and disclosure facilitates imitation." The authors view the choices of IP protection, and its subsequent disclosure, as an important signalling mechanism. Based on this disclosure and limited legal protection, others determine whether to imitate or not.

Model

The Anton and Yao (2004) model begins with a cost reducing process innovation by an innovator. The innovation reduces the marginal cost (MC) of production to c. In the first stage, the protection and disclosure stage, the innovator chooses the form of IP protection (either secrecy or patent) and, as a consequence, the level of disclosure, which acts as a signal. Disclosure occurs under both Secrecy (S) and Patent (P), but only patent provides protection for disclosure. The disclosure allows the second player, the follower, the option of reducing his costs.

Table 2-2: Key Variables in Anton and Yao (2004) model

i = Innovator
j = Follower
$\bar{c}$ = Marginal cost of prior technology
c = Marginal cost of new technology
s = Follower's marginal cost with disclosure where
$s \geq c$

The Innovator must decide between Secrecy (S) and Patenting (P) the innovation. In the second stage, if the Innovator has chosen Patenting, then this stage is the infringement risking imitation stage. In this case, the follower chooses to not imitate (N) or to imitate (I), which is actually a decision to risk losing an infringement lawsuit. If the Innovator has chosen Secrecy, the Follower is assumed to Imitate. The Innovator and Follower have the following decisions:

Table 2-3: Key Decisions in Anton & Yao (2004) model

S = Secrecy
P = Patent
N = Not to imitate
I = Imitate

For the follower, choosing to imitate allows the follower to operate at marginal cost s. However, if the innovator has chosen Patent, the probability of being found to infringe is γ and damages are calculated based on the principle of reasonably royalty at τ.

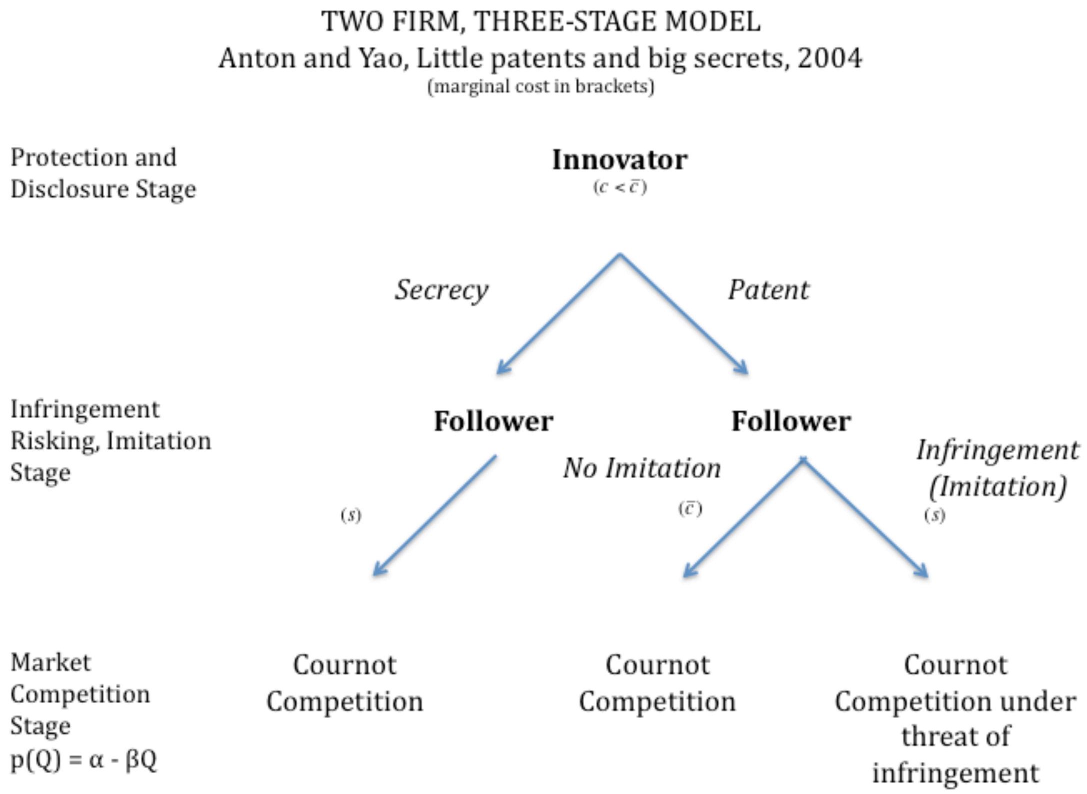
In the final, competition stages, the firms compete in a Cournot duopoly where:

γ = probability of being found to infringe

τ = royalty rate

The model can be summarized in the following game tree:

Figure 2-2: Anton and Yao (2004) Game Tree



The best response (BR) functions for each firm are:

[2-2]

$$q_i^{BR} = \frac{1}{2\beta}\left[\alpha - c - \beta(1+g)q_j\right]$$

[2-3]

$$q_j^{BR} = \frac{1}{2\beta}\left[\alpha - \frac{1}{1-g}s - \beta q_i\right]$$

Where g = damages rate = γ τ, which is the probability of the Follower being found to infringe, multiplied by the royalty rate that the court would require the Follower to pay the Innovator.

Innovator's Strategy

Using separating perfect Bayesian equilibrium and backwards induction, the authors determine that the best strategies for the innovator are based on their innovation size. The Innovator chooses to signal its innovation either partially (via secrecy) or more fully (via patenting.) Anton and Yao define the size of the innovation by the cost reduction it creates; the results are summarized here:

Figure 2-3: Anton and Yao (2004) Marginal Cost and Innovation Size

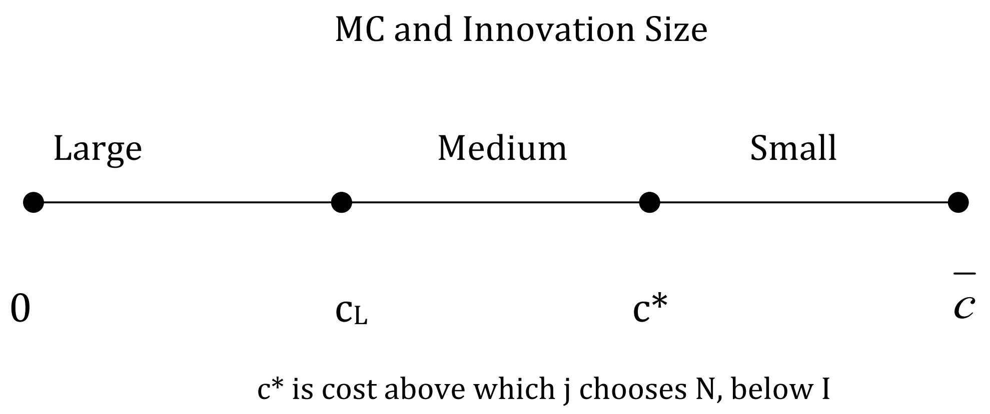


Table 2-4: Anton and Yao (2004) Model Conclusions

Anton and Yao model conclusions			
Innovation Size	Large	Medium	Small
Effect	Waiver Effect	Licensing Effect	No Imitation
IP	secrecy	patents	patents
Disclosure	partial	partial	full
Follower's Action	Produces at s	Imitates, risks damages	Does not imitate (s ≥ c ≥ c*)

Small innovations – No Imitation Effect

Small innovations are always patented because the innovator knows the follower will not imitate. To the follower, because the cost advantage is so small, the risk of paying damages outweighs the benefits of the lower marginal cost. Therefore, the disclosure associated with patents is acceptable for the innovator.

More specifically, a small innovation is defined as one that the marginal cost remains above c*. When c ≥ c*, disclosure is full. The follower could imitate, but the risk of damages outweighs the cost reduction benefits thus the follower remains at s where s ≥ c ≥ c*. The follower then earns $(1/9\ \beta)(\alpha - 2c + \bar{c})^2$

which is dependent on the cost of the prior technology (where the follower remains) and the cost with the innovation (where the innovator operates.) The disclosure of $c \geq c^*$ only affects the follower's behaviour in that they do not imitate, knowing that damages would outweigh the cost benefit.

Medium innovations – Licensing Effect

For medium innovations, the follower is enticed to imitate, as expected damages no longer outweigh the benefit from infringing and the innovator patents. The follower imitates incurring the expected damages knowingly. These expected damages are transferred to the innovator through litigation and the damages function as a license.

Anton and Yao define the medium innovation as larger, where $c<c^*$. This cost reduction is enough to trigger imitation by the follower. Knowing that types above c* (small innovations) disclose fully, disclosure to signal cost below c* has to be less than c*. Thus, the innovator will patent and disclose partially (e.g. not patent the entire innovation.) It is here that Anton and Yao add the crucial observation that patents and secrecy are not mutually exclusive. The decision to disclose partially and entice innovation means that the innovator will lose in terms of market revenue, but, as the follower is infringing, gain in terms of expected damages. Thus the authors define this area as the "licensing affect", because the follower chooses to use the innovation in exchange for expected damages payments.

Large innovations - Waiver Effect

As the innovation becomes larger, $c \leq c_L$, the innovator faces a trade-off, when signalling low cost, between operating revenues and damages (licensing.) Lower costs will reduce the market price and, therefore, reduce expected damages (which are calculated based on reasonable royalty.) Thus, the innovator utilizes the cost advantage in the market as the main source of revenue and elects not to use damages by choosing secrecy.

Thus, the larger innovation uses trade secrecy to minimize disclosure and limit the follower's ability to imitate. However, the authors highlight some of the practical difficulties with this conclusion. The decision not to patent may be due to the non-patentability of the innovation. They also suggest that a patent with a nominal lump sum may be a viable alternative but leave this option for later research.

Anton and Yao make one statement that contradicts the technical definition of a trade secret. They call the decision not to patent a "non-action." The implication is that the decision to use trade secrets is thereby a non-action. This is not necessarily true, as discussed in Arundel (2001), as the decision to use trade secrets is an active decision. The decision to use trade secrets is a decision to utilize confidentiality agreements, secrecy and other legal measures for the protection of the innovation.

Furthering Anton and Yao

Encaoua and Lefouili (2006) develop a model similar to Anton and Yao's. However, Encaoua and Lefouili focus on the probabilistic nature of patents, rather than the signalling aspect of choosing an IP regime. They focus on three parameters that affect the firm's IP choice: patent strength (likelihood patent will be held up in court), cost of imitating (the cost to the follower of imitating a patented innovation relative to a secret innovation) and the innovation size (the extent of the cost reduction.)

Both patent strength and innovation size are referred to explicitly in the Anton and Yao model. However, the cost of imitating, in Anton and Yao, is not explicit and is only captured partially in a consequential cost of imitation – that of expected damages under the patent regime. Instead, the Encaoua model focuses on the costs to reverse engineer or develop the innovation independently, which is typically higher under secrecy than under patent protection. The Encaoua model treats expected damages as a separate cost.

A higher cost of imitation is likely to dissuade a follower from imitating. At the same time, a strong patent regime (patent strength) is also likely to dissuade imitation due to expected damages payments. Lower costs or weaker patent strength, on the other hand, make imitating more attractive. Thus, Encaoua and Lefouili view patent strength and the cost of imitation as strategic substitutes. The Encaoua and Lefouili (2006) paper also departs significantly from Anton and Yao's focus on signalling by permitting the innovation (cost reduction) to be directly observable. This is a fairly limiting assumption, as it would require firms to know marginal costs of the innovator directly, before and after the innovation.

The Encaoua and Lefoulli paper focuses on two competing effects: the damage effect and the competition effect. The damage effect is the advantage that patents have over secrecy. Patents allow for the possibility of damages payments, whereas secrecy does not[38]; thus, ceteris paribus, the firm would choose patents. The competition effect allows for imitation levels to differ between patents and secrecy. The regime that has less imitation will be preferred. The Encaoua and Lefoulli paper highlights the interaction between these two effects.

The Encaoua and Lefoulli (2006) model is very similar to the Anton and Yao model. An innovator creates a cost reducing process innovation and then proceeds to compete with a follower in a Cournot duopoly in three stages: the protection stage, the imitation stage, and, finally, the market competition stage. However, the new model introduces one important new variable: I (cost of imitating), where imitating a patented innovation costs, at most, as much as under imitating an innovation protected by secrecy.

The results of the Encaoua and Lefoulli model are similar to that of Anton and Yao. They argue that small innovations are always patented. This, however, is due to the low cost of imitating a small innovation coupled with the lack of damages under secrecy. Also like Anton and Yao, the Encaoua model predicts

[38] In the case of reverse-engineering, which is permitted under trade secrets law.

that large innovations are kept secret because any disclosure reduces I (the imitation cost) and invites imitation.

For medium sized innovations, the two models differ. In the Encaoua and Lefoulli model, medium sized innovations are either patented or kept secret, as opposed to Anton and Yao, where they are patented and partially disclosed. Imitation occurs partially under secrecy and may occur under patenting. The difference between the two models' conclusions stems from the fact that patent strength and imitation costs interact to influence the follower's behaviour in the Encaoua model, whereas signalling by the innovator plays a role in the Anton and Yao model.

Encaoua and Lefoulli (2006) also develop the licensing option hinted at in Anton and Yao. They develop a fixed fee plus royalty licensing scheme which allows for the same equilibrium outcomes as in patenting under the shadow of infringement. This is akin to Anton and Yao's "licensing effect" which arises through litigation. Encaoua and Lefoulli frame licensing deliberately as an alternative to litigation. Jointly, these two papers embrace Shankerman and Scotchmer's (2001) observations on the circularity of damages, in that reasonable royalty is determined by a combination of willing licensing, and coerced licensing through litigation. Encaoua and Lefoulli argue that licensing in lieu of litigation may lead to poor quality patents being licensed and decrease social surplus.

As the Encaoua and Lefoulli paper notes, the introduction of probabilistic patents to theoretical models allows for more thorough analysis of IP policy by opening up new research avenues. The authors claim that the one-size-fits-all approach of patents does not take into account the heterogeneous nature of innovations and patents. Instead, they suggest that:

> …some flexibility could be introduced by allowing each innovator to choose a patent inside a menu of characteristics. For instance an innovator may have to choose between a patent with strong property rights and high disclosure requirements and a patent with weak property

rights and low disclosure requirements.[39]

These theoretical models begin to address current debates in IP policy by incorporating cumulative innovation, knowledge diffusion, the probabilistic nature of patents and other policy tools, such as licensing. Collectively, these papers develop the theoretical underpinnings of the firm's IP decisions and provide insight into the effects of policy changes.

2.5 Empirical Analyses

Finally, the literature addresses the policy and current debates in IP with empirical analyses. Surveys and litigation data provide the evidence for analysis of both patents and trade secrets. Patents are assisted further by their procedural requirements, which generate a large body of citation and application data. This section presents a brief overview of the empirical analyses of patents and trade secrets, with a focus on evidence from litigation.

2.5.1 Patents

With the advent of electronic, available and easily searchable patent databases, there has been an increase in the empirical branch of the patent literature looking at valuation, strategy and innovation.

Evidence from Litigation

Litigation is also a useful source of empirical evidence in part because IP polices are often refined by the courts. Litigation further defines patent scope, the patentability of innovations and the relationship between cumulative innovations. Litigation is also an enforcement mechanism and patent lawsuits are often infringement disputes.

Lanjouw and Shankerman (1997, 1999, 2001, and 2004) author a number of papers examining evidence from litigation. Their studies examine the damages[40] side of litigation, which often indicates patent value. Damages are awarded on

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[39] Encaoua and Lefoulli (2006), p. 26.
[40] According to Black's Law Dictionary, damages, or economic damages in this context, are "money claimed by, or ordered to be paid to, a person as compensation for loss or injury."

the legal basis of lost profit (profit lost to the patent holder), unjust enrichment (gains to the infringer as a result of the infringement) and other methods. These methods allow for an indirect valuation of the patent in question, as will be discussed in Chapters 4 and 5. Additionally, the litigation data provide insight into policy effects on litigation. Using data from the US Patent and Trademark Office and US district courts, their research determines that small patent portfolios are more likely to be litigated and small firms are at a disadvantage. These results stem from the argument that larger patent portfolios are more likely to end in settlements due to cross-licensing, whereas smaller patent portfolios have less bargaining power or may be in the hands of patent trolls.[41]

Litigation also affects the determination of licensing fees, as in Shankerman and Scotchmer (2001.) In their model, courts determine damages levied against an infringer using the doctrines of lost profits or unjust enrichment. Shankerman and Scotchmer develop an argument that licensing fees cannot exceed expected damages. If the licensing fee were greater than the expected damages, it would be in the potential licensor's interest to infringe. At the same time, the lost profits doctrine is often interpreted as lost royalties (often referred to a reasonable royalty – the licensing fee arrangement that the parties would have agreed upon in the absence of the infringement.) Shankerman and Scotchmer note this circularity.

The creation of the Court of Appeals for the Federal Circuit, a US court dedicated to IP disputes, lead Jaffe and Lerner (2004) to write an entire book lamenting the state of the US patent system. They argue that the creation of a specialized court has led to a weakening of patent standards as a whole as it has created a patent-

[41] A current trend in patent litigation is the new pariah of the patenting world, the patent troll. The patent troll is a euphemism for businesses that hide behind shell companies and only make their presence known when another company seeks to enter their territory; or, even worse, they deliberately allow other companies to stray into their territory and then attack. Essentially, the term "patent troll" describes a company that usually has no production and no other assets other than a patent portfolio, which it wields as a weapon to litigate others. Patent trolls do not conform to traditional business practices because they have little to lose. Unlike disputes between active companies, where cross licensing and other negotiating tools result in more mutually beneficial litigation, the patent troll seeks only financial awards. The 2005 Blackberry case is a prime example (see article by Ian Austen, "Court Ruling in BlackBerry Case Puts Service to U.S. Users at Risk", *New York Times*, October 8, 2005.)

owner-friendly court system. They note that the number of patent suits has increased from around 1,000 in 1982 to over 2,600 in 2001.[42] The increasingly litigious environment of IP cannot be denied.

However, it is important to remember that only a minority (roughly 1%) of patents are litigated.[43] Many disputes never reach the courts as they end in settlements. Additionally, more valuable patents are more likely to be litigated (Lanjouw and Shankerman, 1992.) Alternatives such as private mediation and arbitration do not provide the same amount of publicly available data as open court documents. While evidence from litigation provides a rich source of data, it has a skewed distribution due to the low percentage of patents litigated and their relatively higher value.

Patent Citations

In a patent application, the applicant must cite the prior art (the state of technology before the patent), which can include other patents (Scotchmer, 2005.) These patent citations are easily searchable and provide an indication of how important a patent/innovation is. As discussed earlier, Bloom and VanReenan (2002) use patent citation data to model the option value of patents.

However, as Montobbio (2007) notes, there are significant problems with using patent citation data. Citations differ across patent regimes, not all innovations are patented and some innovations are patented for primarily strategic reasons. For example, differences in the US and EPO citation requirements mean that the US has significantly more citations, as the author notes. Citations also change chronologically – an innovation from five years prior will likely be cited more than a recent innovation from the current year. Despite these empirical difficulties, Montobbio, and others, conclude that frequently cited patents are, on average, more valuable.

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[42] Jaffe and Lerner, *Innovation and its Discontents* (Princeton, New Jersey: Princeton University Press, 2004), p. 14.
[43] Jaffe and Lerner (2004), pp. 12, 14.

Patent citations can also be used to track knowledge spillovers and flows. The prior art disclosures provide a central source of the previously existing information, as detailed in Breschi and Lissoni (2004). The citations create a paper trail of knowledge flows, which, given the patent system's goal of knowledge diffusion, is an important empirical resource.

2.5.2 Empirical Analysis: Trade Secrets

In contrast to patents, trade secrets do not provide the same wealth of data for researchers. The overriding obstacle is that, by definition, trade secrets are secret. However, researchers have found ways to gather evidence via surveys and evidence from litigation. This final section presents the empirical papers examining trade secrets.

Surveys

The interest in trade secrets research from an economic perspective was rekindled by surveys indicating that firms use trade secrecy more than had been previously expected. The first survey addressing a company's use of trade secrecy, uncovered in this literature review, is that of Scherer (1977.) Scherer examines the impact that compulsory licensing has on company's strategic use of IP. He finds that "companies subjected to antitrust mandatory licensing decrees were patenting fewer of their inventions and keeping relatively more of their new technology secret."[44] He further surmises that these companies were not changing their strategy formally, but experiencing a change in corporate culture that favoured secrecy.

The most widely cited contemporary survey is that by Cohen, Nelson and Walsh (2000.) In their groundbreaking paper, the authors conduct an extensive survey in 1994 of manufacturing firms and note that secrecy is much more heavily used than had been anticipated. In addition to preferring secrecy, the survey finds that exploitation of lead-time, moving rapidly down the learning curve and use of

[44] Scherer (1977), p. 64

complementary sales and services are other popular methods of exploiting innovations.

Cohen, Nelson and Walsh argue further that firms choose not to patent due to difficulty in meeting patentability requirements, aversion to disclosure in patent applications, costs of legal defence and ease of inventing around. However, their study also indicates that firms patent in order to prevent copying, block other patents, earn licensing revenue, improve bargaining positions, prevent infringement suits, measure internal performance and enhance the firm's reputation.

In a similar paper, Arundel (2001) uses a 1993 European Community innovation survey to determine the relative importance of trade secrecy over patents. Arundel finds that secrecy is relatively more valuable than patents, although this varies depending on firm market size. Small firms patent less because they prefer to have fewer, more valuable patents, and are perhaps less likely to develop patentable innovations. Larger firms, on the other hand, may prefer secrecy as it allows them to use lead-time advantages in the market. Arundel concludes that trade secrets and patents are often used together as complementary protection measures.

The findings of these two papers caught the attention of the economic community and spurred the growth in non-patent, IPR research. The surveys' surprising results demonstrate that firms' preference for trade secrecy over patenting is much higher than previously anticipated. However, these surveys suffer from a lack of empirical certainty in that, by their survey nature, they are subjective. Despite this, the results are surprising and open up a new area in IP and economics research.

While not strictly a survey, Friedman, Landes and Posner (1991), in their foundational paper on the economics of trade secrets law, propose a list of reasons why a firm would choose not to patent and might use trade secrets instead:

1. Time for competitors to independently invent the innovation is:
    a. As long as the term of the patent and the innovation has modest value.
    b. Longer that the term of the patent.
2. Innovation is non-patentable but difficult to independently invent.
3. Firm seeks to avoid disclosure in patenting process.
4. Patenting not cost-effective.
5. Innovation is a process innovation and therefore hard to detect infringement.
6. Innovation not easily licensed.
7. Innovation believed to be an early stage of a cumulative innovation.

The strength of their arguments has since been proven by other researchers and their paper directed later avenues of research. The first point, regarding patent term, has been extensively modelled and analysed for policy implications in both patenting and trade secrets terms (as noted in Gilbert and Shapiro, 1990; Denicolo, 1996; and Scotchmer, 2005, among others.) Their last two points are those that are currently being examined. The suggestion that trade secrets are used because the innovation is not easily licensed is being approached from the licensing and choice of protection point of view, as in Beckerman-Rodau (2002.) Finally, the issue of cumulative innovation is under scrutiny from the perspective of trade secrets, as in Bhattacharya and Guriev (2006).

Evidence from Litigation

The empirical analysis of trade secrets using evidence from litigation is in its infancy. Lerner (2006) conducts a preliminary investigation into the empirical evidence found in litigation. Lerner examines approximately 500 litigation cases from two states known for their innovation; Massachusetts and California. His groundbreaking analysis provides some surprising conclusions and indicates a rich area for future research.

Lerner notes that trade secrecy cases face a cost not present in patent cases – the disclosure of the trade secret and subsequent loss of trade secrecy protection. Whereas a patent gains its protection from its government issued, legally defined status, the same cannot be said of the trade secret. In trade secrecy litigation, the plaintiff must prove that the protected intellectual property (the trade secret), exists; patents do not suffer from this same burden of proof. In order to prove its existence, the disclosure of the trade secret in the course of litigation may be required. This disclosure risks becoming public knowledge at which point the trade secrecy protection is lost. While the patent may risk invalidation via litigation, trade secrecy protection can be lost entirely, and, with it, market advantage.

A recent case involving the insurance company Allstate in the U.S. demonstrates the risk of loss of secrecy via litigation that Lerner highlights. In a lawsuit filed by an insurance claimant, Allstate was asked to turn over documents produced by a consulting firm, which spell out Allstate's approach to handling claims. On appeal, an opinion details the extent to which Allstate claimed trade secrecy to prevent the admission of the documents to the court.[45] Mauldin (2008) notes that Allstate declared that the "documents are valuable and that great lengths have been taken to ensure that such documents are not disseminated outside of the company."[46] Allstate ultimately won the lawsuit and claimed that the documents should be sealed to preserve their trade secrecy. However, the judge ruled that the documents were disclosed at a public hearing and should, therefore, remain public.[47] Thus, Allstate's trade secrets ultimately were made public.

Lerner's survey results in some interesting conclusions. First, he notes that trade secrets are often employed in industries, such as software, where patent protection has been limited. Additionally, the probability of winning a trade secrecy lawsuit is less than 40% and only 9% result in damages. This compares to a roughly two-thirds success rate in patent litigation. The damages awarded in the survey averaged $1.5 million, which is roughly one-third of the average patent litigation award.[48]

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[45] Allstate Floridian Insurance Company et al v. Office of Insurance Regulation, Case No 1D08-0275, District Court of Appeal, First District, State of Florida, Opinion filed April 4, 2008.
[46] Mauldin (2008), p. 163.
[47] Ortiz, Brandon "Secret Allstate documents should be public, judge rules," Lexington Herald-leader, November 16, 2007 accessed from www.kentucky.com/181/story/233007.html.
[48] See Lerner (2006), p. 13.

Lerner highlights the fact that this is an empirical area ready for exploration. At the conclusion of his paper, he indicates his future research will be to expand the database and investigate the litigation decisions themselves. However, Lerner's paper provides an indication that this will prove to be a fruitful area of research.

In a law paper, Almeling et al (2010) present their descriptive analysis of a database constructed from trade secret litigation in federal courts. The authors gathered data from 394 cases with issued written opinions from 1950 to 2008. The authors selected a random 25% sample of available cases from 1950 to 2007 (273 cases) and all cases in 2008 (121 cases.) As the authors note, the use of litigation remains fraught with selectivity bias. "The unit of analysis – written decisions that are available on WESTLAW – is only a small part of the complete universe of trade secret misappropriations."[49]

The authors find that the number of cases of trade secrets litigation in federal courts doubled from 1988 to 1995, and again from 1995 to 2004. Additionally, they find that the laws of Illinois, California or New York were applied in 30% of the cases. This likely coincides with the fact that courts located in these states are the busiest and in areas of economic importance in the U.S. They also find that the trade secrets themselves are divided roughly between two general categories: internal business secrets and technical secrets.

Furthermore, the authors find that perpetrators of most trade secrets thefts are insiders (i.e. someone known to the owner of the trade secrets.) The perpetrators are most commonly current or former employees or business partners. The authors report their descriptive findings in the table below.

[49] Almeling et al (2010), p. 7.

Table 2-5: Identity of Alleged Misappropriator in Trade Secret Litigation (1950 - 2008)[50]

	Percentage
Employee or former employee	53%
Business partner	36%
Unrelated third party	4%
Other or unknown	6%

Almeling et al (2010) also address the legal burden of trade secrets' owners to prove that the trade secret was reasonably protected. Using a logistic regression, whose details are not reported in the paper, they find that the employee confidentiality agreements and partner confidentiality agreements increased the likelihood, by "more than a factor of 100",[51] that the court would find in favour of the trade secret owner. Additionally, the authors report the following success rates of these litigations:

Table 2-6: Outcome of Trade Secret Litigation in Federal Courts[52]

	1950 – 2007	*2008*
Owner prevails	42%	52%
Owner does not prevail	53%	43%
Owner prevailed on some trade secret claims but not on others	5%	5%

These values are approximately similar to Lerner's findings that the owner wins in only 40% and again is lower than the two-thirds win rate of patent litigation. However, the 2008 outcome rates reported in Almeling, and the authors' observation that the number of trade secret cases is increasing, could indicate that these outcome rates may shift further in favour of owners.

Evidence from Litigation: the EEA

[50] *Ibid.*, p. 9.
[51] *Ibid.*, p. 26.
[52] *Ibid.*, p. 17.

Finally, the literature begins to address the evidence gathered from prosecutions under the EEA. The data used in these papers are most closely related to the focus of this thesis. Two papers pay specific attention to evidence from the EEA: Zwillinger and Genetski (1996), who focus on the valuation of the stolen trade secrets, and Carr and Gorman (2001), who examine the impact of the announcement of the theft of trade secrets on the victim firm.

Zwillinger and Genetski (1996) present a legal view of the valuation of trade secrets within the EEA cases. The authors examine best practices for reaching fair and consistent calculations of loss in EEA cases. The authors present an argument that the Fair Market Value and Reasonable Royalty are appropriate methods for EEA cases. The authors highlight the "ad hoc" application of Fair Market Value and argue for sentencing to be more closely based on intended loss to victim and gain to defendant. These issues are further developed in Chapters 4 and 5 of this thesis.

In a paper that adopts a business and law approach, Carr and Gorman (2001) analyse the impact of the announcement of the theft of trade secrets on the victim firm's stock price. They find that the victim firm's stock price decreases after a trade secret theft is announced and dub this effect the "revictimization" by the stock market. The authors model the announcement of the theft of trade secrets and use a regression analysis to determine the impact of the announcement on the stock price. Their hypothesis is that the public disclosure of the theft has an immediate and negative impact on the stock returns of the victim firms, which is seen via a negative average abnormal return. Using the S&P 500 as a benchmark, they find that the announcement of the theft results in a statistically significant average abnormal return of -0.89% in the victim's stock price. Thus, the authors find in favour of their revictimization hypothesis.

The body of empirical literature examining trade secrets is limited due to the lack of available data sources. This literature review has detailed the background behind this situation and examined the current state of the literature. The conclusion is that trade secrets are an area ripe for further research.

2.6 Conclusion

The study of intellectual property, from an economics point of view, has led to a wealth of analysis (as noted in Scotchmer, 2005.) The area of patents has been particularly well researched (e.g. Mansfield et al, 1981; Scherer, 1983; Klemperer, 1990; Gallini, 1992; Lanjouw and Shankerman, 1997; Lerner and Jaffe, 2004; Hall et al, 2005.) However, the same cannot be said of trade secrets (with some notable exceptions, e.g. Friedman et al, 1991; Cohen et al, 2000; Arundel, 2001; Anton and Yao, 2003; and Lerner, 2006.) Nonetheless, research in trade secrecy is on the rise and the future points to a plethora of potential research avenues

Intellectual property in general remains an internationally contentious issue, with policies differing across regimes. As economists develop IP research, these policies should be better informed and more suited to increasing social surplus. As this literature review has demonstrated, the literature pays particular attention to knowledge diffusion, harmonization and the firm's decision to use IP.

The patent system, and IP systems as a whole, remain under public scrutiny. While the philosophical justifications for IP are well developed, the current systems are contentious. Arguments that the system is unfair and that patent protection is expensive for firms to obtain, maintain, enforce and defend against (as discussed in Lerner and Jaffe, 2004) have provoked scholars into examining the international impact of IP systems, particularly in the context of agriculture and pharmaceuticals. The recognition that IP systems represent an imperfect solution to providing incentives for innovation is at the root of debates over harmonization, cumulative innovation and diffusion of knowledge. These debates are not unique to patent systems and, as this literature has demonstrated, can be applied to trade secrets.

The theoretical models of the firm's decision to use trade secrets or patent, as discussed in Section 2.4, are an attempt to respond to the criticism of IP systems. These economic models provide the theoretical basis for the empirical analysis of IP. As this chapter has repeatedly emphasized, the patent literature, in both models and empirical analysis, is more developed than the trade secrets literature. Capitalizing on the new EEA policy, this thesis seeks to examine the role of trade secrets further.

The next chapter will present the evidence from the EEA gathered as part of this thesis, discuss the policy implications of the EEA and provide illustrative case studies of the firm's use of trade secrets. These case studies provide insight into how issues highlighted in the literature, such as knowledge diffusion (e.g. Scotchmer, 2005), cumulative innovation (e.g. Erkal, 2005) and the patent-trade secret mix (Arundel, 2001) have influenced these decisions. The EEA cases demonstrate that the concerns addressed by the literature are practical concerns for firms and influence their use of IP.

As this literature review has demonstrated, a number of theoretical models incorporate the value of patents or trade secrets (e.g. Bloom and VanReenen, 2002; Cugno and Ottoz, 2006; Encaoua and Lefouili, 2006) or damages calculations (e.g. Lanjouw and Shankerman, 1997; Marco, 2003; Anton and Yao, 2004; and Erkal, 2005.) Data from the EEA database provide material for the exploration of the value of trade secrets. Chapters 4 and 5 will explore these data and the valuation methods employed to assess the value of trade secrets.

Chapter 6 addresses the determinants of trade secret intensity. Developing a relative measurement of the propensity to use trade secrets and the propensity to innovate, this chapter examines the predictions of the theoretical models in light of the empirical evidence. This chapter furthers the work of Arundel (2001) and Lerner (2006) on trade secrets by extending the analysis to a regression model. The evidence suggests that smaller firms are relatively more dependent on trade secrets than larger firms.

Further mention of the literature can be found throughout the thesis as the analysis is extended to incorporate related areas, such as the economics of crime, and the literature presented in this chapter is revisited. However, as Lerner (2006) notes, the literature has thus far focused nearly exclusively on patents. Strong themes identified in this chapter and present within the thesis include the use of litigation data, the decision to use trade secrets, and the relationship between patents and trade secrets. The inherently secret nature of trade secrets has limited their study, but trade secrets remain an important means of protecting innovations. This thesis focuses on exploring the empirical evidence of trade secrets.

Chapter 3: The Theft of Trade Secrets: Evidence from the Economic Espionage Act of 1996

3.1 Introduction

This chapter introduces the Economic Espionage Act and its economic implications. As the EEA data form the foundation of this thesis, this chapter provides institutional detail and policy analysis of the EEA. It begins with a short history of the legislation, progresses to a statistical analysis of the composition of EEA cases and examines the EEA's impact on economic incentives for economic spies and firms alike. The second part of the chapter provides a cluster analysis that presents a three-way division of the evidence. Typical members of each cluster are considered through three sets of case studies.

One of the most famous trade secrets in the world, the secret Coca-Cola formula, has long been a subject of fascination.[53] Tales of this century-long, highly maintained secret have become part of the company's folklore.[54] However, Coca-cola's secrecy was recently tested when Joya Williams and her two partners attempted to sell Coke secrets to its main rival, Pepsi, for $1.5 million.[55] Pepsi turned these unmasked offenders over to the authorities and Williams was subsequently sentenced to eight years in prison.[56]

The law that led to Williams's incarceration is the Economic Espionage Act of 1996 (EEA). Amid concerns over the vulnerability of American trade secrets, the United States enacted the EEA in 1996. Prior to the EEA, the theft of trade secrets was, by itself, not a crime. This chapter of the thesis reports on research

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[53] In addition to press coverage, there have been at least three books written on Coca-Cola and the formula in the last 18 years. See *Secret Formula: How Brilliant Marketing and Relentless Salesmanship Made Coca-Cola the Best-Known Product in the World* by Frederick L. Allen (1995); *For God, Country, and Coca-Cola: The Definitive History of the Great American Soft Drink and the Company That Makes It* by Mark Pendergrast (2000); and *The Real Thing: Truth and Power at the Coca-Cola Company* by Constance L. Hays (2004).

[54] For a discussion on the Coke folklore, see http://www.snopes.com/cokelore/formula.asp by Barbara Mikkelson.

[55] CNN online, May 7th, 2006, 3 arrested in Coca-Cola trade secret scheme, Accessed 12/09/2008 from http://money.cnn.com/2006/07/05/news/companies/coke_pepsi/

[56] U.S. v. Williams et al, Criminal Case 1:06-cr-00313-JOF-GGB (Northern District of Georgia, filed July 11, 2006.)

directed towards developing a new database of EEA prosecutions. This new database provides extensive insightful information on 147 defendants who were charged with EEA violations in 95 cases from 1996 to 2008. Insights into the stolen trade secrets include methods of valuation, variations in valuations and the role of insiders versus outsiders in such crimes.

The EEA was created to reinforce the protection of American trade secrets by increasing the gravity of the theft of trade secrets from a civilian wrong to a felony, and further by broadening the definition of trade secrets (Nasheri 2005.) In order to address the concerns of economic espionage by foreign entities, the Act also includes new provisions that extend its jurisdiction to extraterritorial applications (Carr and Gorman, 2001.) This chapter examines the impact of this new law and the insight into economic and legal processes that its application provides. These criminal prosecutions offer a hitherto unexplored data source of trade secrets, which presents exciting new analytical issues; e.g. concerning valuation, deterrence and the determinants of trade secret intensity.

The EEA prosecution data has been collected using online court records, media reports and academic papers. The aggregation of this data provides a rich source of evidence on the value of trade secrets and the way in which they are used by firms. While the process of data collection raises some non-trivial challenges, once obtained, the data represent a unique source of trade secret information which, by its nature, is typically undisclosed. To illustrate, contrary to the operating assumptions of the EEA, the data demonstrate that the majority of defendants are classified as insiders and are U.S. citizens. Furthermore, the data show that the majority of these trade secrets would not qualify for patent protection, which indicates that the use of trade secrets is particularly important for protecting these intellectual assets.

The first half of the chapter addresses how the elevation of the theft of trade secrets from civil malfeasance to a felony affects the incentives for both firms (Carr and Gorman, 2001) and potential thieves (Nasheri, 2005). In comparison to penalties used in civil cases, the new incentive of a criminal deterrent to trade secret theft introduces severe consequences, such as incarceration as a form of punishment (Carr et al, 2000.) Additionally, the criminalization of trade secrets plays into the property versus liability debate found in Ayres (2005.) When confronted with a theft of trade secrets, a firm must decide whether to seek legal recourse and, if so, whether that recourse should be criminal and/or civil, as noted in Hodkinson and Wasik (1986). However, the financial damages assessed in EEA criminal cases can be compared to civil cases, as in Lerner (2006), and are found to be lower. In favour of the EEA route, choosing to punish thieves via a criminal action has some positive incentives from the perspective of the victim firm in terms of future deterrence, moral punishment and the shifting of legal costs from the victim company to the state.

The second half of this chapter focuses on categorizing the EEA prosecution cases by industry and the type of trade secret. The technique of cluster analysis is used to identify three distinct clusters objectively, determined by whether copyright, patent or neither potentially protected the trade secret. It is found that the first cluster, effectively manufacturing and construction sectors, is dominated by those trade secrets that are potentially patentable. The second cluster, effectively business services and retail sectors, has predominantly trade secrets that could also be subject to copyright protection. The third cluster, which is not found to be sector specific, involves trade secrets that do not offer any other forms of IP protection. The attributes of these three clusters are further developed using two illustrative case studies per cluster.

This chapter begins in Section 3.2 with a discussion of trade secrets, followed by Section 3.3, which explores the economic and political factors that lead to the genesis of the EEA and the property versus liability rule debate. Section 3.4 explains how the data was gathered to create the EEA database. Sections 3.5 and 3.6 present descriptive statistics that display the underlying composition of defendants, victims and trade secrets. Section 3.7 examines the effects of criminalization and the detection of trade secret theft in EEA cases and the impact this has on the incentives, as far as would-be thieves and the owners of trade secrets are concerned. Sections 3.8 and 3.9 present a classification of the cases via a cluster analysis and thereafter develop illustrative case studies. Finally, Section 3.10 concludes.

3.2 Trade Secrets

Trade secrets present a challenge to economists. Amongst intangible assets, trade secrets represent the elusive and difficult to quantify extreme. Unlike their counterparts, patents, copyright and trademarks, trade secrets are not subject to a formal registration process or any obligatory disclosure (Cugno and Ottoz, 2006.) Given their widespread use, it is these characteristics that make trade secrets a challenging yet important subject of research.

Cohen, Nelson and Walsh (2000) caught the attention of economists with their survey which indicated that patenting is considered to be an inferior strategy by firms when compared to trade secrets, lead time[57] and marketing. This new research has caused a change in thought to the traditional, patent-focused lines of research, and has generated an interest in alternative means of IP protection, such as trade secrets.

To qualify as a trade secret, the intangible property must meet three requirements: it must be secret; it must derive economic value from being secret; and it must be subject to reasonable protection measures to maintain its secrecy (Scotchmer, 2005.) The interpretation of these requirements varies by jurisdiction and, in some jurisdictions, trade secrets are not recognised as intellectual property (Effron, 2003.) However, these three requirements reflect the standards of most countries and are reflected in the World Trade Organization's agreement on Trade Related Aspects of Intellectual Property (TRIPS), which dictates the minimum standards required of TRIPS signatories.[58]

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[57] Lead time, or in this context, strategic lead-time, is the time between the design, procurement and production of the good and the distribution to the market. It is used in supply chain management and related to the life cycle of the project (definition by Biz-Development, available at www.biz-development.com/SupplyChain/6.12.Leade-Time-Definition.htm).
[58] For further information, see the WTO's website on TRIPS http://www.wto.org/english/tratop_e/TRIPS_e/TRIPS_e.htm

While the law literature examines trade secrets regularly, this is less so in the economic literature. In contrast to the patent literature, which is well established; e.g. Scherer (1965, 1977, 1983); Mansfield (1986); Gallini (1992); Lerner (1995); Lanjouw and Shankerman (1997); Scotchmer and Shankerman (2001), the economics literature addressing trade secrets is relatively small. Economic models of trade secrets are fairly well-developed and their maturation has mimicked the development of the patent literature; e.g. incorporating trade secrets into the decision of the firm's choice of intellectual property protection: e.g. Anton and Yao (2003); Bessen (2004); Erkal (2005); Encaoua and Lefoulli (2006); and licensing: e.g. Cugno and Ottoz (2006); Bhattacharya and Guriev (2006). To name but a few, these patent models address cumulative innovation: Chang (1995) and Scotchmer (1991, 2005); patent design: Klemperer (1990); Gilbert and Shapiro (1990); Gallini (1992); Denicolo (1996); and Scotchmer (2005); and harmonization: Kotabe (1992); and Park & Ginarte (1997).

The empirical literature on patents benefits greatly from the vast data resources available to researchers.[59] The same cannot be said of the current state of the empirical basis of the trade secret literature. The data are limited and the literature extends to just a few papers including surveys (including some evidence from litigation) (see Lerner 2006; Cohen, Nelson and Walsh 2000; and Arundel 2001). This scarcity of material makes the new evidence attained from the EEA, the subject of this thesis, particularly valuable for research into trade secrecy, its causes, consequences, incentive and allocation properties, and policy implications.

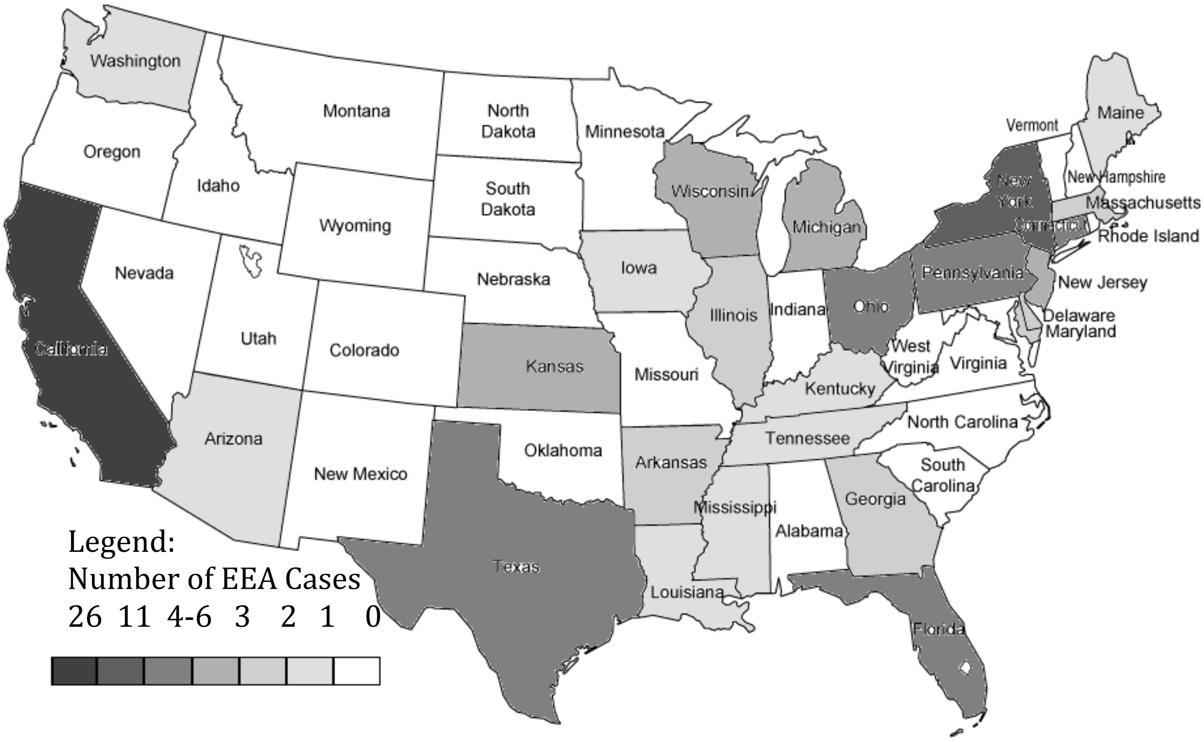
3.3 The Economic Espionage Act (EEA) of 1996

Amid reports of the theft[60] of American trade secrets by foreigners, the United States enacted the EEA[61] in 1996. The act marked a significant change in the

[59] Patent applications are available freely online (e.g. Google patent search) and contain a wealth of information on the patent and cross-references to prior art. Furthermore, patent litigation in the U.S. is centralized and occurs through a dedicated court.
[60] See Fialka (1997).
[61] 18 U.S.C. §§ 1831-1839.

legal approach to trade secrets by increasing the category of the theft of trade secrets to a felony, broadening the definition of trade secrets and including extraterritorial jurisdiction. While most American states had passed the Uniform Trade Secrets Act (UTSA),[62] the EEA harmonized trade secret law across the country. This new harmonization makes it possible to examine trade secrets thoroughly in a consistent manner across all states. Figure 3-1 shows the distribution of EEA cases from 1996 to 2008 through the United States. This map roughly coincides with the economic distribution (by gross domestic product) of the United States. The highest number of cases occurs in California, which has the largest state economy in the U.S. and is home to Silicon Valley. The second most popular state for EEA cases is New York, which is the financial heart of the United States.

Figure 3-1: Number of EEA Cases, by state, from 1996-2008



[63]

The EEA was enacted under the presidency of Bill Clinton and coincided with a time of economic prosperity in the U.S. It was, as Carr and Gorman (2001) note,

[62] Effron (2003), p. 1485.
[63] Data from the EEA database created as part of this thesis.

drafted in a post-Cold War era during which time the U.S. enjoyed a relatively militarily peaceful time.[64] Given these circumstances, many authors[65] argue that the closing down of the market for political and military spies meant that these spies adapted their trade to industrial espionage. While this research project into EEA cases has uncovered no evidence to either refute or support this argument, the plausible concept that former spies were now engaging in economic espionage was of great interest to U.S. politicians and businesses, as noted in Fialka (1997) and Effron (2003.) According to Fialka (1997), a series of incidents involving French businessmen and spy allegations in the early 1990s caught the attention of the U.S. intelligence agencies.[66] Acquisitions of American assets by Chinese and Japanese entities alarmed American businesses.[67] At the same time, the economy was in the process of shifting to an ever more information based, digital platform which both increased the bulk of potentially valuable information and exposed that information to the inherent insecurity (e.g. its easily replicable nature) of the digital world, as noted in Carr and Gorman (2001). These political and economic shifts drew to public attention the potential threat of economic espionage and the vulnerability of trade secrets to theft.

Prior to the EEA, the theft of trade secrets was dealt with primarily via civil actions and related criminal charges (as noted in Carr et al, (2001); e.g. transporting stolen property and wire fraud.) In two main provisions, sections 1831 and 1832, the EEA elevated economic espionage and the theft of trade secrets to a felony. Section 1831, Economic Espionage, makes the theft of trade secrets to benefit a foreign agent a criminal act punishable by up to 15 years imprisonment and $500,000 for individuals and up to $10 million fine for corporations. Section 1832, Theft of Trade Secrets, makes theft of, attempted theft of, or conspiracy to steal trade secrets a crime. In this case, the individual can be fined up to $250,000 and imprisoned for up to 10 years, while

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[64] Carr and Gorman (2001), p. 30.
[65] Carr, Moron and Furniss (2000), Carr and Gorman (2001), Nasheri (2005).
[66] Fialka, John, War by Other Means: Economic Espionage in America, 1997, Chapter 8, pp. 87-112.
[67] Fialka (1997), Chapters 4, 5, pp. 41-65.

corporations are subject to fines up to $5 million. The longer prison terms and higher fines of economic espionage indicate that the drafters of the act intended it to be a harsher sentence than the theft of trade secrets.

Two elements of the act have been controversial: the extension of the definition of trade secrets and the potential extraterritorial application of the act. Effron (2003) notes the EEA's broader definition of trade secrets in comparison to the previous UTSA standard:

> To the UTSA's "formula, pattern, compilation, program, device, method, technique, or process," the EEA adds "plans, . . . program devices, . . . designs, prototypes, . . . techniques, . . . procedures, . . . or codes" and expressly protects "financial, business, scientific, technical, economic, or engineering information.[68]

This extension to named types of information broadens the overall definition of trade secrets. In addition, the concept of "public" as a test for secrecy is somewhat obfuscated in the EEA, which merely states, "from not being generally known to … the public",[69] which leaves considerable room for interpretation of who the public entails. This has been a point of debate in EEA cases.[70]

In addition, the act has extraterritorial applications specifically included in Section 1837, Applicability to Conduct Outside the United States, which extends the prosecution of economic espionage and the theft of trade secrets:

> To conduct occurring outside the United States if
> (1) The offender is a natural person who is a citizen or permanent resident alien of the United States, or an organization organized under the laws of the United States or a State or political subdivision thereof; or
> (2) An act in furtherance of the offense was committed in the United States.

This extraterritorial reach may force companies with U.S. links to enact protection schemes for the trade secrets, or alter their behaviour in ways that they would have done prior to the EEA, as discussed in Effron (2003.) While this provision does not appear to be a major point of contention in policy debates, at

[68] Effron (2003), p. 1487.
[69] 18 U.S.C. §1839, Definitions.
[70] For an example, see the appeal documents in USA v. Lange, 2:99-cr-00714-JPS-1, filed 08/09/1999 in E.D. WI.

least one case has involved conduct outside the U.S. In the U.S. v. Cartwright et al,[71] two of the individual defendants were U.S. citizens living abroad in Prague and receiving stolen information to benefit two foreign corporations (owned by the defendants) from their U.S.-based counterpart in Maryland. However, in cases involving acts committed by foreign nationals, a difficulty arises where other countries may not be willing to extradite suspects, as noted in Nasheri (2005.) This was the case with U.S. v. Okamoto[72] in which Japan refused the U.S. extradition request.[73] These two cases are the only two, of EEA prosecutions, that appear to involve the extraterritorial application and the question of extradition. The challenges associated with extraditing suspects will limit the extraterritorial applications of the EEA.

To mitigate some of this controversy, the Attorney General (Janet Reno at the time of the signing of the EEA) required that the first five years of prosecutions be subject to express approval of the office of the attorney general, as noted in Uhrich (2001). As a result, 23 cases were filed in the first five years of the EEA, but 38 were filed in the following five years. This may, however, reflect the growing awareness of the EEA (Nasheri 2005), or an increase in the detection of these activities.

3.3.1 The Property Liability Debate

This section introduces the property liability debate and then presents it using the novel analytical structure of optional law[74]. As noted earlier, the legal protection of trade secrets prior to the EEA rested primarily in tort and contract law. As such, trade secrets are an entitlement protected by liability[75] as opposed

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[71] U.S. v. Cartwright et al, Criminal case 1:07-cr-00570-WMN (District of Maryland, filed January 7, 2008).
[72] U.S. v. Okamoto, Criminal case 1:01-cr-00210-DDD-1 (North District of Ohio, filed May 8, 2001).
[73] Pearson, Natalie Obiko, March 29, 2004, "Tokyo Rejects Extradition of Alleged Spy", *Associated Press*, Accessed September 08, 2008, from http://www.economicespionage.com/tokyo_rejects_extradition_of_all.htm
[74] Optional law takes real options analysis and applies it to law.
[75] Liability rules, according to Ayres (2005), protect entitlements by compensating the entitlement holder in the event of a non-consensual taking.

to other IP, such as patents, which are protected by property rules[76]. The EEA, in the criminalization of theft of trade secrets, continues with the protection of trade secrets under liability rules. The economic efficiency of the decision to protect entitlements through property or liability rules is an ongoing debate and merits some discussion here in its context with the EEA.

In their seminal paper, Calabresi and Melamed (1972) set up the framework for this debate. Consider the owner of a land and neighbour who wishes to pollute (which would cause damage to the land.) If the property entitlement lies with the owner, the neighbour can only pollute with the owner's permission (i.e. the owner has the right to request a court injunction.) If the property entitlement lies with the neighbour, the neighbour has the right to pollute. In these cases, the entitlement can result in an enjoinment of the nuisance (pollution) or does not recognise a nuisance. However, under the liability rules, the situation is different. Assuming entitlement lies with the owner, the neighbour can pollute but must compensate the owner. [77] In this case, the rules allow for damages[78] and the nuisance to continue.

Calabresi and Melamed (1972) argue that entitlements promote economic efficiency in that they minimize the administrative costs of enforcement, promote pareto optimality and can address society's distributional goals. Furthermore, the authors argue that liability rules are enacted when transactions costs are too high. This argument, as noted by Ayres (2005) has become standard delineating theory of the decision to use property or liability rules. A similar argument, also in Ayres, is the "Posnerian theory" which argues that where transactions costs are not too high, property rules are favoured as they "force" parties to negotiate.[79]

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[76] Property rules, also according to Ayres (2005) protect the holder of the entitlement by deterring non-consensual takings.
[77] Calabresi and Melamed (1972) also discuss the case in which the, under the liability rule, the entitlement lies with the neighbour, but note that this is not common. In the interests of brevity, we will leave that discussion to other authors.
[78] Liability rules in criminal sanctions serve to approximate the value (damages) of the entitlement to its owner, which is the subject of Chapter 4 of this thesis. Further discussion of criminal prosecution under the property law can be found in Kaplow and Shavell (1996.)
[79] Ayers (2005) p. 143.

When applied to IP, the use of property rights should reduce transactions costs. As Merges (1994) argues, "property rules can and do work effectively in many situations involving IPRs. This is so because, in the presence of high transaction costs, industry participants have an incentive to invest in institutions that lower the costs of IPR exchange." This argument can justify the property protection of patents. However, Blair and Cotter (2002) argue that trade secrets should have different protection than patents due to the unique characteristics of trade secrets including the lack of disclosure and the right of competitors' to reverse engineer.

Futhermore, the application of the property – liability debate when applied to the EEA is not straightforward as the use of a property rule to protect trade secrets is problematic. The conversion of the trade secrecy entitlement into a property rule would imply that the use of a trade secret could be enjoined. In practice, while the court could issue injunctions with respect to stolen trade secrets, the theft itself can destroy the secrecy of the trade secret itself. The value of the entitlement is destroyed by the theft. Furthermore, Blair and Cotter (2002) acknowledge "a trade secret owner's rights are not valid against the world, but rather only against persons who have acquired the secret in certain ways or who stand in a confidential relationship to the owner."[80] Epstein (2003) concludes that the case for the treatment of trade secrets as property from a legal perspective "remains a mess."[81] Hence, the theoretical application of property rules to the entitlement of trade secrets does not fit the Calabresi and Melamend (1972) definition of property rules. Thus, the use of a variant of the liability under the EEA is in line with the unique characteristics of trade secrets, which, as discussed earlier, do not involve the public disclosure associated with patents.

Options Analysis of the Law

[80] Blair and Cotter (2002), p. 6.
[81] Epstein (2003) p. 23.

Ayres (2005) applies the real options theory of economics to that of law to argue that property rules are a special case of liability rules. Using the put/call framework of options theory, Ayres describes liability rules as a call option in which the entitlement is taken non-consensually and the owner is paid damages.[82] He describes property rules as having a call option (damages[83]) so high that it deters non-consensual taking. In this sense, Ayres argues, "property rules are liability rules with an exercise price so high that the option is (almost) never taken."[84]

Ayres (2005) notes that the legal trend in the U.S. is the increasing "propertization of intellectual entitlements"[85] in the form of IP. However, despite the trend to strengthening the property status of IP, the options theory framework of Ayres (2005) argues that the property protection for IP is, as noted above, a variant of the liability rule.

In his analysis of the debate between property and liability rules, he criticizes Calabresi and Melamed's (1972) argument that liability rules are preferred when transactions costs are high. As Ayres argues, the transactions cost argument neglects to address the fact that bargaining can happen in the shadow of liability and property rules. Additionally, Ayres argues that options theory can show that liability rules can dominate property rules in economic efficiency terms.

However, Ayres (2005) does not solve the liability versus property rules debate. As he notes, "The stark truth is that despite the empirical prevalence of property (and indeed the headlong rush toward the extreme propertization of intellectual property), no one has to date produced a satisfying algebraic model in which property rules dominate liability rules."[86] Thus, in the liability – property rule

[82] This application of options theory is in line with Scotchmer's (2005) observation of the circular relationship between damages and royalty rates. As Scotchmer argues, the potential infringer can seek to negotiate royalty rates or exercise a call option in the form of infringement and the subsequent payment of damages.
[83] Further discussion on damages valuations, and the role of options analysis, can be found in Chapter 4.
[84] Ayres (2005) p. 5.
[85] Ayres (2005) p. 185.
[86] Ayres (2005) p. 199.

debate, the property status of other IP (e.g. patents) may raise more questions than it does answers.

Overall, the examination of the property – liability rule debate in the context of the EEA further underscores the structural differences between trade secrets and patents.

3.4 Database Construction

During the period covered by this thesis (1996-2008), there were 147 defendants in 95 cases involving the EEA. For this research, these cases have been identified using two sources: the Department of Justice (DOJ) Computer Crime and Intellectual Property website,[87] and the Public Access to Court Electronic Records (PACER) system. From the DOJ, two sources were used: a table of EEA prosecutions[88] from 1999 to 2005 and the DOJ press releases.[89] This method identifies high profile cases. The second method, using PACER, requires a time intensive searching of each court by prosecution code and is detailed in the appendix to this chapter. This method was performed to identify all 1832 (theft of trade secret) cases, as the process is time consuming. The PACER search method uncovered roughly 40 cases, which were not issued DOJ press releases or included in the EEA prosecution table. 1831 (economic espionage) cases, given their political importance, are considered to be high profile cases and are identified via DOJ.

Once identified, each case was then investigated via docket reports,[90] court documents and online media coverage. An abbreviated sample of the data collected can be found in the appendix. The docket reports were the most consistent source of quantitative information and provided filing and termination dates, sentences, fines and conviction codes. Linked to some docket

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87 Press releases available from http://www.usdoj.gov/criminal/cybercrime/index.html
88 Available from http://www.usdoj.gov/criminal/cybercrime/eeapub.htm
89 Available from http://www.usdoj.gov/criminal/cybercrime/ipnews.html
90 A docket is a record, kept by the Court clerk, which documents the list of judicial proceedings in court. The docket report is a list of these proceedings along with summaries of the proceedings (e.g. appearances and actions.) See the appendix to this chapter for an example.

reports were court documents (e.g. plea agreements and the original criminal complaint), which contained qualitative information about the defendant, the alleged crime and the victim.

Media reports often provided details on the victim's relationship to the defendant, the alleged value of the stolen trade secrets and parallel civil actions. Further information was gathered from academic papers related to the EEA.[91] Depending on the court, official documents are only available from more recent cases; in some courts, the documents are only available for cases since 2004. For a minority of cases, little to no information on the victim company and stolen information was available.

The information gathered in this prosecution data represents a unique look into the use of trade secrets, their theft and the policy choices available to governments.

3.4.1 Data Issues

The use of prosecution data in economics faces a number of challenges and the EEA data are no exception. The primary obstacle is that of adverse selection. Prosecutors select cases based on the severity of the crime and the likelihood of successful prosecution. Thus, the sample set is less likely to include minor thefts and more likely to include major thefts which leads to a negative skew in the distribution of the prosecuted thefts in comparison to actual thefts.[92] There are exceptions, however, as when a prosecutor chooses to prosecute a specific defendant in the hopes of deterring other criminals by increasing Becker's (1968) cost of committing a crime. This was most likely the case with U.S. v.

[91] Particularly Effron (2003), Carr, Morton and Furniss (2000), Carr and Gorman (2001), Zwillinger and Genetski (2000) and Nasheri (2005).

[92] However, Chapter 6 of this thesis tests the observed values for evidence of a truncated sample and fails to find statistical proof of its existence.

Genovese,[93] where the defendant was convicted based on the sale of Microsoft source code for $20.

Prosecutors are also more likely to seek prosecution in cases where the evidence is strong and a conviction is likely as the burden of proof in criminal cases has a "tougher criterion than in one used in civil disputes", as noted in Dnes (1996, 2009) and Cooter and Ulen (2003.) The EEA data have a conviction rate of 69% on at least one count (includes plea bargains), 11% not convicted and the remaining 20% pending. This compares to an estimated 90% conviction rate in federal court[94] of all federal cases that go to trial. The majority of prosecutors is elected and, therefore, has an incentive to keep their conviction rates high to appeal to voters.[95] In order to maintain these high rates, weaker cases are turned away. According to Transaction Records Access Clearinghouse (TRAC), from 2000 to 2002 U.S. attorneys declined to prosecute 32% of cases referred to them by investigative agencies.[96] Additionally, these referred cases have already been filtered as the agencies only refer cases deemed worthy of potential prosecution.[97]

There is also concern that the shift in priorities towards combating terrorism has led to a decrease in the FBI's attention to white-collar crime. FBI Assistant Direct Chip Burrus "likened the FBI's current fraud-enforcement policies – in which losses below $150,000 have little chance of being addressed – to 'triage.'" Even cases with losses approaching $500,000 are much less likely to be accepted for investigation than before 9/11."[98] The shifting to cases with higher losses means that the EEA data should contain a truncated sample with an overrepresentation of high loss cases. However, evidence discussed in Chapter 6 suggests that this is

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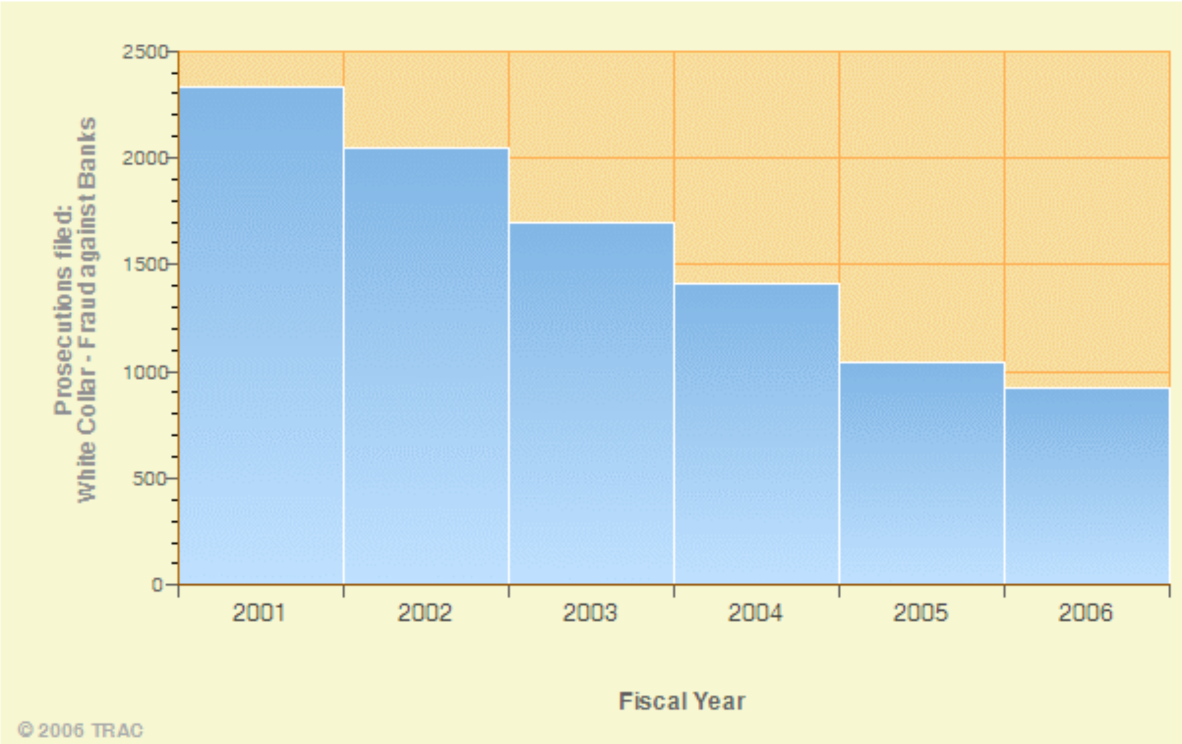
[93] U.S. v. Genovese, Criminal case 1:05-cr-00004-WHP (Southern District of New York, filed January 4, 2005).
[94] From http://www.masscriminal-lawyers.com/pages/types/whitecollarcrimes.html
[95] From http://www.lovefraud.com/06_legalSystemFailures/scant_prosecution.html
[96] From http://www.lovefraud.com/06_legalSystemFailures/scant_prosecution.html The TRAC website is http://trac.syr.edu/tracfbi/
[97] For a discussion of the incentives and relationships of prosecutors, judges and cases, see Cooter and Ulen (2003), pp. 422-425.
[98] Shukovsky, Paul, Johnson, Tracy and Daniel Lathrop, April 11, 2007, "The FBI's terrorism trade-off," *The Seattle Post-Intelligencer*, accessed September 09, 2008 from http://seattlepi.nwsource.com/printer2/index.asp?ploc=t&refer=http://seattlepi.nwsource.com/national/311046_fbiterror11.html

not the case. Enforcement of White Collar Crime as measured by prosecutions of fraud against banks has also been falling, as seen in Figure 3-2. This evident decrease in the priority of white-collar crime can further influence the data by excluding weaker EEA cases and including only strong cases.[99]

Figure 3-2: FBI Enforcement of White Collar Crime (2001-2006)



[100]

Additionally, the level of criminal sophistication may be correlated with detection (i.e. the colloquial expression that "only the stupid ones get caught.") If the intelligence of criminals and the level of sophistication of the crime are negatively correlated with detection and conviction, then the sample data may be biased towards less intelligent criminals committing simpler crimes. As Dnes (1996) mentions, there is a "common observation that members of the criminal classes are frequently of below average intelligence (Wilson and Herrnstein,

[99] The economic events and bank failures of 2008 onward have not been included in this sample and their prosecution would occur outside the scope of the1996-2008 EEA data.
[100] From TRAC, accessed September 09, 2008 from http://trac.syr.edu/cgi-bin/tracslides2.pl?id=fbi2005&slide=7

1985)."[101] Unfortunately, intelligence measurements are not readily available in the EEA cases and thus the argument that the intelligence of prosecuted criminals leads to data bias will remain untested.

A final point, which further obfuscates the use of the prosecution data, is the actual reporting of the theft of trade secrets. In order to seek prosecution, victims must first report the alleged crime to the FBI via an official document reporting the offense.[102] As Nasheri (2005) notes, "Probably the greatest reason why trade secret theft is not prosecuted more often is the failure of victim companies to report such thefts to government authorities."[103] The decision to report is influenced by a number of factors including initial detection, fear of negative publicity and reputation costs, fear of having the trade secret made public during the process of prosecution, and the burden of proving that the trade secret existed in the first place, as stated in Carr and Gorman (2001.) These incentives are discussed further in Section 3.7.

The cumulative effect of these challenges to the use of prosecution data is that conclusions arising from the data are tempered by the inherent sample bias. Despite this, it is important to remember that, given the nature of trade secrets, very little empirical data are available on their use. While the EEA data have its limitations, it gives us a unique insight into the use and theft of trade secrets. Economists have long used evidence from litigation to investigate the use of patents and their economic importance (Scotchmer 2005.) Patent litigation, for example, has many parallels with trade secret prosecution in that it requires detection of the infringement and the decision to prosecute. As Jaffe and Lerner (2004) note, evidence from patent litigation also encounters a selection bias arising from the fact that only a minority of patents are litigated, and, of these, a further portion are settled in out of court decisions. The use of patent litigation evidence can be found in Lanjouw and Shankerman (1997, 1999, 2001, and 2004), Shankerman and Scotchmer (2001), and Jaffe and Lerner (2004). As such,

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[101] Dnes (1996), p. 142.
[102] Via their local FBI office, reporting form is "Checklist for Reporting Theft of Trade Secret Offense", available from http://www.usdoj.gov/criminal/cybercrime/reportingchecklist-ts.pdf
[103] Nasheri (2005), p. 52

the EEA prosecution data are a legitimate means of analysis and offer a glimpse into the unseen world of trade secrets.

Lanjouw and Shankerman (2001) aptly describe the benefits of using litigation data:

> Intellectual property litigation reflects competition and conflict…. An empirical analysis of how these [litigation] choices are related to the characteristics of intellectual property assets and their owners, and to industry structure, offers a useful window through which to view strategic interaction among firms.[104]

The empirical analysis of EEA data developed throughout this thesis furthers the understanding of the strategic use of trade secrets as a means of protecting innovation and builds on the similar existing litigation studies in patents. This thesis joins Zwillinger and Genetski (2000), Lerner (2006) and Almeling et al (2010) in the use of court data to understand trade secrets.

3.5 Composition of Defendants

From its inception in 1996 through to 2008, 147 defendants were charged under the EEA. These defendants are alleged to have taken a trade secret from its legitimate owner. Given the economic espionage concerns that surrounded the birth of the EEA, the composition of the defendants themselves provides insight into the relevance of the drafters' concerns.

3.5.1 Relationship to the Victim

In order to commit the act of trade secret theft, the defendant had to be aware of, and gain access to, the trade secret. The data indicate that this threat of theft is not external but predominately internal. As shown in the last row of Table 3-1, the EEA data demonstrate that 76% of the defendants are insiders, 17% are outsiders and 7% have an unknown relationship. An "insider" is defined as a current or former employee, which includes permanent and temporary employees and consultants or workers performing contracted-out work (for a

[104] Lanjouw and Shankerman (2001), p. 129.

third party company.) These insiders had legitimate reasons to have knowledge of, and at least partial access to, the trade secret. In contrast, only 25 defendants were classified as outsiders, which include competitors, non-employees, or other roles that do not provide legitimate access.

While the fact that insiders are disproportionately responsible for theft in EEA cases should come as no surprise, as stated in Almeling et al (2010), it highlights the vulnerability that trade secrets face when much of their protection is based on nondisclosure agreements and the implicit trust required to support them. It also indicates that some of the presumptions which led to the signing of the EEA, as in Carr et al (2000), were concentrated misguidedly on outside threats, when the focus should have been more on the internal threat to the security of trade secrets. However, as Chapter 6 details, while insiders are responsible for the majority of thefts, outsiders target higher levels of trade secret intensity. That is, relative to the size of the firm, outsiders target more valuable trade secrets. This suggests that the concern over external threats to trade secrets was not unfounded.

Table 3-1: EEA Characteristics of Defendants

*Characteristics of Defendants**								
	Total		Relationship to the Victim					
Nationality	Count	%	Outsider	%	Insider	%	Unknown	%
Foreign	32	22%	7	5%	25	17%		
National**	115	78%	18	12%	86	59%	11	7%
Total	147		25	17%	111	76%	11	7%

Source: EEA database as seen in Appendix 3.11.3.

* Reports on 136 of 147 defendants; insufficient information available for the missing 11 observations.

**If nationality unknown, defendant assumed to be US national

3.5.2 Nationality

The nationality of the defendants presents another test to the original presumptions of the EEA. As seen in the second column of Table 3-1, only 22% of the defendants were foreign nationals, with the remaining 78% being either US nationals or nationality unknown. A binomial test rejects that the proportion of US nationals and foreigners is equal (the observed distribution is statistically different from a proportion of 50% US nationals and 50% foreign with a p-value 0.000.) Of the 32 foreigners charged with EEA violations, only one was convicted under 1831 (Economic Espionage.)[105] Given the concern with economic espionage at the drafting of the EEA, these numbers suggest that either economic espionage is less prevalent than trade secret theft, or that its detection is more difficult. In the fourth column of Table 3-1, only 5% of defendants were both foreign and classified as an outsider. The remaining 17% of foreign defendants were classified as insiders, which indicates that they had some form of formal employment relationship with the victim. However, given the relatively small sample size of only 32 foreigners, it is difficult to extend these estimates to draw strong conclusions. Despite this, patriotism, nationalism and existing relationships make foreigners in the US prime recruitment targets for economic espionage, as noted in Nasheri (2005). A 2008 review of 60 years of American spies revealed that foreign influences and loyalties play an increasing role in espionage.[106] While the role of monetary payoffs is likely to be an important motivation in economic espionage, nationalism can be a contributing factor.

3.6 Composition of Victims and Stolen Trade Secrets

In all EEA cases, the trade secrets and their legitimate owners have been the targets of trade secret theft. The composition of these targeted firms can further explain the strategic use of trade secrets.

3.6.1 Industrial Sectors of Victims

The EEA data also provide a look into the industries using trade secrets. The trade secret theft victim companies were identified and a Standard Industrial Classification (SIC) code assigned. For listed companies, this was done in a straightforward manner via the United States Securities and Exchange

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[105] Source: Excerpt from EEA database as seen in Appendix 1.
[106] Herbig (2008).

Commission (SEC) filing system Edgar.[107] Where Edgar did not provide a code, a description of the company was obtained via Goliath Company Profiles[108] and then the SIC code cross-referenced using the US Department of Labor's SIC Search System.[109] For 14 cases, the victim company was not identified. Table 3-2 shows the results, grouped by the SIC divisions and, where larger than 5%, the SIC major group. Note that in the majority (57%) of cases (based on cases, not number of defendants), the victim company operated in the manufacturing sectors. Of those in manufacturing, the largest groups include those in semiconductor manufacturing and manufacturers with software applications. The second largest sector is the service industry (17% of cases) and the remaining cases are scattered throughout other sectors.

The 1997 US Census[110] indicates that only 6% of establishments were classified as manufacturing. The largest sector is Service Industries, which comprises 32% of all establishments and 17% of the EEA cases. Interestingly, the census lists Retail Trade as the second largest sector, which accounts for 24% of all establishments but no EEA cases. The relative positions change slightly when the sectors are ranked by gross receipts (instead of number of establishments), where Manufacturing represents 22% of total gross receipts, Service Industries 10% and Retail Trade 14%.

The large discrepancy between the 57% of EEA cases and only 6% of establishments being in manufacturing suggests that protection of trade secrets from theft is particularly important to this sector. Manufacturing has long had patents available as a robust form of protection.[111] The cluster analysis, found in Section 3.8, indicates that the trade secrets used in manufacturing and construction were potentially patentable. This long history of IP, and the variety of available IP tools, suggests that the industry is well aware of IP and their use

[107] http://www.sec.gov/edgar.shtml
[108] http://goliath.ecnext.com/coms2/page_subscribe_compint
[109] http://www.osha.gov/pls/imis/sicsearch.html
[110] The 1997 Economic Census: Comparative Statistics for United States available from http://www.census.gov/epcd/ec97sic/E97SUS.HTM
[111] Several studies examine the use of patents in manufacturing sectors, including Arundel and Kabla (1998) and Scherer (1965).

of IP and its enforcement more likely. It is also possible that the relative concentration of the manufacturing sector makes detection more likely. For example, two firms dominate the aerospace industry: Lockheed Martin and Boeing. Movement of employees between these two firms is easy to track, so trade secrets can be more closely watched than in less concentrated sectors.[112]

That the manufacturing sector, a sector that has both patent and copyright protection available, should be so active in trade secrets, emphasizes the importance of trade secrecy protection. In the absence of this protection, the sector would have to alter its behaviour either to shift towards greater reliance on patents and copyrights, or enact potentially costly protection schemes to preserve the confidentiality of trade secrets. These results are in line with the findings of Cohen et al (2000) in their survey of manufacturing firms.

[112] US v. Branch and Erskine, Criminal case 2:03-cr-00715-RSWL-1 (Central District of California, filed July 17, 2003).

Table 3-2: EEA Victims by SIC

Industries of Victims by SIC code: EEA Cases from 1996-2008		
Industry	Count	%
Agriculture, Forestry and Fishing	0	0%
Mining	0	0%
Construction	2	2%
Manufacturing	54	57%
Electronic And Other Electrical Equipment And Components, Except Computer Equipment (Includes Semiconductors)	*16*	*17%*
Chemicals And Allied Products	*10*	*11%*
Industrial And Commercial Machinery And Computer Equipment	*8*	*8%*
Other	*20*	*21%*
Transportation, Communications, Electric, Gas and Sanitary Services	3	3%
Wholesale Trade	2	2%
Retail Trade	0	0%
Finance, Insurance and Real Estate	4	4%
Services	16	17%
Business Services	*11*	*12%*
Other	*5*	*5%*
Public Administration	0	0%
Unknown	14	15%
Total	95	

Source: EEA database as seen in Appendix d.

3.6.2 Subject Matter of Stolen Trade Secrets

Trade secrecy protection has a large scope. It encompasses confidential information including source code for software; test data; strategic business information; and potentially patentable subject matters. In the EEA cases, as seen in Table 3-3 column 2, only 39% of the stolen trade secrets are deemed potentially patentable (meaning that their subject matter is not excluded from patents; inventive step was not judged.) 11% of stolen trade secrets had no descriptive information publicly available. Of the remaining 49%, which is comprised of diagrams, pricing information, test data, marketing plans, software code etc, 20% of the stolen trade secrets has the potential to receive copyright protection. This 20% is predominately source code for computer software programs. The other 29% had only trade secrecy as a form of IP protection, which means that this confidential information is particularly vulnerable and its theft particularly damaging. Table 3-3 shows the summary statistics of the characteristics of these stolen trade secrets.

Table 3-3: EEA Trade Secrets

Characteristics of Stolen Trade Secrets: EEA Cases from 1996-2008		
Type	Count	%
Potentially patentable	38	39%
Not patentable	47	49%
Protected by other IP	19	20%
Not protected	28	29%
Unidentified	9	11%
Total	95	

Source: EEA database as seen in Appendix d.

It is important to emphasize that these classifications are based on limited information regarding the nature of the stolen trade secrets. Given the stringent requirements for patent protection, Table 3-3 most likely represents an overestimation of the number of stolen trade secrets that are potentially patentable. Additionally, copyright can provide insufficient protection for software source code, as reverse engineering is relatively easy and the information contained in source code allows competitors to develop add-on programs that may compete with the source code owner's other products, as noted in the Gower's Review (2006.) Thus, it is likely that this table overstates the number of trade secrets that could rely on other IP protection. The fact that these trade secret owners chose not to use those alternate protections is proof further of the importance of trade secret protection for protecting innovations.

3.7 Criminalization and Detection

In order to have an accurate picture of the evidence found in the EEA prosecutions, it is essential to examine the external effects created by the advent of criminal prosecutions of trade secrecy theft. The EEA offers firms a means of seeking criminal, in addition to the existing civil, action against trade secret thefts. It also affects the behaviour of employees and increases the potential punishment associated with theft.

3.7.1 Comparison to Civil Actions

Lerner (2006) investigates trade secret litigation for insights into trade secrets and compares this data to similar data on patent litigation. He notes, "In those cases where the damages were determined, they averaged $1.5 million in 2004 dollars. This is less than one-third the mean level of damages in the patent cases examined by Moore [2000]."[113] In the EEA cases, which do not exclude the possibility of parallel civil cases, defendants are subject to fines, forfeitures and restitution. The victim can benefit from restitution but does not necessarily receive the benefits of fines and forfeitures. The median restitution was $193,043, which is just over one tenth of the damages in Lerner's cases. The average restitution of $1.5 million resembles Lerner's average more closely but has an upward bias due to a number of high awards. A t-test suggests that the mean Restitution amount is $1,400,000 higher than the mean Fine (p-value

[113] Lerner (2006) p. 13 referring to Moore, Kimberly, 2000, "Judges, Juries, And Patent Cases — An Empirical Peek Inside the Black Box," *Michigan Law Review*, 99, 365-409.

0.004). Table 3-4 contains the standard deviations, minima and maxima for the fines, forfeitures and restitutions levied against convicted EEA defendants.

Table 3-4: EEA Fines, Forfeitures and Restitutions

EEA Fines, Forfeitures and Restitutions, 1996-2008			
	Fine	Forfeiture	Restitution
# of defendants (%)	35 (24%)	1 (1%)	32 (22%)
63 (43%) defendants were subject to fine, forfeiture and/or restitution			
Mean	$74,000	$60,000	$1,474,000
Standard Deviation	$338,000	-	$2,564,000
Minimum	$500	$60,000	$500
Maximum	$2,000,000	$60,000	$7,655,155

Source: EEA database as seen in Appendix d.

An obvious difference from civil cases is the incarceration penalties associated with criminal cases, which are absent in civil cases. In EEA cases, as noted in Table 3-5, 61% of all defendants were sentenced to some form of incarceration, house arrest, probation or supervised release. 61% of defendants were sentenced to probation, which averaged 33 months. Only 37% of defendants were incarcerated for an average of 22 months. However, as the conviction rate of EEA cases is 69%, this data indicate that 88% of those convicted in EEA cases receive some form of incarceration or probation. Five corporations are included in that conviction rate and are not subject to incarceration; therefore, virtually all individuals convicted in EEA cases receive incarceration and/or probation sentences.

Table 3-5: EEA Incarceration and Probation

EEA Incarceration and Probation, 1996-2008		
	Incarceration	Probation
# of defendants (%)	55 (37%)	89 (61%)
90 (61%) defendants were subject to incarceration (including house arrest) and/or probation (including supervised release)		
Mean (in months)	22	33
Standard Deviation	21.5	14.0
Minimum	2	6
Maximum	96	60

Source: EEA database as seen in Appendix d.

Further work remains to be done on the comparison of EEA criminal cases to trade secret civil cases. This work should provide insight into the policy differences between criminal and civil cases, the effects of the escalation of trade secrets to a felony and the influence on firms' behaviour.

Law and Economics Analysis of Tort and Criminal Law

Further analysis of the decision to convert the theft of trade secrets into a felony can be found in the law and economics literature. Dnes (2009) notes that criminalization of activity differs from civil action on three points: the standard of proof, *mens rea* (intent) and the element of public harm (i.e. that the public is harmed by such actions.) Furthermore, Dnes argues, "in tort, we tend to know when the accident or nuisance has occurred" while in criminal action, we may not. Thus, a prime role of the punishment in criminal cases is as a deterrent effect. This has important implications for the economic efficiency of the criminalization of trade secrets.

When applied to the theft of trade secrets, many of Dnes' (2009) elements of criminal law are met. Certainly, the standard of proof in EEA cases should be higher than parallel civil actions. However, the issue of intent may not be as straightforward. For this element to be met, the defendant would have to know that the trade secret they were stealing was, in fact, a protected trade secret. Furthermore, it may be, as in the case of Direct TV[114], that the defendant intended to do harm but without a financial motive. Given that the EEA is primarily concerned with the *economic* effects of trade secret theft, this lack of financial benefit raises concerns about the efficiency of using criminal actions to prosecute a previously civil nuisance.

The element of public harm in EEA cases is indirect. As trade secrets are privately held information, then the individual cases of theft are, by definition, private. However, the general deterrence effect of the EEA criminal sanctions should serve to benefit privately held information in general. If criminals are deterred by the EEA, then the owners of trade secrets can incur less wasteful avoidance expenditures to protect trade secrets. Thus, the public indirectly benefits from a more secure IP environment. Dnes (2009) puts this succinctly, and refers to Landes and Posner (1987), "sufficient penalties create deterrence, which removes the need for wasteful avoidance by potential victims."[115] In deterring the theft of trade secrets, a wasteful crime that benefits the few, in that costs incurred by the many owners of trade secrets in the form of wasteful avoidance are reduced. Thus, the deterrence effects of the EEA increases economic efficiency by decreasing the costs associated with protecting trade secrets.

However, Dnes (2009) is critical of the use of criminal law to protect torts that he deems that in some cases it is "staggeringly inappropriate."[116] He cites the example of the BBC license fee in the UK. The possession of a television without a license is subject to criminal sanctions in the form of fines. In this case, Dnes concludes, "the state is using its coercive power simply to reduce the cost of pursing those taking BBC services, offered to all, and subsequently failing to pay

[114] U.S. v. Serebryany, Criminal case 2:03-cr-00042-LGB (Central District of California, filed on January 16, 2003.)
[115] Dnes in Garoupa (2009) p. 112.
[116] Dnes (2009) p. 120.

for them."[117] However, this example differs from the EEA in that, unlike the BBC monitoring of licenses, in which the BBC has a legal right to issue and monitor licenses[118], the reporting of EEA thefts is a voluntary action on the part of the victim. Nonetheless, both cases involve criminal sanctions to support the business models of corporations.

Dnes (2009) further examines the delineation of criminal and tort law, and the use of criminal law in place of civil law, in a pollution example. In this case, the use of criminal law allows the coercive power of the state to "encourage desirable behaviour."[119] In this case, under tort law, a polluter will prefer to pay fines when the marginal cost of abatement of pollution is higher than that of the fine. However, Dnes argues that criminal fines are equivalent to a strict-liability tort[120] and fines are paid on all pollution above the minimal level. As Dnes points out, fines are always paid under the criminal law, whether or not the polluter abates. This, as Dnes argues, more efficiently discourages pollution.

An extension of this pollution example can be found in the EEA. The criminal prosecution of trade secrets could interact with the reverse engineering exception to trade secrecy. That is, the costs of reverse engineering could be considered abatement costs. Where reverse engineering is more expensive than fines, firms will choose to steal. In tort and contract law, the damages calculation (fine) can function as a compulsory license[121]. Under criminal action, theft is subject to fines and/or incarceration. When reverse engineering is cheaper than fines, firms will reverse engineer. By increasing the punishment associated with theft, the EEA indirectly encourages reverse engineering. Samuelson and Scotchmer (2002) argue that reverse engineering is important to innovation and competition and, thus, the EEA can be an important policy tool with respect to

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[117] Dnes (2009) p. 120.
[118] For details, see http://www.tvlicensing.co.uk/about/foi-legal-framework-AB16/
[119] Dnes (2009) p. 121.
[120] Liability which is independent of culpability (e.g. A common example is illegal drugs where mere possessive is considered intent.)
[121] As Burk (2009) notes, "Courts have in a very few instances denied injunctive relief to patent holders in favor of monetary damages, effectively creating a compulsory license for that patent, at a royalty determined by the court." P. 12.

reverse engineering.[122] Hence, the EEA promotes economic efficiency by encouraging innovation, which is seen as a social benefit.

However, a normative conclusion on the decision to criminalize the theft of trade secrets is beyond the scope of this thesis. While the EEA should improve economic efficiency in the reduction of avoidance costs and the benefits from innovation, the overall optimality of the criminalization of the theft of trade secrets is not certain. The analysis here suggest that the EEA increases economic efficiency by decreasing costs via improved deterrence and increasing social benefits by encouraging innovation. Further empirical investigations on the these effects of the EEA should shed more light on this fact. Whether the EEA's criminalization of the theft of trade secrets is entirely inappropriate remains to be seen.

3.7.2 Defendants' Costs and Benefits

The data concern only those defendants who were caught committing trade secret theft and prosecuted under the EEA. Becker (1968) describes general criminal behaviour as a rational decision. The criminal weighs up the costs and benefits of committing the crime and decides whether the crime is utility maximizing for the criminal. All of the cases in this study involve defendants who decided to commit the crime and whose crimes were discovered.

The defendants' motivations, or utility functions, are a factor in their decision-making. As Wheeler (in Schlegel and Weisburd 1992) notes, risk taking,[123] "fear of falling"[124] and a "culture of competition"[125] are all motivations for white-collar crime.[126] Wheeler points to greed as an incentive for risk-taking, while "fear of

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[122] However, as the Samuelson and Scothmer (2002) note, the legal status of reverse engineering under the EEA is unclear.
[123] Wheeler in Schlegel and Weisburd (2005), p. 113.
[124] *Ibid.*, p. 117.
[125] *Ibid.*, p. 117.
[126] Sutherland (1983) defines white-collar crime in a traditional sense as "a crime committed by a person of respectability and high social status in the course of his occupation" p. 7. While the EEA cases do not necessarily entail Sutherland's "respectability" and "high social status", they

falling" describes a general aversion to loss of prestige and perception of failure. The culture of competition developed in modern capitalism also fosters a desire to succeed and an aversion to failing in white-collar workers.

As Herbig (2008) argues, there are seven main motivations in espionage cases. While Herbig's research addresses that of espionage in general, the results can be applied to the economic espionage cases in this thesis.

1. Money
2. Divided Loyalties
3. Disgruntlement
4. Ingratiation
5. Coercion
6. Thrills
7. Recognition or Ego

With trade secrets, money or financial incentives are a motivation in many cases, as evidenced by the number of cases in which the defendant attempted to sell the trade secret or to use the trade secret for personal benefit.[127] Divided loyalties can be a motivation when the defendant has connections with foreign countries and/or competitors. Disgruntlement suggests that the thief, typically an employee, feels they are owed something. Ingratiation occurs when the defendant uses trade secrets to improve a relationship. Coercion implies that the defendant was forced to commit the crime; however, Herbig notes in her studies that no instances of coercion appear after 1980. Those who are motivated for the thrill of espionage are likely risk-seeking. Finally, some defendants will commit espionage for the recognition or ego-boosting effect it confers on the spy. These motivations will influence the criminal's utility function when making the rational decision to commit a crime (Becker 1968.)

The EEA defendants account for the motivations and the utility associated with the thefts and find them to outweigh the probability of detection and the cost of punishment. As Dnes (1996) notes, "We should find that: 1. Crime rates respond to the costs and benefits of committing crimes. 2. People respond to deterring

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certainly occur in the course of the occupation. As Geis and Goff's introduction to the 1983 edition notes, "occupational crime" and "economic crime" can be used as synonyms.

[127] In 22 out of 95 cases, the defendant attempted to sell the trade secrets to a third party.

incentives."[128] While this thesis does not measure the overall crime rate, it does examine the EEA's impact on incentives for both firms and would-be criminals. The EEA represents an increase in the deterring incentives associated with the theft of trade secrets and economic espionage by introducing criminal sanctions.

3.7.3 Detection and Reporting: The Impact on Victims

In EEA cases, all of the victims have been corporations and not individuals. The decision of these firms to detect, investigate, report and proceed with criminal prosecution involves a different weighing of costs and benefits than is necessary in civil cases.

Benefits to the Victim Firm

From a resource perspective, a decision to seek a criminal prosecution involves a number of benefits to the victim firm. Due to the defendant's right to a speedy trial, EEA criminal cases cannot drag on as long as civil cases, as noted in Oblon et al (1999.) As a result, the victim firm will save itself time and money by not being involved in a lengthy, distracting, resource-absorbing court case, as noted in Nasheri (2005.) In addition, in criminal cases, the cost of prosecution (lawyer's fees, court fees etc.) is borne by the government and not the victim. This is not the case with a civil case, in which the plaintiff must pay their own lawyer's fees and may face expensive countersuits (Cooter and Ulen, 2004.)

The moral benefits of choosing criminal prosecution of trade secrets theft include the ability to prosecute judgment-proof defendants, a stronger sense of retribution and a potentially stronger enforcement message. As Carr et al (2000) note, defendants with no financial resources can commit trade secrecy theft, a civil suit resulting in damages can be a moot point as the defendant is unable to pay (i.e. judgment proof.) The criminal system avoids this problem by including the option of incarceration as a form of punishment (as noted in Dnes, 2009.) Incarceration may have a stronger sense of retribution for trade secret victims as trade secret thieves are removed from the workplace and society at large, as

[128] Dnes (1996), p. 142.

noted in Dnes (1996.) This incarceration also sends a strong enforcement message and decreases the expected benefits of theft.

Costs for the Victim Firm

Criminal prosecutions of defendants entail potential costs for the trade secret owner. A conspicuous resource cost associated with criminal prosecutions in EEA cases is lower financial damages awarded to the victim, as noted earlier. If a victim's primary goal is to seek financial damages, then a criminal prosecution alone will not satisfy that goal. However, a criminal action against the defendant does not preclude a parallel civil action. Victims can choose to seek both a criminal and a civil action[129] and, thereby, mitigate the lower damages observed in criminal cases.

Trade secret cases also run the risk of exposing the secret to the public gaze; however, the EEA does include confidentiality requirements.[130] The trade secret becomes vulnerable to exposure during court cases, which, by definition, will negate its secrecy, as discussed in Lowry (1988.) As Lerner (2006) notes, a cost to the victim of taking legal steps following the misappropriation of a trade secret is the potential for the loss of trade secrecy. Competitors may be able to glean strategic information from the court documents even if the trade secrets are not revealed. Inevitably, a court case will increase the number of Cozzi's (2001) "hints,"[131] and the availability of what Nasheri (2005) calls Competitive Intelligence,[132] by increasing the number of public documents related to innovative activities.

From a relationship perspective, the cost of choosing a criminal prosecution includes reputational and control costs. As with civil cases, the revelation that a

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[129] Two examples in which the victim enacted a parallel civil suit in addition to the criminal charges are US v Kern, 2:99-cr-00015-DFL-1, filed January 21, 1999 in Eastern District of California and U.S. v. Four Pillars, 1:97-cr-00288-PCE-3, filed October 1, 1997 in Northern District of Ohio.

[130] 18 U.S.C. §1835, "Orders to preserve confidentiality".

[131] Cozzi (2001) describes the "hints" associated with innovative activity that alert would-be spies to the existence of such activity.

[132] Nasheri (2005) defines Competitive Intelligence as "a systematic and ethical program for gathering, analyzing and managing information that can affect a company's plans, decisions and operations" p. 73.

company has been the victim of a trade secrets theft can damage its reputation. The market may view the theft as evidence of lax security standards or future potential liability, as evidenced in Carr and Groman (2001). Nasheri (2005) reports on a survey where nearly one half of respondents would not report a theft to anyone outside the company.[133] However, criminal charges are likely to have particularly adverse effects on a firm's relationship and reputation with its employees. As the EEA data demonstrate, the majority of defendants are insiders and employees may object to the criminal prosecution of one of their colleagues. Increased distrust can change company culture and lower social capital within a firm. Indeed, one critique of the functional consequences of the EEA is that it unfairly restricts labour mobility, as noted in Nasheri (2005).

In addition, criminal prosecution requires that the firm relinquish control over the action to the government, as noted in Carr and Gorman (2001) and Oblon et al (1999.) While victims cooperate with the authorities, the FBI is in charge of the investigation and federal prosecutors will make important decisions related to the case. This loss of control presents a risk not found in civil cases where the plaintiff has significant control over the course of the case. Furthermore, Green et al (2000) suggest that if the victim firm is perceived to be "over-involved" in a case, it may negatively impact the outcome of the case as the judge may consider the "criminal case as a dress rehearsal for the civil case."[134]

The victim firm faces a number of options when confronted with a theft of trade secrets: do nothing, discharge the offending employee, or seek legal recourse in the form of criminal and/or civil actions, as noted in Hodskin and Wasik (1986). However, the decision to seek criminal action involves a number of financial and moral costs not associated with civil actions, as noted in Carr and Gorman (2001.) At the same time, the moral and financial benefits may make a criminal action worthwhile. The firms in the EEA cases, by definition, weighed these costs and benefits ex-ante and proceeded with reporting the crime.

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[133] Nasheri, Heidi (2005), p. 59.
[134] Green et al, (2000), p. 265.

From both an empirical and theoretical perspective, the comparison between the civil and criminal actions in trade secrecy cases and firms' decisions presents a potentially fruitful new research area. Such a possibility would need to be preceded by identifying the companion civil cases to the criminal EEA cases. This could also shed further light on the delineation between tort and criminal law as discussed in Dnes (2009.) Further work will need to be done in investigating the EEA data for evidence of these important issues.

3.8 Cluster Analysis

In order to better understand the use of trade secrets and the types of industries using them, the data have been subjected to a cluster analysis, a statistical technique for objectively combining data into distinct sub-sets or clusters. As Sharma (1996) notes, the observations in each cluster are similar and each cluster differs from other clusters with respect to the same characteristic.

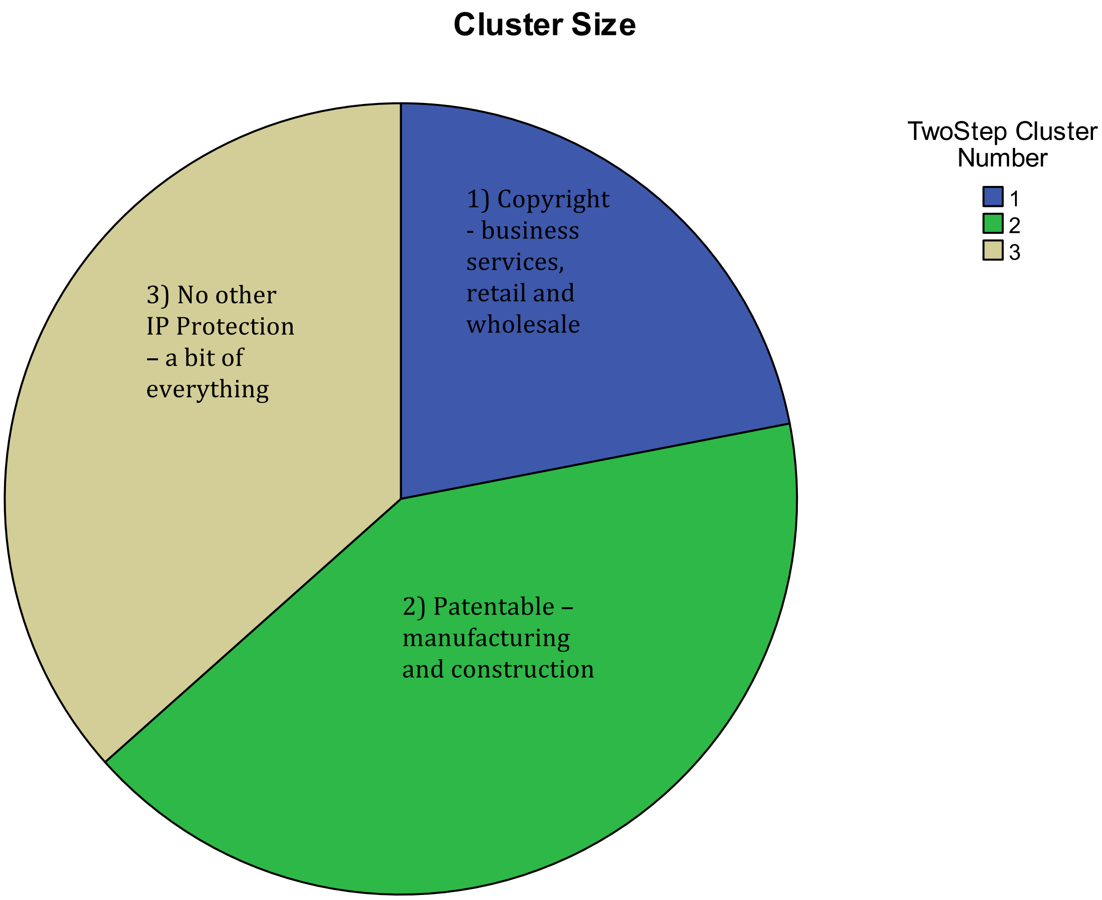
This analysis is done using a two-step cluster analysis. As Norusis (2010) describes, this method pre-clusters the variables and then runs a hierarchical clustering procedure on the remaining clusters. This is a procedure in SPSS that is particularly useful for large data sets and mixed categorical and continuous variables. The hierarchical clustering procedure calculates the squared Euclidean[135] distance between observations and agglomerates clusters iteratively. As the order of the data can affect the cluster analysis, the observations were sorted alphabetically by case name.

The cluster analysis was performed using the victim firm's SIC, the patentability of the trade secret and the ability of the trade secret to be protected by copyright as the clustering variables. The analysis results in three clusters, as shown in the pie chart below. The data cluster into three groups. Cluster 1 comprises the business services, retail and wholesale trade sector and includes trade secrets that could have been protected by copyright. Cluster 2 consists of the manufacturing and construction sectors and has potentially patentable trade

[135] Johnson and Wichern (2007) note that the Euclidean distance is the straight-line distance between two points (p. 30).

secrets. Cluster 3 is a mixed bag of trade secrets that were unlikely to qualify for alternate IP protection and includes a wide range of sectors.

Figure 3-3: Cluster Analysis based on SIC and type of TS



The 95% confidence intervals for the differences between the centroids (means of each cluster) are noted in the Figure 3-4. The chart demonstrates that, while differences between clusters 1 and 2 are statistically significant, the same cannot be said of cluster 3, though it does appear to differ considerably from cluster 1. The confidence interval for cluster 3 overlaps the confidence intervals of both clusters 1 and 2. However, clusters 1 and 2 clearly display statistically significant differences in means.

The SIC variable represents a range of nearly 5,000 integer values for the classification of the victim firm's industry. These values are structured so that similar industries will have similar SIC. Thus, the statistical difference between clusters 1 and 2 coincides with a difference in their industries. Cluster 1, for example, spans SIC from 4,500 to 7,200, which includes retail, wholesale trade and business services. However, cluster 2 ranges from 3,000 to 4,500 and is dominated by manufacturing and construction.

Figure 3-4: Confidence Intervals for Cluster Means

The means and the standard deviations of these clusters, based on SIC, can be found below. As Figure 3-4 suggests, cluster 3 has a mean close to the overall mean (the solid line) and a dispersion that overlaps with the confidence intervals of the other two clusters.

Figure 3-5: Mean of each Cluster based on SIC

Centroids			
		Victim SIC	
		Mean	*Std. Deviation*
Cluster	1	5796.00	2157.37
	2	3751.74	1501.50
	3	4488.90	1768.33
	Combined	4470.17	1903.23

A cross tabulation (Figure 3-6) of the clusters by their patentability, potential for protection by copyright, or neither demonstrates that the trade secrets are highly segregated by these types. As clusters 1 and 2 correspond with sectors, the overlap in the type of trade secret demonstrates that trade secrets with the potential for copyright are used in the business service and retail sector, whereas the manufacturing and construction sectors use trades secrets that are potentially patentable.

Figure 3-6: Cross Tabulation of Type of TS with cluster

Cross Tabulation of Cluster with Patentability, Copyright or Neither							
		Copyright		*Neither*		*Patent*	
		Frequency	*Percent*	*Frequency*	*Percent*	*Frequency*	*Percent*
Cluster	1	18	100.0%	0	0.0%	0	0.0%
	2	0	0.0%	0	0.0%	34	100.0%
	3	0	0.0%	30	100.0%	0	0.0%
	Combined	18	100.0%	30	100.0%	34	100.0%

One caveat to this cluster analysis is that the trade secrets were necessarily determined to be potentially patentable or subject to copyright by exercising judgement. With copyright, this is a sound method as copyright can be applied to most original works.[136] However, the same cannot always be said of patents as they require governmental approval and are not applicable to all subject

[136] As Anson and Sicker in Anson and Suchy (eds.) (2005) note, copyright includes, but is not limited to, "art and artwork, logos and graphics, music, books, databases, cartoons, photography, software, characters and poetry" pp. 102-103.

matters, as noted in Dnes (1996.) Furthermore, it can be argued that firms actively use trade secrets to protect innovation because the innovation is not patentable, as Arundel (2001), Cohen et al (2000) and others note. Finally, the cluster analysis may merely detect the researcher's bias in determining the type of trade secret.

Further attempts at using other cluster analysis methods, such as the hierarchical method, failed to uncover any significant results. This is likely to be due to the small sample size and highly heterogeneous use of trade secrets. Other attempts at applying the two-step cluster method, in the presence of other categorical variables, also failed to produce statistically significant clusters.

However, the two-step cluster analysis provides a useful framework for analysis. It indicates that the manufacturing and construction industries are using trade secrets to protect potentially patentable innovations. This evidence suggests that trade secrets represent a viable alternative to patents, particularly for these industries, which is in line with the findings of the Cohen et al (2000) survey. The heavier use of copyrightable trade secrets in the business services and retail trades points to a number of possibilities. One is that these industries do not produce patentable innovations. Another possibility is that trade secrecy is preferred to copyright protection, as noted in Scotchmer (2005.) These issues will be explored via case studies in the next section.

3.9 Illustrative Case Studies

Using the cluster analysis as a basis for structural analysis, we now turn to look at illustrative case studies of EEA prosecutions. These case studies will shed further light on the strategic use of trade secrets, the considered decision to use trade secrets in the presence of other IPR, the security measures used to protect the trade secret, and the defendant's means and motive of theft. Two case studies are presented for each cluster of the three clusters identified in Section 3.8. The cases have been selected as they represent the spectrum of different industrial sectors, types of theft and size of victim firm.

3.9.1 Cluster 1: Copyrightable Trade Secrets in Service and Retail Sectors

The following two case studies are in the service (software developers) and retail (fashion industry) sectors. In both cases, the trade secret could have been protected by copyright, but it would have proved insufficient for the subsequent criminal prosecution of these thefts.

Fashion: U.S. v Gantt and White

In U.S. v. Gantt and White, the theft of customer lists and other proprietary information demonstrates the strategic importance of trade secrecy protection for potentially copyrightable confidential information in the public relations industry. The trade secret in this case is a database of customer lists; while basic databases do not qualify for copyright protection, the significant time and effort required for its development would allow for copyright protection in this case. The victim company, ENK, runs trade shows for the fashion industry. A then-current employee of ENK, Gantt, aged 24, and a former employee, White, aged 27, conspired to make copies of ENK's database. In total, Gantt and White misappropriated half a gigabyte of password-protected proprietary information, including contact lists, invoices, floor design and décor and pricing information. Gantt used this information to solicit business for her temporary employment agency. The theft was uncovered when another employee reported that Gantt was conducting this business during her working hours at ENK. Gantt was eventually fired, after having e-mailed various lists to White and copying files to a USB drive.

Maintaining the confidential nature of these strategic business documents was crucial to ENK's business model. As such, the information was maintained electronically in password-protected folders.[137] The court papers refer to the files as "ENK's 'crown jewels' and note that the information would give any

[137] ENK International, LLC v. Morgan Gantt and Jeffrey White, 1:08-cv-08007-RJS filed 16/09/08 in S.D. NY, Document 1, Nature of the Action, p. 5.

competitor a tremendous advantage in closing its competitive gap with ENK."[138] The vast amount of files copied by Gantt constituted "an invaluable blueprint for operating a successful fashion industry tradeshow business."[139] The loss of the confidentiality of this strategic information represented a potentially huge negative impact on ENK's business model. Furthermore, the theft of these trade secrets caused reputational harm to ENK. Gantt's employment agency sought to provide temporary staff for exhibitors at ENK trade shows. However, one of the show venues had a contractual arrangement with ENK that only unionized labour would be used at their shows. Gantt's unauthorized staffing of the trade shows violated this agreement and potentially damaged ENK's relationship with the venue.

Gantt's staffing agency was greatly aided by her knowledge stemming from the ENK documents. As an entry-level employee, the civil suit alleges, "Gant was operating MyTempO! Staffing, her private temporary employment business, from ENK's offices during work hours, utilizing ENK's resources and leveraging her connections and access she gained through her employment with ENK."[140] In addition to the financial motivation of the theft, disgruntlement was also a motivation. Gantt's co-defendant, White, was fired from ENK in the months before the theft occurred. White's disgruntlement provides an example of the harmful intent that merits the criminal treatment of trade secret theft. As Dnes (2009) argues, this subjective intent[141] falls clearly on the criminal side of the tort-criminal boundary.

This case provides an example of the technological methods used to prove the theft of trade secrets. An internal investigation at ENK used tracking software to record an image of Gantt's work computer screen every three minutes. The evidence gathered via this software demonstrated that Gantt was specifically targeting ENK events for her staffing agency. Text messages between the two

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[138] *Ibid.*, p. 12.
[139] *Ibid.*, p. 2.
[140] *Ibid.*, p. 7.
[141] *Subjective* intent looks at the state of the defendant's mind in anticipation of the crime (i.e. the expected crime), which is in contrast to *objective* intent which looks at the outcome.

defendants were also traced from Gantt's ENK-issued Blackberry. Together, White and Gantt left an electronic trail that led to their indictment. The technological tools allowed ENK to both understand the extent of the theft and examine White and Gantt's use of the trade secrets.

ENK's business is based on designing, organizing and marketing trade show events and thus the company's value rests in its business network and not on physical assets. As a small business,[142] ENK's provides an illustrative example as to the strategic and financial importance of trade secrets to smaller businesses. The use of the EEA statutes allowed ENK to enforce the protection of these trade secrets with criminal prosecution in addition to relying on contractual law. The criminal charges against Gantt and White were filed in October 2008 shortly after the civil suit filed by ENK. In the civil suit, ENK received a temporary injunction against Gantt or White's use of any data stemming from the ENK confidential documents. Ultimately, however, the criminal charges were dropped. The civil case was dismissed with prejudice in December 2009 after the parties agreed to an undisclosed settlement agreement.

Computer Hacking: U.S. v. O'Neil[143]

The O'Neil case is a prime example of the use of technology in corporate espionage. O'Neil, the 43-year-old CEO of Business Engine Software (BES), a software product and services company, along with two of his colleagues, was charged with various counts of stealing confidential business information from a competitor, Niku (now owned by Computer Associates International.) The BES employees were convicted of hacking into Niku's computer system and downloading over 1,000 strategic documents containing technical specifications, product designs, customer proposals and prospective customers. Given the software and confidential business information nature of these documents, the only available IP protection for Niku was trade secrecy and copyright. However,

[142] According to a profile on manta.com, the company has turnovers of $520,000 and 12 employees. www.manta.com/c/mm3lns0/fashion-coterie

[143] USA v. McKimmy, McMenamin and O'Neil, 3:04-cr-00118-PJH-3, filed 05/05/2004 in N.D. CA.

as software can be reverse engineered, Niku chose trade secrecy and thus derived value from the secrecy of the files.

The actions of BES were uncovered somewhat by chance when a brother-in-law of the Chief Information Officer (CIO) of Niku received an unsolicited phone call from BES. Finding the call unusual, the CIO investigated the Niku's access logs and discovered that BES had accessed the system over 6,000 times since 2001. Using an online Niku training program that was not password-protected, BES was able to hack into the confidential information.[144] In a separate civil suit, BES paid Niku $5 million.[145] The chance discovery of this theft underscores the tenuous status of trade secrets and the difficulty associated with detecting their theft. Furthermore, it provides a clear example of the argument put forth in Dnes (2009) that criminal actions are relatively harder to detect.[146]

Niku had taken significant steps to protect these trade secrets. The civil suit provides details on how the company undertook the reasonable steps required for trade secrecy: non-disclosure agreements with employees, restricted access to sensitive documents, knowledge of trade secrets only on a need-to-know basis, controlled access to company facilities and further security steps.[147] The software company also employed a sophisticated password system in which users had access only to necessary documents. The only users with full access were the system administrators, which were the accounts BES hacked. Niku's sophisticated protection of the trade secrets, despite their failure, indicates that the company was well aware of the business importance of maintaining trade secrecy.

As a software and business services company, Niku has limited options for protection of its innovations. The documents consisted of over 1,000 files of

[144] Gilbert, Alorie (December 09, 2005), "Former software chief admits stealing trade secrets." *Cnet news.com,* available from www.news.com/2102-7350_3-5989750.html
[145] *Ibid.*
[146] Dnes (2009) argues that the coercive power of the state via criminal actions acts as a deterrence. He argues that this is less applicable to tort-related actions as the accident or nuisance is more apparent.
[147] Complaint, Document 1 in Niku vs. Business Enterprise, 3:02-cv-03866-MHP filed 12/08/2002 in N.D. CA., p. 5.

strategic business information, potential customers, ongoing deals and pre-market products. Copyright protection is available for software but does not prohibit reverse engineering. Hence, Niku's reliance on trade secrecy is a strategic mixing of copyright and trade secrecy to protect its software and confidential business information. The stolen trade secrets included design and architecture documents for an unreleased Niku software codenamed "Barracuda." In testimony, the Senior Vice President of Research & Development at Niku stated that,

> The Barracuda documents contain Niku's secret innovations in the field, the functionality of which Niku has not revealed in any released product. … Beyond allowing a competitor to free-ride on Niku's efforts to save time and resources in bringing a product to market, because the Barracuda information is the cutting-edge of Niku's technology, it would allow a competitor to "leap frog" Niku in the market and offer customers next-generation products before Niku would be able to release those features.

This statement highlights the value of trade secrets in the R&D stages of product development. Copyright protection would have been insufficient, as it would not have prevented competitors, once they had the documents, from reading and acting on the information. Thus trade secrets were crucial to the strategic protection of these Niku documents and the prosecution of their theft.

One article described the documents as "the crown jewels" of Niku.[148] The business and marketing information, including details of potential customers and ongoing negotiations, had great potential value for competitors. In fact, the use of these documents allowed BES to become last-minute competitors in major deals. [149] One Niku executive testified that

> In none of these transactions, involving Prudential, Tesco or Lloyds, was I made aware, at the inception of Niku's negotiations with each of them, that Niku was in a competitive situation with Business Engine, and I was surprised to learn, after Niku had spent considerable time and effort in attempting to develop a relationship with those customers, that they were evaluation Business Engine's competing products. … I have strong reason to believe that Business Engine or its agents used the customer related

[148] Kerstetter, Jim (August 23, 2002), "You're Only as Good as Your Password," *Business Week*.
[149] *Ibid.*

> information it obtained from Niku's computer system to interfere with Niku's relationship with those customers.[150]

The theft of these trade secrets gave BES a considerable competitive advantage. At the same time, Niku protected this information using trade secrets, the only IP protection available. This case further reinforces the importance of trade secrecy for service companies.

The motivations of this crime appear to be financial in that the trade secrets gave the defendants access to potential buyers and detailed information on sales tactics. As such, their reputation and financial compensation at BES would have likely increased with their improved sales. It also points to Wheeler's (2005) "culture of competition" within BES as three of their executives were convicted in this criminal case. In addition to the direct negative impact of the criminal case, it is likely that the case had indirect reputational costs for BES. Towards the end of 2005, when the criminal case was well underway, a spokesperson for BES emphasized that BES was trying to put the episode behind them.

The O'Neil case presents a modern tale of cyber crime and industrial espionage in Silicon Valley. It emphasizes the software industry's reliance on trade secrets and the insecurity that arises from the digitization of trade secrecy. All three of the BES employees were convicted and O'Neil was sentenced to 12 months imprisonment and fined. As noted earlier, the civil case resulted in a settlement of $5 million for Niku. However, at the time, Niku was already suffering as a company in 2002 and had cut back from 1,100 employees to 300 and seen sales fall 38% from 2001.[151] Niku has since been acquired by Computer Associates.

3.9.2 Cluster 2: Potentially Patentable Trade Secrets in Manufacturing and Construction

These next two cases occur in the manufacturing sector with one case being Coca-Cola, a foodstuffs manufacturer, and the other a chemical manufacturer.

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150 Declaration of Joshua Pickus, Document 9 in Niku vs. Business Enterprise, 3:02-cv-03866-MHP filed 12/08/2002 in N.D. CA., p. 6.
151 Kerstetter, Jim (August 23, 2002), "You're Only as Good as Your Password," *Business Week*.

The formulas and designs for the trade secrets in question were potentially patentable, but the firms chose instead to use trade secrecy.

Coca-Cola: U.S. v Williams, Dimson and Duhaney[152]

A discussion on trade secrets would be incomplete without the inclusion of the Coca-cola secret formula. Williams, a 42-year-old disgruntled secretary at Coca-cola, stole confidential documents and product prototypes from her employer. Through the assistance of two friends, Dimson, aged 30, and Duhaney, aged 43, Williams attempted to sell the trade secrets to Pepsi, Coca-cola's largest rival. Dimson posed as a Coca-cola executive and offered Pepsi "information that's all Classified and extremely confidential … I can even provide actual products and packaging of certain products…"[153] Pepsi-cola reported the offer to Coca-cola and the trio was implicated in an FBI sting operation.

The defendants' motivations were a combination of financial incentives and disgruntlement. Williams is quoted as telling her co-defendants that she was angry with Coca-cola because she was "not treated right."[154] She was also aware that she had signed confidentiality agreements with Coco-cola. Williams also had two previous convictions, including one "involving making false statements related to unemployment insurance."[155] Her co-defendants had both been incarcerated at the same Alabama federal prison. Money was likely the overriding incentive for this crime as the defendants collectively sought to gain over $1.5 million.

Williams's theft of the secrets was fairly straightforward as she downloaded the secrets, which consisted of confidential information on Coca-cola's marketing campaign, onto a USB drive. These secrets were likely only protectable via trade secrecy. However, Williams also stole samples of new, unreleased Coca-cola

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[152] USA v. Williams et al, 1:06-cr-00313-JOF-GGB-3, filed 11/07/2006 in N.D. Atlanta.
[153] United States Attorney David E. Nahmias, US DOJ press release (October 23, 2006) "Two Defendants Plead Guilty in Coca-Cola Trade Secrets Case" available from www.usdoj.gov/usao/gan/
[154] Appeal Document No. 07-12653 in the U.S. Court of Appeals for the Eleventh Circuit, filed in U.S. v. Joya Williams 1:06-cr-00313-JOF-GGB-3, filed 11/07/2006 in N.D. Atlanta, p. 3.
[155] Weber, Harry P. (2007), "Ex-Coke Secretary gets 8 years in prison", *Associated Press*, published in *USA Today,* 23/05/2007.

products. Like the famous Coca-cola secret formula, these product samples had the potential for patentability, as their chemical makeup is patentable subject matter. However, like the secret formula, Coca-cola had chosen to use trade secrecy to protect this strategically important knowledge. Details on how the files and product samples were protected through technical measures were not available; however, Williams had signed confidentiality agreements. A Google Patent search reveals that Coca-cola has over 420 granted patents[156] and pending applications including some chemical foodstuffs.[157] Thus, the lack of patent protection for this product sample likely represents a deliberate decision not to patent the new product during its R&D phase.

The discovery of the theft came about when Pepsi reported Dimson's attempted sale to Coca-Cola. Pepsi's motivations in reporting the theft may have been altruistic or fear of the potential liability associated with the involvement in a criminal act. Nonetheless, Pepsi's actions alerted Coca-cola to a theft that might otherwise have gone unnoticed. The FBI sting lasted roughly a month as an FBI agent posing as a Pepsi representative negotiated with the trio for initial payments of approximately $50,000 and final payments of $1.5 million for the documents and samples. Throughout these negotiations, Williams was recorded at work taking further documents and samples. As all three defendants had previous convictions, the sentencing periods were longer than if the defendants had been first-time offenders. Williams was sentenced to 96 months of incarceration in addition to community service.

Plastics: U.S. v Kim[158]

Kim, a South-Korean immigrant to the US, was convicted in 2008 of stealing trade secrets from his employer over a period of seven years. Dr. Kim, a 63-year-old with a PhD in Physics, was a Senior Research and Development Officer at

[156] Google Patents, www.google.com/patents performed May 12, 2010, search term "inassignee: Coca-Cola"
[157] As an example, Coca-cola has 13 patents and applications in U.S. Patent Class 426/74, Product with Added Plural Inorganic Material or Element Fortification, Google Patents, Google Patents, www.google.com/patents performed May 12, 2010, search term "uspclass:426/75 inassignee: Coca-Cola".
[158] USA v. Kim, 1:08-cr-00139-SO-1, filed 26/03/2008 in N.D. OH.

Lubrizol, a specialty chemicals company with annual sales of $4.5 billion. Three executives at SK Chemicals, a competitor company located in South Korea, paid Kim $10,000 per meeting for a series of 17 separate meetings lasting several days each in which Kim provided them with information and files related to confidential Lubrizol technology. The theft was discovered in 2007 when Lubrizol noticed "a huge advance in the development of SK Chemicals' thermoplastic polyurethane product…. At the same time, Lubrizol learned from an employee in South Korea that SK had someone on the inside."[159]

Few details are available on the trade secrets themselves as the indictment document has not been made publically available. This could be because the indictment contains revelations about the trade secrecy that would expose the trade secrets. However, the DOJ press release describes the trade secrets as "trade secrets regarding Thermoplastic Polyurethane and other confidential Lubrizol technology; this included Non-Halogen Flame Retardant Technology sold under the Estane® trade name … and static control technology..."[160] Kim provided the SK Chemicals executives with files, handwritten faxes and discussions during the meetings. Collectively, this suggests that the trade secrets were linked to technology related to chemical products that is potentially patentable. Lubrizol is an active patenting entity as a Google Patent[161] search revealed over 500 applications and granted patents where Lubrizol is listed as the sole assignee. Additionally, two applications and one granted patent specifically refer to trademarked brand Estane, one of the technologies included in Kim's theft. Thus, this case provides evidence that Lubrizol uses a strategic combination of patents, trademarks and trade secrecy to protect its innovations.

Another element of this case that provides insight into the use of technology is the extent of the internal investigation into Kim's actions. In a court document, Lubrizol provides a copy of some of the invoices from the $29,000 bill from the

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[159] Sims, Damon (November 22, 2008) "Lubrizol Corp. worker gets prison for selling trade secrets to competitor," Cleveland.com available from http://blog.cleveland.com/metro//print.html
[160] DOJ, N.D. OH (November 12, 2008) "Trade Secrets Charges Against Company Executives and South Korean Nationals".
[161] Conducted May 12, 2010 on google.com/patents using the search term "inassignee: Lubrizol".

private investigators hired to look into the theft.[162] The invoices detail the actions taken to uncover Kim's trail and include extension computer searching, interviews, file signature analysis, reading of personal e-mails and background checks. The invoices demonstrate that the average hour of contracted investigation cost Lubrizol $250 in addition to internal costs incurred. While Kim's theft was unusual in that it occurred over several years and was thus potentially more difficult to investigate, the direct cost to Lubrizol demonstrates the financial burden which victims face.

Extensive details are available on the motivations of Kim in committing this crime. Kim's Sentencing Memorandum details his life as an immigrant and how he had worked his way up from pushcart seller to a PhD in Physics. His defence team sought leniency in sentencing by arguing, "he was driven to commit the charged offenses not merely out of greed, but out of a deep feeling of failure."[163] Kim cited his lack of advancement within the company and a divorce as being the source of this sense of failure. Kim's extensive connections in South Korea may also have led to split loyalties and the court documents suggests that some disgruntlement, due to not being addressed as "Dr." at work, were also contributing motivations. Nonetheless, Kim benefited financially from the $170,000 he received for the sale of Lubrizol's trade secrets. At the conclusion of the case, Kim cited "ignorance" as the reason he agreed to spy.[164]

Kim was sentenced to 19 months imprisonment and ordered to pay $188,700 in restitution to Lubrizol. As a letter from Lubrizol states, "Mr. Kim's criminal conduct harmed Lubrizol. While Lubrizol has not attempted specifically to quantify the total financial loss for restitution purposes, the amounts involved

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[162] Letter to Hon. Solomon Oliver, Jr. from Greg Lewis, Corporate Vice President of Lubrizol, Re: United States v. Kyung J. Kim, dated November 10, 2008, Document 10 in USA v. Kim, 1:08-cr-00139-SO-1, filed 26/03/2008 in N.D. OH.

[163] Defendant's Sentencing Memorandum, dated November 17, 2008, Document 16 in USA v. Kim, p. 3.

[164] Sims, Damon (November 22, 2008) "Lubrizol Corp. worker gets prison for selling trade secrets to competitor," Cleveland.com available from http://blog.cleveland.com/metro//print.html

are far in excess of what Mr. Kim could hope to repay."[165] Given this reality, the prosecution of Kim is an example of the use of the EEA against an otherwise judgment-proof defendant.

An unusual conclusion to this case is that in October 2008, seven months after Kim was indicted, Lubrizol bought SK Chemical's thermoplastic polyurethane business for $5 million.[166] A news report at the time indicates that this portion of SK Chemical's business had annual sales of $30 million.[167] As no civil litigation was uncovered in this research, it is possible that Lubrizol chose not to sue and instead "probably managed to negotiate a good price with SK."[168] With this purchase, Lubrizol gained "equipment, technology, customer lists and manufacturing know-how",[169] in addition to containing the leak of its trade secrets. The fact that the theft had been on-going for seven years indicates that SK Chemical's unfair competitive advantage arising from the theft and the associated civil liability was likely to be very large. It is possible that a civil settlement and/or injunction would have made SK Chemical's thermoplastic polyurethane business unit untenable. Lubrizol's decision to purchase the business unit appears to be a shrewd business move that avoided the costs of litigation. No other EEA cases have been uncovered in which the victim company purchased the beneficiary of the trade secrets theft. Thus, the Lubrizol represents a novel business resolution to the theft of trade secrets.

3.9.3 Cluster 3: Cases Where Neither Patents nor Copyright Were Available

These final two cases are prime examples of trade secrets that could not have been protected by other forms of IP. In both cases, the victim firm was dependent on trade secrecy for maintaining this confidential information.

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[165] Letter to Hon. Solomon Oliver, Jr. from Greg Lewis, Corporate Vice President of Lubrizol, Re: United States v. Kyung J. Kim, dated November 10, 2008, Document 10 in USA v. Kim, 1:08-cr-00139-SO-1, filed 26/03/2008 in N.D. OH.
[166] Lubrizol description, available from http://seekingalpha.com/symbol/lz/description
[167] Sims, Damon (November 22, 2008) "Lubrizol Corp. worker gets prison for selling trade secrets to competitor," Cleveland.com available from http://blog.cleveland.com/metro//print.html
[168] *Ibid.*
[169] Lubrizol description, available from http://seekingalpha.com/symbol/lz/description

The Boeing Case: U.S. v. Erskine and Branch[170]

The Boeing Case is a high profile case of the theft of trade secrets by employees. In this EEA case, Erskine, a 43-year-old Boeing employee, recruited Branch, a 64-year-old Lockheed Martin (Boeing's top competitor) employee, to bring proprietary Lockheed documents to Boeing. At the time, the two companies were in a bidding war for U.S. government military contracts for Evolved Expendable Launch Vehicles (EELV) worth $2 billion.[171] In an unwritten deal, Erskine stole Lockheed bid information documents and gave them to his new employer in return for a 7.5% raise over his salary at Lockheed. Boeing then submitted a bid for the EELV contracts armed with this information. As Oliver (2009) reports, "It was generally believed that Lockheed was the superior rocket builder. However, Boeing had lower prices and won 19 of the first 28 EELV launches."

The theft was uncovered when another employee, whose wife worked at Lockheed, saw the documents and reported them to Boeing's legal department. The matter was initially investigated internally at Boeing in 1999, and later by Air Force personnel who reported identifying 3,800 pages of Lockheed documents.[172] Branch and Erskine were fired in 1999 and indicted in 2003.

This case demonstrates the value of trade secrets for the manufacturing and constructing sectors. Bid information falls into the category of Confidential Business Information and does not meet the originality standards for copyright, nor is it of a patentable nature. Thus, Lockheed could only rely on trade secrecy and security measures to protect this information. As the DOJ press release reports, "Seven of the documents appeared to be related to the manufacturing costs of the Lockheed Martin EELV and, in the opinion of USAF EELV staff, possession of these proprietary documents could have had a 'high' or significant chance of affecting the outcome of a competitive bid." Furthermore, these

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[170] USA v. Branch, 2:03-cr-00715-RSWL-1, filed 17/07/2003 in C.D. CA.
[171] Department of Justice press release (June 25, 2003) "Two Former Boeing Managers Charged in Plot to Setal trade Secrets from Lockheed Martin."
[172] Oliver, Douglas L. (2009), "Engineers and White-Collar Crime," *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction,* February 2009, p. 36.

documents were marked "Lockheed Martin Proprietary of Competition Sensitive" and Lockheed had taken adequate steps to protect the trade secrets.

The Boeing case also highlights the issues of labour mobility as a source of the loss of trade secrecy. When Boeing merged with McDonnell Douglas in 1997, another aerospace and defence manufacturer, the market took another step towards becoming a duopoly. As Zuker (2004) argues, the market for defence contracts essentially functions with two dominant contractors, Boeing and Lockheed. Thus, these two companies dominate the market for the highly specialized skills of aerospace engineers. "With only a handful of rocket builders in the United States, job switchers often moved from one competitor to another."[173] The mobility of employees between the two companies means that former employees represent a potential source of leaks. Indeed, Jennings (2009) reports that, in 1997, "Lockheed sent Mr. Branch a letter reminding him of his confidentiality agreement with Lockheed and his duty not to disclose any proprietary information in his new position at Boeing."[174]

An interesting point of this case is the damage it caused Boeing. While it would appear that Boeing initially benefited from the use of Lockheed's trade secrets, the long-term cost to the firm was immense. To begin with, Erskine and Branch unsuccessfully sued Boeing for wrongful termination. After the internal investigation in 1999, Boeing officially notified the Air Force that it possessed Lockheed documents but "failed to disclose the quantity and importance of these documents."[175] It was not until 2002 and 2003 that Boeing disclosed that it still possessed Lockheed documents and their nature. As a result, in 2003 the Air Force denied Boeing roughly $1 billion in contracts.[176] Furthermore, in combination with other scandals associated with Boeing, these actions resulted in the company paying a $615 million settlement to the U.S. Government in

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[173] Bowermaster, David (January 9, 2005), "Boeing probe intensifies over secret Lockheed thesiss," *The Seattle Times,* p. 2.
[174] Jennings, Marianne M. (2009) Business Ethics: Case Studies and Selected Readings, *South-Western College,* United States, p. 130.
[175] Zucker, Major Jennifer S. (2004), "The Boeing Suspension: Has Increased Consolidation Tied the Department of Defense's Hands?", *The Army Lawyer*, April 2004, p. 21.
[176] Oliver (2009), p. 36.

2006.[177] While there was also discussion of Boeing seeking a tax write-off for this $615 million payment, the government ultimately succeeded in maintaining a tax-neutral approach.[178] The cost to Boeing of allowing and benefiting from the use of a competitor's trade secrets includes the loss of contracts, the $615 million payment to the government and long-term reputational costs.

The motivations of Branch include money and ingratiation. Branch used his position at Lockheed to gain access to trade secrets, which he then leveraged to secure a higher-paying position at Boeing. Furthermore, Branch was flown up to the EELV project's headquarters 43 times over 18 months to meet with Boeing executives, where the topic of discussion was the Lockheed secrets and the bidding process.[179] These meetings suggest that Branch used his knowledge to ingratiate himself further with his superiors and that Boeing was aware of Branch's possession of Lockheed's confidential information. Erskine's motivations are less clear. While he does not appear to have benefited from the spying directly, Erskine may have received financial benefits in the form of performance-related bonuses or recognition within the firm.

This case also brings up issues of company culture and ethics. The employee who reported the theft internally stated that, "he was stunned by Erskine's story, especially since he and Erskine had just completed ethics training. But he said that Erskine told him he was 'hired to win' and 'was going to do whatever it took.'" An employee who initially reported seeing Lockheed documents in 1997 was reprimanded.[180] Boeing's three-year delay in disclosing the documents fully and their admissions that "at least 10 of its workers were aware Branch possessed stolen Lockheed documents"[181] point to a company culture that encouraged underhand techniques. As Wheeler (in Schlegel and Weisburd,

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[177] See Deputy Attorney General Paul J. McNulty's statement before the Senate Committee on Armed Services August 1, 2008 for further details.
[178] *Ibid*., tax-neutral meaning that the IRS received the same amount of taxes as it would have had Boeing not had to pay the settlement fee.
[179] Bowermaster, David (January 9, 2005), "Boeing probe intensifies over secret Lockheed thesis," *The Seattle Times*.
[180] Jennings (2009), p. 130.
[181] Bowermaster, David (January 9, 2005), "Boeing probe intensifies over secret Lockheed thesis," *The Seattle Times*.

1992) notes, "People will commit crimes the greater the frequency, duration and intensity of their contact with others who condone or participate in criminal activity."[182] The company culture that condoned these and other actions cost Boeing at least $1.6 billion. Branch and Erskine faired relatively well as the EEA charges were eventually dropped, although Branch was convicted of a separate charge.

The $8 Million Dollar Company: U.S. v. Lange[183]

"You must admit it is nice to have an $8 million company handed to you (I see a smile on your face.)"[184] This is what Lange, aged 24, reportedly told a competitor of the company whose technical information he was attempting to sell. In 1999, Lange, a sub-contracted draftsman, attempted to sell measurements and manufacturing data required to make copies of RAPCO, an aircraft parts manufacturer, certified parts. The competitor to whom Lange initially tried to sell these documents reported the incident to the FBI. After attempting to sell the documents for $100,000 in an FBI sting, Lange was arrested.

This case is unique in that Lange appealed the decision by arguing that RAPCO's trade secrets did not meet the necessary standards of trade secrecy. Arguing that the RAPCO had not taken the reasonable steps to protect the trade secrets, and that the trade secrets themselves were not secret as they could be reverse engineered, Lange failed in his appeal. The court published an opinion in which the details of RAPCO's security and confidentiality agreements demonstrated the adequate protection of the trade secrets. Furthermore, "It is by keeping secrets from its rivals that RAPCO captures the returns of its design and testing work."[185] The court further argued that Lange's attempt to sell the information for $100,000 demonstrated that the documents had economic value.

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182 Wheeler in Schlegel and Weisburd (1992).
183 USA v. Lange, 2:99-cr-00714-JPS-1, filed 08/09/1999 in E.D. WI.
184 Halligan, Mark (2001), The Trade Secrets Homepage Espionage Act of 1996 available from tradesecretshompage.com/indict.html
185 Circuit Judges Cudahy, Easterbrook and Ripple, U.S. Court of Appeals for the Seventh Circuit, "U.S. v. Matthew R. Lange," No. 00-1681 decided November 26, 2002, p. 7.

These trade secrets were related to the production of airplane parts; however, they would not have qualified for patent protection. RAPCO produces aftermarket aircraft parts. This requires the purchase of original parts, the disassembly of these parts and precise measurements of each part. Through a series of experiments, RAPCO then determines the material compositions to achieve the correct process and product for the Federal Aviation Authority's (FAA) standards. In this case, while the original parts were potentially patentable for the original innovator, RAPCO could not have obtained patent protection as they were not RAPCO's innovation. Furthermore, copyright protection would be unlikely as the information was recordings of tests and not original, creative material. Thus, RAPCO had no other means of protecting the measurements and test data of the trade secrets.[186] As Egbert (2003) notes:

> In order to obtain approval from the FAA, completed assemblies must be exhaustively tested. For a complex part, this process typically required a year or two and considerable expense, in order to complete a design and obtain approval. The process of experimenting and testing can be avoided if the manufacturer demonstrates that its parts are identical (in composition and manufacturing processes to parts that have already been certified.[187]

Thus, while the confidential information could not achieve copyright or patent protection, it would have been extremely valuable to RAPCO's competitor by saving the expenses associated with achieving FAA certification. Trade secrecy, in this case, was a crucial means of IP protection and strategic management of business information for the manufacturing company.

Lange's motivations appear to be a mixture of financial hubris and disgruntlement. Described as a "disgruntled former employee,"[188] Lange sought to benefit financially from the sale of his former employer's trade secrets. His criminal culpability was fairly evident as the court showed that he had actually consulted an attorney, who advised against the attempted sale of the documents, before contacting a potential buyer. Lange committed further criminal offenses

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[186] The trade secrets also included some design drawings, which could have been protected by copyright, albeit only weakly.

[187] Egbert, William (2003), "U.S. v. Lange: Conviction for Attempted Sale of Trade Secret Information," *Baker Bott LLP,* published February 2003, available from www.bakerbotts.com/infocenter/publications

[188] *Ibid.*

by “feigning compliance while retaining an electronic copy” of the trade secrets and tried to persuade a friend to perjure himself on Lange’s behalf.[189] This again represents a clear case of subjective intent where Lange was well aware of the legal status of his actions and sought to benefit from them nonetheless.

This case is again one where the potential buyer, a main competitor of the victim firm, reported the theft to the victim firm. Without this cooperation, RAPCO may not have uncovered the theft. Lange was convicted and sentenced to 30 months imprisonment and ordered to turn over all of the stolen trade secrets. Furthermore, Lange was also convicted of copyright infringement, which is related to his attempt to sell a pirated copy of AutoCAD, a computer assisted design software, as part of his trade secrets bundle. The case demonstrates the vulnerability that manufacturers have to the potential loss of strategic trade secrets via employees.

3.10 Conclusion

The EEA marked a change in the U.S. approach to trade secret theft and the threat of economic espionage. It also offered researchers an unprecedented opportunity to gain insight into the use of trade secrets by US firms, the composition of victims, the content of trade secrets and the composition and motivation of defendants. While the data have some disadvantages, it provides a hitherto unavailable insight into the world of trade secrets.

The data collected for this thesis, 147 defendants in 95 cases of the EEA since its inception in 1996 until 2008, demonstrate that some of the original concerns of the drafters of the EEA were misguided. Insiders present the largest threat to trade secrets and are responsible for the vast majority of thefts; Chapter 6 will further investigate the role of outsiders. Non-nationals, the group whom the drafters of the EEA initially regarded as suspects, emerge as less of a concern, or at least a less detected problem than originally anticipated. The industry reporting the most thefts is the manufacturing sector, which suggests that trade

[189] Circuit Judges Cudahy, Easterbrook and Ripple, U.S. Court of Appeals for the Seventh Circuit, “U.S. v. Matthew R. Lange,” No. 00-1681 decided November 26, 2002, p. 13.

secrets are of particular strategic importance to these firms and their enforcement is a priority. Finally, the nature of the trade secrets in EEA cases reveals that a mere 39% of them could be patented. Even with this liberal estimate, the choice of trade secrecy by firms indicates that the firms view trade secrets as an important strategic IP tool and that these secrets are particularly vulnerable to outright theft or other forms of misappropriation.

The efficiency of criminalisation of the theft of trade secrets remains to be tested. As more cases are prosecuted under the EEA, a clearer picture of the use of criminal law in place of tort or contract law with respect to trade secrets should emerge. As Dnes (2009) notes, the use of criminal law for tort-like actions can be appropriate. He notes that, "Broadly, the emphasis is on the nature of criminal intent, and the manner in which widespread impacts may have very high values attached to them."[190] Given the sometime high values of trade secrets discussed later in this thesis (Chapter 5), the EEA may represent an appropriate policy measure.

The cluster analysis and subsequent case studies illustrate the role of trade secrets in firms and the development of their theft. As the six case studies demonstrate, trade secrets often provide a crucial means of protection of strategic business information. The cases demonstrate how owners either had no other IP available or deliberately chose to use trade secrecy in lieu of, or in conjunction with, patents or copyright. The detection of theft in these cases also provides a cautionary tale for the owners of trade secrets as it is shown to occur frequently through accidental discovery or the report of the theft by the potential buyer. Additionally, these cases provide insight into the motivations and goals of the criminals who commit trade secret theft. In all but one of the presented cases, they were current or former employees whose primary motivation was financial. Collectively, these cases highlight the strategic value of trade secrets and their vulnerability to theft.

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[190] Dnes (2009) p. 123.

This chapter suggests how EEA data create a promising step towards developing more thorough empirical analyses of trade secrets and their strategic use. The chapters that follow will use this EEA data and cases to examine further the valuation of trade secrets (Chapter 4), the statistical content of observed values (Chapter 5) and the determinants of trade secret intensity (Chapter 6.) Furthermore, the EEA data are suggestive of further areas of potential research. These include a more detailed comparison of criminal versus civil cases, theoretical modelling (including game theoretic analysis), and econometric modelling (e.g. of the relations between the value of trade secret theft and the severity of punishment for the theft.)

3.11 Appendix: Use of PACER in Database Construction

Approximately 2,500 pages were accessed via PACER in the construction of the database. The PACER documents and search results were accessed at a cost of $0.08 per page. The PACER website is available to the public but registration and payment for use is required. Additional data were found, at no charge, in company websites, news reports and company databases such as Edgar-Online.

The identification and detailing of cases was through queries run on the criminal charges code. Each of the 94 federal district courts was individually searched. The query process begins with access to the individual district court systems via PACER. The following website contains links to the 94 district court PACER websites: www.pacer.gov/psco/cgi-in/links.pl

Once a district court's PACER portal was accessed, the criminal search window was obtained by using the Reports tab > Criminal reports > Criminal cases. The search query of the district court was as follows:

Table 3-6: PACER Search Criteria for EEA Cases 1996-2008

Selection Criteria for Report	
Office	All
Case Type	Cr
Citation	18:1832.F
Pending Counts	Yes
Disposed Counts	Yes
Filed Date	1/1/1996-12/31/2008
Case Flags	All
Terminal Digits	All
Pending Defendants	Yes
Terminated Defendants	Yes
Fugitive Defendants	Yes
Non-Fugitive Defendants	Yes
Sort by	Case number

Using these query terms, PACER produces the search results with links to the relevant cases. These cases were then accessed for docket reports and links to related documents, such as indictments, plea agreements, appeals, sentencing memoranda and other associated documents.

The following pages contain a sample docket report and a sample document; in this case, an indictment. Note that, in consideration of space, the examples have been chosen for their brevity. From documents such as these, the defendant, victim, trade secret and other such data were achieved. An excerpt from the final product follows these examples. The excerpt provides a snapshot of the type of information gathered for the database. A more complete version of the database can be found in the appendices to this thesis.

3.11.1 Example Docket from PACER: USA v. Dorn

CLOSED

U.S. District Court
District of Kansas (Kansas City)
CRIMINAL DOCKET FOR CASE #: 2:02–cr–20040–GTV–1

Case title: USA v. Dorn
Magistrate judge case numbers: :01–mj–08020
:01–mj–08023

Date Filed: 05/01/2002
Date Terminated: 08/20/2002

Assigned to: Senior Judge G. Thomas VanBebber

Defendant (1)

Jeffrey W Dorn
TERMINATED: 08/20/2002

represented by **Curtis E. Woods**
Sonnenschein, Nath &Rosenthal, LLP — KC
4520 Main Street, Suite 1100
Kansas City, MO 64111
816–460–2425
Fax: 816–531–7545
Email: cwoods@sonnenschein.com
TERMINATED: 08/20/2002
LEAD ATTORNEY
PRO HAC VICE
ATTORNEY TO BE NOTICED
Designation: Retained

Pending Counts	**Disposition**
18:1832(a)(1) Theft of Trade Secret (Indictment filed 5/1/02) (1)	2 years probation w/special conditions of supervision; $100.00 assessment; $15,920.00 restitution

Highest Offense Level (Opening)

Felony

Terminated Counts	**Disposition**
None	

Highest Offense Level (Terminated)

None

Complaints	**Disposition**
None	

Plaintiff

USA

represented by **Leon J. Patton**
Office of United States Attorney — Kansas City
500 State Avenue, Suite 360
Kansas City, KS 66101
913–551–6730

Fax: 913–551–6541
Email: leon.patton@usdoj.gov
LEAD ATTORNEY
ATTORNEY TO BE NOTICED

Date Filed	#	Docket Text
05/01/2002	1	INDICTMENT by USA Jeffrey W Dorn (1) count(s) 1 (TRS) (Entered: 05/03/2002)
05/01/2002	2	PRAECIPE for Summons as to defendant Jeffrey W Dorn (TRS) (Entered: 05/03/2002)
05/01/2002		SUMMONS ISSUED to USM as to Jeffrey W Dorn; arraignment set for 9:00 a.m. on 5/16/02 before Magistrate Judge David J. Waxse (cc: USM) (TRS) (Entered: 05/03/2002)
05/06/2002	3	NOTICE OF HEARING change of plea hearing set for 3:00 p.m. on 6/3/02 for Jeffrey W Dorn before Judge VanBebber (cc: all counsel, USM, USPO) (TRS) (Entered: 05/06/2002)
05/06/2002	4	MOTION to continue initial appearance to 6/3/02 at 11:30 a.m. as to defendant Jeffrey W. Dorn by plaintiff USA referred to Magistrate Judge David J. Waxse (TRS) (Entered: 05/07/2002)
05/07/2002	5	ORDER by Magistrate Judge David J. Waxse; granting motion to continue initial appearance as to defendant Jeffrey W. Dorn [4–1] arraignment reset for 11:30 p.m. on 6/3/02 for Jeffrey W Dorn (cc: all counsel, USM, USPO) (TRS) (Entered: 05/09/2002)
06/03/2002	6	MINUTE SHEET of hearing before Magistrate Judge David J. Waxse as to defendant Jeffrey W Dorn first appearance of deft. Attorney Curtis Woods present Bond set to $50,000 U/S; arraignment held on 6/3/02; change of plea hearing set for 3:00 p.m. on 6/3/02 deft. arraigned; not guilty plea entered; recorded #: 02–18 (YH) (Entered: 06/03/2002)
06/03/2002	7	ENTRY OF APPEARANCE for defendant Jeffrey W Dorn by attorney Curtis E Woods (YH) (Entered: 06/03/2002)
06/03/2002	8	APPEARANCE BOND Posted $50,000 U/S by defendant Jeffrey W Dorn (YH) (Entered: 06/03/2002)
06/03/2002	9	ORDER setting conditions of release for defendant Jeffrey W Dorn. Defendant ordered released on $50,000 U/S bond by Magistrate Judge David J. Waxse (YH) (Entered: 06/03/2002)
06/03/2002	10	MINUTE SHEET of hearing before Judge G. T. VanBebber as to defendant Jeffrey W Dorn change of plea hearing held on 6/3/02; deft. plead guilty at to count 1; sentencing hearing set for 3:00 p.m. on 8/19/02 Court Reporter: Nancy Wiss (YH) Modified on 08/15/2002 (Entered: 06/05/2002)
06/03/2002	11	PETITION TO ENTER PLEA OF GUILTY AND ORDER ENTERING PLEA by Judge G. T. VanBebber guilty plea entered by Jeffrey W Dorn (cc: all counsel, USPO) (YH) (Entered: 06/05/2002)
06/03/2002	12	NOTICE OF HEARING sentencing hearing set for 3:00 p.m. on 8/19/02 for Jeffrey W Dorn (cc: all counsel, USM, USPO) (YH) (Entered: 06/05/2002)
08/13/2002	13	SENTENCING MEMORANDUM by defendant Jeffrey W Dorn (YH) (Entered: 08/14/2002)
08/19/2002	14	MINUTE SHEET of hearing before Judge G. T. VanBebber as to defendant Jeffrey W Dorn sentencing hearing held on 8/19/02 as to Jeffrey W. Dorn; deft. sentenced to 6 months home detention; 2 years supervised release; $100.00 assessment; $15,920.00 restitution Court Reporter: Ryder (YH) (Entered: 08/20/2002)

08/20/2002	15	JUDGMENT ENTERED by Judge G. T. VanBebber as to defendant Jeffrey W Dorn sentencing Jeffrey W Dorn (1) count 1. 2 years probation w/special conditions of supervision; $100.00 assessment; $15,920.00 restitution , terminating party Jeffrey W Dorn , case terminated # of pages: 5 (cc: counsel, USM, USPO, Judge) (YH) (Entered: 08/20/2002)
09/24/2002	16	SATISFACTION of assessment as to defendant Jeffrey W Dorn (cc: Finance) (YH) (Entered: 09/26/2002)
02/03/2003	17	Probation Jurisdiction Transferred to Southern District of Iowa as to Jeffrey W Dorn Transmitted Transfer of Jurisdiction form, with certified copies of indictment, judgment and docket sheet. (mm) (Entered: 06/09/2003)

3.11.2 Sample Document from PACER: Wu Indictment

IN THE DISTRICT COURT OF THE UNITED STATES

For the Western District of New York

MARCH GRAND JURY
(Empaneled 3/16/04)

THE UNITED STATES OF AMERICA

-vs-

XINGKUN WU

05-CR-6007 L(P)

INDICTMENT

Violation:

18 U.S.C. §1832(a)(1)

FILED
05 FEB 17 PM 12:48
U.S. DISTRICT COURT
W.D.N.Y. ROCHESTER

<u>COUNT ONE</u>

The Grand Jury Charges:

From on or about March 30, 2000 and continuing to on or about April 28, 2000, in the Western District of New York, the defendant, **XINGKUN WU**, did knowingly steal and appropriate without authorization trade secrets, specifically (a) an eighteen-page presentation titled "Liquid Crystal Cross & Connect (CCX) Optical Design" dated May 1999; (b) a three-page document titled "Microbend Exchange at Wilmington, Experimental Outlook: Bend Sensitivity Study Using a High Cutoff DC Fiber While in a Multimode Operation" dated March 1998; (c) three pages of technical design drawings for Wavelength Add/Drop Module; and (d) a file concerning a project known as "Project Fox Glove", which trade secrets are related to or included in products that are produced for or placed in interstate or foreign commerce, intending or knowing that his acts would economically benefit anyone other than, and would injure, Corning Incorporated, the owner of the trade secrets.

All in violation of Title 18, United States Code, Section 1832(a)(1).

DATED: Rochester, New York
February 17, 2005

MICHAEL A. BATTLE
United States Attorney

By: [signature]
TIFFANY H. LEE
Assistant United States Attorney
United States Attorney's Office
Western District of New York
620 Federal Courthouse
100 State Street
Rochester, New York 14614
(585) 263-6760, ext. 2251
tiffany.lee@usdoj.gov

A TRUE BILL:

[signature]
WENDY ADAMS
FOREPERSON

3.11.3 EEA Database Extract

Category of Information	Case Information			Characteristics of Defendant		Characteristics of Trade Secret						Characteristics of Victim		Conviction and Punishment						
Source	Docket Reports from PACER			Docket Reports, Media Reports, Academic Papers		Docket Reports, Media Reports, Academic Papers						Docket Reports, Media Reports, Academic		Docket Reports						
Variables	Colloquial Case Name (District)	Filing Date	District	Dummy Nationality (1=foreign)	Insider/Ex vs. Outsider Dummy (1=outsider)	Type of Information Stolen	Potentially Patentable Dummy, 1=yes	Potentially TM or Copyrightable Dummy, 1=yes	Alleged worth of stolen items (low)	Alleged worth of stolen items (high)	Proposed or Actual Sale Price	Victim Company	Victim SIC	Conviction Code	Incarceration	Probation	Total financial punishment	Fine	Forfeiture	Restitution
Defition of Variable	US v. Last Name of Defendant	Date case filed in district court	District and State of court case (S.D. = Southern District, C.D. = Central District, etc.)	Nationality dummy, 1 = foreign or dual nationality, 0 = unkown or US national	Relationship to the victim, 1 = outsider, 0 = insider, N/A = not available	Brief description of the stolen trade secret.	Determines whether stolen trade secret was potentially patentable, 1 = yes, 0 = no, N/A = not available	Stolen trade secret was potentially protected under copyright or trademark, 1 = yes, 0 = no, N/A = not available	Low estimate of stolen trade secrets in dollars	High estimate of stolen trade secrets in dollars	Dollar amount the defendants were seeking to gain from the sale of the information to others	The legitimate owner of the stolen trade secret	SIC code of victim	Convicted offenses by US Criminal Code, 0 = no conviction, 1832 = Theft of Trade Secrets	Sentence in months of incarceration and home confinement	Sentence, in months, of probation and supervised release	Total amount of Fines, Forfeiture and Restitution	Dollar amount of all fines levied against defendant	Dollar amount of forfeiture assessed against defendant	Dollar amount the defendant is required to compensate the victim
Sample Cases	US v. Campbell (Susan)	February 25, 1998	N.D. GA	0	0	Confidential and proprietary information	0	0	150,000	800,000	150,000	Gray Comm.	4833	0	0	0	0	0	0	0
	U.S. v. Petrolino	November 29, 2001	S.D. FL	0	1	securities broker customer and account information	0	0	N/A	N/A	3,800	First Union Securities	6189	1832	0	24	0	0	0	0
	US v. Tejas Procurement Services	December 9, 1999	N.D. TX	0	0	Plan for oil field and pipeline machinery	1	0	7,650,000	200,000,000	100,000	Caterpillar	3531	1832	0	60	7,655,155	0	0	7,655,155
	US v. Krumrei	October 28, 1998	E.D. MI	0	0	Floor coating machine	1	0	31,400,000	31,400,000	350,000	Wilsonart (owned by Illinois Tool Works: ITW)	3083	1832	24	24	10,000	0	0	10,000
	U.S. v. Serebryany	January 16, 2003	C.D. CA	1	0	access card control information	0	1	68,000	25,000,000	N/A	DirecTV	4841	1832	0	60	145,900	0	0	145,900

The above table represents an abbreviated sample of the information contained in the EEA database created as part of this research. In the interest of space, a number of variables (e.g. dropped charges, number of co-defendants and other descriptive information) have been omitted.

Chapter 4: Damages valuations of trade secrets

> We're here because it's no longer enough to have the best ideas or the best manufacturing, or the best pipeline to deliver your product. We're here today because we find ourselves in a world where duplicity and theft are tested daily as replacements for innovation and perseverance.[191]

4.1 Introduction

Continuing with the analysis of EEA cases, this chapter seeks to investigate the damages valuation of trade secrets. As Halligan and Weyand (in Anson and Suchy (eds.), 2005) note, "The economic valuation of trade secret assets has perplexed the intellectual property bar for years. The economic and legal issues seem inextricably intertwined."[192] In EEA cases, the challenge of valuing trade secrets is complicated further by the role the valuation plays in criminal cases. The valuation of the stolen trade secret is a key factor for the application of the Sentencing Guidelines[193] and can determine whether or not a defendant will go to jail. However, as this chapter will demonstrate, the valuation methods vary widely and their application in EEA cases is contentious (Green et al, 2000.) As will be argued, the use of Reasonable Royalty presents a fair method in EEA cases, as in Zwillinger and Genetski (2000.) This chapter presents a critical survey of the valuation models used in EEA cases and examples of their use. It is followed by Chapter 5, which presents a statistical analysis of the values found in these cases.

Academics and practitioners alike have long sought to determine the value of ideas and innovation protected by trade secrets (see Eaton and Kortum, 1995; Helpman, 1993.) Accurate valuation of ideas is challenged by their quasi-public good and intangible nature. Like a pure public good, ideas are non-rival; however, they are not strictly non-excludable as their communication and

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[191] Tom Wilkinson as CEO Howard Tully in *Duplicity*. Produced by Laura Bickford, Jennifer Fox, John Gilroy and Kerry Orent. Directed by Tony Gilroy. Starring Clive Owen, Julia Roberts, Tom Wilkinson and Paul Giamatti. DVD. Universal Pictures. 2009.
[192] Halligan and Weyand (in Anson and Suchy (eds.), 2005), p. 86.
[193] United States Department of Justice (2006), "Prosecuting Intellectual Property Crimes."

dissemination can be limited. IPR enhance the excludability of ideas, transforming them into collective (or club) good.[194] In the case of patents, the information remains non-rival, but the application of the information into processes and products is limited. As noted in Noam (2004), "The difficulty of estimating the demand for public goods is a major problem for public resource allocation. Unlike private goods, public goods are not traded in a market, and no mechanism exists which relates quantities with their price." These difficulties also spill over to the valuation of collective goods (see Graves (2009) for a discussion.)

The intangible nature of the ideas which trade secrets seek to protect also poses challenges to the valuation of trade secrets. Direct valuation of an idea itself is difficult, as the demand for ideas is actually the demand from the processes it improves and the products it creates, rather than from the idea itself. Traditional means of valuation (such as cash flow analysis, replacement cost and comparison to benchmark assets to establish a market value) are compromised by the intangibility of ideas. The attribution of future cash flows to an idea is dependent on many other, both tangible and intangible, inputs. Furthermore, unlike other inputs, an idea does not necessarily depreciate with consumption. The life expectancy of an idea is also uncertain as it may prove long lasting (e.g. the idea of the wheel) or short lasting (e.g. the idea for the portable c.d. player), as discussed in Green et al (2000.) A costing of the inputs used in the creation of the idea is also hampered as ideas stem from various creative processes and may be the result of years of work, or an instant flash of genius (Scotchmer, 2006.) Sales of benchmark assets are difficult to establish, due to the unique nature of each new idea (Smith and Parr, 2005.) These issues, and others surrounding the valuation of trade secrets, and the ideas they protect, will be explored further in this chapter.

Researchers have attempted to overcome some of the difficulties associated with IPR valuations when determining the value of patents (Bloom and Van Reenan, 2002.) The valuation of trade secrets stems from the models created for the

[194] A "collective" or "club" good is a good that is non-rival but excludable.

valuation of patents. Legally more secure, better defined and publicly disclosed, patents are a clearer form of IP than trade secrets. One advantage, which the valuation of patents has over the valuation of trade secrets, is that patents have a well-defined expiration date of 20 years (Anson and Suchy, 2005.) While this date may be tempered slightly by market obsolescence, cumulative innovation and invalidation, the fact that patents have a terminus greatly strengthens the validity of their valuation; for example, through methods such as discounted cash flow or options modelling (Slottje, 2006.) However, these, and other models, lose accuracy when applied to trade secrets because of the greater legal ambiguity of trade secrets, and their lack of an expiration date (Anson and Suchy, 2005.) Additionally, the very secrecy itself of trade secrets means that empirical evidence on trade secrets is limited. Patents, on the other hand, benefit from publication and disclosure, which enhances the evidence available to researchers (Hall et al, 2005.) As Anson, in Halligan and Weyland (2005) notes, "The value of the Trade Secret is an implied value with no tangible proof that the value would have or could have been realized."[195]

Discussions of the valuation of trade secrets, or of any intellectual property, via their estimation arising from court-assessed damages must inevitably confront the ambiguity between damages and valuations (Green et al, 2000.) Valuations seek to determine a market value of an asset, whereas damages generally seek to assess the value lost as a result of the harm created (Slottje, 2006.) As seen in the Venn diagram in Figure 4-1, all damages estimates can be considered valuations, but not all valuations can be considered damages estimates. As Smith and Par (2005) note, "Infringement damages are yet another measure of value under unique circumstances."[196] That is, damages are a proper subset of the more general category of valuations, as shown in the figure below.

[195] Anson and Weston (eds.) (2005), p. 84.
[196] Smith and Parr (2005), p. 615.

Figure 4-1: Damages as a Subset of Valuations

Firms often use traditional economic valuation methods, such as discounted cash flow methods, for internal valuation and accounting purposes (Block and Hirt, 2002.) However, for external business valuation methods or acquisition underwriting, the more conservative damages approach may be more appropriate. Firms may find it more prudent to think of trade secrets in terms of what would be the value in a legal dispute, rather than the value to the company internally (Halligan and Weyland, 2005.) The test of value becomes not one of an internal firm dialogue, but ultimately of what value will stand up in court. As noted by Anson in the introduction to Halligan and Weyland (2005, p. 84):

> …because the context of value for a Trade Secret is usually done in litigation (and far less often in a business transaction), the definition of value is equal to damages, which in turn is equal to loss of future income or loss of current and competitive value. The authors emphasize a key point: a Trade Secret can only be validated in a litigation environment. As to the conclusions of value for Trade Secret, the context again is different, since value is usually established in a litigation context.

For the purposes of this chapter, I will use both the terms “damages” and “valuation”, with the intent that “damages” (along with “damages estimate” and “damages calculation”) refers specifically to court valuations of trade secrets, and “valuation” to the more general concept of determining a monetary value for an asset (albeit, in our case, will typically be intangible.)

The chapter develops these ideas further in the light of evidence from the EEA. Section 4.2 presents the key concepts used in damages valuation models. Section 4.3 provides an overview of the multidisciplinary research on Trade Secret valuations. Section 4.4 examines the principle of damages and dispute valuations. Sections 4.5 through to 4.8 introduce the various models used to assess damages in trade secrets. Section 4.9 discusses the relative merits of these various valuation methods. The final section concludes the chapter.

4.2 Key Concepts in Damages Valuations of Trade Secrets

As this section will show, the multiplicity of values that can be attributed to a trade secret is itself dependent on the wide variety of models that can be used to calculate these values. While these models share solid common economic reasoning, their implied outcomes may vary significantly. Further empirical analysis will develop this theme in Chapter Five. Following Zwillinger and Genetski (2000), the models may be grouped under three general titles: Income, Cost and Market models. While there is overlap amongst the groups (as will be discussed), their division, as displayed in Figure 4-1, is useful for the purposes of discussion.

Table 4-1: Groups of Damages Valuations

Damages Valuations of Trade Secrets: Groups and Descriptions		
Group	**Model**	**Model Description**
Income Models	Unjust Enrichment	Defendant's profits from the Trade Secret (TS)
	Lost Profits	Victim's lost profits from theft
	Reasonable Royalty	Licensing agreement victim and defendant would have agreed on
Cost Models	R&D	Victim's Research and Development costs
	Replacement Costs	Defendant's cost to develop
	Actual Damages	Direct costs to victim as a result of theft
Market Models	Market Models	Value a willing buyer and a willing seller would have agreed on

The Income models are based on cash flow analyses. Unjust Enrichment, also known as Disgorgement, values the trade secrets as the defendant's profits from the use of the trade secret. When assessed from the point of view of the victim firm, the Lost Profits doctrine accounts for the victim's lost profits. Reasonable Royalty allows for the theoretical licensing agreement that the victim and defendant would have agreed upon in the absence of the theft. What they have in common is that these models all examine income flows. These income flows can be seen as arising from the underlying assets that are subject to trade secrecy (see Section 5.2.1 below in Chapter 5.)

The Cost models look at the costs associated with the trade secret or the theft. R&D costs account for the victim's Research and Development cost associated with the trade secret. Replacement costs account for either the victim's R&D savings, or the reverse-engineering costs required to develop the trade secret independently. Actual Damages are a straightforward account of the costs incurred by the victim firm as a direct result of the theft.

Finally, the Market Models, which consist primarily of the Fair Market Value model, look at the market value of the trade secret. The Fair Market Value is said to be the price agreed by a willing buyer and a willing seller in an actively traded market.

The Income, Cost and Market models are developed and discussed further in the course of this chapter.

4.3 Overview of Literature

The development of trade secrets valuations has rested firmly on the economic and legal tools which have been developed for the valuation of patents (Smith, 2002; and Sickles and Ayyar in Slottje (ed.), 2006). However, as noted earlier, the patent literature has reached a level of maturation not yet attained by the trade secrets literature mostly because of the greater ambiguity of trade secrets, but also because trade secrets become increasingly relevant as deindustrialization progresses. Additionally, advanced economies become more service based and the economy as a whole becomes more knowledge intensive. As the Trade Secret literature often takes the patent literature as a point of departure, it is prudent to begin with a discussion of the patent literature.

The economics literature, addressing patent valuation and damages, falls into three main categories: damages models and the incentives to innovate; theoretical comparisons of models; and the development of modelling and calculation methods.

Shankerman and Scotchmer (2001) look at the fundamental question of how damages affect the competitor's decision to infringe. The authors determine that infringement will not occur in equilibrium. More importantly, the authors note the circular relationship of license payments and damages. Damages based on expected license payments (known as Reasonable Royalty[197]) dictate the maximum a licensee will be willing to pay a licensor as the licensee always has the outside option of infringement. On the other hand, damages based on Reasonable Royalty calculations rationally should not exceed the theoretical amount agreed with a willing licensor and a willing licensee. As the authors argue, the option of infringement becomes an implicit or coerced license as the owner of the patent becomes an unwilling licensee. This circularity increases the uncertainty of rewards to innovators and thereby reduces incentives to innovate.

While Shankerman and Scotchmer restrict their analysis to a research tool with no non-infringing substitutes, their paper provides the basis for further research. Anton and Yao (2007) build on their model to explore how damages calculations affect the competitor's decision to infringe. The authors model a patented cost reducing process innovation. The competitor must decide whether to infringe in the light of the potential damages payments. Anton and Yao's paper furthers Shankerman and Scotchmer's work by including infringing and non-infringing options in the market. That is, the competitor can choose to infringe the patent or use an alternative, non-infringing option. Under the Lost Profits[198] doctrine, and given the presence of a non-infringing substitute process, the competitor will always chose to infringe as the competitor will mimic the outcome of the non-infringing option and thus generate no Lost Profits. Alternately, the infringement may generate some Lost Profits, which will be transferred to the owner of the patent, leaving the patent owner in the same position as without infringement. Thus, infringement will always occur in equilibrium.

Anton and Yao further this analysis by examining the implications for incentives to innovation. As infringement always occurs in equilibrium, the Lost Profits doctrine generates an infringing option for the loser of a patent race. In essence, the Lost Profit doctrine reduces the losses associated with losing a patent race and, therefore, reduces the relative benefit of winning a patent race, and, hence,

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[197] Reasonable Royalty values the trade secret at the reasonable license amount the hypothetical licensee and hypothetical licensor would have agreed on in a voluntary setting. Choi (2006)
[198] Lost Profits, as Choi (2006) argues, is "the difference between the patentee's pecuniary condition that would have been without infringement and the one after the infringement." P. 1.

the incentive to innovate. Anton and Yao also extend their analysis to other measures of damages, including Reasonable Royalties and Disgorgement (Unjust Enrichment.)[199] They find that Reasonable Royalties create an implicit licensing deal with the owner of the patent and that, in equilibrium, infringement will always occur. Their findings with Disgorgement are consistent with those of Lost Profits. On the whole, the authors find that "The analysis of these alternative damages measures illustrates that infringement is induced when a damage rule shifts the imitator's best-response function toward higher output while the innovator's best-response function remains unaffected or shifts toward lower output."[200]

In developing a theoretical comparison of models, Henry and Turner (2007) examine the threat points created by valuation models and find that Lost Profits is the strongest for encouraging innovation. They model the decision to infringe in a differentiated duopoly setting and examine the payoffs to players. They find that, given strong patent enforcement, Reasonable Royalty generates the highest incentives and is the only regime that will deter infringement. However, if patent enforcement is uncertain, then Lost Profits generates the highest incentives to innovate for valuable patents. The authors are highly critical of the Unjust Enrichment regime, which they find does not deter infringement. Rather importantly, the authors note, "In practice, setting a damage award for Lost Profits is as much of an art as it is a science but it clearly relies on economic benchmarks."[201]

Choi (2006) also compares models but does so by emphasizing the probabilistic nature of patents. Patents are often described as probabilistic rights in that their legal strength can be challenged by invalidation and market obsolesce (Marco, 2003; Lemley and Shapiro, 2005; Baecker, 2006.) Rather than being an ironclad guarantee, patents represent a probability that the innovation will maintain its

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[199] Method by which damages are assessed as the profit the infringer unjustly gained as a result of the infringement. Also known as "disgorgement" as the infringer is required to "disgorge all the profits from infringement." Choi (2006), p. 1.
[200] Anton and Yao (2007), p. 202.
[201] Henry and Turner (2007), p. 31.

legal monopoly over the course of legal challenges or market changes. In introducing the probabilistic nature of patents, Choi ties together research themes found in the damages papers here and papers such as Lemley and Shapiro (2005) addressing probabilistic patents. Using an oligopolistic model of competition between the patent owner and a potential infringer, Choi argues in favour of Lost Profits and against Unjust Enrichment. If, and only if, the infringer is more efficient then the patent owner, Lost Profits is superior to Unjust Enrichment in terms of social welfare.[202]

Finally, there is a body of quasi-economics literature oriented to the more practical application of the methods and calculations used in damages valuations. The following are illustrative of this genre: Slottje (ed., 2006) develops a handbook of papers written by various experts detailing the methods used for a variety of IPR. Glick, Reymann and Hoffman (2004) develop a comprehensive handbook for practitioners with an emphasis on the theory underpinning the models. Hall and Lazear (1994) contribute to a handbook for forensic economists as a reference guide for estimating damages in IPR cases. Werden, Froeb and Langenfield (2000) examine the application of merger simulation methods to modelling patent damages. An antitrust logit model is used to analyse the market for a good with and without a merger. When applied to patents, the model examines the market with and without infringement. These practitioner-oriented works provide a comprehensive catalogue of the practical methods used in patent valuation. They depart significantly from Anton and Yao (2007) and Scotchmer and Shankerman (2001) in their practitioner-focused, interdisciplinary approach.

One method which is found in the economics literature for the valuation of IP but which is not found in the damages valuations discussed here is that of options analysis. Found in papers such as Bloom and Van Reenen (2002), Marco (2003) and Baecker (2006), options analysis allows for the integration of the probabilistic nature of IP into the valuation method (using the options analysis applied in stock option pricing.) Furthermore, it allows for the valuation of

[202] Choi (2006) defines social welfare as the sum of producer and consumer surplus, p. 12.

disembodied (i.e not in use) IP. Despite the relatively sophisticated nature of options analysis, it is not yet found in EEA cases, perhaps because as a new method, it is unlikely to appeal to the court as it currently lacks a body of case law (unlike the above-mentioned methods.) This may change in the future as more sophisticated valuations methods are embraced, but, for the time being, options analysis is not considered to be standard damages valuation method.

The legal literature examines the various regimes of damages, with a focus on the accuracy and fairness of damages payments in patent cases. Tomlin and Merrell (2005), in a paper borrowing themes from economics, examine the application of the Lost Profits doctrine. The authors note that the Lost Profits doctrine leaves wide scope for manipulation and inaccuracy. The authors highlight the highly subjective application of seemingly objectively derived models. However, the strength of their abstract theoretical legal arguments is weakened by their desire for a quasi-economics approach, for they fail to address substantially the basic economic models that could be used to underpin their arguments.

Blair and Cotter (2001) also develop a regime comparison of the valuation models. The authors conclude that the ideal approach is to take the value which is the greater of either Lost Profits or Unjust Enrichment values. They argue that, from the point of view of fairness, the legitimate owner of the patent should be entitled to at least their Lost Profits. At the same time, the infringer should not be entitled to retain any Unjust Enrichment arising from the infringement. The authors detail the history of the development of damages in IPR cases and argue for a reliance on precedents established in tort law as a basis for damages principles. The Blair and Cotter (2001) paper represents a purely legal argument, which does not include incomplete interdisciplinary arguments.

In addressing trade secrets damages calculations, the economics literature is not as well developed as the law literature. The economics literature focuses more on the possibility of adapting applications of patent models to trade secrets, rather than on developing custom designed trade secrets models independently.

The four handbooks mentioned previously, Smith (2002), Slottje (2006) and Glick, Reyman and Hoffman (2004), and Smith and Parr (2005), discuss applications of this kind and highlight the potential limitations of the use of patent models in trade secrets. It should be noted, however, that these handbooks are not pure economics books and are intended for an interdisciplinary audience.

In a further handbook, Halligan and Weyland (2005) present an analysis that develops trade secret valuation methods independently of the patent valuation models. The authors, a lawyer and a technical trade secrets expert, provide practitioners with a financial and legal analysis of Trade Secret valuation. Relying heavily on discounted cash flow models, the authors present a practical approach to valuing trade secrets and note that Trade Secret valuation often occurs in the context of litigation (Halligan and Weyland, 2005.)[203]

The economics literature largely lacks a body of empirical research on trade secrets valuation. By contrast, the empirical examination of patents is much broader and more established. There are few authors who have written empirical papers addressing trade secrets valuation, with the notable exceptions of Lerner (2006) and Zwillinger and Genetski (2000). In contrast, the patent literature has a large body of developed literature, including key papers such as Shankerman and Pakes (1986); Lanjouw and Shankerman (1997); Lanjouw (1998); Gallini (2002); and Hall, Jaffe and Trajtenberg (2005.)

Carr and Gorman (2000) examine the financial impact on a firm's stock prices following an announcement of the firm being a victim in an EEA case. While the paper is not devoted specifically to the valuation of the stolen trade secrets, the authors estimate the value of 11 of the relevant trade secrets via a survey of relevant players (lawyers, firm executives etc.) and note that the values varied depending on the point of view of the player. As in this thesis, the authors chose to use the lower of the range of values for a particular Trade Secret as supporting a more conservative estimate. This will be further discussed in Chapter 5 which,

[203] Halligan and Weyland (2005), p. 84.

like Carr and Gorman (2000), addresses the range of values for a given trade secret.

Lerner (2006) examines approximately 500 litigation cases from two states known for their innovation: Massachusetts and California. Lerner notes that the probability of winning a trade secrecy lawsuit is less than 40% and only 9% of lawsuits result in damages. This compares to a roughly two-thirds success rate in patent litigation. The damages awarded in his survey averaged $1.5 million, which is roughly one-third of the average patent litigation award.[204] Lerner highlights the fact that trade secrets are an empirical area ripe for exploration. The Lerner paper is the only economics paper identified which, like this thesis, uses empirical evidence from court cases for trade secrets research.

The law literature addressing trade secret damages shows a heavy influence from economics. The handbooks noted earlier represent a mixture of law and economic scholarship. Zwillinger and Genetski (2000) present a comprehensive survey and legal analysis of the damages methods used in EEA cases. As this thesis will argue, the authors conclude that, while no method is ideal in all cases, Reasonable Royalty presents a fair method to use in EEA cases. The Zwillinger and Genetski paper departs from the previous body of EEA literature (e.g. Mossinghoff, Mason and Aoblon (1997); Carr, Morton and Furniss (2000); and Effron (2003)) by analysing the actual EEA cases and the practical application of the damages methods.

Finally, Smith (2002) analyses the legal application of patent damages principles to trade secrets. Smith develops the legal arguments of patent damages and logically bridges the gap between patents and trade secrets. The author, like others, notes that the law concerning trade secrets, particularly trade secrets damages, is "comparatively underdeveloped"[205] when compared to patents. In practice, as Smith outlines, lawyers in trade secrets cases borrow from the more established body of patent case law. This theme of basing trade secrets damages

[204] Lerner (2006) p. 13.
[205] Smith (2002), p. 821.

analysis on the models established for patents can be found throughout the literature, as in Glick, Reymann and Hoffman (2003) and Zwillinger and Genetski (2000).

4.4 Principles of Damages and Dispute Valuation

The principles and justification of damages are central to the legal arguments in the application of damages (Green et al, 2000.) While economic scholarship pays less attention to these philosophical justifications, these principles are important as they dictate the function of damages calculations (Green et al, 2000; Slottje, 2006.) Damages assessments have two primary goals: one, to make the victim whole "but for" the infraction; two, to strip the perpetrator of any unjust enrichment gained from the infraction (Cooter and Ulen, 2004.) In some cases, "enhanced" damages may go even further to punish the perpetrator financially and create a disincentive for would-be perpetrators. These goals are seen clearly in civil litigation cases in which the perpetrator can be liable for up to three times the damages caused.[206]

Another important legal distinction is that between criminal and civil cases. A civil case is a dispute between two private parties in which the party bringing the complaint is referred to as the plaintiff and the other party is the defendant (Cooter and Ulen, 2004.) Criminal cases are legal disputes in which the state seeks to prosecute a party for breaking the law. In this case, there are three major players: the prosecution (the state), the victim (the party suffering from the criminal offense) and the defendant (the party accused of committing the offense.) In EEA cases, the parties are the prosecution, the victim (trade secret owner) and the defendant (trade secret accused thief.)

Cooter and Ulen (2004, p. 446) note five characteristics that distinguish criminal cases from civil cases:

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[206] Quinn, Gene (2009), "Patent Infringement Damages," *IP Watchdog,* available from http://www.ipwatchdog.com/patent/advanced-patent-topics/patent-infringement-damages/.

1. The criminal *intended* to do wrong, whereas some civil wrongs are accidental.
2. The harm done by the criminal was public as well as private.
3. The plaintiff is the state, not a private individual.
4. The plaintiff has a higher standard of proof in a criminal trial than in a civil suit.
5. If the defendant is guilty, then he or she will be punished.

In addition to some counterfeiting and copyrighting crimes,[207] the theft of trade secrets is one of few criminally prosecutable IP legal offences (U.S. D.O.J., 2006.) Other IPR disputes are civil and covered by a combination of contract, tort and other laws (Dessemontet, 1998.) This distinction makes the EEA prosecutions unique, as they are not disputes between two parties but the state seeking to prosecute trade secrets thieves criminally. Civil trade secret cases seek financial compensation and may be strategic market manoeuvring by the parties involved.[208] Criminal cases, on the other hand, focus on prosecuting those who have violated the law and creating a disincentive for would-be criminals.[209] As Cooter and Ulen (2004) report succinctly, "criminal punishment aims to deter intentional harms, not to compensate for them."[210]

In EEA cases, sentencing guidelines[211] link the alleged value of the stolen property to recommended fines and imprisonment. Like civil cases, the involved parties are likely to differ in their opinions as to the value of trade secrets. Victims will seek higher values to maximize their potential restitution payment, whereas defendants will seek lower values to minimize punishment (Cooter and Ulen, 2004.) However, the burden of proof in criminal cases necessitates theoretically sound valuations despite the upward or downward biases of the parties involved, as discussed in Green et al (2000.) The result is that one Trade Secret may have many alleged values depending on the goal of the valuation. The following section will detail these methods.

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[207] 18 U.S.C. § 2320.
[208] For a discussion on the decision to file a lawsuit, see Crampes and Langinier (2002).
[209] A discussion on the development of the criminal prosecution of trade secrets can be found in Mossinghoff et al (1997).
[210] Cooter and Ulen (2004), p. 452.
[211] 2008 Federal Sentencing Guidelines Manual Chapter 2, Part B Basic Economics Offenses, available from http://www.ussc.gov/2008guid/TABCON08.htm.

4.4.1 Damages in Tort and Contract Law

Given that the origins of trade secrecy law lie in tort and contract law, and that much of the valuation methods used in EEA cases stem from civil cases (as noted in Smith (2002), it is useful to discuss damages in the context of tort and contract law.

Reliance and Expectation in Damages Measures

Further concepts in damages calculations can be found in the legal justification for their existence. Damages are traditionally separated into restitution (or reliance[212]) damages and expectations damages. Restitution damages return the victim to the state before the theft (i.e. make the victim whole but for the theft.) Expectations damages, on the other hand, compensate the victim for future losses (typically on the basis of a contractual relationship.) Put differently, by Hall and Lazear (1994), "damages are generally calculated under the expectation principle, where the compensation is intended to replace what the plaintiff would have gotten if the promise or bargain had been fulfilled."[213]

Hall and Lazear (1994) provide a useful graphical representation of the division between damages before a trial and damages after a trial. As they note, restitution and expectations damages can lie in both the damages before the trial and after the trial.

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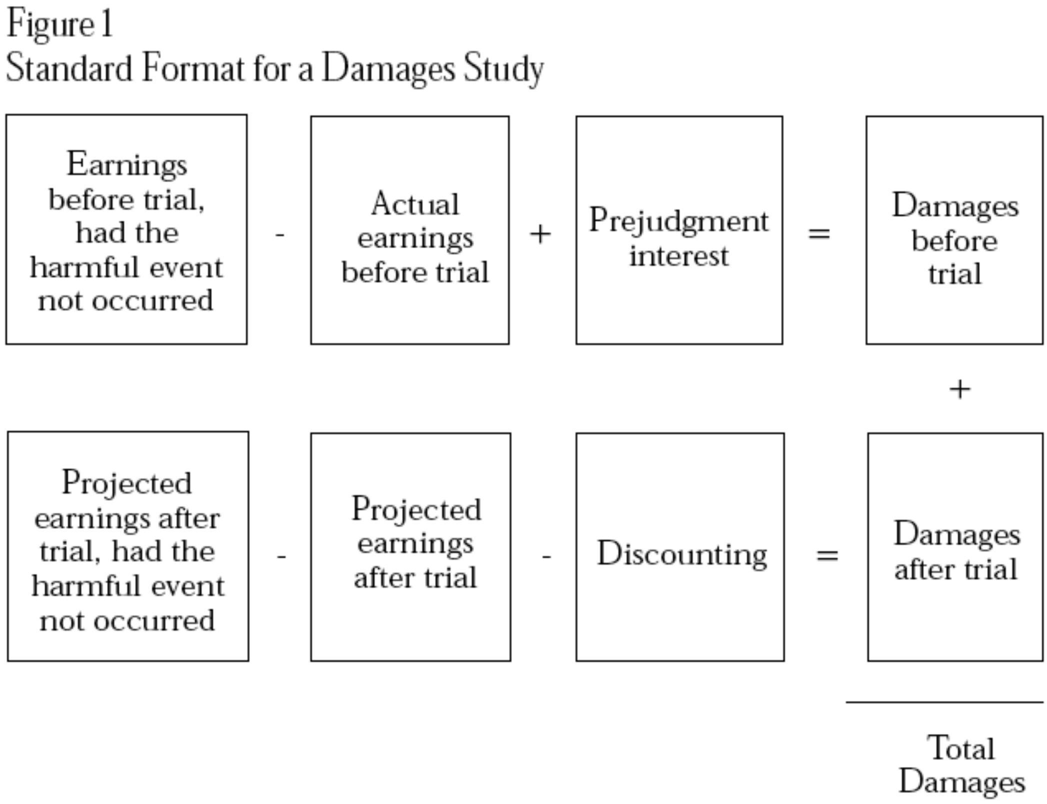
[212] As Hall and Lazear (1994) note, restitution and reliance are related concepts. Restitution is used in cases of injury or theft (and is therefore relevant to the EEA cases.) Reliance is used in cases of fraud and is applicable to tort and contract law.
[213] Hall and Lazear (1994) p. 481.

Table 4-2: Hall and Lazaer (1994) Depiction of Damages[214]



The EEA employs a mix of both restitution damages and expectations damages. Under restitution damages, the victim is compensated for the theft on the basis that the stolen trade secret had value (past and future) that the victim would have benefitted from. This clearly applies to the damages valuation method of Actual Damages and Fair Market Value and is found in variations of other models. As Hall and Lazear (1994) note, the but-for analysis of damages valuations relies on restitution damages.

Under expectations damages, however, the relationship between the victim and the defendant comes into play. As many of the defendants are employees or contractors (see Chapter 3 for a discussion) engaged in the development of the trade secrets, the victim rightfully expected that the trade secret would have maintained its secrecy and perhaps been further developed. This is particularly so in cases in which the trade secret was related to primary research which had

[214]Reprinted from Hall and Lazaer (1994), p. 478.

yet to undergo commercial application.[215] Furthermore, the argument of Reasonable Royalty comes into play under expectations damages in which the defendant could have engaged in a contractual relationship with the victim in order to license the trade secret. In these cases, the defendant violates a theoretical licensing agreement.

However, in application, the EEA cases demonstrate a mix of restitution and expectations damages. As noted in the next chapter, Chapter 5, the damages valuations in EEA cases vary significantly. In many cases, a wide range of estimates are found for the trade secrets. Furthermore, the actual legislation fails to show a clear preference for restitution or expectations damages. As discussed in Chapter 5, the principles of damages valuations in EEA cases are found in the USTSA[216], which allows for the use of Actual Damages, Unjust Enrichment and Reasonable Royalty. Furthermore, the Sentencing Guidelines advocate the use of the Fair Market Value. Thus, neither the principles of restitution or expectations damages are preferred in the legal infrastructure surrounding EEA cases.

Furthermore, the mix of restitution and expectations damages in the EEA suggests that these principles can be manipulated to favour one party over another. For example, if the victim is in an unfavourable contract, the damages expectations based on expectations may exceed that of restitution. In this case, the use of restitution damages would favour the victim. Thus, the use of restitution or expectation damages adds another layer of debate in the calculation of damages in EEA cases.

Pure Economic Loss

[215] The EEA cases involving university research would appear to be obvious examples of this. See U.S. v. Zhu, Criminal case 1:05-cr-10153-GAO-1 (Massachusetts, filed on June 16, 2005) and U.S. v. Okamoto, Criminal case 1:01-cr-00210-DDD-1 (Northern District of Ohio, filed on May 8, 2001).

[216] See Uniform trade secrets act, available at http://nsi.org/Library/Espionage/usta.htm, accessed November 2008 and D.O.J., (2008), *Prosecuting IP Crimes Manual,* p. 267.

A controversial topic in tort law is that of pure economic loss and its relation to economic efficiency. Pure economic loss is financial loss and damages that are purely financial and independent of physical inputs. This differs from consequential (or parasitic) losses, which involve a much narrower definition of all losses. As Bussani and Palmer (2003) define it, "consequential economic loss is recoverable because it presupposes the existence of physical injuries, whereas pure economic loss strikes the victim's wallet and nothing else."[217]

It is tempting to consider EEA damages calculations as pure economic losses in the sense that trade secrets are intangible assets. However, this would represent an overly simplistic interpretation of the delineation between pure and consequential losses. Nonetheless, the damages calculations in EEA case are, in general, based on pure economic loss. The underlying principles of damages valuations in EEA cases are based on cash flow analysis, actual expenditures and market values. All of these concern the financial impact of the theft and not any physical injuries.

The debate amongst legal scholars over pure economic loss arises because, in some jurisdictions, pure economic losses are not recoverable.[218] Furthermore, as Gregen (2006) notes, the whether pure economic losses act to deter or redress injury is the subject of debate. However, a sound theory can be found in Bishop (1982) in his argument that economic loss is not efficient in that it induces "too much avoidance activity by potential tortfeasors[219]."[220]

Further criticism of the economic efficiency of pure economic loss can be found in reference to the insurance market[221]. Under pure economic loss, as Bishop (1982) notes, the cost of insurance for victims or tortfeasors would be prohibitively high. As pure economic loss can be much more than losses associated with physical loss (e.g. the cost of fixing a broken leg is likely to be

[217] Bussani and Palmer (2003) p. 6.
[218] Bussani and Palmer (2003) p. 7.
[219] A *tortfeasor* is someone who commits a tort.
[220] Bishop (1982) p. 13.
[221] Bishop (1982) notes that this is a commonly used rationale in the pure economic loss debate.

less than the lost wages as a result of an injury), an insurance market, which will include administrative costs, will be too expensive and suffer from moral hazard[222] issues. Additionally, pure economic loss could result in the bankruptcy of the tortfeasor (or, in our case, defendant) and render any judgement unenforceable. Given that the EEA sought to extend the reach of punishment of the theft of trade secrets to judgement-proof defendants (as discussed in Chapter 3,) the use of pure economics loss presents challenges to enforcement of the act.

This debate over the role of pure economic losses in the context of the EEA adds yet more legal controversy over the criminalization of the theft of trade secrets. The difference between the valuations of trade secrets argued during the course of the case and those used in sentencing (as discussed in Chapter 5) could suggest, as Bishop (1982) notes in relation to the debate over economic loss that, "courts in deciding cases have reached results that seem broadly efficient."[223] Thus, the evidence of difference of valuations used in sentencing and those discussed in this chapter suggests that, in EEA cases, the courts recognise the lack of economic efficiency found in the pure economic loss approach.

4.5 Value Estimation of Trade Secrets in EEA Cases: Survey of Models and Methods

As noted earlier, the models are grouped under three general titles: Income, Cost and Market models, as in Zwillinger and Genetski (2000.) The Income Models include Unjust Enrichment, Lost Profits and Reasonable Royalty and are based on discounted cash flows. The Cost models, Replacement Costs, R&D Costs and Actual Damages, are based on the costs associated with the trade secret. Finally, the Market models are based on the fair market value of the trade secret.

The intangible nature of trade secrets complicates its valuation in criminal cases. With stolen physical property, the use of Fair Market Value presents a relatively

[222] Moral hazard is "the tendency of agents who are insured to behave more recklessly because of their insurance cover." Pearson Education (2005) Available from http://wps.pearsoned.co.uk/wps/media/objects/2499/2559960/glossary/glossary.html
[223] Bishop (1982), p. 29.

simple argument for the value of the stolen property (Green et al, 2000.) The stolen property is valued at the value a willing buyer and a willing seller would agree upon. However, with trade secrets, as the owner is not actually deprived of the property, the valuation becomes more complex. Often, the estimation is based not on the Fair Market Value of the trade secret, but on the losses suffered by the victim (as in Zwillinger and Genetski, 2000.) As the fair market value of the Trade Secret in EEA cases cannot be measured directly (due to information asymmetries, lack of a willing seller and a willing buyer etc.), loss estimation (damages) often provides a close substitute (Green et al, 2000.) In this section, the estimation methods used in EEA cases are described and their diverse results are then analysed in Chapter 5. In the EEA cases reported here, the valuations have been obtained from a combination of court documents, media reports and academic papers.

Due to the diverse nature of the valuations, a high and low value (as in Carr and Gorman, 2001) of the trade secrets was collected for the EEA cases. These values are reflected in Table 4-3. Due to the lack of a consistent official source for these estimates, estimates are only available for one third of the EEA cases.

Table 4-3: Summary Statistics of Value Estimates of Trade Secrets

Value Estimates for Stolen trade secrets EEA Cases 1996-2008		
	Low Estimate	High Estimate
Mean	$4,471,000	$26,338,000
Median	$576,000	$1,916,000
Minimum	$6,000	$12,000
Maximum	$39,376,000	$271,736,000
Standard Deviation	9,540,000	66,651,000
Number of Cases	29	(1 outlier removed[224])

Expressed in 2008 values

Note that the range of estimates from $6,000 to $272M is large. The mean of the "Low" estimates, which are more conservative than their "High" counterparts, is $4.5M albeit with a relatively high standard deviation of 9.5M. These values suggest that the applications of the valuation models results in highly diverse values for the same trade secret. Chapter 5 will provide a statistical analysis of these valuations.

4.5.1 Points of View and Concepts of Time in the Models

The criminal status of EEA cases means that these methods are calculated from the point of view of either the defendant or the victim, as shown in Table 4-4 below, which is an extension of Table 4-1 above to 'point of view' and 'state.' As Glick et al (2003) argue from a legal and fairness perspective, "Where the trade secret's value has been destroyed, the secret should be valued from the owner's perspective. … Conversely, the value of the secret to the misappropriator is usually the appropriate measure where the secret has not been destroyed."[225] With the exception of Reasonable Royalty and Fair Market Value, the methods applied in EEA cases present one-sided valuations. This creates an inherent

[224] The outlier removed is discussed in further detail in Chapter 6 on page 242.
[225] Glick et al (2003), p. 337.

conflict between the prosecution's valuations and those of the defence, as Becker (1968) discusses.[226] It also points further to the complexity of these valuation models, which gives rise to the highly diverse estimates for trade secrets.

These valuation models incorporate various concepts of time and states. The dominant use of time is the number of time periods, *t*, which is used to account for the time value of money (Slottje, 2006.) The other concepts of time deal with the states as they relate to the timing of the theft of the trade secret, as modelled in Werden et al (2000.) These concepts play a large role in the application of Income Models.

One factor to consider in assessing valuation models is the number of time periods, *t.* Unlike patents, which have a fixed time limit, trade secrets have no legally defined expiration date (Scotchmer, 2004.) The courts must, instead, consider alternate forms of estimating *t*. One is to estimate the time it would have taken the defendant to develop the trade secret independently. This can be called the "head start" or "lead time" advantage.[227] Another is to estimate when the trade secret would have become public knowledge without the theft, or when the trade secret became obsolete (e.g. replaced by a new technology), as in Slottje et al (2006.) These methods are imprecise but necessary in the absence of a legally defined time period.

The valuation models also incorporate different concepts of the state (status) that deal with the sequence of time periods associated with the theft of the trade secret. One concept looks at the status quo in sequence as two time periods that are state 1 – before the theft, and state 2 – after the theft, as in Hall and Lazear (1994.) This real concept of time, which I will refer to as "factual" time, looks at the actual value of variables before and after the theft. For example, in Unjust

[226] Becker (1968) develops the argument for the differing values of criminals, victims and society for criminal cases in general.
[227] Glick et al (2003), p. 338, defines the head start period as "the period of time required to eliminate any competitive advantage obtained by the misappropriator" and allows defendants to limit damages based on the amount of time it would have taken them to discover the trade secrets via legitimate methods.

Enrichment, the thief has per unit production costs of c_1 before the theft and costs of c_2 after the theft (Slottje, 2006.)

An alternate concept of time, found in the Lost Profits Doctrine, again divides time into two states: state 1 – "but for", and state 2 – "actual" or the status quo. This is the state of the variables with the theft (actual) and "but for" the theft (what the state of variables would have been if the theft had not occurred.) I will refer to this theoretical concept of time periods as the "counterfactual" concept of states as it compares actual events to the theoretically modelled events described in the "but for" analysis. In Reasonable Royalty and Fair Market Value, the counterfactual state is used to purport hypothetical agreements between defendant and victim. As Slottje (2006) notes, the use of counterfactual time can be problematic:

> The methodology incorporates fantasy and flexibility – fantasy because it requires a court to imagine what warring parties would have agreed to as willing negotiators; flexibility because it speaks of negotiations as of the time infringement began, yet permits and often requires a court to look to events that occurred thereafter and that could not have been known to or predicted by the hypothesized negotiators.[228]

The use of factual time allows for a valuation that compares actual values to actual values. However, the use of counterfactual time periods requires the theoretical prediction of the counterfactual (profits without the theft) and compares this to the factual (profits with the theft.) This presents a challenge for courts as the use of counterfactual states gives less weight to objective, evidenced values and more weight to subjective, theoretical models, as discussed in Green et al (2000.) From the perspective of justice, the use of factual states may be more appealing due to its more objective nature.

The definitions of time and states in the valuations of trade secrets influence the valuation of the trade secret and lack certainty. Despite these weaknesses, the models are appealing in that they incorporate the long-standing principles of the time value of money (Block and Hirt, 2002.)

[228] Slottje (2006), p. 85.

Table 4-4 presents a summary of the characteristics of the estimation groups.

Table 4-4: Characteristics of Estimation Models

Value Estimation of trade secrets: Models and their Characteristics			
Group	**Model**	**Point of View**	**State**
Income Models	Unjust Enrichment	Defendant	Factual
	Lost Profits	Victim	Counterfactual
	Reasonable Royalty	Both	Counterfactual
Cost Models	R&D	Victim	Factual
	Replacement Costs	Defendant	Factual or Counterfactual
	Actual Damages	Victim	Factual
Market Models	Market Models	Both	Counterfactual

The following section details these models and their use in EEA cases. The foundations of the methods are based in economic reasoning, however, as Chapter 5 will discuss, can result in a wide range of valuations for the same trade secrets.

4.6 Income Models

The Income models, Unjust Enrichment, Lost Profits and Reasonable Royalty[229] all base the valuation of the Trade Secret on calculations of past and future sales and a subsequent cash flow analysis.

Unjust Enrichment and Lost Profits are two prominent Income models. From a fairness perspective, Unjust Enrichment and Lost Profits are appealing as they either strip the infringer of any profits gained illegally, or return the Trade Secret

[229] These are widely used models, discussions of which can be found in Lanjouw and Shankerman (1997); Zwillinger and Genetski (2000); Smith (2002); Smith and Parr (2005); and Slottje (2006), among others.

owner to the situation "but for" the theft (Zwillinger and Genetski, 2000.) In either case, the goal is to return the parties to the same state without the theft, ceteris paribus. This perceived fairness makes them legally attractive doctrines, in addition to the fact that they are based on well-established cash flow valuation models (Block and Hirt, 2002.) However, these methods rely heavily on the vagaries of those involved and are not independent valuations of the Trade Secret. That is, they are valuations based on market structure and the resulting cash flow and not on the intangible innovation itself.

4.6.1 Key Components of Income Models

The Income Models focus on the cash flows stemming from the trade secrets with the cost, price and quantity as the key variables. As these cash flows occur over a period of the misuse of the trade secret, they are adjusted to account for the time value of money and risk. Table 4-5 and Table 4-6 provide a list of the key variables, their definition and notation and utilised for the income models. This common notation will be used in Equations **[4-1]** through **[4-10]**.

The key variables of the income models are related to common market variables that are related to the good produced using the trade secret. The price and quantity of the goods sold are given by p and q, respectively. The goods are produced at a per unit cost of c. To account for the time value of money, the goods are evaluated over number of time periods, t, with a discount rate of r. The risk parameter, which adjusts cash flows to account for market risk is ρ, where $0<\rho<1$. Assuming that the good sold does not consist solely of the trade secret, z accounts for the portion of the value of the good attributable to the trade secret. Royalty rates, denoted γ, are used in licensing situations and assessed as a portion of sales revenue.

Table 4-5: Key Variables of Income Models

List of Key Variables of Income Models:
p = price, the price of the good which uses the trade secret
q = quantity, the quantity of goods sold
c = cost, the per unit cost of producing the good
t = time, number of time periods
τ = the total number of time periods
ρ = risk parameter, the risk associated with the sale of goods
r = discount rate, the discount rate used to account for the time value of money
z = portion of the value attributable to the trade secret
γ = royalty rate

The key subscripts of income models describe the agents, time periods and states. The Innovator, denoted *I*, is the owner of the trade secret. The Follower, denoted *F*, is the one who misappropriates the trade secret (i.e. the thief or defendant.) This use of Innovator and Follower follows that of Anton and Yao (2004), in which the Innovator is the first to innovate and the Follower a competitor who can choose to imitate or not (in this case, the competitor can steal.) The time before the theft is the first time period, *1*, and the time after the theft is time period *2*. Following the earlier discussion of the counterfactual and factual states, the state used in the models are denoted *actual* (the factual state) and *but for* (the counterfactual state.)

Table 4-6: List of Key Subscripts in Income Models

List of Key Subscripts in Income Models:
I = Innovator, the victim or owner of the trade secret
F = Follower, the thief or defendant
1 = time period 1, before the theft
2 = time period 2, after the theft
actual = factual, state that actually occurred after the theft
but for = counterfactual, the theoretical state that would have occurred but for the theft

4.6.2 Unjust Enrichment

Under the doctrine of Unjust Enrichment, the value or loss estimation is determined by the profits gained by the defendant from the use of the stolen Trade Secret. The goal is to determine the thieves' financial gain from the theft and disgorge them of these gains.[230] According to Zwillinger and Genetski (2000), this is typically used when the victim suffered no actual loss or the loss does not represent the value of the Trade Secret fairly. The difficulty is determining the amount related directly to the Trade Secret, as the Trade Secret is unlikely to be used independently of other inputs (e.g. marketing, other intellectual property, labour, raw materials etc.) Courts can either determine all profits related to the Trade Secret as tainted, or attempt to estimate what portion of the profits was related to the Trade Secret directly.

Unjust Enrichment as Cost Savings

[4-1]

$$UE_{CostSavings} = \sum_{t=1}^{\tau}\left[\frac{(c_2 - c_1) * q_F * \rho_t}{(1+r)^t}\right]$$

Formally, this unjust financial gain can be calculated in a number of ways. Equation **[4-1]** is Unjust Enrichment, calculated as the sum of the cost savings to the Follower. If, for example, the stolen Trade Secret (e.g. a process innovation) allows the defendant to produce a good at a lower cost per unit of c_1 as compared to their cost without the Trade Secret, c_2,[231] then the unjust enrichment, *UE,* equals the decrease in the per unit cost multiplied by the number of goods produced by the defendant (the "follower"), q_F. The cash flow is adjusted by parameter ρ to account for market risk and discounted at rate r to reflect the time value of money.

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[230] Unjust Enrichment is also referred to as disgorgement (e.g. Cooter and Ulen, 2004.)

[231] Note that these models of Unjust Enrichment incorporate the concept of real time. The models can be adjusted to use theoretical time, as found in the Lost Profits models.

Unjust Enrichment as Increase in Revenue (via Price Increase)

[4-2]

$$UE_{\text{Price Increase}} = \sum_{t=1}^{\tau}\left[\frac{(p_2 - p_1) * q_F * \rho_t}{(1+r)^t}\right]$$

If, instead, the Trade Secret allowed the defendant to increase the price of an existing product (via additional features, marketing secrets etc.), then the defendant's financial gain would be equal to additional revenue stemming from the increase in price. As Equation **[4-2]** shows, the Unjust Enrichment is calculated as the sum of the cash flows calculated as the increased price, p_2, minus the original price, p_1, multiplied by the quantity. Again, as in Equation **[4-1]**, the cash flows are adjusted for risk and the time value of money.

Unjust Enrichment as Profit of New Product

[4-3]

$$UE_{\text{Profit}} = z\sum_{t=1}^{\tau}\left[\frac{(p_t - c_t) * q_F * \rho_t}{(1+r)^t}\right]$$

A broader definition of Unjust Enrichment can be attributed to a portion of the actual profits earned by the defendant. The court must determine what portion of the profit of the good's price can be attributed to the Trade Secret. In this case, the parameter represented by the fraction z, where $0 < z \leq 1$, is the portion that the Trade Secret contributes to profit. The sum of the cash flows of profit (price minus cost multiplied by quantity) is adjusted for risk and the time value of money. This discounted profit is then adjusted by z.

In the event that all of the defendant's financial gain from the use of the stolen Trade Secret is related solely to the Trade Secret itself (i.e. that the defendant would not have participated in the market without the use of the Trade Secret), then courts may use the Entire Market Value Rule (EMVR)[232] to ascertain unjust enrichment. In this case, all of the profits from the sale of the good can be

[232] Blair and Cotter (2001), p. 16.

included in the unjust enrichment calculation. This represents a special case of Equation [4-3] in which $z = 1$.

Unjust Enrichment as Revenue of New Product

[4-4]

$$UE_{\text{Revenue}} = z\sum_{t=1}^{\tau}\left[\frac{p_t * q_F * \rho_t}{(1+r)^t}\right]$$

Alternatively, the court may look merely at the revenue of the sales of the good and not deduct the costs. In this case, all, or a portion of, revenues of the sales of the good are accounted for. Equation **[4-4]** is the same as **[4-3]**, however the cost of the good, *c*, is not subtracted and thus Equation **[4-4]** accounts for total revenue instead of profit.

In the EEA case of U.S. v. Keppel,[233] detailed later, one value of the goods was $800,000 as the "amount of the defendant's gain from committing the offense."[234] A press release by the Department of Justice reported that Keppel had two bank accounts, one with deposits totalling $756,633, which resulted from sales of Microsoft Certified Systems Engineer and Microsoft Certified Solution Developer tests, and another, with an unspecified amount, from sales of "proprietary information belonging to Microsoft Corporation, Cisco and other business."[235] In this case, the court applied the Unjust Enrichment doctrine and allocated all of the revenue from the first account and an unknown portion of the second account for the upper bound of the loss estimate. However, the plea agreement also states "The parties agree that the actual loss amount is extremely difficult to ascertain."[236]

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[233] U.S. v. Keppel, Criminal case 3:02-cr-05719-RBL (Western District of Washington, filed August 8, 2002.)
[234]See case US v. Keppel, Document 10, Plea Agreement, p. 3.
[235] U.S. DOJ Western District of Washington (August 23, 2002), "Former Vancouver, Washington, Resident Pleads Guilty to Theft of trade secrets from Microsoft Corporation," Accessed July 07, 2008 from http://www.usdoj.gov/criminal/cybercrime/keppelPlea.htm.
[236] See case US v. Keppel, Document 10, Plea Agreement, p. 3.

Unjust Enrichment as Stolen Goods Sale Price

[4-5]

$$UE_{Stolen\ Goods} = P_{TS}$$

Related to unjust enrichment is the value for which the thief sold or attempted to sell the stolen trade secrets.[237] Given the criminal theft of the IP in question, this differs from the typical IP infringement case because the thief may not have intended to exploit the Trade Secret but simply to profit from its stolen goods value (Zwillinger and Genetski, 2000.) The stolen goods price[238] (P_{TS}) may be less than the full market value given that the thief may not have an accurate estimate of the value the market is willing to bear, nor the value to the legitimate owner (Dnes, 1996.) The true market value of the trade secret will function as an upper limit to the stolen goods market price as the rational buyer would not pay extra for stolen goods when the legitimate good could be purchased at a lower value. Additionally, the stolen goods price will represent the lower bound of the market price as the demand for stolen goods will take into account the illegal status of these goods. As Dnes (1996) notes, "We cannot be sure that resources move to their highest-valued uses when items are stolen."[239]

An example is the Genovese case where the thief sold the stolen Windows source code for $20, which hardly begins to approach the value to Microsoft of the Windows programs considered to be the "crown jewels"[240] of the corporation. The potential financial harm and loss of strategic advantage to Microsoft is not reflected in the stolen goods market $20 price tag. Compare this to the case of

[237] Following Carr and Gorman (2000), these estimates are not incorporated into the range of the valuation of trade secrets (*Low* and *High*, as discussed in Chapter 5) due to their weak correlation with other methods. The exception, as in Zwillinger and Genetski (2001), is when the defendant is able to complete the sale.

[238] Note that the "stolen goods market price" is different from the "black market price." According to Roselius and Benton (1973), the black market occurs in the presence of a rationing system or economic sanctions. The market for stolen goods is the market where stolen goods are sold through illegal channels. As the authors note, "A major distinction between the black market and the market for stolen goods is that prices are higher than the official market price in the former, and lower than the free market price in the later", p. 181.

[239] Dnes (1996), p. 141.

[240] Department of Justice, Southern District of New York (August 29, 2005), "Connecticut Man Pleads Guilty in US Court to Selling Stolen Microsoft Windows Source Code," Accessed June 15, 2008 from http://www.usdoj.gov/criminal/cybercrime/genovesePlea.htm.

U.S. v. Trujillo-Cohen,[241] in which the defendant attempted to sell her employer's proprietary software to a competitor for a reported $7 million.[242] The amount by which the thief attempted to profit, the accuracy of their estimation, and whether or not they actually managed to sell, can affect the valuation significantly.

One difficulty facing the application of Unjust Enrichment, particularly in EEA cases, is that it requires that the Follower (defendant) was able to exploit the stolen trade secret. As Zwillinger and Genetski (2000) note, many of the EEA cases involve FBI stings in which the defendant did not have the opportunity to use the trade secret (e.g. U.S. v. Williams and other cases discussed in Chapter 3.) Furthermore, this valuation method is dependent on the Follower's ability to exploit the trade secret in question. That the valuation of a trade secret be dependent on the defendant's business acumen provokes judicial discomfort, as discussed in Stark et al (2000.) Thus, Unjust Enrichment may not be an accurate and reliable means of calculating damages valuations.

Additionally, as Zwillinger and Genetski (2000) point out, in some cases the defendants steal what they believe to be valuable information but which may not actually have value.[243] In these cases, the application of Unjust Enrichment would be inappropriate, as it would have no value. Furthermore, a key element of damages valuation in criminal cases is the matter of intent. In the case where the trade secret was of little value (or the defendant was unable to exploit the trade secret), and, therefore, of low Unjust Enrichment value, the defendant's intended harm is not accounted for in an Unjust Enrichment analysis.

Despite these weaknesses in EEA cases, Unjust Enrichment does provide a pleasing method of valuation from the point of view of fairness. By stripping the

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[241] U.S. v. Trujillo-Cohen, Criminal case 4:97-cr-00251-1, (Southern District of Texas, filed on November 14, 1997.)
[242] Wiggin and Dana, White Collar Defense (1998), "Investigations and Corporate Compliance Advisory, Theft of trade secrets," 2:2, available from http://www.wiggin.com/pubs/advisories_template.asp?GroupName=White-Collar+Defense%2C+Investigations+%26+Corporate+Compliance&ID=143715822000.
[243] Particularly, as the authors note, in cases involving FBI stings in which the defendant steals planted documents.

defendant of the illicit profits from the theft, the defendant achieves no financial gain from the theft. In cases where the defendant was able to exploit the trade secret, such as the Keppel case detailed below, Unjust Enrichment can be a judicially appealing method.

Unjust Enrichment Example

Robert Keppel pleaded guilty to theft of trade secrets in 2002.[244] Keppel purchased copies of Microsoft Certified Systems Engineer (MCSE) and Microsoft Certified Solution Developer (MCSD) certification exams and answer sheets from a test centre in Pakistan. Keppel then set up an online company, www.cheet-sheets.com, and sold copies of the confidential information to customers. Keppel sold these products with the knowledge that they constituted Microsoft trade secrets. Keppel's customers used the information to cheat on the certification exams. Thus, the theft harmed Microsoft through both the theft of the property and by undermining the reputation of the certification process. As the value of certificates largely depends on the reputation of the productivity of certified systems engineers and software developers, the theft of the trade secrets compromised their business model.

The Keppel case incorporated a number of estimates using various methods of the value of the trade secrets, as detailed in Table 4-7. These valuations are a prime example of the wide range of valuations associated with a single theft. The Keppel case highlights the diversity of the results of valuation models with a range of $150,000 to $2.8M for the same Trade Secret. The agreed upon Unjust Enrichment of $800,000 appears to the value of the revenues from theft ($756,633.03), plus an unknown amount from additional accounts mentioned in the press release.[245] The defence argued that Keppel's Unjust Enrichment was only $150,000; however, the plea agreement states a value of $800,000.

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[244] U.S. v. Keppel, Criminal case 3:02-cr-05719-RBL-1 (Western District of Washington, filed on August 8, 2008.)

[245] D.O.J. Western District of Washington, "Former Vancouver, Washington, Resident Pleads Guilty to Theft of trade secrets from Microsoft Corporation," August 23, 2003, available from http://www.usdoj.gov/criminal/cybercrime/keppelPlea.htm.

Furthermore, the tests were estimated to have cost Microsoft $2.8 million to develop and Microsoft requested restitution of $1.9 million.

Table 4-7: Detailed Estimates of the Value of trade secrets in U.S. v. Keppel

U.S. v. Keppel	
Description	*Amount*
Unjust Enrichment	
Keppel's revenues from theft (deposits into bank account associated with Keppel's website)	$756,633.03[246]
Defense's calculation of Keppel's profits associated with theft	$150,000[247]
Defendant's gain (Unjust Enrichment as quoted in Plea Agreement)	$800,000[248]
Other Estimation Methods	
R&D Costs	
Microsoft's R&D costs per test (28 total tests for MCSE and MCSD)	$100,000[249] ($2.8M total)
Restitution	
Restitution requested by Microsoft	$1.9M[250]
Range for restitution agreed in Plea Agreement	$500,000 to $800,000[251]
Actual Restitution	$500,000[252]

[246] D.O.J. Western District of Washington, "Former Vancouver, Washington, Resident Pleads Guilty to Theft of trade secrets from Microsoft Corporation," August 23, 2003, available from http://www.usdoj.gov/criminal/cybercrime/keppelPlea.htm.
[247] CertCities.com, "Keppel Attorney Blasts MS Claim of Losses; Says Client Should Not Face Jail," January 20, 2003, accessed July 7, 2008, from http://certcities.com/editorial/News/story.asp?EditorialsID=400.
[248] U.S. v. Keppel, Court document 10, Plea Agreement, p. 3.
[249] D.O.J. Western District of Washington, "Former Vancouver, Washington, Resident Pleads Guilty to Theft of trade secrets from Microsoft Corporation," August 23, 2003, available from http://www.usdoj.gov/criminal/cybercrime/keppelPlea.htm.
[250] CertCities.com, "Keppel Attorney Blasts MS Claim of Losses; Says Client Should Not Face Jail," January 20, 2003, accessed July 7, 2008, from http://certcities.com/editorial/News/story.asp?EditorialsID=400.
[251] U.S. v. Keppel, Court document 10, Plea Agreement, p. 3.
[252] U.S. v. Keppel, Criminal Docket.

In the Keppel case, the calculation of the Unjust Enrichment valuation method is straightforward for a number of reasons. Firstly, Keppel entered the market for test material based entirely on the direct sale of the trade secrets. Without Microsoft's trade secrets, Keppel would not have had a good to sell. Secondly, the good itself required very little input in terms of capital as the goods were sold as either electronic or printed material. Keppel's production costs were limited to investments in marketing, the sales process and website development. Thus, the revenues stemming from the sale of the good can be interpreted as the direct value of the trade secrets. Thirdly, there are no commercial substitutes for the good. Keppel's customers either had to study more, or cheat using his goods. Keppel operated as a monopoly as no legitimate market for the test material existed, thus no competitors faced Price Erosion or loss of market share. While Microsoft could claim that the cheating by Keppel's customers enabled by Keppel's goods eroded the goodwill of their certifications, this would relate to a Lost Profits analysis and not an Unjust Enrichment analysis.

4.6.3 Lost Profits

Calculating the victim's Lost Profits is another standard valuation method (Smith and Parr, 2005.) Under the Lost Profits doctrine, the damages (losses) are calculated as the financial disadvantage, as measured in lost profits, suffered by the Trade Secret owner as a result of the theft. Restoration of these profits makes the owner whole but for the theft. Under specific market conditions, it is possible for Lost Profits to equal Unjust Enrichments (Zwillinger and Genetski, 2000.)

As Sullivan (in Slottje (ed.), 2006) identifies, Lost Profits consist of multiple components; two dominant elements are price erosion and loss of market share. Market share starts with a defined market and assumes that, "but for" the infringing product, the consumption of the good would be divided amongst existing competitors based on their market share.

The Panduit test (Slottje (ed.), 2006) is a general test to determine the right of the owner to seek lost profits. The test provides a general foundation from which arguments for lost profits can be made. The key points of the test are:

1. Demand for the [patented] product.
2. Absence of acceptable non-infringing substitutes.
3. Manufacturing and marketing capability to exploit demand.
4. Amount of profit owner would have made.

While the application of this test is contentious,[253] it forms the basis of arguments for the owner's right to lost profits. Smith (2002) examines the application of the Panduit test to trade secrets misappropriation cases and notes that, while there is limited published evidence of its use, "there is at least some recognition of the fundamental principle underlying the *Panduit* factors."[254]

The following Lost Profits models, based on Sullivan (2006), are theoretically sophisticated models using the concept of the counterfactual state.[255] Building on the notation described in Table 4-5 and Table 4-6, the models use the standard definitions of profit, Π, and revenue, R, based on price, p, quantity, q, and unit cost, c:

$$\text{Revenue} = R = pq$$

$$\text{Profit} = \Pi = pq - cq$$

where the firm is denoted by a subscript (I for Innovator and F for Follower.) The market is an oligopoly where each firm has market share M_i where:

$$1 = \sum M_i$$

Furthermore, the market share is measured either in the *actual* state or in the *but for* state where

$$1 = \sum M_i^{actual}$$

$$1 = \sum M_i^{but\ for}$$

[253] Slottje (ed.), 2006, p. 134
[254] Smith (2002), p. 832.
[255] The Lost Profit models shown here are more sophisticated than those discussed for Unjust Enrichment (Equations **[4-1]** to **[4-5]**.) However, both the Lost Profits and Unjust Enrichment models can be modelled using either factual or counterfactual time periods.

Lost Profits as Market Share Loss

[4-6]

$$LP_{MarketShare} = \left| \prod_I - \left(\prod_I * \frac{M_I^{Actual}}{1 - M_F^{Actual}} \right) \right|$$
$$where\ M_I^{Actual} < M_I^{But\ for}$$

The model assumes that *I* is the innovator and *F* the infringing follower in an oligopoly setting where the entrance of *F* does not affect the price of the good. It is assumed that the entrance of the Follower takes away market share from the Innovator. M_f denotes the market share of firm *F*, and Π_I denotes the profit of firm *I*. The absolute value of this difference of actual profits versus profits *but for* the loss of the market share is the Lost Profits value of the trade secret. Essentially, this method takes the difference between actual profits, and actual profits adjusted for the *but for* market share.

Lost Profits based on Price Erosion

Lost Profits based on Price Erosion examines the impact on the profits of the Innovator following the Follower's entrance to the market. As the name suggest, Price Erosion argues that the entrance of the Follower decreases the market price of the good. For illustrative purposes only, we do not model the change in market share or quantity in Equation **[4-7]**; we will use it to build up to Equation **[4-8]**.

[4-7]

$$LP_{\text{PriceErosion}} = \Pi_I^{actual} - \left[R_M^{Actual} \frac{\Delta P}{P^{but\ for}} M_I^{Actual} \mu \right]$$

Price Erosion presents a more complete view of the effect of an infringing product on the innovator's profits. Under Price Erosion, the entrance of the defendant's product is assumed to erode the market price of the good.

$$\Delta P = p^{but\ for} - p^{actual}$$
$$where\ \Delta P > 0$$
R_I is the revenue of the Innovator

R_M is total market revenue

$$\Delta R_m = R_M^{actual} - R_M^{but\ for}$$

Instead of incorporating costs directly, this model incorporates them indirectly using the following definition of profit margin, *μ:*

$$\mu = \frac{\pi}{R}$$

In this case, the innovator's revenue R_I changes based on the change in total market revenue R_M, adjusted for the innovator's market share M_I.

To account for the total change in profit, as opposed to merely the change in revenue, total costs are subtracted from total revenue. As in Sullivan in Slottje (2006), these costs are incorporated based on the profit margin that the innovator enjoys but for the infringement (e.g. ex ante.) The *but for* profit margin here is expressed as $\mu=\Pi/R$ and is calculated exogenously. For simplicity, the margin is constant, although the Sullivan model allows for it to change. By definition, the margin will be less than one and non-negative.

However, Equation [4-7] represents an incomplete look and can be modified to incorporate the change in market share by multiplying the innovator's relative market share adjusted for loss of market share. In this case, we incorporate the price elasticity of demand, *e,* which models both quantity and price changes.

Lost Profits based on Price Erosion and Market share

[4-8]

$$LP_{PE,MS} = \Pi_I^{actual} - \prod_I^{but\ for} = \Pi_I^{actual} - \left[R_I^{but\ for} M_I^{but\ for} \mu\right] = \Pi_I^{actual} - \left[R_M^{Actual} \frac{\Delta P}{P}\left(1+\frac{1}{e}\right)\frac{M_I^{Actual}}{1-M_F^{Actual}}\mu\right]$$

This model, which incorporates both Price Erosion and loss of Market Share, represents the most complete look at the effects of the misappropriation of the trade secret. As it allows for changes in quantity and price, Equation **[4-8]** is the most sophisticated of the models thus far. The inclusion of the price elasticity of demand, *e,* is recognition of the market forces that shape price and quantity and brings the model in line with economic theory.

Werden et al (2000) use a market simulation model to estimate lost profits and consumer welfare. The model, used frequently in merger simulations, identifies substitutes, defines the relevant market and assesses changes due to price erosion and demand. The authors develop a Bertrand market model using a logit model of generalized competition. The authors argue that the model, already an established policy evaluation tool in merger analysis, provides a straightforward modelling solution to infringement cases.

However, the use of Lost Profits is not straightforward. It requires a detailed market analysis from experts. This involves estimating demand and supply curves and taking into account the presence of competing products (i.e. substitutes.) Furthermore, the victim (trade secret owner) must be able to prove that they would have been able to satisfy this theoretical demand (as noted in Anson and Suchy, 2005.) In the case where the defendant has much larger production capacity than the victim, this means that Lost Profits could be much lower than the Unjust Enrichment value, as the victim would have been unable to match the defendant's production quantities.

Another difficulty facing Lost Profit calculations is accounting for the portion lost as a result of the theft, as noted in Zwillinger and Genetski (2000.) In the U.S. v. Branch and Erskine case, stolen strategic business information aided Boeing in winning 19 out of 28 contracts worth a total of $2 billion. The victim company, Lockheed Martin, was awarded the remaining nine. Valuing the stolen trade secret at the full value of the remaining 19 contracts awarded to Boeing would require assuming that, in absence of the theft, Lockheed Martin would have been awarded all of the contracts. A series of criminal and civil actions resulted in

Boeing losing some of the contracts and being fined $625 million.[256] The Lost Profits doctrine suffers when the contribution to profits of the trade secrets is unclear and when the actual lost profits do not reflect the value of the trade secret accurately.

Victim Revenues

Another form of valuation related tangentially to the Lost Profits doctrine, is that of the victim revenues. This valuation method, which values the stolen Trade Secret at all or some of the revenues of goods incorporating that Trade Secret, is not used in any of the court documents in EEA cases. However, media reports will include comments[257] regarding the total sales of a particular good that indicates, at least to the owner, the potential value of the Trade Secret. This method is particularly problematic because the value of the product may not reflect the value of the Trade Secret accurately. For example, if the famous Coca-Cola formula were to be stolen, the brand value of Coca-Cola itself would still support sales. The formula may account for the majority of the physical good (the drink), but the intangible qualities of Coca-Cola are not contained merely in the Trade Secret formula but within a myriad of trademarks, know-how and marketing.

Trade Secret as Portion of Total Revenue of Victim's Good

The Value of a trade secret (V_{TS}) can be regarded as proportional (with proportionality factor z) to the revenues it generates for the innovator (R_I).

[4-9]

$$V_{TS} = zR_I$$

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[256] Statement of Deputy Attorney General Paul J. McNulty before the Senate Committee on Armed Services, August 1, 2006, available from http://www.usdoj.gov/archive/dag/testimony/2006/080106dagmcnultystatementsenate.htm

[257] As an example, see Romero, Simon (May 4, 2001) "F.B.I. Says 3 Stole Secrets from Lucent," *The New York Times*, accessed October 23, 2008, from http://query.nytimes.com/gst/fullpage.html?res=9407E0D91338F937A35756C0A9679C8B63&sec=&spon=&pagewanted=all.

where $0 < z \leq 1$

Formally, this is represented by the total sales of the good, R_I, multiplied by the fraction the Trade Secret contributes to the good, z. This fraction is limited by the upper bound of 1 because a 1 would indicate the good was only the Trade Secret.

The Lucent case highlights the relatively high values that can be obtained by using total revenue as a valuation method. In the Lucent case,[258] the source code technology which the defendants stole was generating $100,000,000 in sales for Lucent in 2000. This sales number was included in the Department of Justice's press release regarding the arrests of the defendants[259] and reported subsequently in media coverage.[260] As this was a case of economic espionage in which the source code was intended for use in setting up a Chinese competitor to Lucent, it is possible that there were political motivations in inflating the worth of the source code. Nonetheless, the $100 million figure represents a value of the source code to Lucent.

Lost Profits Examples

Lost Profits were identified as the method of valuation in only two EEA cases. However, due to overlap in the classification of models, the Lost Profits doctrine shares some foundations with the Actual Damages method. Actual Damages measure the loss incurred by the victim, whereas Lost Profits can also include theoretical damages. Thus, a more liberal interpretation of the Lost Profits doctrine could also classify the five cases using Actual Damages as being under the Lost Profits methodology.

U.S. v. Munoz

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[258] US v. ComTriad et al, 2:01-cr-00365-WHW-3 filed on May 31, 2001 in New Jersey.
[259] D.O.J. (May 3, 2001) "Lucent Scientists Arrested, Charged with Stealing Tech Secrets for Joint Venture with China-controlled Company," accessed October 23, 2008, from http://www.usdoj.gov/criminal/cybercrime/ComTriadarrest.htm.
[260] Romero (2001).

One case that incorporates the Lost Profits doctrine is that of Benjamin Munoz.[261] Munoz, a former employee of a construction contractor, Penick and Sons, accessed a confidential bid proposal draft. At the time, in 2006, a competitor who was also participating in the bid competition employed Munoz. The competitor turned the case over to the authorities upon discovering Munoz's actions.

According to the press release, "Munoz acknowledged that the potential loss to Penick and Sons exceeded $400,000."[262] The plea agreement is not available publicly and the total value of the contract is unknown. However, as Penick and Sons was awarded the contract, the $400,000 figure represents a theoretical, not actual, loss to the victim.

U.S. v. Four Pillars

The Four Pillars case, a prominent EEA case, also used Lost Profits as an estimate of the value of the trade secrets.[263] Involving the first corporate defendant and the first application of the Economic Espionage (1831) section of the EEA, the case was brought against three defendants in 1997. The Four Pillars Company employed Ping Yen Yang and his daughter, Hwei Chen Yang. Over a period of several years, Four Pillars paid an employee of Avery-Dennison for trade secrets related to the Avery-Dennison's manufacturing of self-adhesive products.

The trade secrets cost Avery-Dennison $36 million[264] in R&D, with an additional estimate of over $50 million to develop.[265] An expert witness, on behalf of the

[261] U.S. v. Munoz, Criminal case 3:06-cr-00831-JAH-1 (Southern District of California, filed on April 27, 2006.)
[262] D.O.J. Southern District of California, "California Man Sentenced for Electronically Stealing trade secrets from his Former Employer, a Construction Contractor," October 13, 2006, available from http://www.usdoj.gov/criminal/cybercrime/munozSent.htm.
[263] U.S. v. Four Pillars etc, Criminal case 1:97-cr-00288-PCE (Northern District of Ohio, filed on October 1, 1997.)
[264] Green, Savage and Mulhern (2000), p. 264.
[265] Mossinghoff, Mason and Oblon (1998).

victim, estimated Reasonable Royalty at $73 million.[266] However, in an appeal filed by the defendants, the court found Lost Profits where, "Four Pillar's criminal acts caused over $800,000 in loss."[267] The large discrepancy between the $73 million Reasonable Royalty, $36 million R&D costs and the Lost Profits of $800,000, demonstrates the diverse nature of the valuation methods in their application to a single trade secret. In this case, the victim suffered as an existing competitor stole trade secrets and competed in the market using these secrets.

When it came to sentencing, the defendants argued strongly against the higher estimates as values of the trade secrets. As reported in Green et al (2000):

> The defendant said, "Wait a minute. Let's figure this out. Avery Dennison still had their formulas. We didn't take their paper formulas and remove them so that they wouldn't have the formulas anymore. They're still making their products. They're still making money. No loss to Avery Dennison. … Frankly the stuff was worth nothing to us. So, let's see. They didn't lose anything. We didn't gain anything."[268]

The judge in the case chose ultimately to use a loss estimate of $1 million, which was the amount of R&D costs proven (adequately documented) for the development of one of the stolen trade secrets.[269]

4.6.4 Reasonable Royalty

A final Income method of determining values and damages in IP cases is the principle of Reasonable Royalty. This method estimates the damages by calculating the amount for which the trade secrets would have been licensed. The royalty is "based on the amount that a willing buyer would have paid a willing seller to license the stolen Trade Secret."[270] This method differs from previous valuation methods as it focuses on an ex-ante scenario. However, as pointed out in Shankerman and Scotchmer (2001), there is circularity in the fact

[266] Green, Savage and Mulhern (2000), p. 264.
[267] U.S.A. v. Four Pillars etc, On Appeal from the United States District Court for the Northern District of Ohio, Plea Opinion, filed August 12, 2005, p. 5, available from http://www.usdoj.gov/criminal/cybercrime/4Pillars_6thCir.htm.
[268] Green, Savage and Mulhern (2000), p. 265.
[269] Green, Savage and Mulhern (2000), p. 265.
[270] Zwillinger and Genetski (2000), p. 332.

that damages are determined by Reasonable Royalty while, at the same time, royalties are affected by the damages assessed. If a royalty exceeds expected damages sufficiently, a potential licensor may find it more profitable to steal, rather than license, the trade secret.

Reasonably Royalty based on Expected Sales and % Fee

[4-10][271]

$$royalty\ payments = sum\ of\ \frac{(cash\ flow * risk\ adjustment * royalty\%)}{discount\ \ rate}$$

$$RR = \sum_{t}^{\tau} \frac{(Y_t \rho_t)\gamma}{(1+r)^t}$$

Royalties can take on many functional forms and can include fixed fees, percentage fees, thresholds, minimum payments etc. As in Ayyar and Sickles (2006), reasonable royalties in trade secrets cases can be the sum of discounted future royalties payments based on expected sales (adjusted for risk) and the royalty rate. Formally, as in Ayyar and Sickles (2006), royalty payments, *RR*, equal the sum of future cash flow of the infringing good, *Y*, multiplied by the royalty rate, γ. The cash flow, *Y*, is adjusted for risk, ρ, and discounted at discount rate *r* for *t* time periods.

This estimate depends on a number of assumptions that will require economic modelling. The expected sales of the defendant must be forecast taking into account growth rates, changes in consumer preferences etc. The royalty rate itself may be a point of contention, as standard industry rates may not exist. Time period, as discussed below, and risk rate also necessitate estimation. While Reasonable Royalty presents a relatively simple model in terms of the actual calculation, the parameters involved are complex.

[271] Sickles and Ayyar, in Slottje (ed.) (2006), pp. 268-69.

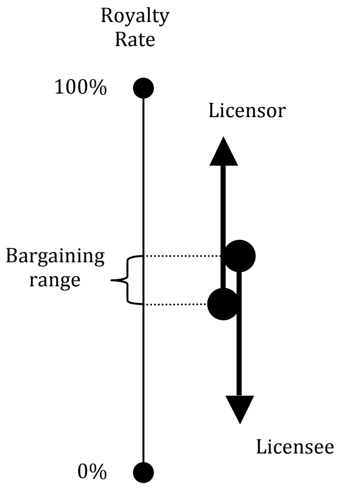
The estimation of the royalty rate, γ, is not straightforward as it requires significant market research to establish an appropriate rate. Hitchner (2006, p. 1001) notes that analysts traditionally develop royalty rates from any of three traditional sources:

1. Negotiated license agreements
2. Surveys performed by various professional, generally in cooperation with trade associations.
3. Judicial opinions, which vary greatly depending on individual fact patterns.

This research method ideally uncovers a range of royalty rates, which have been used for similar trade secrets. In practice, the unique nature of each trade secret, and the necessarily secret nature of their existence, will make the estimation of γ a difficult task. In recognition of the difficulty of this estimation, Hitchner (2006) notes that databases of comparative royalty rates have been developed as commercial tools for these analyses.

Glick et al (2003) represent the bargaining process between the licensor and the licensee over royalty rates in Figure 4-2. They note that the licensor will argue for higher amounts, whereas the licensee will argue for lower amounts. Where, and if, these two ranges overlap represents the potential gains from trade and the mutually acceptable range of the royalty rate.

Figure 4-2: Royalty Bargaining (adapted from Glick et al 2003)



As Zwillinger and Genetski (2001) note, Reasonable Royalty is a useful method in EEA cases as the defendants are often unable to exploit the trade secrets before being caught.[272] Choi (2006) notes that, "When the lost profits or actual damages from the infringement cannot be proved or deemed to be too speculative, the court accepts a 'reasonable royalty' rate as alternative measure of damage."[273] However, it remains difficult for courts to estimate the amount considered reasonable, as it requires conjecturing what the parties would have agreed to in normal license negotiations. Reasonable Royalty can also be equivalent to Lost Profits when you consider that royalty payments can form the expected income of an innovation. Despite the assertion that reasonable royalty is particularly useful, this research has uncovered only one EEA case, detailed below, that relied on Reasonable Royalty.[274]

However, Choi (2006) argues that, given the probabilistic nature of IPR, the use of Reasonable Royalty is logically inconsistent. Building on Shankerman and Scotchmer's (2001) recognition of the circularity of Reasonable Royalty, Choi

[272] These cases are referred to as "inchoate" offenses, meaning that the defendant was unable to complete their intended offense.
[273] Choi (2006), p. 15.
[274] Reasonable royalty is also mentioned in the U.S. v. Four Pillars case discussed in the examples for Lost Profits. However, in that case the court did not rely on that estimate and instead used the much lower R&D estimate.

(2006) argues that given the uncertainty of IP (Choi refers to patents which I am generalizing to IP), the hypothetical *ex-ante* negotiation cannot be consistent with the *ex-post* reality. That is, that via the process of litigation or prosecution, the existence and strength of the IP is confirmed. This information can only be known in the *ex-post* reality, therefore the hypothetical *ex-ante* argument is inherently biased by this knowledge. This is particularly the case with patents as their validity is often challenged in courts. As Choi (2006) argues, "As the value of a winning lottery ticket cannot be equal to the value of a lottery ticket before the drawing, the value of the patent that is certified to be valid in the court cannot be equal to the value of the patent with uncertain validity."[275] This argument can be applied loosely to trade secrets as their status as legally protected trade secrets is often determined in court (Anson, 2005.)

Nonetheless, Reasonable Royalty calculations in trade secrets damages benefit from a large body of legal precedents in patent cases. As Smith (2002) notes, "Perhaps, the area in which courts have most fully applied patent law damages principles to trade secret damages claims is in the area of royalty damages."[276] Glick et al (2003) note that the rule of thumb with royalty to rates is to "set a royalty rate such that 0.25 to 0.33 of licensee's profits go to the patent owner as a license fee. The rational for leaving 0.75 to 0.66 of the profits to the licensee is because of the licensee is expected to assume greater financial risk in commercialising the technology."[277] While this quote refers to patents, the principle that the licensee assumes more risk and should therefore retain a larger portion of the profits remains.

Reasonable Royalty Example

In July, 2006, Anne Lockwood, a former Vice President of Marketing and Sales for the Metaldyne Corporation, was charged with the theft of her former employer's

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[275] Choi (2006), p. 18.
[276] Smith (2002), p. 841.
[277] Glick et al (2003), p. 159.

trade secrets.[278] Lockwood conspired to steal Metaldyne trade secrets related to the production of powdered metal products to aid a Chinese company in a contract bidding competition with Metaldyne. Lockwood instructed a current Metaldyne employee to steal documents and records from Metaldyne. Lockwood and her co-defendants sought to gain commissions based on expected sales by the Chinese company. The theft was detected when the Chinese company approached Metaldyne machinery suppliers to supply machines built using Metaldyne drawings.[279]

According to the plea agreement, the contract in question was worth \$9,646,000 and "the value of the stolen information [was] between \$1M and \$2.5M, based on a reasonable estimation of the value of a license agreement to use Metaldyne's technology for five years."[280] This indicates that the parties chose to use Reasonable Royalty as a method of estimation. Assuming that the technology was to be used for only this contract, the estimate of \$1-2.5M indicates a royalty rate of γ=10-26%. However, this compares to a loosely estimated general industry standard of 2-15%.[281] The discrepancy between the estimate of the court's calculation and the industry standard may indicate that the parties expected the trade secrets to be used in production other than that related to the contract in question directly. Additionally, the designation of a license agreement for five years is important. The five years likely represents the expected lifetime of the Trade Secret, which ends when the Trade Secret becomes obsolete, or when the Chinese company develops the trade secrets independently.

The Reasonable Royalty valuation of \$1-2.5M, as noted above, corresponds to the following range of an application of Equation [4-10]
(Simplified as the value of the contract was already discounted to present value):

$$RR = \left[\$1M = .1(\$9.6M),\quad \$2.5M = .26(\$9.6M)\right]$$

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[278] U.S. v Lockwood, Criminal case 2:06-cr-20331-DPH-DAS-1 (Eastern District of Michigan, filed on July 5, 2006.)

[279] Metaldyne three face 64-count indictment, Metal Powder Report, Volume 61, Issue 7, July-August 2006, p. 4, available from: http://www.sciencedirect.com/science/article/B6VMN-4M0C4S0-3/2/70847ad4bd638b1ff5b4265912f2f280.

[280] U.S. v. Lockwood, Court document 148, Plea Agreement, p. 3.

[281] Anson and Weston (eds.) (2005), p. 154.

The plea agreement also notes:

> In addition, the parties agree that because Metaldyne did not lose business revenues or profits as a result of the conspirators' conduct, basing the sentencing guidelines on the value of the stolen information results in an overstatement of the offense level, and that the guideline range should be reduced by 2 levels.[282]

This statement by both parties highlights the uncertainty in loss estimates in trade secret cases. Lockwood was ultimately sentenced to 30 months incarceration and 24 months probation, which corresponds to a loss value of $200,000, based on the Sentencing Guidelines.

4.7 Cost Models

The Cost models, Research and Development, Replacement Costs and Actual Damages are based on the idea that the trade secret is worth the amount it cost to develop/redevelop, or the amount it cost to protect.

Cost models have an advantage over other methods in that they are, in general, based on documented accounts (Green et al, 2000.) This minimizes the need for conjecture on the part of expert witnesses and provides judges with relatively well-documented evidence as to the alleged value of the trade secret. Despite these evidentiary advantages, from a theoretical point of view the cost model may not reflect the value of the trade secret to its owner. Rational investors will invest in innovation with the intention of generating a profit not included in the cost method approach (Zwillinger and Grenetski, 2000.) Thus, the cost models and the owner's valuations of the trade secrets may have low correlation.

4.7.1 Research & Development

According to Research & Development costs methodology, the value is seen to reside in the amount invested by the trade secret owner to develop the trade secret. For the defendant, the costs required to research and develop the trade secret independently are known as the Replacement Costs. Despite their similar

[282] U.S. v. Lockwood, Court document 148, Plea Agreement, p. 3.

accounting of costs of development, Research and Development costs may vary from Replacement Costs (Green et al, 2000.) The defendant had the option of reverse engineering the trade secret and, therefore, saving on research costs, whereas the legitimate owner may have started from a blank canvas and invested in other costly but failed projects before the successful project (Smith and Parr, 2005.) Additionally, development costs may not reflect the value of the trade secrets accurately. A brilliant flash of insight may cost a trade secret owner very little, while an arduous process of developing a new formula, for example, may incur years of salaries and inputs. As Zwillinger and Genetski (2000) note:

> Research and development overstates the loss because when someone steals a Trade Secret, the theft rarely deprives the owner of the Trade Secret from the full value of the stolen technology… Conversely, research and development costs understate the fair market value of stolen trade secrets because rational actors will not invest $5 million to develop information that will be worth only $5 million. Instead, a company invests $5 million only with the expectation of producing a significant return on the investment.[283]

Thus, these costs may not account for the added value of a trade secret to its owner.

It is also important to note that R&D costs represent a sunk cost to the owner of the trade secret. According to traditional theory, sunk costs are not incorporated into short-term decision making processes once they have been incurred. R&D costs do not reflect the value of the trade secret accurately to the owner and are only a measure of the resources committed to its creation. Smith and Parr (2005) note, "As a general rule, cost does not equal value. Unless economics benefits can be earned from ownership of property, its value must be relatively low, regardless of the amounts needed to develop it."[284] However, equally, Green et al (2000) further the argument using the Coca-cola example: "Imagine how much it must have cost to create that formula for Coca-Cola versus the value of it today. … But a cost approach can understate the true market value of an

[283] Zwillinger and Genetski (2000), pp. 344-45
[284] Smith and Parr (2005), p. 165.

asset."[285] The rational agent will value the trade secret on the basis of future expected value rather than retrospective costs. Despite this, however, anecdotal evidence suggests that judges favour the use of R&D costs in valuing trade secrets (Green, Savage and Mulhern, 2000.)[286]

Research and Development Costs as the Innovator's Costs

Research and development (R&D) costs of the owner (i.e. the innovator), RD_I, may be regarded as the variable costs, VC_I, of producing the Trade Secret plus the fixed costs, FC_I, of R&D (a portion of the fixed costs of setting up laboratories, failed projects etc.):

$$RD_I = FC_I + VC_I \qquad [4\text{-}11]$$

Of course, research and development costs can be categorized in a number of ways. Failed research and development projects which drive up the overall cost of successful innovation can be interpreted to be part of fixed costs. However, this leaves wide scope for interpretation, or even misinterpretation, which highlights the difficulty of using these methods to assess the value of a trade secret.

4.7.2 Replacement Costs

Replacement costs can be interpreted in two ways: one is the costs the defendant would have incurred to reverse-engineer or develop the Trade Secret independently; the other is the savings in research and development costs the defendant received as a result of the use of the Trade Secret (Green et al, 2000; Samuelson and Scotchmer, 2002.) The calculation of reverse engineering costs is

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[285] Green et al (2000), p. 270.

[286] However, despite this anecdotal evidence, the EEA data reported in the next chapter contradict this with a significant caveat. R&D is identified as the method used in only four cases (Market Value is the most commonly observed method with six observations.) However, the data collected reflect the values employed throughout the EEA cases and not necessarily those utilised by the judges. The Cost models, which include R&D, are the most popular models of valuation.

based on an ex-ante scenario of what the costs would have been, whereas the savings in research and development is an ex-post reality. In some cases, the costs estimation will be the acquisition cost of the Trade Secret if it was, for example, purchased from another entity (Zwillinger and Genetski, 2000.)

Research and Development Costs as Reverse Engineering (Replacement Costs)

Reverse engineering costs (RE) may be regarded as proportional (by factor *z*) to the innovator's R&D costs, RD_I

[4-12]

$$RE = \alpha RD_I$$

where $\alpha>0$.

Reverse engineering can be more or less costly for the follower than the original innovator (RD_I). This depends on the type of innovation.[287] Pharmaceuticals can be relatively cheap to reverse engineer because their chemical make-up is easily observed and much of the cost in developing them was in identifying the correct formula (Samuelson and Scotchmer, 2002.) If the innovation occurred is difficult to observe (e.g. a process innovation), then the costs of reverse engineering may be more expensive than RD_I. Thus, the reverse engineering costs, *RE*, are adjusted by the proportion parameter α, which is the relative difficulty (ease) of copying where $\alpha>1$ when copying is difficult, and $\alpha<1$ when copying is easy.

Research and Development Costs as Savings to Follower

Let change in R&D costs (ΔRD) be defined as the difference between the Innovator's R&D costs, RD_I, and the follower's R&D costs, RD_F:

[4-13]

$$\Delta RD = RD_I - RD_F$$

287 Samuelson and Scotchmer (2002) detail the economics of reverse engineering.

This recognises that the trade secret may allow followers to save in their own research and development costs. In this case, the trade secret can be valued at the savings incurred by subtracting the costs to the follower RD_F from the costs of the innovator RD_I. This method could also be considered under the Unjust Enrichment category as it identifies the cost savings to the defendant.

Some examples of the discrepancies created using the replacement costs and other methods can be found in the EEA cases. The stolen Microsoft tests cost the company $200,000 to develop[288] but were valued at $500,000 to $800,000 in court documents. In U.S. v. Krumrei,[289] the defendant stole trade secrets related to a laminate that cost the company $31.4 million to develop,[290] which the defendant attempted to sell for $350,000[291] and was ultimately required to pay $10,000 in restitution. These diverse values demonstrate the highly variable estimates stemming valuations based on development costs in comparison with other methods.

4.7.3 Actual Damages

Actual Damages reflect the sum of direct costs stemming from the theft (similar concepts are discussed in Cooter and Ulen, 2004.) Actual Damages share some features with Lost Profits, but rather than representing income not earned due to the theft, it represents the costs incurred. Actual Damages are the sum of the costs in detecting and investigating the theft, in addition to any loss of property and assets. For example, it can include the sum of extra labour hours required internally to investigate, legal expenses, cost of systems, down time, etc.

Actual damages (AD) are defined as equal to the sum of the costs incurred, e_i:

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[288] Two tests at $100,000 each from DOJ press release, August 23, 2002, "Former Vancouver, Washington Resident Pleads Guilty", available from http://www.usdoj.gov/criminal/cybercrime/keppelPlea.htm.
[289] U.S. v. Krumrei, Criminal case 2:98-cr-80943-DPH-1 (Eastern District of Michigan, filed on October 28, 1998.)
[290] Honolulu Star Bulletin, News Briefs, May 15, 1998, "Attorney accused of industrial espionage", accessed May 20, 2008, from http://starbulletin.com/98/05/15/briefs.hmtl.
[291] See U.S. v. Krumrei, Court document 47 related to appeal case #99-2500, 2001 Fed App. 0241P (6th Cir.)

[4-14]

$$AD = \sum e_i$$

These costs incurred by the firm are denoted by e_i, where *i* is the index for each type of expense. This method of valuing a Trade Secret can have low correlation with other costs and market valuations. An example of Actual Damages is the $68,000 incurred by DirecTV[292] in tracking down the source of a Trade Secret disclosure and mitigating damages in U.S. v. Serebryany.[293] The trade secrets disclosed related to bypassing restrictions in conditional access cards for subscription television. The potential for lost profits and the $25 million DirecTV spent on developing the access cards are not reflected in the $68,000 incurred as a direct result of the theft. Furthermore, these out-of-pocket expenses could be interpreted as the cost of doing business and the general costs associated with obtaining the reasonable protection required to achieve trade secret status. In this case, however, the defendant sought no financial gain from the trade secrets and was ordered to pay $146,085 in restitution. The cards in question were replaced within two years due to compatibility problems.[294]

4.8 Market Models

The Market Models, a broad category, seek to define a Fair Market Value of the trade secret. The Fair Market Value is the value that the trade secret would command in a transaction between a willing buyer and a willing seller (Zwillinger and Genetski, 2000.) A variety of tools can be employed to determine this, including the use of benchmark sales and surveys of industry members (Smith and Parr, 2005.) However, one advantage of trade secrets is that they derive value from their secrecy and are therefore unlikely to be available on the open market (Green et al, 2000.) Additionally, the owner of the trade secret, by

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[292] Poulsen, Kevin, April 24, 2003, "DirecTV Mole to Plead Guilty", Security Focus, accessed August 04, 2008, from www.securityfocus.com/print/news/4173.
[293] U.S. v. Serebryany, Criminal case 2:03-cr-00042-LGB (Central District of California, filed on January 16, 2003.)
[294] "DirecTV – Access Card History, D1 replaces P4," accessed September 07, 2008, from http://www.experiencefestival.com/a/DirecTV_-_Access_Card_History/id/4986861.

definition, will have more complete information regarding the trade secret and its value than a potential buyer (Slottje, 2006.) These information asymmetries and secrecy hamper efforts to identify benchmark sales and substitute goods.

It should be noted that Fair Market Value is a fairly broad concept that often overlaps with Income and Cost models. In this thesis, however, Fair Market Value will be used to categorize those cases in which a market value was achieved without the specific use of the other models.

4.8.1 Market Guideline Transaction Approach

In recognition of the multitude of methods of valuing intellectual property, a final approach, related to the use of the Market Models, is to consolidate multiple estimates of the value of the trade secret into a single value or range. This approach is detailed in Hitchner (2006, p. 1001) in four steps, as paraphrased below:

1. Research the market for benchmark transactions.
2. Verify that the information obtained is accurate.
3. Compare and apply the benchmark transactions' financial and operational aspects.
4. Reconcile the various valuations into a single valuation or range.

This comprehensive approach involves a significant amount of market and empirical research into benchmark transactions of trade secrets. The fact that the verification of the information obtained is detailed as a step in the process is an indication of some of the difficulties associated with the valuation of trade secrets. As many benchmark transactions will be highly protected and confidential, investigation into these transactions will be rife with inaccuracies (Hitchner, 2006.) The third step, the comparison and analysis, is a fairly subjective process as it entails an assessment of the terms and conditions of the benchmark transactions and their relevance to the trade secret in question. The final step, the reconciliation of the valuations, will again be a subjective process in which the relative strengths and applicability of the valuation methods will be weighed.

4.8.2 Market Models: Fair Market Value Example

Gary Min worked for the DuPont Company as a chemist for nearly ten years. In October 2005, Min signed a contract to begin work for a DuPont competitor. This work was not to begin until January 2006. From August 2005 to December 2005, Min used an internal server to downloaded approximately 16,700 confidential documents related to DuPont's new and existing technologies.[295]

Min's theft of these documents was detected when he announced his intent to leave the company and computer records indicated the high volume of downloads. According to the press release, "the fair market value of the technology accessed by Min exceeded $400 million."[296] The plea agreement is not publicly available. Min was ultimately sentenced to 18 months imprisonment with a fine of $30,000 and a restitution of $14,467.89.[297]

Market models provide a theoretically pleasing solution to the valuation conundrum. They value the trade secret at what the fair market value would be. However, as a market for a specific trade secret is unlikely to exist – due to its uniqueness and the owners wish to continue to receive economic benefit from its secrecy – fair market value represents a constructed calculation of the value of the trade secrets. The actual value of the trade secret may not be captured by its calculated fair market value.

4.9 Discussion of Relative Merits of Models

The methods used for damages valuations in EEA cases can provide a wide range of values, as will be examined in Chapter 5. As Zwillinger and Genetski (2000) argue, the Reasonable Royalty method offers a robust calculation that is less

[295] U.S. v. Min, Criminal case 1:06-cr-00121-SLR-1 (District of Delaware, filed on November 6, 2006.)
[296] D.O.J. District of Delaware, "Guilty Plea in trade secrets Case," February 15, 2007, p. 2.
[297] Due to a coding error, the Min case is included in the larger database (which includes all defendants) but not the reduced database reported in the appendix (which only includes all cases.) This is an inadvertent exclusion of data in the reduced set which should not affect overall results.

sensitive to the vagaries of the particular case than other methods. Reasonable Royalty does not require that the defendant actually exploit the trade secret, unlike Unjust Enrichment, as it uses a counterfactual state to estimate the value. Furthermore, Reasonable Royalty is not influenced by the need to allocate a proportion of the good to the value of the trade secret as in Lost Profits; it relies instead on a royalty rate (Hitchner, 2006.) Reasonable Royalty also avoids the pitfalls of Cost models, in which the costs to develop or protect the trade secret may not be, as Zwillinger and Genetski (2000) note, related to the value of the trade secret. It does, however, share some of the weaknesses of the Market Models in the need to identify similar benchmark transactions. Nonetheless, Reasonable Royalty benefits from its robust foundation in the established financial models discussed in Hitchner, 2006. Furthermore, in basing the calculation of damages on a presumed contractual relationship, Reasonable Royalty approximates expectation damages.

However, the criminal context of the EEA cases cannot be ignored as the question of "intent" is necessarily raised in criminal cases. As the discussion in Green et al (2000) notes, there is a lack of consensus of whether the valuations should be based on intended harm or actual harm. As in the stolen goods market price discussion, the defendant may not be aware of the value of the trade secret. As Green et al discuss, if a defendant steals something worth $10 million with the intent of making $500,000, what is the appropriate damages valuation?[298] Cooter and Ulen (2004) emphasize that criminal cases require proof of the intent of the defendant. Judicial discretion may ultimately make that decision. To borrow from Cooter and Ulen's example,[299] a thief may shatter a car window worth $100 to steal a car radio worth $75. Based purely on Unjust Enrichment, the value of the radio is $75. However, the total actual damages are $175. In EEA cases where the defendant was unable to exploit the trade secret, Unjust Enrichment may be zero. Furthermore, as Zwillinger and Genetski (2000) note, in some cases the defendant stole items that they believed to have value but which were not actually valuable. These matters complicate the damages

[298] Green et al (2000), p. 281.
[299] Cooter and Ulen (2004), p. 451.

valuations further and suggest that, as Zwillinger and Genetski argue (2000), no method is ideal in all cases.

4.10 Conclusion

The damages valuations of trade secrets provide insight into their economic value. As trade secrets may be regard as worth the value that can be proved in court (Anson, 2005), the damages valuation methods provide a crucial tool for estimating their value. However, as this chapter has discussed, the methods are formulated quite differently and can produce a range of values for the same trade secret. Furthermore, the point-of-view of the valuation methods can influence the valuation as defendants and victims seek to manipulate the value in their favour. Nonetheless, the valuation models themselves rest on economically sound principles.

The Income models, which include Unjust Enrichment, Lost Profits and Reasonable Royalty, are based on sound economic principles with well-established financial methods (as discussed in Slotjje, 2006 and Hitchner, 2006.) However, the attribution of the cash flows stemming from a good to the input of the trade secret is not straightforward. Furthermore, both Unjust Enrichment and Lost Profits are subject to the market performance of the defendant and the victim, respectively. However, Reasonable Royalty, as argued by Zwillinger and Genetski (2000), is, on balance, an appealing model for EEA cases.

The other two categories of damages valuations are the Cost and Market models. Cost models have the distinct benefit of being based on actual cash flows and do not require any theoretical modelling, which makes them appealing to the court (Anson and Suchy, 2005.) However, the costs involved in developing a trade secret are not necessarily related to the value of the trade secret (Zwillinger and Genetski, 2000.) The Market models suffer because trade secrets, by definition, are secret. Thus, finding comparable benchmark assets is difficult, as the content of the trade secret is not divulged publically during a sale.

The EEA cases provide a body of illustrative examples of the damages valuations of trade secrets. The cases outlined in this chapter have shown how one trade secret can have multiple valuations. The intent of the defendant, the actual damages and the value of the trade secret are not easily defined. It is the application of these models in each case that results in the range of values for a single trade secret. In Chapter 5, the values used in the EEA cases will be examined in more detail, using tools of statistical inference.

Chapter 5: Statistical Evidence and Analysis of EEA Valuations

5.1 Introduction

Following the mapping of the valuation methods used in EEA cases in Chapter 4, this chapter provides a statistical analysis of the observed values of trade secrets. The valuation of the stolen trade secret in EEA cases plays a key role in the selection of the case for prosecution,[300] the determination of sentence lengths and the amount of financial fines (Zwillinger and Genetski, 2001.) Despite this important role, the literature has not examined the valuations used in EEA cases, with the notable exception of Zwillinger and Genetski (2001.)

This chapter addresses the distribution of the values of the EEA trade secrets. Building on Chapter 4, the data are explored for evidence of statistical differences between the various valuation methods. While the results of this exploration are equivocal, the observed use of the valuation models provides some illustration of the practical application of these models. Finally, to investigate the observation that multiple values can be found for the same trade secret, the range of the values is also examined. It is found that the differences between high and low estimates of trade secrets are statistically significant. Furthermore, there is statistical evidence that the values used in sentencing differ from those argued during the course of the case.

The Section 5.2 develops the lognormal distribution of the value of trade secrets. The third and fourth sections examine the differences between the applications of the valuation methods. The fifth section examines the range of values for trade secrets and their use in sentencing. Finally, section six concludes.

5.2 Distribution of the Value of Trade Secrets

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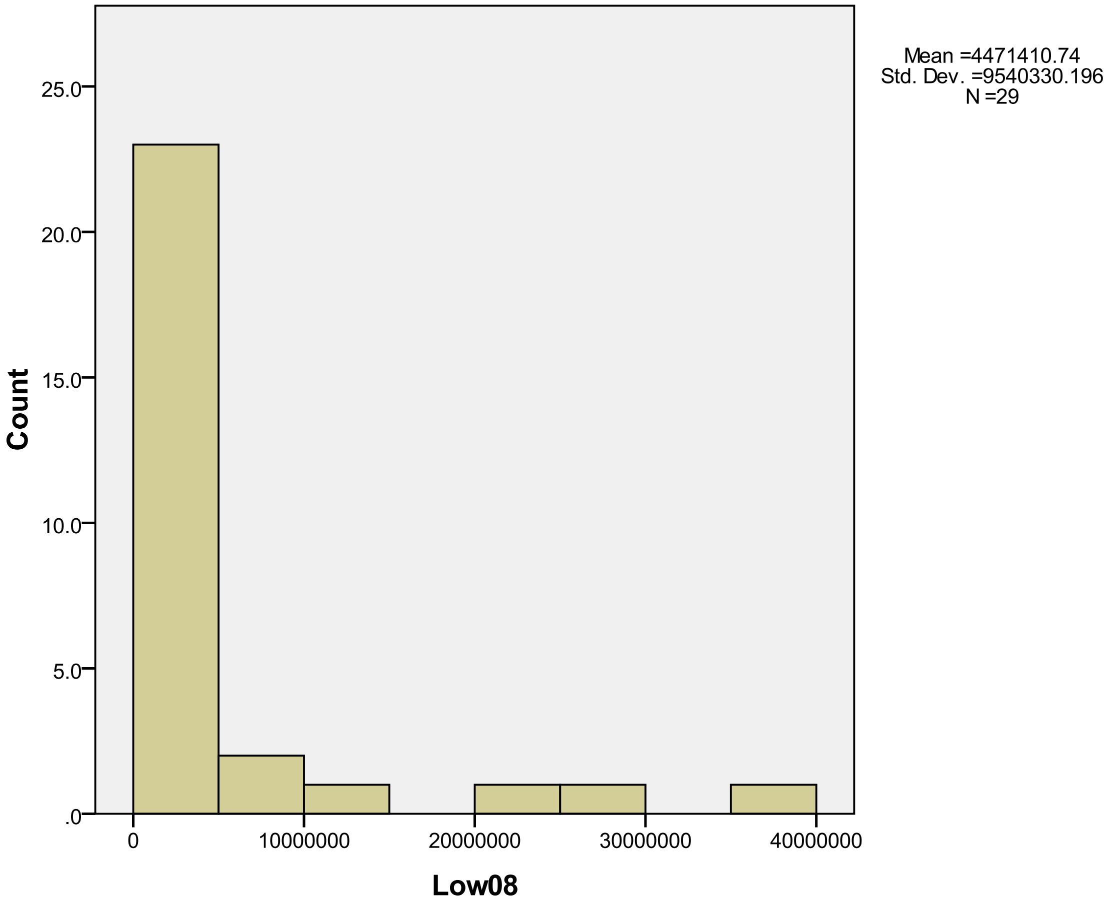
[300] The FBI's Reporting Theft Checklist asks victims to place the estimated value of the stole trade secret within a range. See www.justice.gov/criminal/cybercrime/reportingchecklist-ts.pdf.

As noted in Chapter 4, the estimates of the value of the stolen trade secret are grouped into low and high estimates; the “low” estimates form the basis of most of the analysis. This method of addressing the diverse nature of the values and using the more conservative lower estimate follows Carr and Gorman (2001.) The values of the trade secrets, both low and high estimates, have been deflated to reflect 2008 values.

A histogram of all of the low estimates suggests a lognormal distribution, as seen in Figure 5-1. The majority (79%) of the stolen trade secrets are worth less than $5 million.

Figure 5-1: Histogram of Low Estimates expressed in 2008 Values[301]

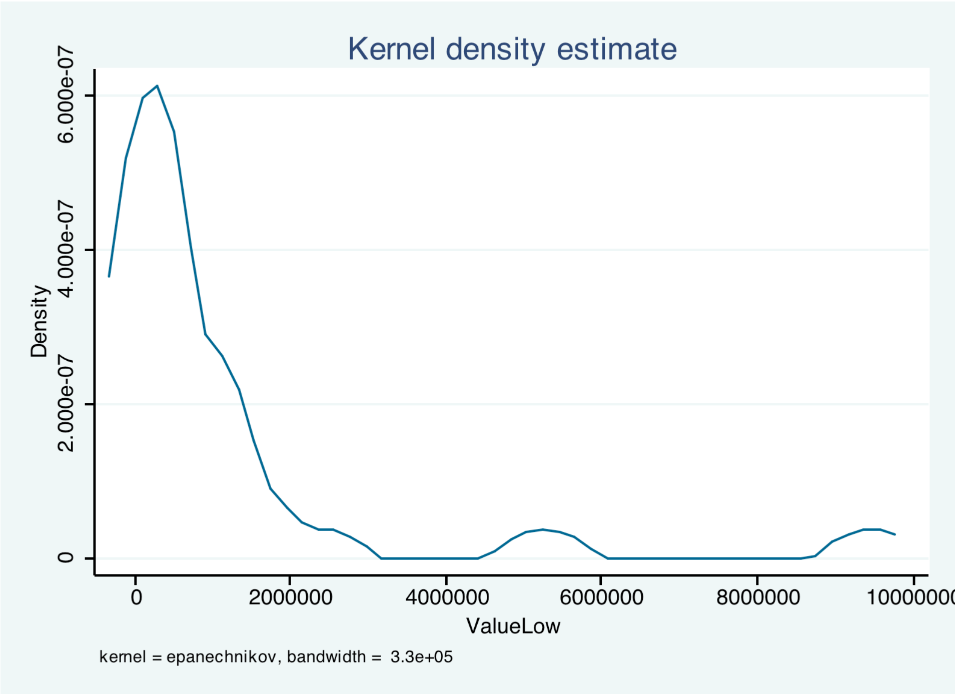


A smoothing exercise, using the Kernel Density Estimates in Stata, further emphasizes the lognormal distribution, as shown in Figure 5-2. The figure

301 Performed in Minitab.

demonstrates that the low estimates are distributed with the characteristically long tail. As the sample size is relatively small (n=29), if the lognormal distribution holds, then a larger sample size would likely show a smoother long tail.

Figure 5-2: Kernel Density Estimates of Low Estimates[302]

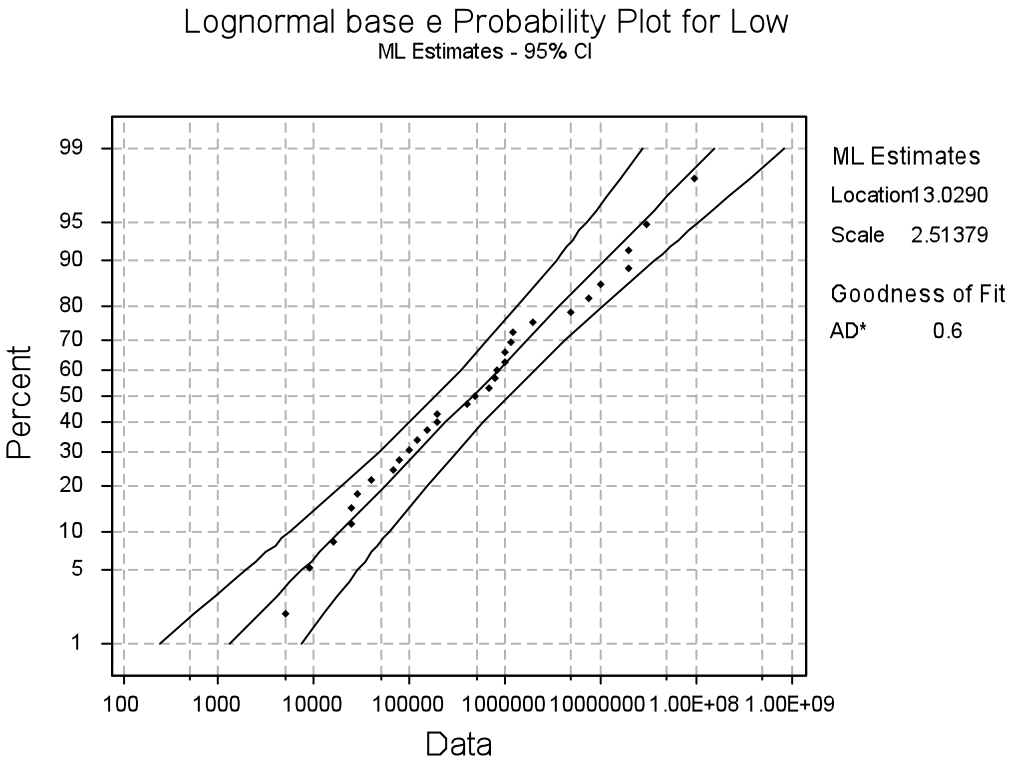


A probability plot, as seen in Figure 5-3, suggests that the data fit a lognormal distribution, as all of the data points are within the 95% confidence interval indicated by the two lines surrounding the data. The ML estimates provide the coefficients for estimated fit line that runs between the confidence intervals. The Goodness of Fit statistic, noted as AD for Anderson Darling,[303] allows for a comparison between distributions where smaller values are preferred.[304] In this case, the AD statistic for the lognormal distribution (AD = 0.6) was found to be the lowest when compared to alternate distributions. The p-value, calculated

[302] Performed in Stata. Note that this graph does not contain all of the observations; the data have been truncated in order to illustrate the lognormal distribution.
[303] The Anderson Darling statistic is also known as the Empirical Cumulative Distribution Function (ECDF) test.
[304] These graphs and tests were performed in Minitab. According the to Minitab's online support, the software uses "the weighted square distance between the fitted line of the probability plot and the nonparametric step function." Minitab support, "What is the Anderson-Darling goodness-of-fit statistics?", ID 731, available from www.minitab.com/en-GB/support/answers/answer.aspz?id=731.

based on the AD statistic[305], is p-value = 0.108. As the null hypothesis is that the data fit the lognormal distribution and the p-value in this case is greater than 0.05, then the null is not rejected.

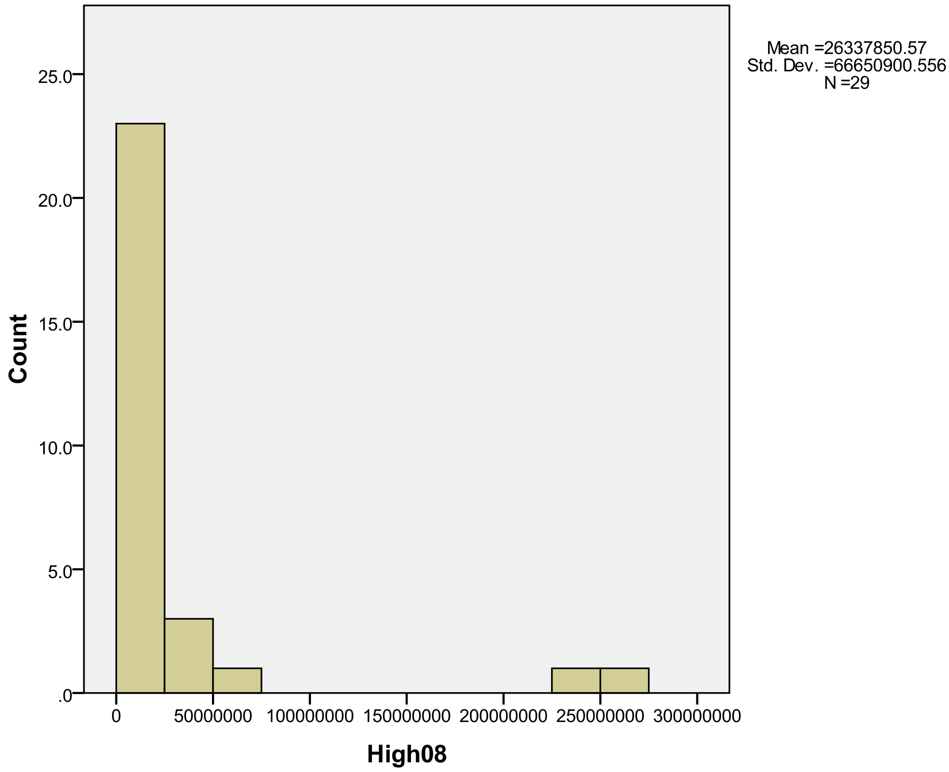
Figure 5-3: Confidence Intervals for Lognormal Distribution of Low[306]



The same is true for the high estimates. Figure 5-4 is the histogram of the high estimates, which suggests a lognormal distribution. Notably the range of the high estimates is greater than that of the low estimates.

305 According to the Minitab Support, "Calculating the Anderson-Darling Normality Test p-value using the AD statistic", ID 897, available from http://www.minitab.com/en-US/support/answers/answer.aspx?id=897&langType=1033.
The formula for calculating the p-value from the AD statistics is as follows:
"Suppose asq = AD, and n = number of observations.
Let ast = asq*(1 + 0.75/n + 2.25/(n*n)).
If 0.600 < ast < 13, then p = exp(1.2937 - 5.709*ast + 0.0186*ast*ast).
If 0.340 < ast < 0.600, then p = exp(0.9177 - 4.279*ast - 1.38*ast*ast).
If 0.200 < ast < 0.340, then p = 1 - exp(-8.318 + 42.796*ast - 59.938*ast*ast).
If ast < 0.200, then p = 1 - exp(-13.436 + 101.14*ast - 223.73*ast*ast)."
306 Performed in Minitab.

Figure 5-4: Histogram of High Estimates expressed in 2008 Values[307]



Again, a Kernel Density estimate suggests that the data fit lognormal distribution as in Figure 5-5 below.

[307] Performed in Minitab.

Figure 5-5: Kernel Density Estimates for High Values[308]

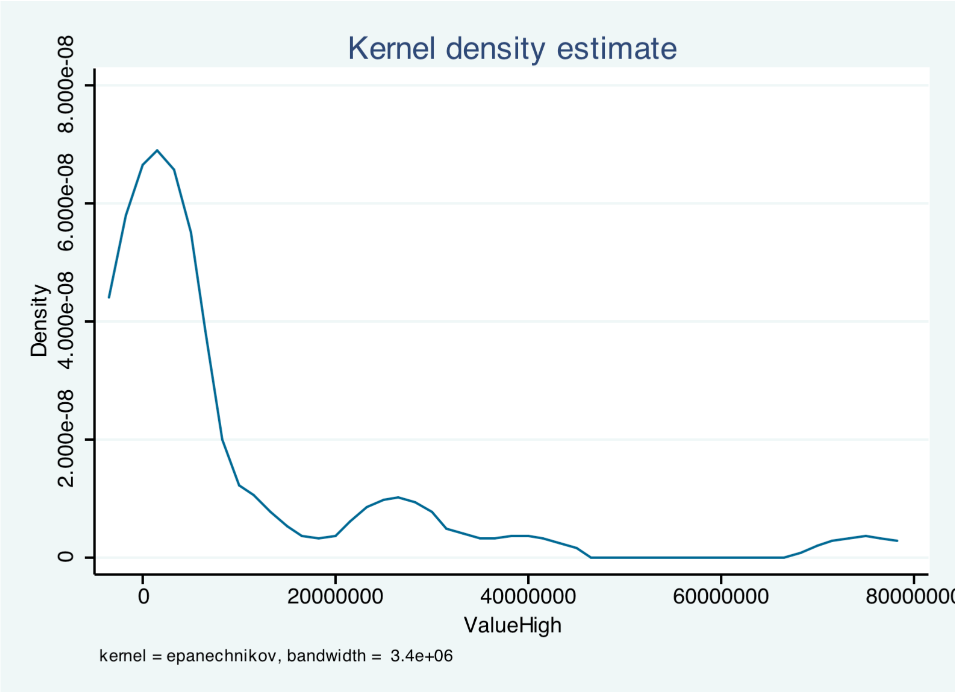
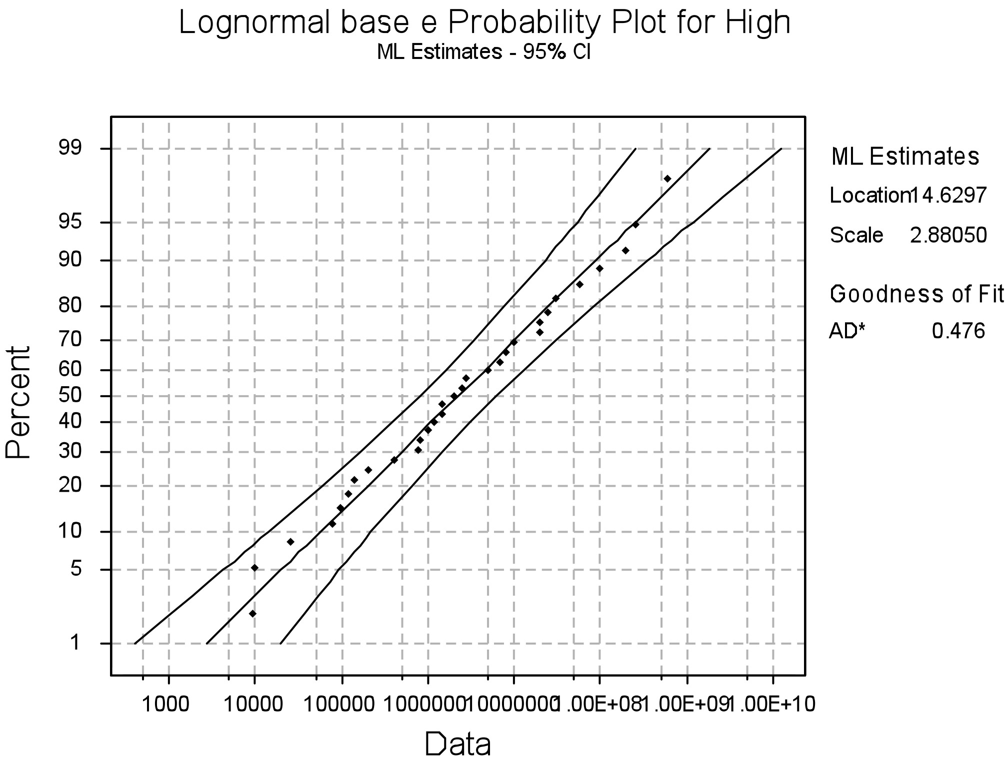


Figure 5-6 again shows a probability plot of the high estimates against their expected lognormal distribution and confirms that all estimates are within the 95% confidence interval. Again, the AD statistic (AD = 0.48) indicates that the lognormal distribution is preferred to alternate distributions. The corresponding p-value is 0.221, which again, as it is greater than 0.05, results in a failure to reject the null hypothesis that the data conform to the lognormal distribution.

[308] Performed in Stata.

Figure 5-6: Confidence Intervals for Lognormal Distribution of High[309]



As Figure 5-3 and Figure 5-6 suggest, the distribution of the value of trade secrets, for both the Low and High estimates, conforms to a lognormal distribution.

5.2.1 Discussion of the Lognormal Distribution of the Value of Trade Secrets

The lognormal distribution of the EEA data point to a situation in which the majority of trade secrets is relatively modest in value (in the case of the low estimates, less than $5 million), while a few trade secrets are very valuable. As noted in Limpert et al (2001), the lognormal distribution is often seen in income distributions. This commonality between income and the value of the trade secret underscores the idea that trade secrets are worth what they can earn; that is, that the value estimates generated by the various models behave in a manner similar to that which we would expect to see in values based purely on the potential income of the trade secret. Another comparison can be drawn with

309 Performed in Minitab.

gold deposits, which are also, as noted in Limpert et al (2001), lognormally distributed. The value of trade secrets follows the distribution of gold with lots of small nuggets and a few large ones.

The lognormal distribution of the value of trade secrets also mimics that of the distribution of its sister IP, patents. As Trajtenberg (1990) notes, "the distribution of patent values is highly skewed toward the low end, with a long and thin-tale to the high value side."[310] Harhoff et al (1997) find that the distribution of patented invention values, based on interviews with German patent holders, also fits a lognormal distribution value. As Lanjouw et al (1998) notes, lognormal distributions for the values of patents are also found in Shankerman and Pakes (1986), Lanjouw (1992) and Shankerman (1998). Thus, trade secrets exhibit the same distribution of patents. Given the emphasis this thesis places on the decision between patents and trade secrets, the similar distribution of their values suggests that the underlying values of the innovation protected by these IPR are similar.

5.3 Analysis of the Value of Trade Secrets Based on the Valuation Method

Following the discussion in Chapter 4 of the variety of methods of damages valuations of trade secrets, the data are now analysed for evidence of statistical differences between the methods. In Table 5-1, the cases are tabulated by estimation method using the low estimates. The estimation method was identified in roughly two-thirds of EEA cases where an estimate of the stolen trade secret was published. One outlier using the Market Value method, the $108M estimate for the Lucent source code, has been removed.[311] The sample size is small with only 21 observations among six estimation methods, as shown in Table 5-1. Additionally, the sample size is noisy with the Standard Deviation being, on average, 44% greater than the mean among the identified cases (when

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[310] Tratjenberg (1990), p. 173.

[311] As noted in Chapter 4, the Lucent case, US v. ComTriad et al, 2:01-cr-00365-WHW-3, filed on May 31, 2001 in New Jersey, the source code technology the defendants stole was generating $100,000,000 in sales for Lucent in 2000. This is considered an outlier as it is five times the value of its closest neighbour and seven standard deviations from the mean.

the sample includes cases in which the estimation method has not been defined, this Standard Deviation is 113% greater than the mean.)

Table 5-1: The Value of Trade Secrets by Method

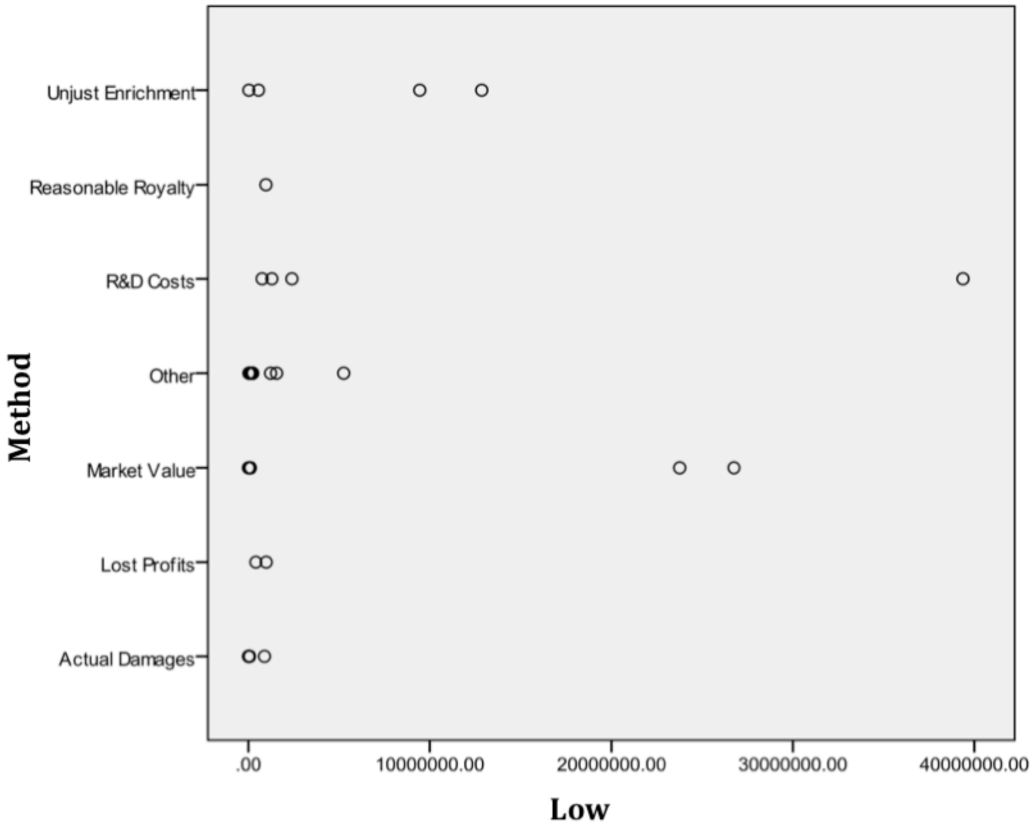
Estimate of TS using various methods (i-vi)* *EEA Cases 1996-2008*						**Using "low" estimates*
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Method	Unjust Enrichment	Lost Profits	Reasonable Royalty	R&D	Actual Damages	Market Value
Mean	$5,728,000	$708,000	$1,000,000	$10,968,000	$207,000	$10,145,000
Standard Deviation	$6,422,000	$411,000		$18,950,000	$390,000	$13,832,000
Number of cases	4	2	1	4	5	5 (1 outlier removed)[312]

A dot plot of the values by method, as seen in Figure 5-7, shows the clustering of values on the lower end of the scale. This is in line with the lognormal distribution discussed in the previous section. However, the distribution of these values by calculation method does not suggest systematic differences between the methods.

In a number of cases, the method used was not identified. This is the case when a figure was identified with respect to the stolen trade secret, but no detail was provided as to the method employed. The cases are noted by the "other" category in the table below.

[312] See footnote 17.

Figure 5-7: Dot Plot of Low Values of Stolen Trade Secrets (in 2008 values) by Method



In order to examine the evidence for statistical differences between the methods, the data are subject to ANOVA and Independent Samples tests. Student t-tests for differences between the means of the various methods are inconclusive. That is, there is no statistical evidence for differences between the average values generated by the different methods, as indicated in the ANOVA in Table 5-2. The tests are conducted using the logarithmically transformed observations to account for the lognormal distribution.

Table 5-2: ANOVA Test for Statistical Differences Between the Methods

ANOVA					
Low					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.76E14	6	9.59E13	1.11	0.39
Within Groups	1.99E15	23	8.65E13		
Total	2.57E15	29			

Result: As the test statistic is not significant at even the 10% level, the null hypothesis of equal means is not rejected.

As the sample size is small and the number of categories relatively high, the data are aggregated by groups of estimation methods. This grouping of the estimation methods by income, cost and market models also fails to detect a difference between the means, as seen in Table 5-3.

Table 5-3 T-Test for Statistical Difference Between the Values Generated by Income, Cost and Market Models

Independent Samples T-Test					
	Model	N	Mean	Mean Difference	Significance
Cost and Income Models	Cost	9	4.99E6	1.37E6	0.80
	Income	7	3.62E6		
Cost and Market Models	Cost	9	4.99E6	-5.16E6	0.50
	Market	5	1.01E7		
Income and Market Models	Income	7	3.62E6	-6.53E6	0.28
	Market	5	1.01E7		

Result: The tests show there is no statistically significant difference between the mean values generated by the models. None of the differences are significant at the 10% level. This suggests that, despite the differences in valuation models, the various methods do no produce statistically different mean values.

There are two plausible explanations for the lack of observed differences in the observed means of the various models. One explanation is that the sample size remains too small to detect the differences. The lack of the detection of a difference is possibly due to the noisy sample and the small sample size per method (particularly in the case of Reasonable Royalty, which has only one observation). However, an alternative explanation is that no difference between the methods exists. This follows from the discussions in Chapter 4, which detailed the valuation methods and highlighted the fact that the valuation methods are all based on economically sound theory. Furthermore, the EEA cases suggest that different valuation methods may, in application, produce different valuations for the same trade secret (as discussed in Section 5.5.) However, the EEA cases do not point to a systematic difference in the methods themselves. Thus, the results in Table 5-3 are in line with the analysis in Chapter 4.

5.4 Comments on the use of Models

The statistical analysis of the data highlights some important issues regarding the application of the damages models.

5.4.1 Income Models

Despite their theoretically robust foundations, income models are only used in one third of all cases. This is surprising as the discounted cash flow analysis at the heart of these models is a standard tool in financial analysis (Hitchner, 2006.) This suggests that not only will firms be more familiar with these methods, but also that their long established and well-researched status makes these models a strong legal tool.

Further support for the use of income models can be found in the Uniform trade secrets Act (UTSA). The UTSA is the state legislation that regulates civil trade secrets cases. The act pre-dates the EEA but is only used in 43 states; however the general principle of the act is used nationwide.[313] The act states:

> Damages can include both the **actual loss** caused by misappropriation and the **unjust enrichment** caused by misappropriation that is not taken into account in computing actual loss. In lieu of damages measured by any other methods, the damages caused by misappropriation may be measured by imposition of liability for a **reasonable royalty** for a misappropriator's unauthorized disclosure or use of a trade secret. [Emphasis added.] [314]

The UTSA's use of the phrase "actual loss" can be interpreted to include Lost Profits and/or Actual Damages. The use of the Income models in UTSA cases further underscores the well-established foundations of these models. In addition, it provides legal practitioners with a body of case law.

Reasonable Royalty is a particularly appealing model as it can be implemented regardless of the actions of the thief. Unlike Unjust Enrichment and Lost Profits, which both require that the thief actually use the trade secret, Reasonable Royalty can be more universally applicable. Zwillinger and Genetski (2000) argue for the use of Reasonable Royalty in EEA cases as being most in line with Sentencing Guidelines. They argue "When ascertainable, this [Reasonable Royalty] measure values stolen information at the moment and in the context of the misappropriation, and it takes into account, but does not exclusively rely upon, the defendant's intention to exploit information."[315]

Despite these arguments, the EEA data show only one identified case of the use of Reasonable Royalty in the low estimates. This suggests that, despite its theoretical popularity, the method is not popular with prosecutors and defendants. This could suggest an aversion to the use of models that are entirely theoretical. Unlike Cost Models and instances of Lost Profits or Unjust Enrichment, in which relatively stronger proof of the value of the trade secret

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[313] Notes on the Uniform trade secret Act available from http://www.ndasforfree.com/UTSA.html.
[314] Uniform trade secrets act, available at http://nsi.org/Library/Espionage/usta.htm, accessed November 2008.
[315] Zwillinger et al (2000), p. 342.

exists, Reasonable Royalty relies entirely on the hypothetical agreement between the willing licensee and willing licensor. This suggests a difference in the culture of Economists and Prosecutors, as discussed in Anson and Suchy (2005.)

5.4.2 Cost Models

The cost models are used in approximately one third of identified EEA cases. Innovative firms are likely to keep good accounts as to the Research & Development costs, which makes the model appealing for its ease of application. As Glick et al (2004) argue, "the owner's investment in the trade secret can be used as a proxy for the trade secret's minimum value."[316] Despite this, the lack of statistical difference between the average values generated by using Cost Models in EEA cases indicates that R&D investment may not represent the minimum value.

Actual Damages are used in five cases, which represent roughly 17% of the EEA cases with identified trade secret values. Despite the lack of theoretical robustness, as damages associated with the theft could be independent of the trade secret value, Actual Damages presents a fairly straightforward legal approach. The victim must merely present evidence of the direct costs resulting from the theft, as in U.S. v. Kim[317] discussed in Chapter 3. The relative popularity of this method is likely due to the fact that the damages value is restricted to those damages incurred as a direct result of the theft.

5.4.3 Market Models

The Sentencing Guidelines favour the use of Fair Market Value, when available:

> The fair market value of the property unlawfully taken or destroyed or, if the fair market value is impractible to determine or inadequately measures the harm, the cost to the victim of replacing that property.[318]

[316] Glick et al (2003), p. 337.
[317] USA v. Kim, 1:08-cr-00139-SO-1, filed 26/03/2008 in N.D. OH.
[318] D.O.J., (2008), *Prosecuting IP Crimes Manual,* p. 267.

However, the Market Models have the widest range of the three types of models. This wide range is likely explained by the relatively subjective nature of the measurement of Fair Market Value when compared to other models. Unlike the Cost models, which rely on past expenditures, and the Income models, which rely on past and projected income, the Fair Market Value models use the somewhat nebulous concept of the value placed on the trade secret by the theoretical seller. The reported range actually represents a conservative estimate as the removed outlier ($108 million) was calculated using Fair Market Value. The use of Fair Market Values is limited by the type of trade secret, as there may be a limited market for the trade secrets in question as they are often specific. Bid information, for example, has no legitimate Fair Market Value as no legal market for bid information exists. Thus, while the sentencing guidelines may call for Fair Market Value, its application is less than straightforward.

5.5 Statistical Analysis: The Range of Estimates

As mentioned previously, each trade secret included in the analysis has at least one estimated value, and, in most cases, has two values – one low estimate and one high estimate. To test for a statistical difference between the two samples, a paired t-test is performed, the results of which are shown in Table 5-4. The sample size is restricted to only those cases in which the high estimate differs from the low estimate. This reduces the sample size to 16, but the statistical results agree with the unreduced sample. The test is run on the natural-logged values of the estimates to reflect the sample's lognormal distribution.

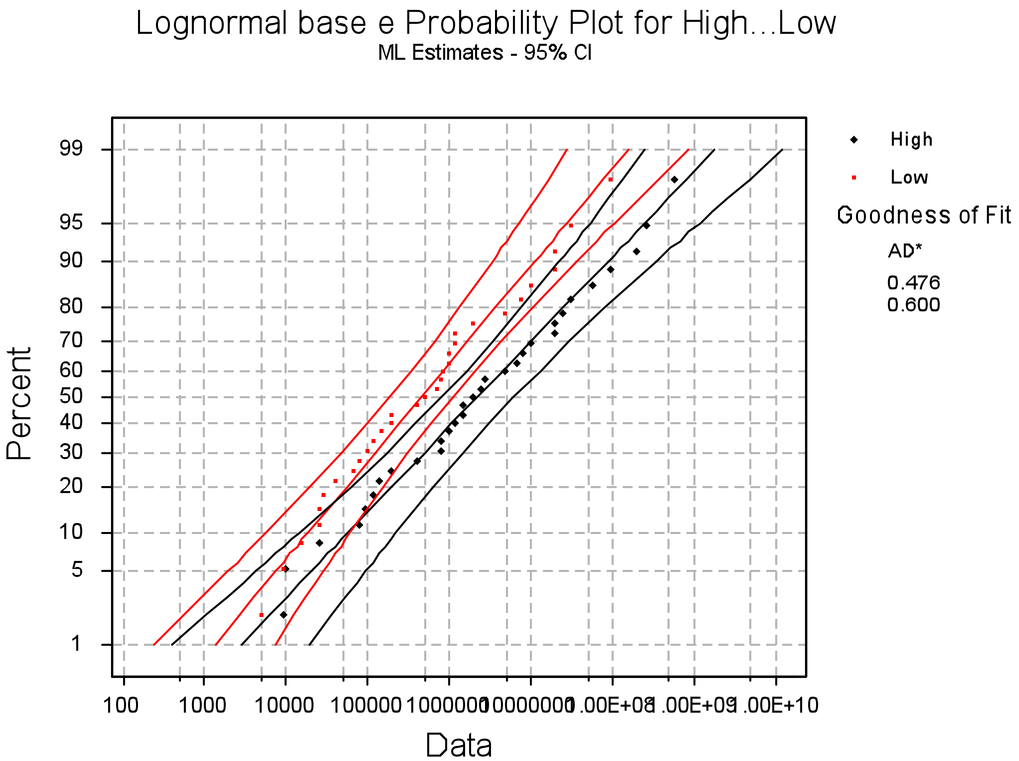
Table 5-4: Paired T-Test for Difference between Low and High Estimates

Paired Sample Statistics					
	Mean	N	Std. Deviation		
Ln (Low)	12.33	16	2.04		
Ln (High)	14.91	16	2.73		
		Paired Sample Correlations			
	N	Correlation	Sig.		
Ln (Low) & Ln (High)	16	0.46	0.07		
		Paired Samples Test			
	Paired Differences				
Ln (Low) –Ln (High)		95% Confidence Interval of the Difference			
Mean	Std. Deviation	Lower	Upper	df	Sig. (2-tailed)
-2.58	2.54	-3.93	-1.22	15	0.001

While the low and high values are correlated (coefficient of correlation is 0.46 and is significant at the 10% level), the t-test indicates that the means of the two samples are statistically different. The mean of the ln(*Low)* is -2.58 lower than the mean of the ln*(High)*; this is significant at the 1% level. This corresponds to a to a difference of $39.6 million based on the untransformed means. A non-parametric test, the Wilcoxon test, confirms that the statistical difference between the two samples is significant (p-value = 0.00.)

A visual representation, Figure 5-8, in the form of a probability plot of both the Low and High Estimates, also demonstrates the differences between the two samples. As mentioned earlier in this chapter, the probability plot is a measure of how well the data fit, in this case, the lognormal distribution. Figure 5-8 presents a combination of Figure 5-3 and Figure 5-6, which, as discussed, suggests that the lognormal distribution is appropriate. Furthermore, Figure 5-8 highlights the differences between the Low and High estimates as they form two separate populations (denoted by the dots and diamonds.)

Figure 5-8: Probability Plot for *High* and *Low*



The implications of this statistical difference between the estimates are far-reaching. Reporting of trade secret theft,[319] the decision to prosecute[320] and sentencing decisions are all linked to the alleged value of the stolen trade secrets. Given the differences in estimations for the same trade secret, this increases uncertainty for owners of trade secrets, as the value of these secrets is unclear. Additionally, these statistical differences provide evidence for the suggestion

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[319] Victims are required to estimate the value of the trade secret when reporting the theft. See "Reporting Intellectual Property Crime: A Guide for Victims of Counterfeiting, Copyright Infringement, and Theft of trade secrets" Department of Justice document, available from http://www.usdoj.gov/criminal/cybercrime/AppC-ReportingGuide.pdf.

[320] FBI Assistant Direct Chip Burrus "likened the FBI's current fraud-enforcement policies – in which losses below $150,000 have little chance of being addressed – to 'triage.' Even cases with losses approaching $500,000 are much less likely to be accepted for investigation than before 9/11." As reported in Shukovsky, Paul, Johnson, Tracy and Daniel Lathrop, April 11, 2007, **"**The FBI's terrorism trade-off," *The Seattle Post-Intelligencer*, accessed September 09, 2008, from http://seattlepi.nwsource.com/printer2/index.asp?ploc=t&refer=http://seattlepi.nwsource.com/national/311046_fbiterror11.html.

that the valuations are sensitive to the point of view of the party arguing the value (as noted in Carr and Gorman, 2001.) Given the burden of proof in criminal cases, this presents a problem for achieving justice when sentencing thieves.

5.5.1 Statistical Analysis: Cross Referencing Method

Following Zwillinger and Genetski (2000), the values of the trade secrets in EEA cases are estimated in a cross referencing method using a combination of actual sentences and sentencing guidelines. The guidelines associate the offence level with a corresponding loss figure. Starting with a base offence level of six to reflect the base level recommended by the Department of Justice,[321] the figure was adjusted up by two levels for convictions including Economic Espionage or crimes committed by defendants considered insiders to the company (as in Zwillinger and Genetski, 2000.) Using the incarceration period obtained via docket reports and the offence level, the corresponding loss estimate was obtained using the 2008 Sentencing Guidelines for consistency.

Formally, the method is expressed as follows:

First, the incarceration period (months) of the convicted defendant is cross-referenced with the Offence Points, according to the sentencing guidelines, in the first column as shown in Table 5-5. Note that the ranges for the incarceration months overlap; thus the mid-point of this range was used to find the closest match to the defendant's incarceration period.

[321] Based on base offence of 6 level from the D.O.J. Prosecuting IP Crimes Manual, available from http://www.usdoj.gov/criminal/cybercrime/ipmanual/08ipma.html.

Table 5-5: Incarceration and Corresponding Offence Points

	Range of Months of Incarceration	
Offence Points	*Incarceration Minimum*	*Incarceration Maximum*
8	0	6
9	4	10
…	…	…
14	15	21
15	18	24
16	21	27
…	…	…
42	360	life

Second, the Offence Level is calculated according to Table 5-6 using information about the defendant gathered from the case documents and reports.

Table 5-6: Calculation of Base Offence Level

Base Offence Points	*Adjustment*
6	Base Offence level according to DOJ Manual
+2	Assumed for all defendants (for more than minimal planning (according to Zwillinger et al))
-2	Assumed for all defendants (for acceptance of responsibility (according to Zwillinger et al))
6	*subtotal*
+2	If Charged with 1831 (Economic Espionage, which has a higher offence level)
+2	If considered "insider" (also a higher offence level)
	Total, then cross-referenced with Sentencing Guidelines

The value obtained from the total in Table 5-6 is then subtracted from the value obtained in Table 5-5. The remainder is then cross-referenced with the values of the stolen trade secrets, as dictated by the Sentencing Guidelines. The corresponding value, in the second column, is the *Xref* value.

Table 5-7: Offence Points based on Value of Stolen trade secret.

Points	Value of Stolen trade secrets
0	5,000
2	5,000
4	10,000
6	30,000
8	70,000
...	...
30	400,000,000

To illustrate this method further, I will use the case of U.S. v. Meng.[322] The defendant, Meng was sentenced to 24 months in prison for stealing software source code from Quantum 3D. Meng was also charged with Economic Espionage (1831).

According to the *Xref* method, based on an incarceration period of 24 months, Table 5-5 dictates that the offence points total 16. Moving to Table 5-6, Meng is assigned 6 for the base offence level and +2 for the 1831 charge, which gives a total of 8. Subtracting 8 from 16 gives a remainder of 8. Cross-referencing this value with Table 5-7, we find that the corresponding value of the stolen trade secret was assumed by the court to be $70,000.

It should be noted that this method is precisely the reverse of how the court calculates the incarceration period. The court first calculates the offence points and then calculates the incarceration period. This *Xref* method seeks to start with the incarceration period and work backwards to obtain the estimated value of the stolen trade secret. Furthermore, the Sentencing Guidelines[323] do not link

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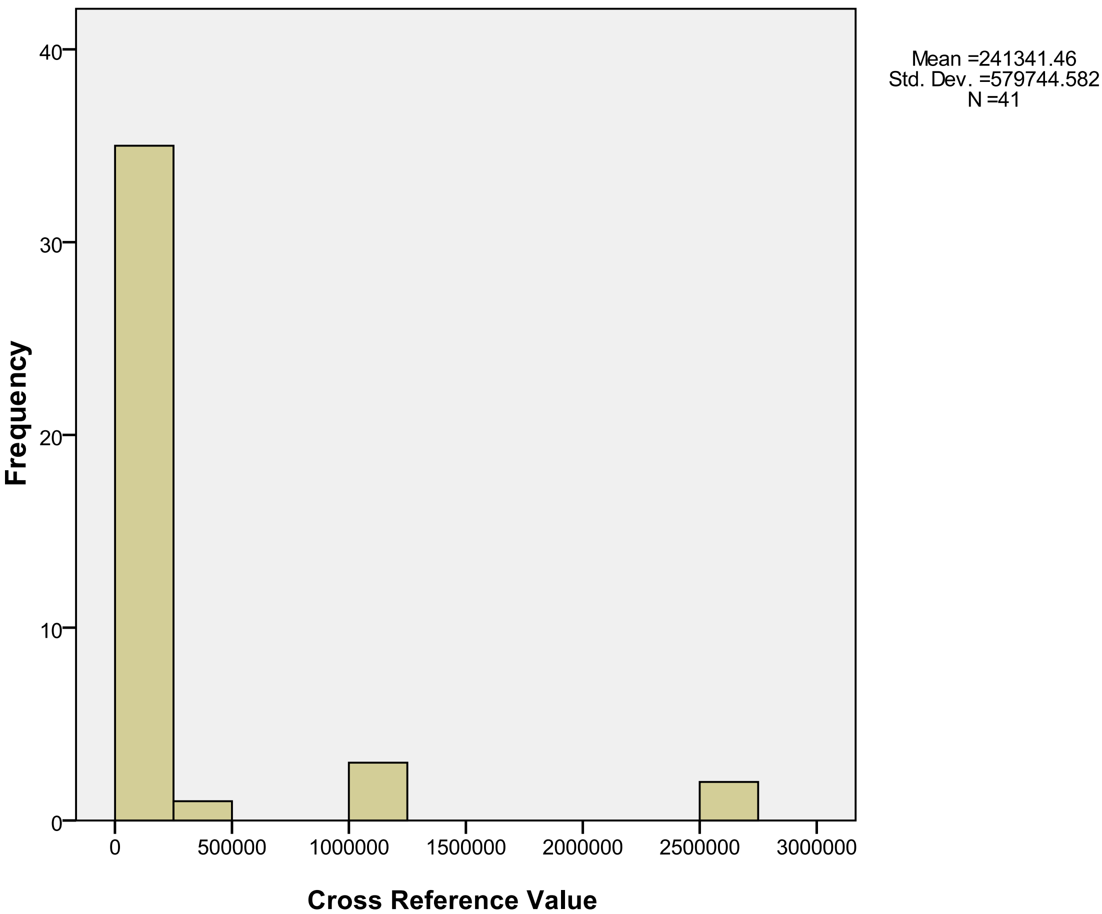
[322] U.S. v. Meng, Criminal case 5:04-cr-20216-JF-1 (Northern District of California, filed December 16, 2004)

[323] The Sentencing Guidelines (2008) allow for upward and downward departure considerations of the offense level and note that EEA defendants will likely argue for downward departures on

the calculation of fines, forfeiture and restitution with the incarceration sentencing. That is, the formula used to calculated incarceration periods is independent of that used in calculating fines, forfeiture and restitution. Thus, in some cases, such as U.S. v. Keppel[324], the restitution amount of $500,000 is considerably different from the *Xref* estimate of the trade secret of $5,000.

Using this method, loss estimates were obtained for 41 cases, as seen in the histogram of the variable *Xref* in Figure 5-9.

Figure 5-9: Histogram for Loss Estimates Calculated via Cross Referencing Method Using Sentencing Guidelines

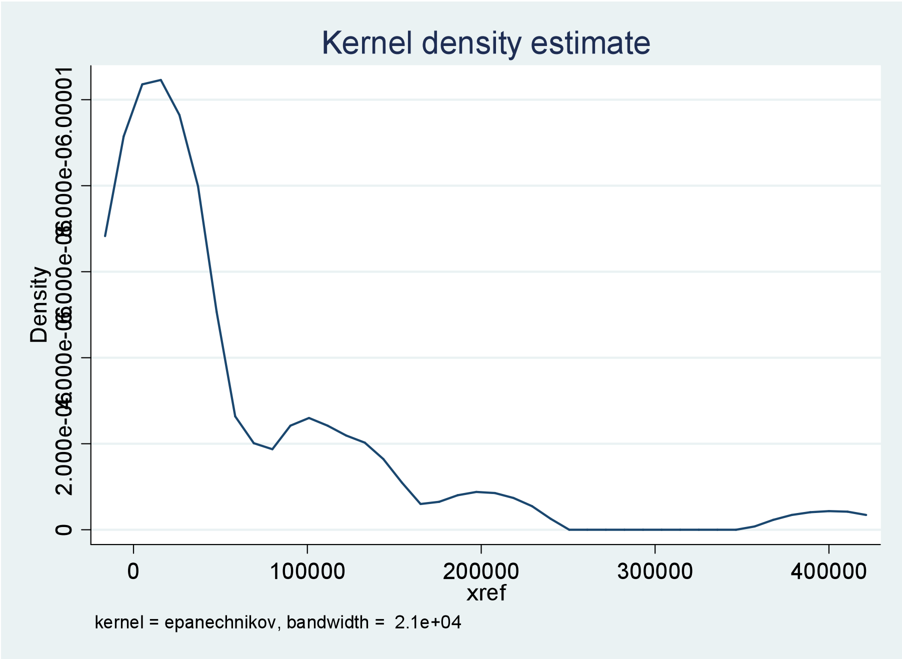


A Kernel Density smoothing estimate further suggests a lognormal distribution:

the basis that the "offense level substantially overstates the seriousness of the offense." (p. 274)

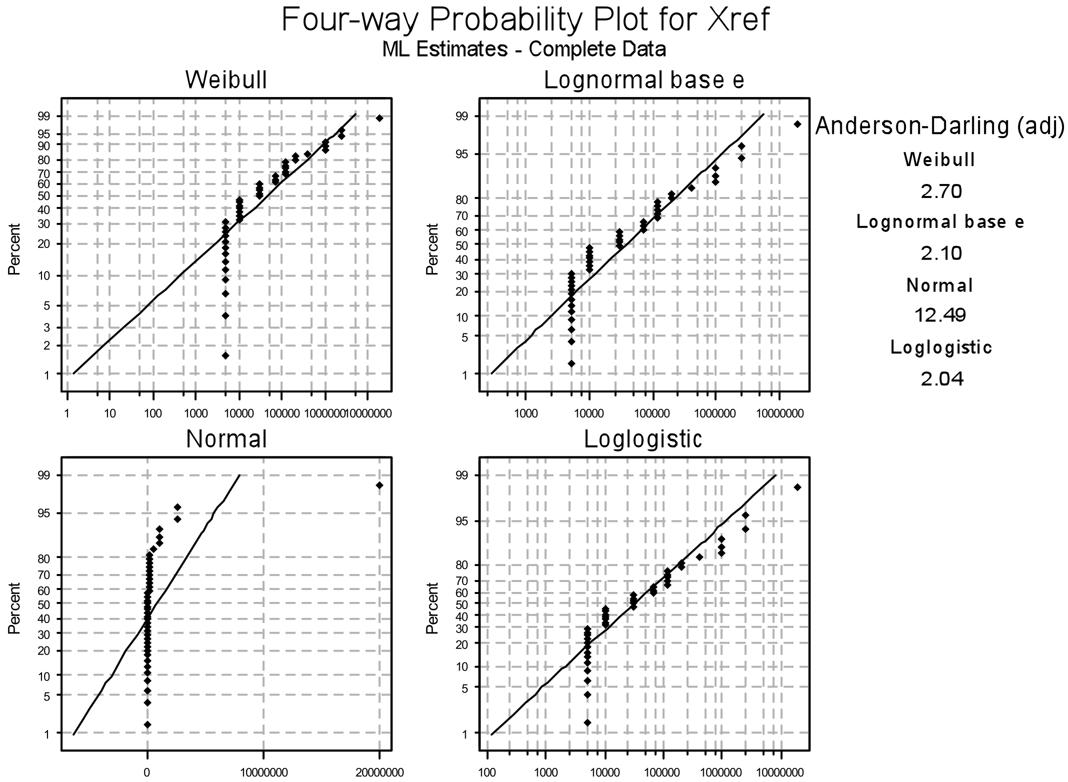
[324] U.S. v. Keppel, Criminal case 3:02-cr-05719-RBL (Western District of Washington, filed August 8, 2002.)

Figure 5-10: Kernel Density for *Xref* Values



However, a statistical analysis of the distribution of the *xref* values fails to confirm a lognormal distribution. In fact, a comparison of four different probability distributions appears to favour a loglogistic distribution (AD = 2.04) over the lognormal distribution (AD = 2.10.) However, the test statistics for these two distributions result in a rejection of the null hypotheses (of lognormal or loglogistic distribution) with a p-value of 0.01 (for both lognormal and loglogistic.) Hence, the data do not appear to confirm to these classic probability distributions.

Figure 5-11: Comparison of Probability Distributions for Xref



The evidence that the *Xref* values do not follow the same distribution as the High and Low values suggests that the *Xref* values differ from the other two valuations fundamentally. A statistical analysis of the data indicates that the loss estimates used in sentencing (*Xref*) are statistically lower than both the high and low estimates, as noted in Table 5-8. As the distribution of *Xref* does not follow the lognormal distribution, then ln(*Xref*) does not have a normal distribution. Given the non-normal distribution, we cannot use a paired samples t-test to test for differences between *Xref* and the other valuations. Hence, we use the non-parametric Wilcoxon[325] signed-rank test, which does not require the normal distribution.

[325] The Wilcoxon signed-rank test compares the difference between the values of each pair. According to SPSS online help topic *Wilcoxon Matched-Pairs Signed-Rank Test*, "all nonzero absolute differences are then sorted into ascending order and ranks are assigned." The sum of the ranks for positive and negative differences are calculated as is the average positive and negative rank. The test statistic is as follows:

Table 5-8: Wilcoxon Signed-rank test of Cross Reference Method and Low

Ranks

			N	Mean Rank	Sum of Ranks
Xref - Low	Negative Ranks	*Xref < Low*	16	11.25	180
	Positive Ranks	*Xref > Low*	4	7.50	30
	Ties	*Xref = Low*	0		
	Total		20		

Test Statistics

	Z	Asymp. Sig. (2-tailed)
Xref - Low	-2.800	0.005

Result: The Wilcoxon test confirms that the mean of the *Xref* values is statistically lower than that of the *Low* values. This is significant at the 1% level.

Logic dictates that if *Xref < Low* and *Low < High*, therefore *Xref < High.* A Wilcoxon test confirms that the mean of the Xref values is statistically lower than that of the High values. This is significant at the 1% level.

$$Z = \frac{\min(S_p, S_n) - (n(n+1)/4)}{\sqrt{n(n+1)(2n+1)/24 - \sum_{j=1}^{l}(t_j^3 - t_j)/48}}$$

where

n = number of cases with non – zero differences

l = number of ties

t_j = number of elements in the j – th tie, j = 1,...,l

S_p = sum of positive ranks

S_n = sum of negative ranks

The Wilcoxon Signed Ranks test suggests that the Cross Referencing and the low and high estimates are different in so far as their means are significantly different (both at the 1% level.) The evidence suggests courts are using considerably lower values than even the low estimates generated by the various models. This difference in the means translates into a difference in raw means in the paired Cross Referencing–Low sample as much as $6.45 million. This statistical evidence suggests that the values used in sentencing are statistically lower than those argued in the course of the case.

5.5.2 Implications of Difference in Means in the Valuations

The statistical difference between high and low valuations of the same trade secret is cause for concern, both in terms of the impact of the economic policy and the prosecution of trade secret crimes in the justice system.

As Zwillinger and Genetski (2000) note, "Because the loss analysis in an EEA case largely determines whether the defendant is going to prison, slight variations in the loss amount are quite meaningful."[326] The evidence demonstrates that incarceration periods may be lower due to courts choosing to use lower valuations. This could be due to the defendants' successful arguments for the application of the lower values. Considering that the defendant and prosecution are on opposite ends of the bargaining relationship, the statistically lower values used in sentencing guidelines suggests that this may be the case. It also suggests that courts may recognise the difficulties facing the valuation of trade secrets and are maintaining a conservative approach by using lower values. In an examination of three case studies, Green et al (2000) note, "the department essentially went in the tank on two of them and just said, 'We cannot value this thing [the trade secret],' and the guys [defendants] got probation."[327]

As Zwillinger and Genetski (2000) note, in addition to the complexity of valuation methods, the goal of the values used in sentencing (i.e. *Xref* values) is not solely that of determining a fair market value:

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[326] Zwillinger and Genetski (2000), p. 341.
[327] Green et al (2000), p. 276.

> The purpose of the Guidelines is to achieve sentences that accurately reflect the culpability of offenders in a consistent, uniform and proportional manner. In attempting to adhere to both the letter and purpose of the Guidelines, sentencing courts often struggle to make a fair market value determination. … In EEA cases, where the actual or intended loss to the victim or gain to the defendant can be disproportionate to the market value of the trade secrets, use of the market value determination alone will not always produce a sentence that is just.[328]

Indeed, the authors note that the discrepancy between the values argued in the course of the case and those used in sentencing is recognition by the court that these values may overestimate the actual/intended loss or gain. Thus, the criminal context of the EEA may necessitate the statistical differences between these values.

Nonetheless, while the evidence indicates a favourable environment for would-be trade secret thieves, it lowers the incentives to innovate. Given the wide variability of the calculation methods and the evidenced use of lower values, the trade secret owner faces increased uncertainty as to the strength of the protection provided by trade secrets. Thieves face lower disincentives to steal and the trade secret owner is confronted with diverse estimates of value. This inherent uncertainty therefore reduces the value of trade secrets to owners as a weakly protected trade secret has lower expected value to its owner. While Shankerman et al (2001) argue that infringement and damages payments may be beneficial for the patent owner, their argument is based on a patent protected research tool. Trade secrets, unlike patents, by definition derive value from their secrecy. The weaker the protection of this value, the lower the rewards to innovation. Thus, the increased uncertainty associated with the protection of trade secrets decreases incentives to innovate.

The EEA sought to increase the overall protection for trade secrets, unify the legal status at the federal level and provide protection against foreign Economic Espionage. The evidence uncovered regarding the damages calculations indicates that the EEA is not being used to its full capacity. Legal scholars, including Carr et al (2000), have raised concerns that the EEA may go too far in

[328] Zwillinger and Genetski (2000), p. 353.

increasing the strength and definition of trade secrets. The use of lower values by courts could be a deliberate move to balance out some of the controversy surrounding the increased legal power of trade secrets created by the EEA.[329]

5.6 Conclusion

The value created by trade secrets indicates that they play an important economic role, albeit one that has received limited academic attention. The body of trade secrets research rests on the precedents set by the patent scholarship. A mapping of the methods used to assess damages in trade secret cases demonstrates that the methods rely heavily on those used in patent cases. However, their application to trade secret cases is challenged by the secret nature and legal ambiguity of trade secrets.

The lognormal distribution of the observed values of trade secrets suggests that trade secrets follow the same growth model as income and patents. This suggests that the value of the innovations can be related to income. Furthermore, it suggests that the innovations protected by secrets and patents have similar value distributions.

The EEA prosecution data provide a unique opportunity for empirical analysis of the use of trade secrets and their value. The analysis of the damages valuations demonstrates that the valuations are highly diverse. The loss estimates used in sentencing are significantly lower than those argued in the media and courts. The high variability of these values undermines the legal protection for trade secrets and ultimately decreases the incentives to innovate.

Trade secrets remain a rich source for future research. Investigations into the sample bias of cases chosen for prosecution may illuminate the practical use of trade secrets further. The patent damages models used in trade secrets require further exploration and may result in the development of models specifically for trade secrets. As empirical evidence of trade secrets is limited, the development of further empirical sources is a promising area.

[329] See Carr et al (2000) for a discussion on the goals and controversy of the EEA.

Chapter 6: The Determinants of Trade Secret Intensity: Evidence from the Economic Espionage Act

6.1 Introduction

Building on the empirical insights set out in Chapter 5, this chapter develops a regression analysis to examine the parameters of the use of trade secrets more thoroughly. This chapter uses the data from the 95 EEA cases from 1996 to 2008 to explore the relationships between the use of trade secrets and the explanatory variables, such as the nature of the trade secret. Specifically, we examine the determinants of the intensity of trade secret usage, which we will term "trade secret intensity."

The next section (Section 6.2) explains the theoretical framework of this chapter further and provides an overview of the analytical arguments related to trade secret intensity. Section 6.3 sets out the foundations of the regression model that is subsequently developed throughout the chapter. Section 6.4 details the relevant variables used in the regression model. Sections 6.5 and 6.6 examine the functional form of the model and discuss the results. Further testing of the model is performed in Section 6.7, which tests the robustness of the results. Further consideration of sample selectivity is modelled in Section 6.8. The role of the defendant as an outsider is considered Section **Error! Reference source not found.**. The elasticities developed throughout the chapter are examined in Section 6.10. Section 6.11 concludes.

6.2 Theoretical Overview

In recent years, economists have begun to examine how alternate methods to patents have been used for the protection of intellectual property. Trade secrets are a primary example of an often-used but under-examined form of protection of innovation. The necessarily undisclosed nature of trade secrets thwarts efforts for their study, thus there are few empirical examinations of their use. Examples of empirical studies of trade secrets fall largely into two categories:

evidence from litigation (e.g. Lerner, 2006; Almeling et al, 2010) or survey results (e.g. Jensen and Webster, 2006; Cohen et al, 2001; Arundel, 2001.) This study falls into the former category as an empirical study into the criminal prosecution of the theft of trade secrets. However, none of the papers mentioned above include a regression analysis, which makes this study unique.

Empirical studies have highlighted the importance of trade secrets but little has been done to analyse the relationship between trade secrets and firm size empirically. A number of theoretical arguments have been put forward to describe this relationship. In order to widen the scope of these theoretical arguments, we proceed with the assumption that theoretical arguments *for* the use of patents represent a theoretical argument *against* the use of trade secrets. This assumption is not without controversy. The decision to use patents is an active decision, as it requires that the owner seek official patent protection. In this sense, a decision to apply for patent protection is a decision not to use trade secrets to protect the same innovation. The reverse argument is more difficult as rigorous standards for patentability are more stringent than those required to achieve trade secret protection.[330] The decision to use trade secrets may be a passive decision, as the owner may already have reasonable protection in place, and may not represent an active decision not to use patents. However, for the purposes of this chapter, we will proceed with the assumption that the owner must decide between patents and trade secrets. We find papers arguing both for and against an inverse relationship between trade secrets and firm size, as will be discussed later in this section.

To move from theoretical arguments to empirical implementation, we will construct a measure of *Trade Secret Intensity (TSI)*, the purpose of which is to calibrate the firm's use of trade secrets objectively. As befits the term "intensity," we seek a relative measure of the extent of use of trade secrets. In the numerator is a measure of the use of trade secrets; in the denominator, a

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[330] In order to qualify as a trade secret, the innovation needs to be secret, to derive economic value from its secrecy and to be reasonably protected (see TRIPS Section 7 Article 39.) It is possible to concurrently use trade secrets to protect some portion of an innovation and patents to protect other portions of the same innovations (Arundel, 2001.)

measure of the scale, or size, of the business (see equation [6-1]). The numerator could be measured in a variety of ways; e.g. as a count of use of trade secrets, or as the value of some or all of a firm's trade secrets. As Chapter 4 has shown, various valuation methods may be used. In the denominator, measures of scale may be used, including employment, sales and assets.

[6-1]

$$Trade\ Secret\ Intensity = TSI = \frac{Extent\ of\ use\ of\ Trade\ Secrets}{Scale\ of\ Business}$$

Our empirical goal is to provide a good explanation of the trade secret intensity in our cross-section of data. This will value a choice of both suitable functional form and appropriate explanatory variables. At is simplest, the specification is:

[6-2]

TSI = f(firm size)

This will be used as the main point of departure for developing a more complete specification as below. Adopting the first line of theoretical arguments put forth that the use of trade secrets is positively related to firm size, we have $f' > 0$ in Equation [6-2]. Arundel (2001) argues that larger firms prefer trade secrets to patents as larger firms have the power of their market strength at their disposal to appropriate returns to innovation quickly, creating a lead-time advantage which is thereby denied to smaller firms. As disclosure via patenting[331] aids the developing of competing goods, large firms prefer trade secrecy, which involves no disclosure before goods enter the market. Scherer (1965) argues that larger firms receive less marginal benefit from patents as larger firms are more sensitive to disclosure via patenting and do not require patents in order to secure financing and enable partnerships. This argument suggests that smaller firms are more reliant on patents in forming partnerships and obtaining financing. Levin et al (1988) and Cohen et al (2001) concur with this as they argue that smaller firms need a patent portfolio in order to compete in the

[331] Disclosure is an inherent part of the patenting system. Disclosure of the knowledge behind the innovation is necessary for courts and competitors to understand what knowledge the patent protects. Furthermore, it provides the public with knowledge and can lead to subsequent innovations. However, most innovators prefer not to disclose as it may aid competitors (Scotchmer, 2005.)

market. Scherer (1965) and Arundel (2001) argue that patents can create a buffer for smaller firms which protects them from larger firms. They go on to argue that small firms may be unable to exploit innovations quickly due to their lack of manufacturing and marketing capability. Thus, patents create a legal buffer against larger firms, who are able to exploit market power and benefit from economies of scale. Following these arguments, we conclude that there is a tendency for larger firms to prefer trade secrets and for smaller firms to prefer patents as a means of protecting intellectual property.

Empirical support for a positive relationship between firm size and the use of trade secrets can be found in the works of Jensen and Webster (2006) and Cohen et al (2001.) Jensen and Webster use a combination of survey and patent data to argue that larger firms have lower patent intensities than SMEs. Cohen et al (2001) demonstrate, by their survey, that larger firms cite the motive of patenting to enhance their firm's reputation less than frequently than do smaller firms.

A converse line of theoretical arguments would argue that use of trade secrets is negatively related to firm size and thus $f'' \leq 0$. Lerner (1996), Cordes et al (1999) and Arundel (2001), for example, argue that patenting may be too costly for smaller firms. As patenting and patent protection is relatively expensive for smaller firms, so the argument runs, trade secrets can provide a more efficient protection for innovation. Arundel (2001) further argues along the Schumpeterian argument that smaller firms may produce smaller, incremental innovations and may therefore produce less patentable innovations. Described by Reid and Ujjual (2008) as scale economies in R&D,[332] the Schumpeterian hypothesis stems from Schumpeter's (1942) work which argues that large firms are the most innovative. Furthermore, Arundel argues, larger firms will prefer patents to trade secrecy as their economies of scale reduce the marginal cost of patenting. Scherer (1965) argues this, as do Jensen and Webster (2006.) Additionally, Jensen and Webster argue that costs of litigation of patents for

[332] Reid and Ujjual (2008) note that the Schumpeterian argument would hold that, "because of scale economies in innovation, big business had superior innovative performance to small business", (p. 30.)

larger firms are lower relative to firm size. They argue that larger firms stand to benefit more from a reputation for aggressive litigation, which will dissuade would-be infringers. Thus, these papers develop a case for smaller firms preferring trade secrets and larger firms preferring patents.

Empirical evidence in support of the negative relationship between the use of trade secrets and firm size is found in a number of survey and patent data studies. Arundel (2001) uses survey data to show that small firms value secrecy more than large firms. In another survey, Arundel & Kabla (1998) find that the tendency to patent increases with firm's size. Using a combination of survey and patent data, Mansfield (1986) shows a positive correlation between firm size and the percentage of patentable innovations that are patented. Finally, Scherer (1983) uses R&D and patent data to demonstrate that expenditures on R&D are positively correlated with patenting activity.

Other research addresses the general relationship between firm size and innovation further, but usually with a different focus from this thesis; e.g. patenting, R&D. While related to this paper tangentially, the literature on the determinants of firm size and innovation enhances our understanding of the dynamics of innovation. Baldwin et al (2000) support the Schumpeterian hypothesis that firm size is positively related to innovation, although empirically they find that the relationship is non-monotonic. They also suggest a positive relationship between the use of trade secrets and innovation. Lunn (1986) finds that the firm's market power and the market concentration of the industry are positively correlated with process innovations. As Friedman, Landes and Posner (1991) argue, firms tend to prefer to use trade secrets rather than patents for protecting process innovations. Finally, Cohen et al (1987) find weak support for the Schumpeterian hypothesis as their findings indicate that the size of the firm has only a small positive effect on R&D intensity. They do, however, find that fixed industry effects have a stronger effect on R&D intensity.

However, with the partial exception of Baldwin et al (2000), none of these empirical studies addresses the relationship between trade secrets and firm size specifically. The assumption that a decision to use patents represents a decision not to use trade secrets also requires further investigation. The fact that theoretical arguments for both a positive and a negative relationship between trade secrets and firm size can be found in the same paper is also an indication that this area requires further work. In this sense, the empirical work of this thesis provides a resolution of the equivocal position presented by theorists of innovation.

This paper seeks to understand the nature of the use of trade secrets via an empirical analysis using regression tools. As such, while the relationship between trade secrets and firm size is of primary concern, other factors such as industrial sector, the type of trade secrets, other valuations of the stolen trade secrets and characteristics of the defendant must also be considered. The primary purpose of this study is to establish the relationship between the use of trade secrets and the factors that influence this, with a focus on firm size. The paper is structured in four main sections: the framework of the model, the data, results and analysis, and the implications.

6.3 Specification of the Model

The reference point for the model is Equation [6-2] with $f'' > 0$. The first step in developing the model is to construct a suitable proxy of the dependent variable, *TSI*. A value measure of trade secrets is preferred to a count measure, as being more accurate, and offering superior economic interpretation. The particular measure of value preferred is *Low* estimate detailed in Chapter 5. As Carr and Gorman (2001) suggest, given that the range of values in EEA cases for the same trade secret often stems from the differing points of view (i.e. victim or defendant), the use of the lower value in a range of estimate represents a more conservative valuation. Furthermore, additional regression results using *High, Xref* and a mean of *High* and *Low*[333] show that the choice of the value estimate

[333] To illustrate, the histograms of ln(*TSI)* using the mean of *High* and *Low, High, Xref* and the preferred valuation, *Low,* are displayed in the table below. The preferred dependent variable (as

does not unduly change the regression results. To normalize the value measure, we use the headcount of firm employees as the size measure in the denominator. The measure so constructed has a number of merits. One, in terms of economic interpretation, is that *TSI* can be treated as a type of productivity measure, gauging the value of trade secrets generated per employee. The other, in terms of econometric estimation, is that this ratio measurement should mitigate potential heteroskedasticity.

[6-3]

$$TSI = \frac{\text{Extent of use of Trade Secrets}}{\text{Scale of Business}} = \frac{\text{Value of Trade Secrets (low)}}{\text{Number of Firm Employees}}$$

Our focus is on those variables that determine trade secret intensity, and the best functional form for representing this relationship. Thus, the simple specification of equation [6-2] is generalized to:

[6-4]

$$TSI = f(\text{firm size, additional explanatory variables; additional control variables})$$

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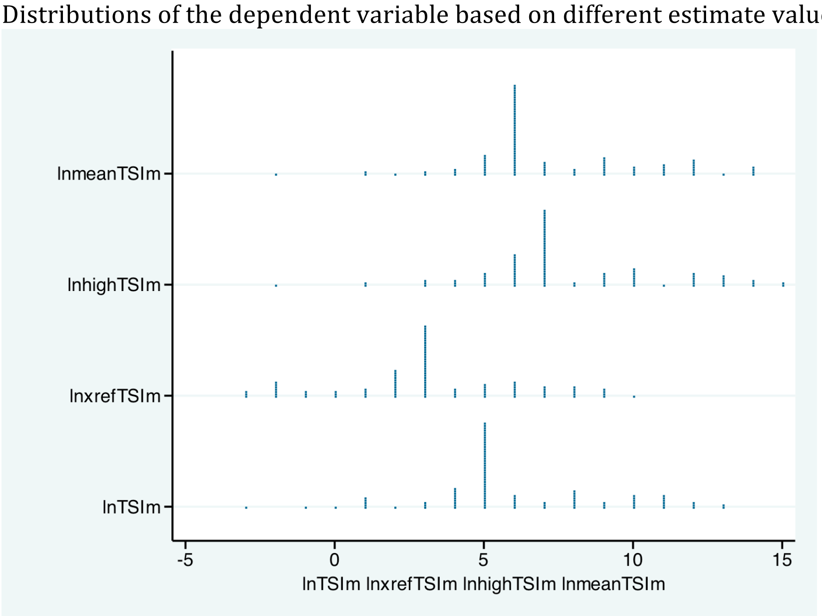
seen in *lnTSIm*) lies within the range of the other valuations and, overall, the distributions are similar.

Distributions of the dependent variable based on different estimate values of the trade secret



Where the appropriate functional form *f(.)* is itself to be investigated.

To illustrate the general specification of [6-4] could be implemented by a variant such as:

[6-5]

$$TSI = f(\text{firm size; cross-referenced value, patentability, copyright; nationality, sector})$$

Where the cross-referenced value, patentability and copyright are additional explanatory variables and nationality and sector are control variables. Interactions between control variables are possible and there are a wide variety of possible models for the function form of [6-5].

6.4 Data

The data originate from cases prosecuted under the EEA as described in Chapter 3. Estimation is based on a sample of 95 cases under the EEA from 1996 to 2008. The construction of the database stems from a variety of sources, including court documents, media reports, company databases, FBI press releases and academic papers. Each case was identified and then researched thoroughly using these sources.

The characteristics of the defendant, for example, were discovered primarily through Indictment documents, FBI press releases and media reports. This allowed for the collection of information regarding the relationship of the defendant to the victim firm (*outsider*), nationality of the defendant (*foreign*) and descriptive information related to the nature of the theft. The primary information of interest is that of the nature of the defendant-victim relationship and whether it involved any formal contractual relationship, such as employment.

Qualitative information on the trade secret in question stems from a variety of sources. In most cases, descriptive information on the nature of the trade secret was available via the Indictment documents or media reports. These descriptions of the trade secrets, such as project plans, prototypes, bid information etc., were then categorized according to the type of IP protection available (i.e. *patentable* or *copyright*.) For example, blueprints for machine designs could be protected through trade secrecy, copyright and, in some cases, patent.

Quantitative information on the trade secret was relatively less available when compared to the above-mentioned qualitative information. Again, this information comes from a wider variety of sources. The estimation of the value of the trade secret, which has been described as more of an art form than a science,[334] was particularly fraught with lack of availability or conflicting sources. Zwillinger and Grenetski (2000) and Carr and Gorman (2001) were the primary academic sources of these valuations, while many valuations were found in media reports and Indictment documents. The method used in the construction of this database is consistent with Carr and Gorman's (2001) "objective" estimate and, like the Carr and Gorman paper, relies on the low end (*Low)* of the value range for a particular trade secret.

Finally, information on the victim firm was gathered first by indentifying the victim firm from reports in the court documents. This data were then cross-referenced with information found on the victim firm's website, media reports and databases[335] to establish the firm's annual revenue (*vsales*), number of employees and primary activities. The annual revenue and number of employees were then cross-referenced with the Small Business Administration's (SBA) definitions of small business by sector (*sbdummy*.) The descriptions of primary activities were also cross-referenced with the SIC classifications of sectors in order to determine the primary sector of the victim firm (*SIC)*. These were then grouped into dummy variables to account for the most common sectors of victims (i.e. *mandum* or *servdum.)*

334 Henry and Turner (2007), p. 31.

335 This was done first by searching Edgar Online (the Electronic Data Gathering, Analysis and Retrieval System of the U.S. Securities and Exchange Commission.) If the data on Edgar were incomplete, further information was found via the commercial databases www.goliath.ecnext.com and www.thomasnet.com.

However, Cohen et al (1987) criticize the approach of using firm-level data. Firstly, they argue that inadequate attention is paid to the appropriate unit of analysis and that more emphasis should be placed on the business unit. They would claim that arguments for relationships between innovation and firm size may break down at the business unit level. Secondly, they argue that the use of a single industrial sector per firm ignores the multiproduct character of larger firms. However, in our case, data at the business unit level were not available. With 26% of the sample classified as being a small business, the development of the data at the business unit level could refine the results further with regards to the determinants of *TSI.*

The variables used in this analysis are listed below. A summary of these variables along with some descriptive statistics is listed in Table 6-1.

6.4.1 Continuous Variables

TSI = the low value of the stolen trade secrets (as reported in relation to the case) / the number of firm employees.
vsales = the victim firm's annual sales revenue, expressed in 2008 U.S. dollars.

6.4.2 Dummy Variables

manudum = manufacturing sector, where 1 = manufacturing and 0 = other sector, based on Standard Industrial Code (SIC). In this sample, the observations range from 1500 (Construction industries) through 8900 (Service industries.)
servdum = service sector, where 1 = service and 0 = other sector, based on SIC.
patentable = the potential patentability of the trade secrets, 1 = the stolen trade secret is judged to have the potential to be patented and 0 = the stolen trade secret did not have the potential to be patented.
copyright = whether the trade secret was the copyrightable, where 1 = the stolen trade secret had the potential to be protected under copyright law and 0 = the stolen trade secret did not have the potential to be protected under copyright.

foreign = the nationality of the defendant, where 1 = the defendant is a foreign national and 0 = the defendant is a U.S. national. When defendant's nationality is not mentioned, the default value is 0 as the EEA is particularly concerned with the theft of trade secrets by foreigners, and thus cases in which the defendant was foreign received significant attention.

outsider = the relationship of the defendant to the victim company, where 1 = defendant had no direct employment history with the victim company and 0 = defendant was a current or former employ at the time of the theft; the observation was left blank when no information was available.

sbdummy = indicates a small business, where 1 = victim firm is considered a small business under Small Business Administration[336] standards and 0 = victim is not considered a small business.

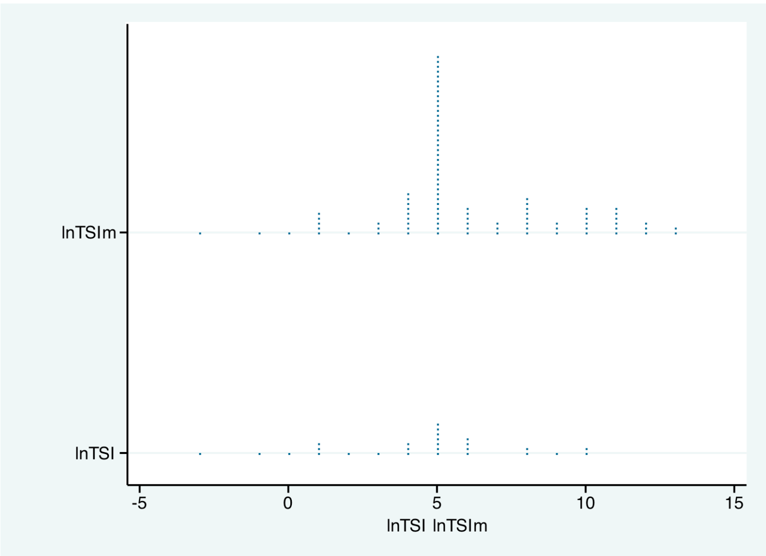
Given the nature of the data collection process and the EEA cases themselves, data are not available for all observations. In order to account for these missing observations, the mean values of the relevant variables are used to replace missing values. This model of missing values has only been performed on the continuous variables and is noted by the addition of the letter "m" after the name of the variable (e.g. *TSIm*[337].) Additional regression work, in addition to the

[336] See the SBA's sizing standards, available from http://www.sba.gov/contractingopportunities/officials/size/index.html.

[337] The model of missing values for *TSI* was calculated by imputing missing values in the numerator and the denominator and calculating the result value of *TSI.* This does not unduly distort the dependent variable as seen in the distributions of ln(*TSIm*) and ln(*TSI*) in the histograms below.

Histogram of ln(*TSIm*) and ln(*TSI*)

robustness checks later in this chapter, indicate that this model of missing values does not unduly distort the analysis.[338]



[338] Regression results without the model of missing values can be found in Table 6-5.

Table 6-1: Definitions of Regression Variables

Definition of Variables[339]				*n=95*
Variable *(m indicates mean inputted for missing values)*	type	description	mean	standard deviation
TSIm	continuous	trade secrets Intensity	32,097	114,380
vsalesm	continuous	Victim Annual Sales Revenue (dollars)	10.9 e+9	17.8 e+9
Xrefm	continuous	Cross Referenced Value (dollars)	711,786	2,048,750
manudum	dummy	Manufacturing	0.56	0.50
servdum	dummy	Service	0.18	0.39
patentable	dummy	Potentially patentable	0.39	0.49
copyright	dummy	Potentially copyrightable	0.21	0.41
outsider	dummy	Defendant is outsider	0.16	0.37
foreign	dummy	Defendant is foreign	0.22	0.42
sbdummy	dummy	Victim is small business	0.26	0.44

Note: the mean and standard deviation is calculated on the data after missing value analysis; thus, while the mean is the same before and after the missing value analysis, the standard deviation reported in the table above is lower than the pre-missing value input.

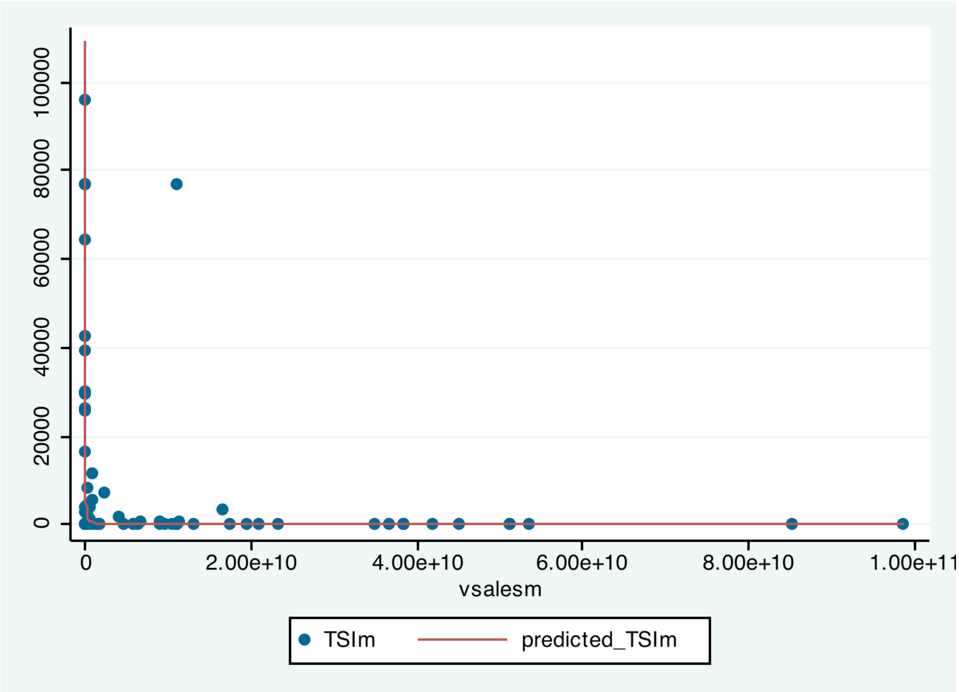
6.5 Functional Form

The relationship we are interested in measuring is that between the use of trade secrets and the size of the victim firm. Our measure of the use of trade secrets is

[339] A number of the variables have missing observations for reasons discussed in Chapter 3. The count of non-missing values for the relevant variables are *valuelow = 31, vworkers = 66, vsales = 76, Xref = 42* and *outsider = 85.*

that of TSI and our measure of the size of the victim firm is *vsales*. A scatter plot of the relationship between *TSIm* and *vsalesm* reveals the following:

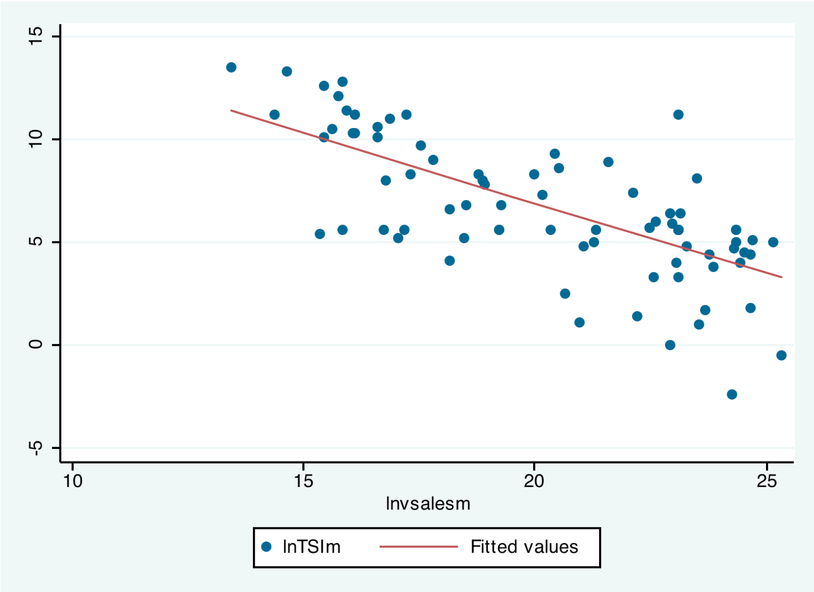
Figure 6-1: Scatter Plot of TSIm and vsalesm[340]



The scatter plot in Figure 6-1 suggests a highly nonlinear relationship in terms of raw data on *TSI* and size. Applying a log-log transformation to *TSIm* and *vsalesm*, we have the following graph:

[340] The outlier, at *vsalesm* = 1.09e+10, *TSIm* = 76,960, is U.S. v. White, 1:08-mj-02332-UA-1, filed 24/10/08 in S.D.N.Y. This appears as an outlier because the number of workers of the firm was observed (=100), but the mean has been inputted for the value of the trade secret and *vsalesm*. The combined effect is unique and artificial. The outlier is something of a statistical artefact. It arises because of a one-off combination of three effects. First, in the case the value of the trade secrets in the numerator of *TSI)* was unobserved and was assigned the mean value. Second, the firm in question was one of the smallest with a headcount of only 100 (in the denominator.) Third, the value of sales was itself unobserved, so was assigned its mean value, which would be a relatively high estimate for so small a firm.

Figure 6-2: Log-log Scatter Plot of TSIm and vsalesm with Regression Line



Superimposed on the data in Figure 6-2 is a log-linear regression line fitted by least squares: Ln(*TSIm*) = 20.3-0.67*ln(*vsalesm)+ε* This was estimated using Stata.[341]

Thus, a visual interpretation of the data suggests that a log-log transformation is appropriate. However, in order to better establish the basis for preferring the log-log specification, we should test for the functional form using a Box-Cox test.[342] Our starting point is a simple bivariate linear regression model using untransformed variables:

[6-6]

$$TSIm = \beta_0 + \beta_1 vsalesm + \varepsilon$$

[341] Stata is commonly used statistical and econometrical software. StataCorp (2009), *Stata Statistical Software: Release 11.* College Station, Texas: StataCorp LP.

[342] As Maddala (1992) describes, the Box-Cox test uses a Maximum Likelihood estimator to estimate λ in the following transformation: $y(\lambda) = \begin{cases} \frac{y^{\lambda}-1}{\lambda} & for \lambda \neq 0 \\ \log y & for \lambda = 0 \end{cases}$

Where it is assumed that there is some value of λ that transforms the response variable to normality and generates a homogeneous variance. Thus, when the test confirms λ = 0, the appropriate transformation is log (*y*).

A Box-Cox test was used to identify the most appropriate transformation of the dependent and independent variable. [343] The results of this test are reported in Table 6-2:

Table 6-2: Box Cox Transformation

(testing for dependent and independent variable transformation)

```
                                        Number of obs   =        95
                                        LR chi2(1)      =     65.82
Log likelihood = -822.18972             Prob > chi2     =     0.000
```

TSIm	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
/lambda	.0107836	.0201795	0.53	0.593	-.0287674	.0503346

Estimates of scale-variant parameters

	Coef.
Notrans	
_cons	20.46993
Trans	
vsalesm	-.5897063
/sigma	2.334247

Test H0:	Restricted log likelihood	LR statistic chi2	P-value Prob > chi2
lambda = -1	-1367.0063	1089.63	0.000
lambda = 0	-822.33279	0.29	0.593
lambda = 1	-1239.4174	834.46	0.000

Table 6-2 is an edited version of the STATA output, where running the Box-Cox transformation tests for the appropriate transformation of the dependent and independent variables. The 95% confidence interval (-0.03, 0.05) for the estimate of λ clearly encloses the origin. Referring to the last three lines of Table 6-2, the test rejects λ = -1 (which would imply a reciprocal transformation of the

[343] Stata allows the user to run the Box-Cox test with the option of having "both sides with the same parameter" which test for both the transformation of the independent and dependent variables.

dependent and independent variable); and also rejects $\lambda = 1$ (which would imply no transformation.)

Finally, the test fails to reject $\lambda = 0$ (the p-value of the Chi-square is 0.593) which suggests using a logarithmic transformation of the dependent and independent variable.

Further Box-Cox testing (below) on generalizations of the simple linear model including the sectoral dummies also confirms the wisdom of using a log-linear transformation. To illustrate, consider the following model which introduces additional control variables for sectors; one for manufacturing (*mandum*) and one for services (*servdum*.)

[6-7]

$$\mathrm{Ln}(TSIm) = \beta_0+\beta_1\ln(vsalesm)+ \beta_2 manudum+\beta_3 servdum+\varepsilon$$

Table 6-3 presents an edited version of the STATA printout, showing regression estimates and associated diagnostics.

Table 6-3: Box Cox Transformation on Log-linear model with Sectoral Dummies[344]

```
                                                  Number of obs   =         95
                                                  LR chi2(3)      =      26.68
Log likelihood = -841.76065                       Prob > chi2     =      0.000
```

TSIm	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
/theta	-.0174348	.0245549	-0.71	0.478	-.0655615	.0306919

Estimates of scale-variant parameters

	Coef.
Notrans	
vsales	-7.48e-11
servdum	.8490193
manudum	.7494561
_cons	6.273469
/sigma	2.390435

Test H0:	Restricted log likelihood	LR statistic chi2	P-value Prob > chi2
theta = -1	-1364.264	1045.01	0.000
theta = 0	-842.0094	0.50	0.481
theta = 1	-1237.8198	792.12	0.000

.

In the bottom three lines of Table 6-3, the Box-Cox test is applied to the transformation of the dependent variables using estimates of θ (the generalized equivalent of λ.) Again, the Box-Cox transformation accepts θ = 0 (and rejects the alternatives, θ = -1,1) which confirms that the log-linear transformation is an appropriate one to adapt.

6.6 Analysis and Results

In order to test the relationship between *TSI* and *vsales,* a linear regression was performed using *TSI* as the dependent variable. As a reminder, *TSI* is our measure of trade secret intensity, which is defined as:

[344] This particular application of the Box-Cox test is testing only the transformation of the dependent variable. As a logarithmic transformation can only be performed on strictly positive numbers, the test is unable to test for a transformation of dummy variables (which include the value of 0.)

TSI = Value of trade secrets (using least values) / The number of workers in the firm (viz. the headcount.)

There are three independent variables: our measure of the victim firm's size given by *vsales*, and two dummy variables to capture sectoral effects. The manufacturing and service sectors (as represented by *manudum* and *servdum*) account collectively for 74% of our observations. Earlier analysis has suggested a non-linearity in the relationship between the dependent and independent variables, and further analysis has suggested using a log-linear form. In particular, this is the choice suggested by the Box-Cox test results, which have been discussed above, with reference to Table 6-3. We now turn to estimates of the regression.

[6-8]

$$\text{Ln}(TSIm) = \beta_0+\beta_1 \ln(vsalesm)+ \beta_2 manudum+\beta_3 servdum+\varepsilon$$

Which are given by the STATA edited printout in Table 6-4.

Table 6-4: Regression Results for Equation [6-8]

Source	SS	df	MS
Model	451.722481	3	150.57416
Residual	451.072871	91	4.95684474
Total	902.795352	94	9.60420587

Number of obs =	95
F(3, 91) =	30.38
Prob > F =	0.0000
R-squared =	0.5004
Adj R-squared =	0.4839
Root MSE =	2.2264

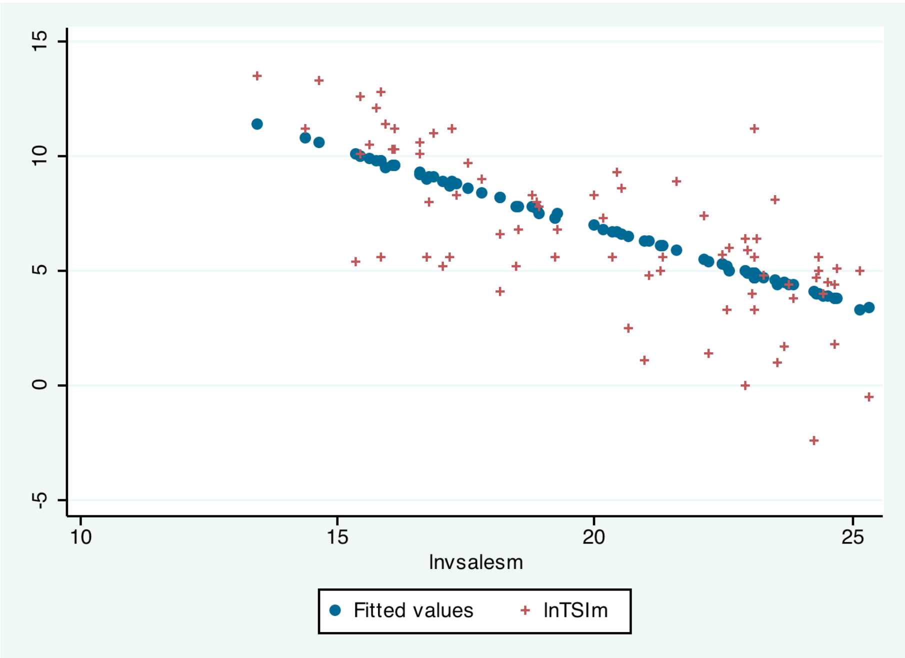
lnTSIm	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnvsalesm	-.6730572	.0717021	-9.39	0.000	-.8154847	-.5306297
servdum	.20263	.7117624	0.28	0.777	-1.211199	1.616459
manudum	.1814181	.5506373	0.33	0.743	-.9123553	1.275192
_cons	20.25921	1.60693	12.61	0.000	17.06724	23.45118

.

This log-linear model with sectoral dummies was estimated to facilitate analysis of the effects of firm size and industrial sector on trade secret intensity. Our log-linear model is a good fit to the data, having an R squared of 0.5004. Overall, the model is highly statistically significant, having an F-statistic of F(3, 61) = 30.38

with an associate p-value of 0.00. Figure 6-3 below shows a scatter plot of the predicted (fitted) values of [6-8] versus the observed values using the coefficient estimates given in Table 6-4 (last four lines, leftmost column.) We note first that the size coefficient is negative (-0.673) and highly statistically significant. It is less than unity in absolute value. Considered as an elasticity, it suggests that given a proportional increase in size, ceteris paribus, leads to a less than proportional decrease in trade secret intensity (namely about two thirds reduction.)

Figure 6-3: Log Linear Model with Sector Dummies: Scatter Plot of Fitted versus Observed ln(*TSIm*)



However, we note above that not all the individual coefficients are statistically significant. In particular, both the *manudum* and *servdum* dummy variables are not statistically significant. This suggests that sector does not appear to affect the *TSI* of a firm. Further regressions using a variety of sector dummy variables for narrower SIC codes (e.g. construction, transportation etc.) also failed to uncover any sectoral effects on ln(*TSIm*).

6.6.1 Consideration of Other Independent Variables

While *vsales* and sector dummies are the focus of this analysis, other independent variables are considered to control for their effects. The results of regressions performed with these variables are reported in Table 6-5. As noted in the table, the only variables whose coefficients are reported to be significant are that of *ln(vsalesm)* and the constant.

Table 6-5: Log-linear Regressions with Combinations of Variables

	Log-linear Regression Results Dependent variable = ln(*TSIm*)					
Variables	no m*					
ln(vsales)	**-0.61**					
	(0.00)					
ln(vsalesm)		**-0.68**	**-0.67**	**-0.65**	**-0.67**	**-0.67**
		(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
manudum	0.32		0.18			
	(0.88)		(0.74)			
servdum	0.42		0.20			
	(0.85)		(0.78)			
outsider				0.21		
				(0.76)		
foreign					-0.49	
					(0.38)	
patentable						-0.29
						(0.58)
copyright						-0.60
						(0.34)
constant	**17.2**	**20.47**	**20.26**	**19.82**	**20.47**	**20.35**
	(0.00)	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
Overall p-value	*(0.01)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*	*(0.00)*
R-squared	0.37	0.50	0.50	0.46	0.50	0.50
N	27	95	95	85	95	95

Values in parentheses are the p-value of the coefficient; italics indicate a p-value of less than 5%. Bold indicates a coefficient that is significant at the 5% level
**the first column is without the model of missing values*

Of interest in Table 6-5 is that a number of the dummy variables are not statistically significant. In terms of the dummy variables, both *outsider* and *foreign* are not significant in their regressions. As Zwillinger and Grenetski

(2000) note, the Sentencing Guidelines include harsher punishments for those who steal from their employers (i.e. when *outsider* = 0); however, this does not appear to affect the use of trade secrets. Additionally, the EEA was designed with the intent to criminalize Economic Espionage which, by its definition, requires the involvement of foreigners. However, *foreign* again does not appear to influence the use of trade secrets. Finally, the nature of the trade secrets, as indicated by *patentable* and *copyright*, also fails to influence *TSI.* This result is surprising as the nature of the trade secrets and the availability of alternate methods of protecting the innovation could influence the intensity of the use of trade secrets. Thus, the modelling of these dummy variables in the log-linear regression has resulted in the elimination of additional variables that do not influence *TSI*.

6.6.2 Consideration of Other Functional Forms

While the Box-Cox regression indicates that the log-linear approach is best, it is still worthwhile examining the behaviour of other forms. The poor performance of these regressions, as reported in Table 6-6, confirms that that the log-linear form is a superior form for our model. The linear regression model, as reported in the first column of the table, has a low R-squared of only 0.03. The quadratic models, which should perform better as they capture some of the non-linearity of the relationship between *TSIm* and *vsalesm*, also have low R-squared of 0.05 and 0.08. Further, the quadratic term is not significant. Thus the linear and quadratic forms both do a poor job of predicting the value of *TSIm.*

Table 6-6: Regression with Linear and Quadratic forms

Regression with other (not log-linear) forms			
	Dependent Variable = TSIm		
Form	Linear Regression	Quadratic	Quadratic with dummies
Variables			
vsalesm	-0.000001	**-0.000003**	**-0.000003**
	(0.10)	*(0.04)*	*(0.04)*
$vsalesm^2$		0.00	0.00
		(0.12)	(0.13)
manudum			44823.06
			(0.11)
servdum			11662.97
			(0.74)
constant	**43,960.49**	**54,645.76**	27,336.91
	(0.00)	*(0.00)*	(0.28)
Overall p-value	(0.10)	(0.08)	(0.09)
R-squared	0.03	0.05	0.08
N	95.00	95.00	95.00

Values in parentheses are the p-value of the coefficient; italics indicate a p-value of less than 5%. Bold indicates a coefficient that is significant at the 5% level

6.6.3 Test for Heteroskedascity

In order to strengthen the regression results further, it is necessary to test for heteroskedasticity.[345] Using Equation [6-8], we run a series of tests to detect heteroskedasticity.

[345] Heteroskedasticity is the case in which the regression errors do not have a constant variance.

Table 6-7: Breusch-Pagan Test for Heteroskedasticity[346]

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of lnTSIm

         chi2(1)      =     0.16
         Prob > chi2  =   0.6870

.
```

The test fails to reject the null hypothesis that the variances are constant and thus homoskedasticity is not rejected. However, given the small sample size, White's test (which is a special case of the Breusch-Pagan test and is the "Heteroskedasticity" test on the chart below) may be a more appropriate measure.[347]

Table 6-8: White's Test for Heteroskedasticity

Cameron & Trivedi's decomposition of IM-test

Source	chi2	df	p
Heteroskedasticity	3.72	6	0.7142
Skewness	11.75	3	0.0083
Kurtosis	2.15	1	0.1427
Total	17.63	10	0.0616

.

Again, the null hypothesis of homoskedasticity is not rejected. This indicates that neither the sectoral dummy variables, nor the level of sales have significant impact on the error variances of the model.

6.7 Robustness testing

[346] As Maddala (1992) notes, the Breusch and Pagan tests the assumption of homoskedasticity. The test performs a hypothesis test as to whether the coefficients of a function influence the error variance are all equal to zero.

[347] This method is suggested by Kennedy (2003), "Koenker (1981) notes that the Breusch-Pagan test is sensitive in small samples to its assumption that the errors are distributed normally. He suggests replacing … in this (the suggested) form, it is seen that the White test is a special case of this "studentized" Breusch-Pagan test, as noted in Waldman (1983)", p. 154.

In order to test the robustness of these models, it is important to re-examine the regression results in terms of outliers, Cook's distance and trimming. The resilience of the model to these tests will help mitigate concerns about undue influence of outliers. However, one issue that remains unaddressed is Error in Variables problem. It is possible that the data contain measurement errors and that the use of proxies has resulted in errors. The use of robustness testing helps to mitigate the influence of errors in variables.

6.7.1 Outliers

Due to the highly heterogeneous estimation of the value of the trade secrets, one outlier has been excluded from the dataset.[348] This observation has been excluded on the theoretical grounds that the estimated value includes significant innovative inputs other than the trade secret itself. In this case, the outlier is the estimate of the value of source code stolen in the Lucent case.[349] The value of this trade secret is estimated at $100M; however, this represents the total sales of the software stemming from the source code that likely includes high levels of other outputs. In addition, this case is 8.8 standard deviations away from the mean of $5.6M and 6.1 standard deviations away from its nearest neighbour.[350] Hence, this case is treated as an outlier and is excluded from the analysis.

6.7.2 Robust Regression

Further outlier and trimming analysis confirms the robustness of the regressions performed on the remaining observations. A robust regression was run on the basic form of the model to determine the Cook's distance of each of the observations.

Table 6-9: Robust Regression Results of Log-linear model with Sectoral Dummies

$\text{Ln}(TSIm) = \beta_0+\beta_1\ln(vsalesm)+ \beta_2 manudum+\beta_3 servdum+\varepsilon$

---

[348] Details on the valuation of trade secrets can be found in Zwillinger and Genetski (2001) and empirical evidence of their heterogeneity can be found in Chapter 4.
[349] US v. ComTriad et al, 2:01-cr-00365-WHW-3 filed on May 31, 2001 in New Jersey.
[350] Mean of sample including outlier = $5.6M with a S.D. of $12.9M.

Robust regression Number of obs = 65
F(1, 63) = 108.71
Prob > F = 0.0000

lnTSI	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnvsales	-.7784082	.0746575	-10.43	0.000	-.9275993	-.6292171
_cons	22.89559	1.520473	15.06	0.000	19.85717	25.93402

This rreg method in Stata weights and reweights least squares using a M-estimator. As Hamilton (1991) describes, rreg performs a regression and then calculates weights iteratively based on absolute residuals; it then regresses again until the weight drops below a specified tolerance. [351] Essentially, this method weights outliers based on how extreme they are and will eliminate extreme outliers entirely.

Further analysis of the robust regression indicates that the Cook's distance exceeds the value of one in five of the observations. Stata assigns a value of zero weight to those observations with Cook's distance greater than one.[352] A tabulation of these weights, as in Table 6-10, reveals that five observations were assigned weights of zero. These five observations were eliminated during the robust regression procedure. However, the values in the robust regression are similar to those found in the regression in the Log-linear model with Sectoral Dummies.

Table 6-10: Weights based on Cook's Distances for Robust Regression

Variable	Obs	Mean	Std. Dev.	Min	Max
cooks	95	.7901809	.3082981	0	.9999612

6.7.3 Trimming: Kernel Density

[351] Lawrence C. Hamilton, "How robust is robust regression?", *Stata Technical Bulletin* (July 1991): 21-26.
[352] As noted in Verardi and Croux (2008), Robust Regression in Stata, p. 4.

A trimming analysis using a Kernel Density[353] method to trim ln(*vsales*) based on the distribution also indicates that the regression results are fairly robust. Table 6-11 below indicates the distribution and percentiles of ln(*vsales*). This distribution dictates the observations at which the trimming will occur.

Table 6-11: Distribution of ln(*vsales*)

lnvsalesm

	Percentiles	Smallest		
1%	13.4185	13.4185		
5%	15.42495	14.37513		
10%	15.83041	14.60397	Obs	95
25%	17.51186	15.34157	Sum of Wgt.	95
50%	22.22712		Mean	20.71288
		Largest	Std. Dev.	3.237256
75%	23.11203	24.65748		
90%	24.3696	24.70319	Variance	10.47983
95%	24.65748	25.16977	Skewness	-.5110243
99%	25.31622	25.31622	Kurtosis	1.85814

The model used in the trimming analysis is [6-8:

Ln(*TSI*) = β_0+ $\beta_1$ln(*vsales*)+ β_2*manudum*+β_3*servdum*

Table 6-12: 10% Trim of ln(*vsales*) (5th to 95th percentile)

Source	SS	df	MS
Model	266.886548	3	88.9621827
Residual	383.838733	80	4.79798416
Total	650.725281	83	7.84006363

Number of obs =	84
F(3, 80) =	18.54
Prob > F =	0.0000
R-squared =	0.4101
Adj R-squared =	0.3880
Root MSE =	2.1904

lnTSIm	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
manudum	.2719973	.5584387	0.49	0.628	-.839331	1.383326
servdum	.4214769	.7512585	0.56	0.576	-1.073575	1.916529
lnvsalesm	-.6179887	.0850698	-7.26	0.000	-.787283	-.4486944
_cons	19.00777	1.871677	10.16	0.000	15.28301	22.73252

[353] The Kernel Density method eliminates observations based on where they fall in the distribution of observations. Thus, a 20% trim will trim off all those observations which lie above the 90th percentile and below the 10th percentile. In this case, we are applying this method to the independent variable ln*(vsalesm)*.

Table 6-13: 20% Trim of ln(*vsales*) (10th to 90th percentile)

Source	SS	df	MS
Model	198.438133	3	66.1460443
Residual	346.344001	74	4.68032434
Total	544.782134	77	7.07509265

Number of obs	=	78
F(3, 74)	=	14.13
Prob > F	=	0.0000
R-squared	=	0.3643
Adj R-squared	=	0.3385
Root MSE	=	2.1634

lnTSIm	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
manudum	.1355867	.5596964	0.24	0.809	-.9796327	1.250806
servdum	.7080694	.7726339	0.92	0.362	-.8314372	2.247576
lnvsalesm	-.5908295	.0929298	-6.36	0.000	-.7759963	-.4056628
_cons	18.42829	2.033467	9.06	0.000	14.37652	22.48006

The trimming analysis, resulting in a cull of up to 20% of observations, reduces the value of R-squared from 0.50 in the complete sample, to 0.36 in the 20% trimmed sample. However, the R-squared decreases only to 0.41 after a 10% trim, which indicates that the regression is fairly robust under a considerable trim. Additionally, the coefficient of ln(*vsales*), β_1, is reasonably stable and includes the set [-0.62, -0.59] under two levels of trimming and is stable when compared to the untrimmed analysis of value of β_1= -0.76. This trimming analysis confirms the robustness of the results of the regression analysis further.

6.7.4 Trimming: Trimmed Least Squares

An alternate method of trimming is Least Trimmed Squares (LTS),[354] which is performed in Stata using `robreg lts` and allows for a specified level of trimming. In this case, the software calculates the regression and then trims off the α specified portion. Again the test is performed on [6-8].

[354] Judge et al (1985) describe this method as a series of steps in which a desired proportion is trimmed off. The procedure is as follows (p. 838).

Table 6-14: LTS Trim of 10, 20 and 30% on Log-Linear Model[355]

Least Trimmed Squares Results			
Trim	10%	20%	30%
dependent variable = ln(*TSIm*)			
ln(*vsalesm*)	-0.67	-0.79	-0.78
manudum	-4.62E-16	0.05	-5.37E-16
servdum	-1.38	-1.17	-1.18
constant	21.01	24.07	23.66

This again suggests the robustness of the model, with coefficients being relatively stable under trimming.

6.8 Endogenous Switching: Endogenous Selection and Sample Selectivity

The use of prosecution data for economic analysis is rife with challenges. One major challenge is that of self-selectivity within the sample. As a whole, this can be referred to as endogenous switching and includes both endogenous selection and sample selectivity. In this study, the data are restricted to only those cases in which a trade secret was stolen, the theft was detected, the theft was reported to the FBI, the FBI referred the case the district attorney and the case reached court. This series of steps means that the EEA cases represent a small portion of the wider population of trade secrets, and even stolen trade secrets. Endogenous variables influence the observed data and the inclusion of observations in the observed data. Hence, a strictly OLS regression will fail to account for this sample selectivity or endogenous selection.

This section of the study uses methods to correct for this endogenous switching problem including the Heckman Correction and, while not strictly an endogenous switching correction, Truncated Regression.

[355] Note that the Stata code used in this case was user-generated by Jann (2010) and thus does not conform to the standard Stata output. In this case, no p-values are calculated.

6.8.1 Heckman Correction

A method to correct for endogenous switching is that of a sample selectivity correction. The sample is sample selected in that, of all trade secrets, only those that have been stolen are observed. However, when working with the Heckman correction[356] for sample selectivity, the procedure needs missing values on which to base its analysis. Hence, the use of a complete data set (i.e. one that has had all missing values replaced) is inappropriate as the model reverts to an OLS analysis.

In order to examine the sample selectivity of TSI, we will proceed by examining the original data set (i.e. before adjusting for missing values.) However, the data set is solely for those cases that concluded in prosecution and no information is available for unprosecuted cases. The missing values are due to incomplete information in terms of the availability of the value of the trade secrets, details regarding the victim firm, ongoing cases and other complications with data collection. Thus, the data set will only allow the Heckman correction to account for missing information and not the sample selection concern of the decision to prosecute. Table 6-15 below reports on the results of a Heckman correction applied to the data using the logs of firm size (*vsales*) and a valuation of the trade secret (*xref*) as the variables in the selection model.

Table 6-15: Heckman Correction of Log-linear model with Sectoral Dummies; Selection Model Based on Sales and Xref

(no model of missing values)

[356] Also known as the Heckman selection model, or Heckman's estimator for sample selection, the Heckman correction calculates expected value of the error, known as the Inverse Mill's Ratio (IMR), and then uses it as a regressor in the linear outcome model. The IMR is the ratio of the probability density function over the cumulative distribution function of a distribution and is calculated using a probit model. See Greene (1993) for further details.

```
Heckman selection model -- two-step estimates   Number of obs      =        35
(regression model with sample selection)        Censored obs       =        19
                                                Uncensored obs     =        16

                                                Wald chi2(3)       =      0.23
                                                Prob > chi2        =    0.9731
```

lnTSInom	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnTSInom						
lnvsales	-.2240232	.9930672	-0.23	0.822	-2.170399	1.722353
manudum	.7606698	2.801146	0.27	0.786	-4.729476	6.250816
servdum	1.364441	3.084258	0.44	0.658	-4.680593	7.409476
_cons	5.64224	26.56018	0.21	0.832	-46.41476	57.69924
select						
lnvsales	.1837641	.0760947	2.41	0.016	.0346213	.3329069
lnxref	-.1152328	.1254731	-0.92	0.358	-.3611557	.13069
_cons	-2.58051	1.611671	-1.60	0.109	-5.739327	.5783068
mills						
lambda	4.996229	8.905446	0.56	0.575	-12.45812	22.45058
rho	1.00000					
sigma	4.996229					
lambda	4.996229	8.905446				

However, a number of problems appear with the results in Table 6-15. One is that the model overall, and virtually all of the coefficients, are not significant. The other is that ρ is equal to 1, which indicates that the sample is not conforming to the Heckman assumptions. The use of the Heckman correction is, therefore, inappropriate. Additionally, the sample size has dropped to 16 making the analysis rather weak. In this case, the Heckman correction does not further the analysis.

6.8.2 Truncated Regression

Another method of correcting for sample selection is the similar concept of truncation. Truncation assumes that we do not observe variables below or above a certain level. The sample is truncated in that, of stolen trade secrets, only those reaching a certain minimum value of value reach the court. That is, that the FBI likely investigates only those trade secrets whose value exceeds a minimum. The FBI's Reporting Theft checklist[357] asks victims to place the value of their trade secret within a range. As discussed in Chapter 3, FBI Assistant Direct Chip Burrus "likened the FBI's current fraud-enforcement policies – in which losses below $150,000 have little chance of being addressed – to 'triage.' Even cases with losses approaching $500,000 are much less likely to be accepted for investigation than before 9/11."[358] While there is no public document supporting this triage policy, anecdotal evidence suggests that, in practice, it exists. If this were the case, we would expect that a truncated regression would improve the analysis.

The use of missing value analysis is permitted in truncated regression.[359] Using the `truncreg` method in Stata, and the mean inputted for missing values, we get the following:

Table 6-16: Truncated Regression for Log-linear Model with Sectoral Dummies

```
Truncated regression
Limit:   lower =       -inf                          Number of obs =     95
         upper =       +inf                          Wald chi2(3)  =  95.14
Log likelihood = -208.79238                          Prob > chi2   = 0.0000
```

lnTSIm	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lnvsalesm	-.6730572	.0701764	-9.59	0.000	-.8106004	-.535514
manudum	.1814181	.5389203	0.34	0.736	-.8748463	1.237683
servdum	.20263	.6966168	0.29	0.771	-1.162714	1.567974
_cons	20.25921	1.572736	12.88	0.000	17.1767	23.34171
/sigma	2.179022	.1580829	13.78	0.000	1.869185	2.488858

These results are close to those presented in Table 6-4, which is comforting but, in this way, the truncation analysis does not add to our earlier analysis.

[357] www.justice.gov/criminal/cybercrime/reportingchecklist-ts.pdf.
[358] Shukovsky, Paul et al (2007.)
[359] Truncated regression assumes that the observed cumulative density function is a truncation of the standard normal. In this case, $150,000 could be level at which the observations are truncated. Taking this truncated standard normal density function, Truncated regression performs a ML estimate with a normalized density function.

Additionally, it suggests that the FBI is not, in fact, conducting the alleged triage discussed earlier and in Chapter 3. This is supported further by a case studies analysis. The analysis suggests that the FBI is seeking prosecution for a wide range of values of trade secrets. For example, in the case of Genovese,[360] the FBI chose to prosecute the theft of Microsoft source code, which the defendant sold for $20. The decision to prosecute a theft which the defendant valued at a mere $20 is likely a case of the FBI strategically choosing to prosecute a single defendant with the intent of dissuading other would-be thieves. Thus, in the absence of a truncation, the `truncreg` method fails to enhance the analysis.

6.9 The Role of Outsiders

A further empirical consideration of the potential for endogenous switching lies in the choice of the thief. The dummy variable *outsider* records whether or not the thief was an employee/former employee or had a direct relationship with the owner of the trade secret. An "outsider" would not have a direct or employment relationship with the victim firm. An "insider" would likely know the value of the trade secret before attempting to steal it and would have easier access to complete the theft. Therefore, we would expect to find evidence of differences in the actions of outsider versus insiders.

While the literature pays considerable attention to the fact that, in most trade secret cases, the perpetrator is an insider, little has been done to analyse the nature of this fact empirically. In a recent, fairly comprehensive statistical review of trade secrets, Almeling et al (2010) note that, "Most alleged misappropriators are someone the trade secret owner knows. Specifically, in over 85% of cases, the alleged misappropriator was either an employee or business partner."[361] Mossinghoff et al (1997) also demonstrate that, in EEA cases, the defendant is often an insider. Almeling et al additionally argue that,

[360] U.S. v. Genovese, Criminal case 1:05-cr-00004-WHP-1 (Southern District of New York, filed on January 4, 2005.)
[361] Almeling et al (2010), p. 9.

"Based on the data, a prudent trade secret owner should focus on protecting trade secrets from unscrupulous employees and business partners."[362]

In order to examine the decision to act as an insider or an outsider, we model a simple probit of the decision to act as an outsider. Equation [6-9] below presents a simple probit model.

[6-9]

$$C_i^* = \gamma' w_i + u_i$$
$$C_i = 1 \; if \; C_i^* > 0$$
$$C_i = 0 \; otherwise$$

In our case, we model the decision to act as an outsider, as reflected below.

[6-10]

$$outsider^* = \gamma'(size\ of\ the\ firm, value\ of\ the\ TS, dummies, etc\ldots) + u_i$$
$$outsider = 1 \text{ if } outsider^* > 0$$
$$\text{and} = 0 \text{ otherwise}$$

The results of the probit model run[363] with the variables described in Section 6.4 are reported in the table below.

[362] *Ibid.,* p. 9.
[363] Probit models were run in Stata.

Table 6-17: Probit Results of *Outsider*

	Probit model results Where dependent variable = *outsider*			
Variables				
ln(TSIm)	-0.04			
	(0.52)			
ln(vworkersm)		0.08		
		(0.28)		
ln(vsalesm)			0.07	
			(0.21)	
ln(valuelowm)		0.04	0.04	0.05
		(0.68)	(0.64)	(0.58)
manudum		-0.27	-0.30	0.10
		(0.42)	(0.40)	(0.83)
Servdum				0.71
				(0.17)
Foreign				-0.04
				(0.91)
Constant	**-0.76**	-2.09	-2.95	-2.00
	(0.04)	(0.18)	(0.11)	(0.20)
p-value (χ^2)	0.52	0.50	0.42	0.53
Pseudo R^2	0.00	0.03	0.04	0.04

Values in parentheses are the p-value of the coefficient; italics indicate a p-value of less than 5%. Bold indicates a coefficient that is significant at the 5% level.

However, as Table 6-17 reflects, the probit models fail to provide satisfactory results with regards to the decision to be an outsider. In the first column, the use of ln(*TSIm*) further examines the relevant variable discussed earlier in this chapter. The second and third columns deconstruct *TSI* and use the size of the firm, as measured by ln(*vworkersm*) or ln(*vsalesm*), and the value of the stolen trade secret, ln(*valuelow*) as separate explanatory variables. The fourth column uses the value of the stolen trade secret and a number of dummy variables. However, the probit models reflected here have low explanatory value and are not statistically significant. Further combinations of explanatory variables produced similarly unsatisfactory results.

Much of the available summary statistical evidence points to the majority of trade secret misappropriators being insiders. Furthermore, the literature suggests trade secret owners' focus on internal efforts to protect trade secrets. As Almeling et al (2010) argue, "the data calls into question the extensive and expensive efforts to stop espionage from unrelated third parties."[364] However, these summary statistics fail to provide a more comprehensive picture on the impact of theft by insiders versus outsiders has on the firm. Informed opinion suggests that further work moving beyond summary statistics would lead to a fruitful outcome. Thus, the results here suggest that more research using a different approach is required.

6.10 Elasticity Analysis Across Multiple Forms

One advantage of the use of the log linear form is that it implies a constant elasticity (η) of the dependent variable with respect to the independent variables. Elasticity is a measurement of the proportional response of the dependent variable with respect to a proportional change in the independent variable. Alternate functional forms of the model, as presented in Table 6-18, suggest that the elasticity is fairly stable. We have been using the following definition of elasticity:

[6-11]

$$\eta = \frac{d\ln(TS\mathrm{Im})}{d\ vsalesm}\frac{vsalesm}{1}$$

Our general conclusion, based on all the estimates reported above, is that the value of the elasticity of *TSI* with respect to *vsales* has remained fairly stable, under both alternative specifications and under sample trimming. In the most basic log linear model, the elasticity of *TSI* with respect to *vsales* is η = -0.67.

[364] Almeling et al (2010), p. 9.

This is derived from the coefficient β_1 as in Equation [6-8] presented in Table 6-4.

[6-12]

$\text{Ln}(TSIm) = \beta_0 + \beta_1 \ln(vsalesm) + \varepsilon$

For which the estimated coefficients were:

$\beta_0 = 20.26$, $\beta_1 = -0.673$,

Further, if we turn to a more complex functional form, which involves the log-linear model with an interaction term, we shall see that this elasticity is robust. Consider the model:

[6-13]

$\text{Ln}(TSIm) = \beta_0 + \beta_1 \ln(vsalesm) + \beta_2 \ln(\text{xrefm}) + \beta_3 \ln(vsalesm)\ln(\text{xrefm}) + \varepsilon$

Coefficient estimates are found to be:

$\beta_0 = 37.0$, $\beta_1 = -1.48$, $\beta_2 = -1.37$, $\beta_3 = 0.066$

This results in an elasticity of *TSIm*, evaluated at the means, with respect to *vsalesm,* $\eta = -0.68$.[365] Thus, we conclude that a fairly solid basis is established for regarding this elasticity as having a (negative) value of about two-thirds.

A summary of the values of the elasticity obtained under various forms of regression is detailed in Table 6-18, which shows considerable stability of η using log-linear regressions.

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[365] The calculation of the elasticity was done using the following estimates:

$$\ln(TS\,\text{Im}) = 37 - 1.48\ln(vsalesm) - 1.37\ln(xrefm) + 0.66\ln(vsalesm)\ln(xrefm)$$

$$\eta = \frac{\partial \ln(TS\,\text{Im})}{\partial \ln(vsalesm)} = \frac{\partial \ln(TS\,\text{Im})}{\partial vsalesm}\frac{vsalesm}{1}$$

$$\eta = \left(\frac{-1.48}{vsalesm} + \frac{0.066\ln(xrefm)}{vsalesm}\right)vsalesm = -1.48 + 0.066\ln(xrefm)$$

evaluated at the means, where mean of $\ln(xrefm) = 12.18$

from which the elasticity is:

$\eta = -1.48 + 0.066(12.18) = -0.68$

which is close to the value obtained with other estimates and sample sizes.

Table 6-18: Elasticity of *TSIm* with Respect to *vsalesm* Under Log-linear Regressions

	Elasticity of TSIm with respect to vsalesm under Log-linear models				
Independent Variables	ln(*vsalesm*)	ln(*vsalesm*) *manudum servdum*	ln(*vsalesm*) *outsider*	ln(*vsalesm*) *patentable copyright*	ln(*vsalesm*) *foreign*
Elasticity	-0.67	-0.67	-0.65	-0.67	-0.67

Under a variety of robustness checks (see Table 6-19) we also find a stable η.

Table 6-19: Elasticity of *TSIm* with Respect to *vsalesm* Under Robustness Testing

	Elasticity of TSIm with respect to vsalesm under Robustness Testing						
Method	Robust Regression	Kernel Density Trim		Least Trimmed Squares			Truncated Regression
Level of trim		*10%*	*20%*	*10%*	*20%*	*30%*	
Elasticity	-0.71	-0.62	-0.59	-0.71	-0.77	-0.79	-0.67

The range of the estimations for η is (-0.59, -0.79). It is more varied under the robustness testing than under the various log-linear regression of Table 6-18, but still very stable.

Overall, the estimated values of the elasticity of *TSIm* with respect to *vsalesm* are stable and remain around η = -0.7. As the absolute value of η is less than unity, this elasticity is inelastic, in that a one percent change in *vsalesm* leads to a less than one percent change in *TSIm*. Additionally, the monotonic negative value of η indicates that the two variables are moving in opposite directions, for large as well as for small changes: an increase in *vsalesm* results in a decrease in *TSIm.*

Returning to our discussion at the beginning of the chapter, we asked of Equation[6-2] whether $f' > 0$ or $f' < 0$? We can now assert with confidence that $f' < 0$, and, further, from the estimated log-linear form, that f is convex (see Figure

6-1.) That is, the results of this study confirm that the use of trade secrets is negatively related to firm size. Smaller firms are relatively more reliant on trade secrets, and larger firms are relatively less reliant on trade secrets. The elasticity analysis adds the nuance that this relationship is nonlinear and that changes in firm size results in smaller changes to the intensity of trade secrecy.

6.11 Conclusion

Empirical investigations into the use of trade secrets remain an under-examined area due to the challenges of conducting research on trade secrets. This study represents a start in understanding the relationship between the use of trade secrets and firm size. Based on a regression analysis of EEA data, we conclude that there is a negative relationship between firm size and the intensity of trade secrecy. Additionally, it is an inelastic relationship, with an elasticity of -0.68 of *TSIm* with respect to *vsalesm.* Rigorous testing of this relationship, including methods to correct for endogenous switching, confirms that this relationship remains stable.

The results find in favour of a negative relationship, $f' < 0$, and in favour of explanations that smaller firms prefer trade secrets. This represents an argument that larger firms prefer patents to trade secrets and that the opposite is true for smaller firms. Given the high costs of both obtaining and maintaining patents, smaller firms may find trade secrets a more efficient method of protecting innovations. Trends in aggressive patent enforcement (as in Lerner and Jaffe, 2004) and the emergence of patent trolls suggest that the costs of patenting will increase. Future changes in the cost of patenting will create the possibility of empirically testing the assumption that this cost drives smaller firms to use trade secrets. Certainly, there is more work to be done in this area.

The implications that the relationship between the use of trade secrets and firm size has for arguments for and against the Schumpeterian (1934, 1942) hypotheses also merit further scrutiny. Our evidence shows that smaller firms use trade secrets more intensively and this agrees with the findings of Arundel

(2001.) As Arundel notes, the Schumpeterian argument supports the concept that smaller firms may produce less patentable innovations and, therefore, are more reliant on trade secrets. The findings of this study, along with Arundel (2001), also suggest that empirical studies which use patents as a proxy for innovations will have results that underestimate the innovative activity of smaller firms.

As economists shift their focus away from patents and towards alternate methods of protecting innovation, the use of trade secrets will be better understood. Important questions regarding the value of trade secrets, the firm's decision between trade secrets and patents, the role of outsiders, and other considerations of the strategic use of trade secrets remain. Further investigation into these matters will benefit practitioners, policy makers and academics alike.

Chapter 7: Conclusion

7.1 Introduction

The use of trade secrets represents an important element of the wider IP infrastructure. While patents have provided a wealth of data for study, trade secrets have suffered some neglect in academic research, mostly due to the empirical and analytical challenges associated with their research. This thesis has sought to rise to these challenges. It has done so by making four contributions: the creation of a new dataset based on prosecutions under the EEA; the analysis of the impact of the EEA; the comparative analysis of valuations methods of trade secrets; and the estimation of a new model of the determinants of trade secret intensity. This chapter will develop the nature and content of these contributions further. To establish a context for these contributions, detailed in Sections 7.2 and 7.3, some preliminary comments should prove relevant.

A strong theme which runs throughout this thesis is the contrast between the state of research into patents and that of trade secrets, as discussed in Chapters 2, 4 and 6. Much of the literature frames trade secrets as an alternative to patents and the analysis of trade secrets in terms of valuation and legal precedents begins with that of patents (e.g. Paine, 1991; Smith, 2002.) However, as trade secrets embrace a broader class of innovations and can be used in conjunction with patents (Arundel, 2001; Scotchmer, 2006), we would argue that trade secrets merit more attention as a form of IP in their own right (Lerner, 2006.) However, until now, the lack of available data and the legal ambiguity of trade secrets have slowed the development of trade secrets research.

The advent of the EEA represents a significant change in the approach to trade secrets in the U.S., as noted in Carr et al (2001.) Arguably, this change is a boon to researchers, as the insights offered by prosecutions under the EEA provide great potential for analysis of the use of trade secrets (Zwillinger and Genetski, 2000; Carr and Gorman, 2001; Nasheri, 2005.) To illustrate, the empirical results of this thesis indicate that the valuation of trade secrets generates a highly heterogeneous range of valuations (Chapter 5) using different, but economically sound, valuation models (Chapter 4.) This problem of diverse valuations is not unique to trade secrets, but its consequences for hampering research are compounded by issues of secrecy and legal ambiguity of trade secrets (Smith, 2002.)

As we have shown (Chapters 3 and 4), the individual cases of trade secrets theft have great diversity of form. We shall demonstrate that the use of trade secrets, their theft and their value are all highly varied. The cases considered above in Chapters 3 and 4 have ranged from the casual (e.g. wayward employees forwarding information to the wrong person) to the systematic (e.g. long-term, organized plots to steal confidential information from competitors.) The types of trade secrets stolen have been diverse and have included confidential bid information, customer lists, secret formulas, project plans and technical drawings. Overall, these findings demonstrate that trade secrets are highly flexible in implementation as a method of protecting innovation (as noted in Almeling et al, 2009.) Yet, despite this, trade secrets remain vulnerable to theft and are, by their nature, a weaker means of protecting innovation, as noted in Scotchmer (2005.)

7.2 Overview of Thesis: Chapters 2-6

The body of this thesis is developed across five chapters. Chapter 2 of this thesis presents a review of the relevant research literature. Chapter 3 explains the nature of the EEA and then examines its impact on the use of trade secrets, and presents a series of case studies which illustrate its functioning. Chapter 4 provides a critique of the diverse methods used for damages' valuations of trade secrets. Chapter 5 supports Chapter 4 with a comparative statistical analysis of valuations. Finally, Chapter 6 presents a statistical and econometric analysis of the principal determinants of trade secrets' intensity.

As Chapter 2, the research literature review, details, the literature on trade secrets is relatively less developed than that of patents. Given the well-documented history of patents, and the relatively rich sources of qualitative and quantitative data available, patents have long been the darling of economic and law researchers. However, more recent research has paid significant attention to the role of trade secrets. As the literature review demonstrates, the evolution of research on trade secrets has to some extent been similar to that of patents. Beginning with the identification of the philosophical justification for IP, the literature review presents the foundations of IP systems in Locke (1690), and modern arguments for the justification of trade secrecy as in Paine (1991.) Furthermore, current debates, such as cumulative innovation, disclosure and harmonization span both trade secrecy and patents. The models developed by economic theorists detail the choices of firms in strategic competition using IP and the social surplus impact of competing IP policies. Models such as Anton and Yao (2004) examine the decision to use trade secrets. These theoretical models provide the basis for further analysis via the analysis of empirical evidence. However, empirical evidence of trade secrets remains limited.

Chapter 3 explained in detail how a new database was constructed and presented key statistics and illustrative case studies from prosecutions under the EEA. It was found that key statistics from the EEA database suggest some surprising results. To illustrate, 29% of the trade secrets in question had no other IP protection available, which highlights the important role of trade secrecy for these forms of IP. Most of the trade secrets were not potentially patentable, which emphasizes the fact that trade secrets can protect a broad class of innovations. Furthermore, the majority (57%) of patents were in the manufacturing and construction industries, compared to a minority (6%) of the overall count of establishments in the manufacturing and construction industries in the 1998 U.S. census. This discrepancy suggests that these industries are heavily present in the sample and that they are particularly dependent on trade secrets as a means to protect innovations. Furthermore, and consistent with previous descriptive studies such as Almeling et al (2010), it was found that the majority of defendants would be considered to be insiders (i.e. had some formal association with the firm), rather than outsiders (e.g. competitors engaging in economic espionage.)[366]

Moreover, Chapter 3 presented a statistical cluster analysis of the EEA data. This procedure reveals three distinct clusters. The two most distinct clusters were dominated, respectively, by potentially patentable trade secrets in manufacturing and construction; and by copyrightable trade secrets in the services sector. The third cluster was less distinct and involved a range of industries using trade secrets that were not obviously patentable or copyrightable. These clusters were illustrated by two case studies per cluster. These examined the motives of defendants, the trade secret in question and other important elements of EEA cases. Collectively, the elements of Chapter 3 statistically summarized the EEA data and provided an overview of the economic impact of the EEA, which was illustrated through a series of case studies.

As Chapter 4 discussed, the valuation of trade secrets remains an art as much as a science (Henry and Turner, 2007.) Like all IP, trade secrets suffer from a lack of precision on their valuation. However, this situation is not unique to IP and thwarts the valuation of all intangible goods (Helpman, 1993.) Chapter 4 presented a critical analysis of the damages valuation methods used in EEA cases. The main groups of methods (income, cost and market) were shown to be susceptible to the reality of the criminal case in their application. Furthermore, the different concepts of time and the point of view of the valuation model influence the valuation. In accordance with Zwillinger and Genetski (2000), Chapter 4 argues that Reasonably Royalty is likely to be the most applicable method in EEA cases.

Chapter 5 built on Chapter 4 by presenting a statistical analysis of the EEA valuations. Chapter 5 examined the distribution of the valuations of EEA trade secrets and found a lognormal distribution. Furthermore, the range of valuations for trade secrets (*low* estimates versus *high* estimates) was found to have statistically different means. These *high* and *low* estimates were also found

[366] The insider/outsider argument was introduced in Chapter 3 and is refined in Chapter 5.

to have statistically higher means than the values used in sentencing (*xref*.) Given the criminal context of EEA cases, the valuation of trade secrets plays an important role in determining incarceration and punishment (Zwillinger and Genetski, 2000.) The statistical evidence suggests that a wide range of values can be obtained for the same trade secret. These different valuations reduce the strength of the protection provided by the trade secret by increasing the ambiguity of the value of the trade secret (Green et al, 2000.)

The regression analysis in Chapter 6, using EEA data, suggests that smaller firms are particularly dependent on trade secrets as a form of protecting innovation (Arundel, 2001.) The regression models finds in favour of a negative relationship between trade secret intensity and firms size ($f' < 0$.) This also implies that larger firms are more dependent on patents for appropriating returns to innovation (Arundel & Kabla, 1998.) Furthermore, the regression model does not find evidence of sectoral influences on trade secret intensity. Robustness testing of the relationship between firm size and trade secret intensity suggests that the relationship is fairly stable and the elasticity of *TSIm* with respect to *vsalesm* remains around negative two thirds.

Collectively, these five chapters presented an economic analysis of the EEA using prosecution data from 1996 to 2008. This unique database has allowed for the thorough analysis of the impact of the EEA, damages valuations and the determinants of trade secret intensity. In the next section, we summarize the main findings of the thesis.

7.3 Summary of Main Findings

This thesis has confronted the challenges of trade secret research, as recognized by Lerner (2006) and discussed in Chapter 2, and adapts the evidence from the litigation approach (e.g. Lanjouw and Shankerman, 1997, 1999, 2001, and 2004) to the empirical examination of trade secrets in criminal proceedings. As discussed in Chapter 3, the advent of the EEA allowed for the harmonized prosecution of trade secret theft at the federal level and presented an opportunity for the analysis of these prosecutions. The EEA dataset constructed as the empirical foundations of this thesis provides a unique source of empirical evidence for analysis.

For the firm, the evidence uncovered in this thesis has some encouraging implications. Primarily, the evidence suggests that, contrary to the rhetoric that led to the enactment of the EEA, the threat of economic espionage (trade secret theft to benefit a foreign entity) is minimal. The strengthening of the protection of trade secrets will be of particular benefit to the manufacturing and construction industries, which, as the data suggest, use trade secrets to protect potentially patentable innovations. The data also suggest that the service industries use trade secrets to protect potentially copyrightable innovations. This is likely due to their focus on services rather than goods, which, subsequently, implies that the services industries are less likely to produce potentially patentable innovations. This evidence, and the fact that nearly a third of the EEA trade secrets were neither patentable nor copyrightable, suggests that trade secrets are an essential IPR for this valuable knowledge. Thus, the EEA has had a positive impact on the protection of secrets.

A further finding of this thesis is that the valuation of trade secrets is fraught with subjective decisions; thus, using valuations of trade secrets for business decisions involves a high degree of insecurity (Green et al, 2000.) The evidence from the EEA regarding the valuation of trade secrets in a legal context suggests that these valuations are challenging. The income, cost and market models all represent economically sound valuations, yet their application is not straightforward. The particularities of each criminal case may prefer one valuation method to another, but there is no consensus; as Zwillinger and Genetksi (2000) note, no method is best in all situations. The lack of stable valuations for these intangible assets means that the inclusion of trade secrets on balance sheets may not be prudent.

Furthermore, the statistical evidence of Chapter 5 suggests that the upper and lower limits of the range of valuations have statistically different means. Given the criminal context of the EEA cases and the high burden of proof, the values used in sentencing are statistically lower than those argued during the case. This points to a conservative approach to valuations on the part of the court and suggests that the valuation methods can be improved. The wide variability of valuations implies that the value of trade secrets continues to present a potential source of ambiguity for innovators.

Additionally, this thesis provides a unique examination of the determinants of trade secret intensity. The data suggest that trade secret intensity is determined primarily by firm size in a negative relationship and that a proportional change in firm size results in a smaller change in trade secret intensity. That is, an increase in firm size results in a relatively smaller decrease in trade secret intensity. The data also show no systemic relationship between the sector of the trade secret owner and the observed trade secret intensity. However, these findings suggest that smaller firms are particularly dependent on the use of trade secrets to protect innovations. For policy makers, the evidence of this regression model emphasizes that the impact on small businesses should be considered in trade secret policy. Additionally, it calls into question the appropriateness of the patent system if smaller firms are using trade secrets due to the high cost of patenting (as discussed in Anton and Yao, 2004.)

Collectively, these findings paint a more complete empirical picture of the use of trade secrets and the application of the EEA for the protection of this IP. Furthermore, these findings provide empirical evidence for the valuation of trade secrets and its context in EEA cases. The finding that trade secrecy is used more intensely at smaller firms also suggests that IP policy, with respect to trade secrets, should consider the role of small businesses.

7.4 Possible Research Extensions

As a unique piece of legislation that criminalizes the theft of IP, the EEA presents researchers with a new approach to protecting IP. This work could be extended to incorporate an empirical Economics of Crime analysis of the EEA and the prosecution of IP crimes. The long-term impact of this criminalization of a previously civil matter could be extended into other areas of IP. The theft of copyright, for example, is a hotly debated topic[367] as technology challenges the traditional approach to protecting creative works. New legislation, such as the EEA, changes the relationship between consumer and producer; employee and employer dramatically. In the U.K., the Digital Economy Act of 2010 introduces a number of new sanctions for copyright infringers.[368] The choice of punishment, the long-term effects on the protection of trade secrets, and the behaviour of firms could all provide further insight into the efficacy of the criminalization of the theft of trade secrets.

This thesis has expanded the empirical analysis of trade secrets. The use of trade secrets has many implications for the IP system as a whole. As trade secrets involve no disclosure, what does their use imply for the role of IP in economic development? Recent trends suggest that employers may be using the enhanced protection of trade secrets to limit their employee mobility. What implications does the strategic use of trade secrets have on labour mobility? Future developments in methods of the study of trade secrets may allow for further exploration of these issues. Thus, the area of trade secrets is ripe for further exploration.

7.5 Final Remarks

The role of trade secrets, as evidenced by EEA cases, provides a compelling alternative to that of other forms of IPR. As IP is debated internationally, trade secrets may quietly emerge as a preferred form of IP protection for smaller firms, as this thesis suggests. Trade secrets require researchers to consider a

[367] Authors such as Lunney (2001) and Lemley and Reese (2004) highlight the issues surrounding the prevention and prosecution of copyright infringement.
[368] The Digital Economy Act of 2010, Chapter 24, enacted by the U.K. Parliament, introduces, among other sanctions, requirements that Internet service providers report on the copyright infringing activities of their customers.

broader scope of innovations, which are free from the subject matter restrictions of other forms of IP, such as patents. While research into trade secrets is particularly challenging, this thesis demonstrates that it is both relevant and rewarding.

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Appendices

a) The Economic Espionage Act: Text

UNITED STATES CODE
TITLE 18 - CRIMES AND CRIMINAL PROCEDURE
PART II - CRIMINAL PROCEDURE
CHAPTER 90 - PROTECTION OF TRADE SECRETS
Cite as the "Economic Espionage Act of 1996"

§ 1831. Economic espionage

(a) In General.-- Whoever, intending or knowing that the offense will benefit any foreign government, foreign instrumentality, or foreign agent, knowingly--

(1) steals, or without authorization appropriates, takes, carries away, or conceals, or by fraud, artifice, or deception obtains a trade secret:

(2) without authorization copies, duplicates, sketches, draws, photographs, downloads, uploads, alters, destroys, photocopies, replicates, transmits, delivers, sends, mails, communicates, or conveys a trade secret:

(3) receives, buys, or possesses a trade secret, knowing the same to have been stolen or appropriated, obtained, or converted without authorization:

(4) attempts to commit any offense described in any of paragraphs (1) through (3); or

(5) conspires with one or more other persons to commit any offense described in any of paragraphs (1) through (4), and one or more of such persons do any act to effect the object of conspiracy.

shall, except as provided in subsection (b), be fined not more than $500,000 or imprisoned not more than 15 years, or both.

(b) ORGANIZATIONS.- Any organization that commits any offense described in subsection (a) shall be fined not more than $10,000,000.

§ 1832. Theft of trade secrets

(a) Whoever, with intent to convert a trade secret, that is related to or included in a product that is produced for or placed in interstate or foreign commerce, to the economic benefit of anyone other than the owner thereof, and intending or knowing that the offense will , injure any owner of that trade secret, knowingly--

(1) steals, or without authorization appropriates, takes, carries away, or conceals, or by fraud, artifice, or deception obtains such information;

(2) without authorization copies, duplicates, sketches, draws, photographs, downloads, uploads, alters, destroys, photocopies, replicates, transmits, delivers, sends, mails, communicates, or conveys such information;

(3) receives, buys, or possesses such information, knowing the same to have been stolen or appropriated, obtained, or converted without authorization;

(4) attempts to commit any offense described in paragraphs (1) through (3); or

(5) conspires with one or more other persons to commit any offense described in paragraphs (1) through (3), and one or more of such persons do any act to effect the object of the conspiracy, shall, except as provided in subsection (b), be fined under this title or imprisoned not more than 10 years, or both.

(b) Any organization that commits any offense described in subsection (a) shall be fined not more than $5,000,000.

§ 1833. Exceptions to prohibitions

This chapter does not prohibit--

(1) any otherwise lawful activity conducted by a governmental entity of the United States, a State, or a political subdivision of a State; or

(2) the reporting of a suspected violation of law to any governmental entity of the United States, a State, or a political subdivision of a State, if such entity has lawful authority with respect to that violation.

§ 1834. Criminal forfeiture

(a) The court, in imposing sentence on a person for a violation of this chapter, shall order, in addition to any other sentence imposed, that the person forfeit to the United States--

(1) any property constituting, or derived from, any proceeds the person obtained, directly or indirectly, as the result of such violation; and

(2) any of the person's property used, or intended to be used, in any manner or part, to commit or facilitate the commission of such violation, if the court in its discretion so determines, taking into consideration the nature, scope, and proportionality of the use of the property in the offense.

(b) Property subject to forfeiture under this section, any seizure and disposition thereof, and any administrative or judicial proceeding in relation thereto, shall be governed by section 413 of the Comprehensive Drug Abuse Prevention and Control Act of 1970 (21 U.S.C. 853), except for subsections (d) and (j) of such section, which shall not apply to forfeitures under this section.

§ 1835. Orders to preserve confidentiality

In any prosecution or other proceeding under this chapter, the court shall enter such orders and take such other action as may be necessary and appropriate to preserve the confidentiality of trade secrets, consistent with the requirements of the Federal Rules of Criminal and Civil Procedure, the Federal Rules of Evidence, and all other applicable laws. An interlocutory appeal by the United States shall lie from a decision or order of a district court authorizing or directing the disclosure of any trade secret.

§ 1836. Civil proceedings to enjoin violations

(a) The Attorney General may, in a civil action, obtain appropriate injunctive relief against any violation of this section.

(b) The district courts of the United States shall have exclusive original jurisdiction of civil actions under this subsection.

§ 1837. Applicability to conduct outside the United States

This chapter also applies to conduct occurring outside the United States if--

(1) the offender is a natural person who is a citizen or permanent resident alien of the United States, or an organization organized under the laws of the United States or a State or political subdivision thereof; or

(2) an act in furtherance of the offense was committed in the United States.

§ 1838. Construction with other laws

This chapter shall not be construed to preempt or displace any other remedies, whether civil or criminal, provided by United States Federal, State, commonwealth, possession, or territory law for the misappropriation of a trade secret, or to affect the otherwise lawful disclosure of information by any Government employee under section 552 of title 5 (commonly known as the Freedom of Information Act).

§ 1839. Definitions

As used in this chapter

(1) the term 'foreign instrumentality' means any agency, bureau, ministry, component, institution, association, or any legal, commercial, or business organization, corporation, firm, or entity that is substantially owned; controlled, sponsored, commanded, managed, or dominated by a foreign government;

(2) the term 'foreign agent' means any officer, employee, proxy, servant, delegate, or representative of a foreign government;

(3) the term 'trade secret' means all forms and types of financial, business, scientific, technical, economic, or engineering information, including patterns, plans, compilations, program devices, formulas, designs, prototypes, methods, techniques, processes, procedures, programs, or codes, whether tangible or intangible, and whether or how stored, compiled, or memorialized physically, electronically, graphically, photographically, or in writing if --

(A) the owner thereof has taken reasonable measures to keep such information secret; and

(B) the information derives independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable through proper means by, the public; and

(4) the term 'owner', with respect to a trade secret, means the person or entity in whom or in which rightful legal or equitable title to , or license in, the trade secret is reposed.

b) *Reporting Theft of Trade Secrets (FBI Document)*

Available from
http://www.justice.gov/criminal/cybercrime/reportingchecklist-ts.pdf

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Checklist for Reporting a Theft of Trade Secrets Offense

If you or your company have become the victim of a theft of trade secrets offense, please fill out the information indicated below and contact a federal law enforcement official to report the offense. An insert with contact information for law enforcement officials in your area should be included at the end of this guide.

NOTE ON CONFIDENTIALITY: Federal law provides that courts "shall enter such orders and take such action as may be necessary and appropriate to preserve the confidentiality of trade secrets, consistent with the requirements of the Federal Rules of Criminal and Civil Procedure, the Federal Rules of Evidence, and all other applicable laws." 18 U.S.C. § 1835. Prosecutors utilizing any of the information set forth below will generally request the court to enter an order to preserve the status of the information as a trade secret and prevent its unnecessary and harmful disclosure.

<u>Background and Contact Information</u>

1. Victim's Name:

2. Primary Location and Address:

3. Nature of Primary Business:

4. Law Enforcement Contact:

   Phone: Fax:

   Email: Pager/Mobile:

<u>Description of the Trade Secret</u>

5. Generally describe the trade secret (e.g., source code, formula):

5

Provide an estimated value of the trade secret identifying ONE of the methods and indicating ONE of the ranges listed below:

Method

___Cost to Develop the Trade Secret;

___Acquisition Cost (identify date and source of acquisition); or

___Fair Market Value if sold.

Estimated Value:

___Under $50,000;

___Between $50,000 and $100,000;

___Between $100,000 and $1 million;

___Between $1 million and $5 million; or

___Over $5 million

Identify a person knowledgeable about valuation, including that person's contact information:

General Physical Measures Taken to Protect the Trade Secret

6. Describe the general physical security precautions taken by the company, such as fencing the perimeter of the premises, visitor control systems, using alarming or self-locking doors or hiring security personnel.

7. Has the company established physical barriers to prevent unauthorized viewing or access to the trade secret, such as "Authorized Personnel Only" signs at access points? (See below if computer stored trade secret.) ___YES ___NO

8. Does the company require sign in/out procedures for access to and return of trade secret materials? ___YES ___NO

9. Are employees required to wear identification badges? ___YES ___ NO

10. Does the company have a written security policy? ___YES ___NO

a. How are employees advised of the security policy?

b. Are employees required to sign a written acknowledgment of the security policy? ___YES ___NO

c. Identify the person most knowledgeable about matters relating to the security policy, including title and contact information.

11. How many employees have access to the trade secret?

12. Was access to the trade secret limited to a "need to know" basis? ___YES ___NO

Confidentiality and Non-Disclosure Agreements

13. Does the company enter into confidentiality and non-disclosure agreements with employees and third-parties concerning the trade secret? ___YES ___NO

14. Has the company established and distributed written confidentiality policies to all employees? ___YES ___NO

15. Does the company have a policy for advising company employees regarding the company's trade secrets? ___YES ___NO

Computer-Stored Trade Secrets

16. If the trade secret is computer source code or other computer-stored information, how is access regulated (e.g., are employees given unique user names and passwords)?

17. If the company stores the trade secret on a computer network, is the network protected by a firewall? ___YES ___NO

18. Is remote access permitted into the computer network? ___YES ___NO

19. Is the trade secret maintained on a separate computer server? ___YES ____NO

20. Does the company prohibit employees from bringing outside computer programs or storage media to the premises? ___YES ___NO

21. Does the company maintain electronic access records such as computer logs? ___YES ___NO

Document Control

22. If the trade secret consisted of documents, were they clearly marked "CONFIDENTIAL" or "PROPRIETARY"? ___YES ___NO

23. Describe the document control procedures employed by the company, such as limiting access and sign in/out policies.

24. Was there a written policy concerning document control procedures, and if so, how were employees advised of it? ___YES ___NO

25. Identify the person most knowledgeable about the document control procedures, including title and contact information.

Employee Controls

26. Are new employees subject to a background investigation? ___YES ___NO

27. Does the company hold "exit interviews" to remind departing employees of their obligation not to disclose trade secrets? ___YES ___NO

Description of the Theft of Trade Secret

28. Identify the name(s) or location(s) of possible suspects, including the following information:

Name (Suspect #1):

Phone number:

Email address:

Physical address:

Employer:

Reason for suspicion:

Name (Suspect #2):

Phone number:

Email address:

Physical address:

Employer:

Reason for suspicion:

29. Was the trade secret stolen to benefit a third party, such as a competitor or another business? ___YES ___NO

    If so, identify that business and its location:

30. Do you have any information that the theft of trade secrets were committed to benefit a foreign government or instrumentality of a foreign government? ___YES ___NO

    If so, identify the foreign government and describe that information.

31. If the suspect is a current or former employee, describe all confidentiality and non-disclosure agreements in effect.

32. Identify any physical locations tied to the theft of trade secret, such as where it may be currently stored or used.

33. If you have conducted an internal investigation into the theft or counterfeiting activities, please describe any evidence acquired:

Civil Enforcement Proceedings

34. Has a civil enforcement action been filed against the suspects identified above? ___YES ___NO

   a. If so, identify the following:

      i. Name of court and case number:

      ii. Date of filing:

      iii. Names of attorneys:

      iv. Status of case:

   b. If not, is a civil action contemplated? What type and when?

35. Please provide any information concerning the suspected crime not described above that you believe might assist law enforcement.

c) *Small Business Association Definitions*

This table is a condensed form of the SBA definitions based on the information gathered from: http://www.sba.gov/services/contractingopportunities/sizestandardstopics/summarywhatis/index.html

Industry Group	Size Standard
Manufacturing	500 employees
Wholesale Trade	100 employees
Agriculture	$750,000
Retail Trade	$6.5 million
General & Heavy Construction (except Dredging)	$31 million
Dredging	$18.5 million
Special Trade Contractors	$13 million
Travel Agencies	$3.5 million (commissions & other income)
Business and Personal Services	$6.5 million
Except: *Architectural, Engineering, Surveying, and Mapping Services*	*$4.5 million*
Dry Cleaning and Carpet Cleaning Services	*$4.5 million*

d) Database of EEA Prosecutions from 1996 to 2008

7.5.1 Descriptions of Key Variables in EEA Prosecutions Database

Key Variables Collected for EEA Database			
	Description	*Type of Variable*	*Definitions*
ID	Unique ID	Continuous	
Casename	Colloquial Case Name	Alphabetic	Name of the case US v. Last Name of Defendant
Casenumber	Case number	Alphanumeric	Case number - Ex: 2:03-cr-00715-RSWL-2 district division: filing year-criminal case - case number - judge identifier - sub case number (e.g. 1 for the first defendant, 2 for the 2nd)
Filingdate	Date Filed	Date	Date case filed in district court
Termdate	Date Terminated	Date	Date case terminated (sentenced, dropped etc.)
District	District	Alphabetic	Federal district the case is in (94 in total, only 89 in US proper)
Conviction	Conviction Code	Category	Conviction Code - This category lists the United States Code provisions of the charging document or offenses which were the basis of conviction. 0 indicates not convicted, blank indicates that the case is ongoing at the time of data collection in 2008.
Individual	# of Individual Defendants	Count	Individual Defendants - This category lists the number of individual defendants charged in the case

Corporate	# of Corporate Defendants	Count	Corporate Defendants - This category lists the number of corporate defendants charged in the case
Relation	Relationship to victim	Category	Relationship - This category indicates the status of the defendant relative to the victim.
Outsider	Outsider Dummy	Dummy	Indicates outsider where 1 = outsider and 0 = insider
Patentable	Patent Dummy	Dummy	Indicates whether trade secret is deemed patentable where 1 = patentable and 0 = non patentable
Copyright	Copyright Dummy	Dummy	Indicates whether trade secret is deemed copyrightable where 1 = copyrightable and 0 = not copyrightable
Incarceration	Incarceration (months)	Continuous	Incarceration or home confinement
Probation	Probation (months)	Continuous	Probation or supervised release
SpecialAssessment	Special Assessment ($)	Continuous	Special Assessment (dollars) defendant required to pay court
Fine	Fine ($)	Continuous	Fine (dollars) defendant require to pay the state
Forfeiture	Forfeiture ($)	Continuous	Forfeiture (dollar) amount defendant required to turn over to the state
Restitution	Restitution ($)	Continuous	Restitution (dollar) amount defendant required to pay victim
Victim	Name of Victim	Alphabetic	Name of the victim company/owner of the trade secret
Vticker	Victim Stock Ticker	Alphabetic	Stock ticker name of victim company
SIC	Victim SIC	Continuous	Standard Industrial Code of victim's primary industry

Manufacturing	Manufacturing Dummy	Dummy	Dummy to indicate victim is in Manufacturing and Construction industry
Services	Services Dummy	Dummy	Dummy to indicate victim is in Services industry
SBDummy	Small Business Dummy	Dummy	Dummy to indicate victim is considered a small business by SBA definitions
Vworkers	Victim number of employees	Continuous	Victim's headcount of employees
Vsales	Victim annual sales revenue ($)	Continuous	Victim's annual sales revenue, 2008 values where available
Foreign	Nationality of Defendants	Dummy	Dummy variable where 1 = defendant is a non-national, 0 = defendant is a U.S. national
Salesprice	Proposed or Actual Sale Price ($)	Continuous	Sale price - the amount the defendants were seeking to gain from the sale of the information to others
MethodL	Method use to estimate Value Low	Category	RR = Reasonable Royalty, UE = Unjust Enrichment, LP = Lost Profits, RD = Research & Development, AD = Actual Damages, MV = Market Value and O = Unidentified
MethodH	Method use to estimate Value High	Category	RR = Reasonable Royalty, UE = Unjust Enrichment, LP = Lost Profits, RD = Research & Development, AD = Actual Damages, MV = Market Value and O = Unidentified
Low	Alleged worth of stolen items ($) low end	Continuous	The low estimate of the value of the trade secrets (from media, court documents or academic papers)

High	Alleged worth of stolen items ($) high end	Continuous	The high estimate of the value of the trade secrets (from media, court documents or academic papers)
Xref	Cross Referenced Values of Trade Secret ($)	Continuous	Cross Referenced Value as described in Chapter 5.
Category	Type of Information Stolen	Category	General description of the type of information stolen

Note: For the Sentencing Information (e.g. conviction code, fines, incarceration etc.) the defendant who received the highest incarceration term is listed or, in the case of ongoing cases, the defendant deemed the primary defendant.

7.5.2 EEA Prosecutions Database 1996 - 2008

ID	1	2	3	4	5
Casename	U.S. v. Zhang	U.S. v. O'Neil	U.S. v. Tsai	U.S. v. Genovese	U.S. v. Woodard
Casenumber	5:05-cr-00812-RMW-1	3:04-cr-00118-PJH-3	5:05-cr-00540-RMW-1	1:05-cr-00004-WHP-1	5:03-cr-20066-RMW-1
Filingdate	12/22/09	04/06/08	08/25/09	01/05/09	05/15/07
Termdate		07/13/10	06/20/10	02/03/10	06/06/10
District	N.D.CA	N.D.CA	N.D.CA	S.D.NY	N.D.CA
Conviction		1832	2314	1832	1832
Individual	1	1	1	1	1
Corporate					
Relation	Ex-employee	Competitor	Insider	Outsider	Insider
Outsider	0	1	0	1	0
Patentable	1	1	0	0	0
Copyright	0	0	0	0	0
Incarceration		12	12	24	24
Probation		24	60	36	36
Special Assessment		100	100	100	100
Fine		3,000	3,500		
Forfeiture					
Restitution					
Victim	Marvell Semiconductor,Inc.	Niku (Computer Associates International)	Volterra Semiconductors	Microsoft	Lightwave Microsystems
Vticker	MRVL	CA	VLTR	MSFT	
SIC	3674	7372	3674	7372	3674
Manufacturing	1	0	1	0	1
Services	0	1	0	1	0
SBDummy	0	1	1	0	1
Vworkers	1,900	206	164	89,800	100
Vsales	33,000,000	16,200,000	75,000,000	51,122,000,000	10,000,000
Foreign	0	0	1	0	0
Salesprice				20	
MethodL		O	MV		
MethodH		O	MV		
Low		5,265,370	126,578		
High		5,265,370	126,578		
Xref		5,000	10,000	70,000	120,000
Category	Misc	Misc	Confidential business information	Source code	Confidential business information

ID	6	7	8	9	10
Casename	U.S. v. Lam	U.S. v. Serebryany	U.S. v. Branch	U.S. v. Garrison	U.S. v. Sun
Casenumber	5:04-cr-20198-JF-1	2:03-cr-00042-LGB-1	2:03-cr-00715-RSWL-1	1:03-cr-00104-RJA-1	3:02-cr-00106-MMC-1
Filingdate	11/04/08	01/17/07	07/18/07	05/24/07	04/10/06
Termdate		09/09/07	12/09/10	01/30/08	06/19/07
District	N.D.CA	C.D.CA	C.D.CA	W.D.NY	N.D.CA
Conviction		1832	1512	1030	1832
Individual	2	1	2	1	1
Corporate					
Relation	Ex-employee	Insider	Ex-Employee	Insider	Insider
Outsider	0	0	0	0	0
Patentable	1	0	0	1	0
Copyright	0	1	0	0	0
Incarceration				12	15
Probation		60	12	18	60
Special Assessment		100	100	100	100
Fine			6,000		10,000
Forfeiture					
Restitution		146,085			
Victim	C&D Semiconductor Services	DirecTV	Lockheed Martin	Wendt Corp	Online Interpreters
Vticker		DTV	LMT		
SIC	3674	4841	3760	5084	4899
Manufacturing	1	0	1	0	0
Services	0	0	0	0	0
SBDummy	1	0	0	0	0
Vworkers	50		140,000		3,000
Vsales	5,000,000	17,246,000,000	41,862,000,000	28,100,000	163,300,000
Foreign	0	1	0	0	1
Salesprice					3,000,000
MethodL	RD	AD			
MethodH	RD	RD			
Low	1,309,928	77,160			
High	1,309,928	28,367,577			
Xref				10,000	30,000
Category	Technical information	Technical information	Confidential business information	Technical information	Confidential business information

ID	11	12	13	14	15
Casename	U.S. v. Murphy	U.S. v. Ye	U.S. v. Morris	U.S. v. Kissane	U.S. v. Keppel
Casenumber	5:03-cr-20038-RMW-1	5:02-cr-20145-JW-1	1:02-cr-00120-GMS-1	1:02-cr-00626-RCC-1	3:02-cr-05719-RBL-1
Filingdate	04/03/07	12/05/06	09/11/06	05/15/06	08/09/06
Termdate	09/06/10		01/31/07	10/16/06	02/01/07
District	N.D.CA	N.D.CA	DE	S.D.NY	W.D.WA
Conviction	1832		1832	1832	1832
Individual	1	2	1	1	1
Corporate					
Relation	Ex-Employee	Ex-Employee	Ex-Employee	Ex-Employee	Outsider
Outsider	0	0	0	0	1
Patentable	0	0	0	0	0
Copyright	1	0	0	1	1
Incarceration	6			9	12
Probation	36		24	15	36
Special Assessment	100		100		100
Fine	2,000				
Forfeiture					
Restitution					500,000
Victim	Jasmine Networks and Silicon Wave Corporation	0	Brookwood Companies, Inc.	System Management Arts Incorporated	Microsoft
Vticker					MSFT
SIC	3674		2299	7372	7372
Manufacturing	1	0	1	0	0
Services	0	0	0	1	1
SBDummy	0		0	1	0
Vworkers				195	89,800
Vsales				6,000,000	51,122,000,000
Foreign	0	1	0	0	0
Salesprice			100,000		700,000
MethodL					UE
MethodH					UE
Low					576,400
High					2,190,321
Xref	5,000			10,000	5,000
Category	Source code	Technical information	Confidential business information	Source code	Technical information

ID	16	17	18	19	20
Casename	U.S. v. Zhu	U.S. v. Dorn	U.S. v. Okamoto	U.S. v. ComTriad	U.S. v. Daddona
Casenumber	1:05-cr-10153-GAO-1	2:02-cr-20040-GTV-1	1:01-cr-00210-DDD-1	2:01-cr-00365-WHW-3	3:01-cr-00122-AVC-1
Filingdate	06/17/09	05/02/06	05/09/05	06/01/05	06/07/05
Termdate	04/19/11	08/21/06		05/04/09	03/13/06
District	MA	KS	N.D.OH	NJ	CT
Conviction	0	1832			1832
Individual	2	1	2		1
Corporate				1	
Relation	Insider	Insider	Insider	Insider	Insider
Outsider	0	0	0	0	0
Patentable	1	0	1	0	1
Copyright	0	0	0	1	0
Incarceration					5
Probation		24			36
Special Assessment		100			100
Fine					4,000
Forfeiture					
Restitution		15,920			10,000
Victim	Harvard	Spencer Reed Group	Cleveland Clinic Foundation	Lucent Tech	Fabricated Metal Products, Inc.
Vticker				ALU	
SIC	8221	7361	8821	3661	3499
Manufacturing	0	0	0	1	1
Services	1	1	1	0	0
SBDummy	0	0	0	0	0
Vworkers	1,434	450	2,714	30,500	
Vsales	798,358,276	77,000,000	235,400,000	16,477,400,000	
Foreign	1	0	1	0	0
Salesprice					
MethodL		UE	RD	MV	
MethodH		UE	RD	MV	
Low		29,162	2,412,997	108,654,251	
High		29,162	2,412,997	108,654,251	
Xref					5,000
Category	Technical information	Confidential business information	Technical information	Source code	Technical information

ID	21	22	23	24	25
Casename	U.S. v. Rector	U.S. v. SayLyeOw	U.S. v. Chang	U.S. v. Petrolino	U.S. v. Wu
Casenumber	8:00-cr-00123-JSM-1	5:00-cr-20110-JF-1	5:00-cr-20203-JF-1	0:01-cr-06291-JIC-1	6:05-ccr-06027-DGL-MWP-1
Filingdate	04/28/04	03/30/04	06/15/04	11/30/05	02/18/09
Termdate	01/26/06	12/12/05	12/05/05	09/27/07	
District	M.D.FL	N.D.CA	N.D.CA	S.D.FL	W.D.NY
Conviction	1832	1832	1832	1832	
Individual	2	1	2	2	1
Corporate					
Relation	Insider	Ex-Employee	Insider	Outsider	Ex-Employee
Outsider	0	0	0	1	0
Patentable	1	1	0	0	0
Copyright	0	0	0	0	0
Incarceration	14	24	12		
Probation	24	24	36	24	
Special Assessment	200	100	100	100	
Fine					
Forfeiture			60,000		
Restitution					
Victim	R.P. Scherer	Intel Corporation	SemiSupply	First Union Securities	Corning Incorporated
Vticker		INTC			GLW
SIC	2834	3674	3674	6189	3357
Manufacturing	1	1	1	0	1
Services	0	0	0	0	0
SBDummy	0	0	1	0	0
Vworkers	2,400	86,300	25	17,900	24,800
Vsales	155,700,000	38,334,000,000	5,000,000	6,700,000,000	5,860,000,000
Foreign	0	1	0	0	0
Salesprice	50,000		300,000	3,800	
MethodL		MV			
MethodH		MV			
Low		23,756,285			
High		23,756,285			
Xref	30,000	120,000	10,000		
Category	Technical information	Technical information	Confidential business information	Confidential business information	Technical information

ID	26	27	28	29	30
Casename	U.S. v. Wang	U.S. v. Estrada	U.S. v. Dai	U.S. v. Morch	U.S. v. Corgnati
Casenumber	5:01-cr-20065-JF-1	1:01-cr-00616-SWK-1	6:00-cr-06135-MAT-WGB-1	3:01-cr-00100-MMC	0:99-cr-06268-WPD-1
Filingdate	04/20/05	06/27/05	10/27/04	03/14/05	12/01/03
Termdate	04/27/05	11/15/05	08/21/05	06/28/05	06/03/04
District	N.D.CA	S.D.NY	W.D.NY	N.D.CA	S.D.FL
Conviction	0	1832	2701	1030	1832
Individual	1	1	1	1	1
Corporate					
Relation	Insider	Outsider	Ex-Employee	Ex-Employee	Outsider
Outsider	0	1	0	0	1
Patentable	1	0	0	0	0
Copyright	0	0	1	1	1
Incarceration		12			
Probation		24	24	36	60
Special Assessment			10	100	100
Fine					
Forfeiture					
Restitution			50,000		120,000
Victim	Acuson Corporation (owned by Siemans)	MasterCard	X/Net Associates	Cisco Systems	Motorola
Vticker		MA		CSCO	MOT
SIC	3845	7389	7370	3576	3663
Manufacturing	1	0	0	1	1
Services	0	1	1	0	0
SBDummy	0	0	1	0	0
Vworkers	1,900	4,600		61,535	66,000
Vsales	475,000,000	4,067,600,000	7,500,000	34,922,000,000	36,622,000,000
Foreign	0	0	0	1	0
Salesprice		200,000			
MethodL				MV	
MethodH				MV	
Low				6,011	
High				12,022	
Xref		5,000			
Category	Technical information	Confidential business information	Source code	Source code	Source code

ID	31	32	33	34	35
Casename	U.S. v. Everhart	U.S. v. Worthing	U.S. v. Hsu	U.S. v. Yang	U.S. v. Davis
Casenumber	2:00-cr-00056-WLS-1	2:97-cr-00009-MBC-1	2:97-cr-00323-SD-1	1:97-cr-00288-PCE-1	3:97-cr-00124-1
Filingdate	03/31/04	01/03/01	07/11/01	10/02/01	09/25/01
Termdate	03/31/04	06/06/01	07/14/03	01/07/04	04/21/02
District	W.D.Pa	W.D.Pa	E.D.Pa	N.D.OH	M.D.TN
Conviction	1832	1832	1832	1832	1832
Individual	1	2	3	2	1
Corporate					
Relation	Ex-Employee	Insider	Competitor	Competitor	Ex-employee
Outsider	0	0	1	1	0
Patentable	0	0	1	1	1
Copyright	0	0	0	0	0
Incarceration		15		6	27
Probation	12	36	24	24	36
Special Assessment	100	100	100	200	500
Fine			10,000	250,000	
Forfeiture					
Restitution					1,271,171
Victim	Werner Ladder (Werner Corporation)	PPG Industries	Bristol-Myers Squibb	AveryDennision	Gilette (owned by P&G)
Vticker		PPG	BMY	AVY	
SIC	3499	2851	2834	2670	3420
Manufacturing	1	1	1	1	1
Services	0	0	0	0	0
SBDummy	0	0	0	0	0
Vworkers	1,800	45,000	43,000	37,300	
Vsales	142,200,000	11,206,000,000	19,348,000,000	6,307,800,000	10,477,000,000
Foreign	0	0	1	1	0
Salesprice		1,000	400,000	150,000	
MethodL		MV	O	LP	O
MethodH		MV	O	MV	O
Low		26,749,673	253,121	999,678	1,568,575
High		26,749,673	253,121	74,975,850	1,960,719
Xref		30,000		5,000	120,000
Category	Confidential business information	Technical information	Technical information	Technical information	Technical information

ID	36	37	38	39	40
Casename	U.S. v. Trujillo-Cohen	U.S. v. Campbell(Carroll)	U.S. v. Pei	U.S. v. Krumrei	U.S. v. Camp
Casenumber	4:97-cr-00251-1	1:98-cr-00059-ODE-1	98-M-4090	2:98-cr-80943-DPH-1	2:98-cr-00048-DBH-1
Filingdate	11/15/01	02/26/02	07/28/02	10/29/02	09/19/02
Termdate	10/27/02	08/26/02	12/11/06	11/19/03	12/08/03
District	S.D.TX	N.D.GA	NJ	E.D.MI	ME
Conviction	1832	1832	0	1832	1832
Individual	1	3	1	1	2
Corporate					
Relation	Ex-employee	Insider	Outsider	Ex-employee	Insider
Outsider	0	0	1	0	0
Patentable	0	0	1	1	1
Copyright	1	0	0	0	0
Incarceration	48	3		24	
Probation	36	36		24	36
Special Assessment		100		100	1500
Fine		2,800			
Forfeiture					
Restitution	337,000			10,000	7,500
Victim	Deloitte & Touche	Gray Comm.	0	Wilsonart (owned by Illinois Tool Works)	Idexx Labs.
Vticker		GTN		ITW	IDXX
SIC	8721	4833		3083	2835
Manufacturing	0	0	0	1	1
Services	1	0	0	0	0
SBDummy	0	0		0	0
Vworkers	165,000	1,020		3,402	3,900
Vsales	23,100,000,000	103,500,000		742,900,000	922,600,000
Foreign	0	0	1	0	0
Salesprice	7,000,000	150,000		350,000	
MethodL		O		RD	O
MethodH		O		RD	O
Low		194,289		39,375,889	50,092
High		1,036,208		39,375,889	175,322
Xref	1,000,000	5,000		120,000	
Category	Source code	Confidential business information	Technical information	Technical information	Technical information

ID	41	42	43	44	45
Casename	U.S. v. Hallstead	U.S. v. Fulton	U.S. v. Lange	U.S. v. Sindelar	U.S. v. Kern
Casenumber	4:98-cr-00041-PNB-1	2:98-cr-00059-DWA-1	99-CR-174	2:98-cr-20070-KHV-1	2:99-cr-00015-DFL-1
Filingdate	06/03/02	04/18/02	09/09/03	10/17/02	01/22/03
Termdate	12/05/02	11/14/02	03/03/04	03/06/03	04/05/04
District	E.D.TX	W.D.Pa	E.D.WI	KS	E.D.CA
Conviction	1832	1832	1832	1832	1832
Individual	2	1	1	1	1
Corporate					
Relation	Outsider	Competitor	Ex-employee	Insider	Ex-Employee
Outsider	1	1	0	0	0
Patentable	1	1	1	0	0
Copyright	0	0	0	0	0
Incarceration	77	12	30		12
Probation	36	60	36	60	36
Special Assessment	100	100	525	200	100
Fine	10,000		2,500	10,000	
Forfeiture					
Restitution				16,618	
Victim	Intel	Joy Mining Machinery, Inc.	Replacement Aircraft Part Co. Inc (RAPCO)	Preco	Varian Associates (Varian Medical Systems)
Vticker	INTC				VARI
SIC	3674	3532	3728	3531	3845
Manufacturing	1	1	1	1	1
Services	0	0	0	0	0
SBDummy	0	0	1	1	0
Vworkers	86,300	5,200	40	257	4,500
Vsales	38,334,000,000	562,200,000	19,300,000	9,500,000	1,776,624,000
Foreign	0	0	0	0	0
Salesprice	75,000	1,500	100,000		
MethodL	UE		O		O
MethodH	UE		O		O
Low	12,858,852		124,457		1,241,624
High	12,858,852		9,956,596		1,862,436
Xref	2,500,000	5,000	200,000		10,000
Category	Technical information	Technical information	Technical information	Confidential business information	Technical information

ID	46	47	48	49	50
Casename	U.S. v. Tampoe	U.S. v. Kim	U.S. v. Shearer(Jack)	U.S. v. Costello	U.S. v. Dimson
Casenumber	4:99-cr-00158-1	1:99-cr-00481-1	3:99-cr-00433-D-1	4:99-cr-00623-1	1:06-cr-00313-JOF-GGB-1
Filingdate	03/25/03	10/12/05	12/10/03	10/29/03	07/12/10
Termdate	10/26/03	10/19/09	06/16/04	06/06/04	05/24/11
District	S.D.TX	N.D.IL	N.D.TX	S.D.TX	N.D.GA
Conviction	1832	1030	1832	1832	1832
Individual	1	1	3	1	3
Corporate					
Relation	Insider	Insider	Insider		Insider
Outsider	0	0	0		0
Patentable	0	0	1	0	1
Copyright	1	1	0	1	0
Incarceration	15	6	54		60
Probation	24	24		36	36
Special Assessment	200		100	100	100
Fine		5,000			
Forfeiture					
Restitution			7,655,155		
Victim	IBM	3Com	Caterpillar	0	Coca-cola
Vticker	IBM	COMS	CAT		CCE
SIC	3570	3576	3531		2080
Manufacturing	1	1	1	0	1
Services	0	0	0	0	0
SBDummy	0	0	0		0
Vworkers	386,000		101,333		90,500
Vsales	98,786,000,000	1,267,500,000	44,958,000,000		20,936,000,000
Foreign	0	1	0	0	0
Salesprice			100,000		1,580,000
MethodL	O	MV	UE		
MethodH	O	MV	RD		
Low	251,235	85,879	9,449,363		
High	753,705,437	85,879	247,042,170		
Xref	30,000	5,000	1,000,000		2,500,000
Category	Source code	Source code	Technical information	Source code	Technical information

ID	51	52	53	54	55
Casename	U.S. v. Jin	U.S. v. Cotten	U.S. v. Zeng	U.S. v. Chung	U.S. v. Cartwright,
Casenumber	1:2008-cr-00192	2:08-cr-00042-EJG-1	4:08-cr-00075-1	8:08-cr-0024-CJC-1	1:07-cr-00570-WMN-1
Filingdate	04/02/12	01/31/12	02/21/12	02/07/12	01/08/12
Termdate		05/17/12	05/21/12		
District	N.D.IL	E.D.CA	S.D.TX	C.D.CA	MD
Conviction		1832	1832		
Individual	1	1	1	1	3
Corporate					1
Relation	Insider	Insider	Insider	Insider	Insider
Outsider	0	0	0	0	0
Patentable	1	1	1	0	0
Copyright	0	0	0	0	0
Incarceration		24	12		
Probation		36	36		
Special Assessment		100	100		
Fine					
Forfeiture					
Restitution		15,000			
Victim	Unidentified	Genesis Microwave	Unidentified Paint Manufacturer	Rockwell and Boeing	Avcard (Kropp Holdings, Inc)
Vticker				ROK,BA	
SIC		3679		3721	6159
Manufacturing	0	1	0	1	0
Services	0	0	0	0	0
SBDummy		1		0	0
Vworkers		10			
Vsales		672,330			222,000,000
Foreign	1	0	1	1	0
Salesprice		250,000			
MethodL					
MethodH					
Low					
High					
Xref		120,000	10,000		
Category	Technical information	Technical information	Technical information	Misc	Confidential business information

ID	56	57	58	59	60
Casename	U.S. v. Lee	U.S. v. Meng	U.S. v. Lin	U.S. v. Chilowtiz	U.S. v. Grande
Casenumber	5:06-cr-00424-JW-1	5:04-cr-20216-JF-1	6:07-cr-06083-CJS-1	1:07-cr-00080-JFK-1	3:07-cr-00019-JCH-1
Filingdate		12/17/08		02/01/11	02/03/11
Termdate		06/19/12			05/22/11
District	N.D.CA	N.D.CA	W.D.NY	S.D.NY	CT
Conviction		1831			1832
Individual	2	1	1	2	1
Corporate					
Relation	Insider	Insider	Insider	Insider	Insider
Outsider	0	0	0	0	0
Patentable	0	0	1	0	0
Copyright	1	1	0	0	0
Incarceration		24			
Probation		36			60
Special Assessment		200			
Fine		10,000			
Forfeiture					
Restitution					
Victim	NetLogics Microsystems, Taiwan Semiconductor Manufacturing Corp.	Quantum 3D	Corning Incorporated	Morgan Stanley & Co.	Duracell Corporation (P&G)
Vticker	TSM		GLW	MSSWL	
SIC	3674	7372	3357	6159	3690
Manufacturing	1	0	1	0	1
Services	0	1	0	0	0
SBDummy	0	0	0	0	0
Vworkers	20,000	100	24,800	48,000	1,047
Vsales	9,509,000,000	29,300,000	5,860,000,000	85,328,000,000	2,365,000,000
Foreign	1	1	1	0	0
Salesprice					
MethodL					
MethodH					
Low					
High					
Xref		70,000			
Category	Source code	Source code	Misc	Confidential business information	Technical information

ID	61	62	63	64	65
Casename	U.S. v. Munoz	U.S. v. Lockwood	U.S. v. Ramsiss	U.S. v. Noval	U.S. v. Alavi
Casenumber	3:06-cr-00831-JAH-1	2:06-cr-20331-DPH-DAS-0	5:02-cr-20083-JF-1	3:08-cr-00237-MHP-1	2:07-cr-00429-NVW-1
Filingdate	04/28/10	07/06/10	06/20/06	04/11/12	04/13/11
Termdate	10/26/10	02/14/13	10/03/07		
District	S.D.CA	E.D.MI	N.D.CA	N.D.CA	AZ
Conviction	1832	1832	1030		1702
Individual	1	3	1	3	1
Corporate					
Relation	Ex-employee	Ex-employee	Ex-employee	Ex-employee	Ex-Employee
Outsider	0	0	0	0	0
Patentable	0	1	0	0	0
Copyright	0	0	0	0	1
Incarceration	6	30	46		
Probation	36	24	36		
Special Assessment	100	100	200		
Fine	2,500				
Forfeiture					
Restitution			6,339		
Victim	T.B. Penick and Sons	Metaldyne	Diva Systems Corporation	Korn/Ferry	0
Vticker				KFY	
SIC	1541	3714		7361	
Manufacturing	0	1	0	0	0
Services	0	0	0	1	0
SBDummy	0	0		0	
Vworkers	455	6,500			
Vsales	107,500,870	1,700,000,000	18,500,000	689,200,000	
Foreign	0	0	0	0	0
Salesprice					
MethodL	LP	RR			
MethodH	LP	RR			
Low	418,060	983,735			
High	418,060	2,459,337			
Xref	5,000	200,000	1,000,000		
Category	Confidential business information	Technical information	Misc	Confidential business information	Source code

ID	66	67	68	69	70
Casename	U.S. v. Clinton	U.S. v. Ameri	U.S. v. Norris	U.S. v. Laude	U.S. v. Smith
Casenumber	4:06-cr-00072-WRW-4	4:02-cr-00182-WRW-1	3:07-cr-02913-L-2	3:06-cr-02147-L-1	3:02-cr-00163-JBA-1
Filingdate	02/23/10	10/17/06	11/07/11	10/07/10	06/06/06
Termdate	03/01/10	09/11/08	02/23/12	01/10/11	05/03/07
District	E.D.AR	E.D.AR	S.D.CA	S.D.CA	CT
Conviction	1832	1832	1832	1832	1832
Individual	4	1	2	1	1
Corporate					
Relation	Competitor	Exemployee	Exemployee	Exemployee	
Outsider	1	0	0	0	
Patentable	0	0	0	0	0
Copyright	0	1	0	1	0
Incarceration		96			
Probation	36	36	36	36	60
Special Assessment	100		100	100	100
Fine		1,800	5,000	5,000	
Forfeiture					
Restitution	pending	1,405,694			311,000
Victim	Acxiom	Arkansas DMV Contractor	The Imperial Group	Qualcomm	Stran Technologies
Vticker	ACXM			QCOM	
SIC	7374	7372	1542	3663	3357
Manufacturing	0	0	0	1	1
Services	1	1	0	0	0
SBDummy	0	0	0	0	1
Vworkers	7,225			12,800	20
Vsales	1,395,100,000			8,871,000,000	7,500,000
Foreign	0	1	0	0	0
Salesprice					
MethodL	AD	RD			
MethodH	AD	MV			
Low	903,782	773,544			
High	7,378,686	1,105,064			
Xref		20,000,000			
Category	Confidential business information	Source code	Confidential business information	Source code	Misc

ID	71	72	73	74	75
Casename	U.S. v. Sprenger	U.S. v. Halvorsen	U.S. v. Pompa	U.S. v. Gunderson	U.S. v. Childs
Casenumber	3:02-cr-00087-JCH-1	3:02-cr-00002-JCH-1	2:02-cr-14014-DLG-2	1:02-cr-00055-MWB-1	6:03-cr-10131-WEB-1
Filingdate	03/26/06	01/04/06	04/12/06	08/07/06	07/30/07
Termdate	10/08/06	10/08/06	02/19/07	04/02/08	07/02/09
District	CT	CT	S.D.FL	N.D.IA	KS
Conviction	1832	1832	1832	1832	1030
Individual	1	1	2	1	1
Corporate					
Relation					Ex-employee
Outsider					0
Patentable	0	0	0	0	1
Copyright	0	0	0	0	0
Incarceration	6		5	37	
Probation	36	24	36	24	12
Special Assessment	100	100	100	100	25
Fine	3,000	2,000			500
Forfeiture					
Restitution			240,000		
Victim	0	0	Chemplex Industries	0	Precision Pattern Incorporated
Vticker					
SIC			3826		2273
Manufacturing	0	0	1	0	1
Services	0	0	0	0	0
SBDummy			1		1
Vworkers			12		181
Vsales			2,200,000		16,000,000
Foreign	0	0	0	0	0
Salesprice					
MethodL					
MethodH					
Low					
High					
Xref	5,000		5,000	400,000	
Category	Misc	Misc	Misc	Misc	Misc

ID	76	77	78	79	80
Casename	U.S. v. Zak	U.S. v. Liou	U.S. v. Bittenbender	U.S. v. Forgues	U.S. v. Ulmer
Casenumber	3:01-cr-00023-JGH-CCG-1	3:05-cr-00085-RET-CN-1	1:08-cr-00005-WMN-1	4:02-cr-40011-NMG-1	1:05-cr-00203-GJQ-1
Filingdate	02/22/05	03/25/09	01/08/12	04/26/06	08/30/09
Termdate	02/05/06	04/11/08		10/11/06	12/16/09
District	W.D.KY	M.D.LA	MD	MA	W.D.MI
Conviction	0			1832	1832
Individual	2	1	1	1	1
Corporate					
Relation		Ex-employee	Ex-employee	Competitor	Ex-employee
Outsider		0	0	1	0
Patentable	0	1	0	0	1
Copyright	1	0	0	0	0
Incarceration				2	
Probation				24	12
Special Assessment				100	
Fine					1,300
Forfeiture					
Restitution					9,045
Victim	ZirMed.com	Dow	Avcard (Kropp Holdings, Inc)	Alpha Gary Corp	J. Rettenmaier USA LP
Vticker					
SIC	8741	2821	6159	2899	2869
Manufacturing	0	1	0	1	1
Services	1	0	0	0	0
SBDummy	1	0	0	1	1
Vworkers	100	46,000		260	43
Vsales	1,750,000	53,513,000,000	222,000,000	10,000,000	4,600,000
Foreign	0	0	0	0	0
Salesprice	10,000				
MethodL					AD
MethodH					AD
Low					9,669
High					9,669
Xref					
Category	Source code	Technical information	Confidential business information	Technical information	Confidential business information

ID	81	82	83	84	85
Casename	U.S. v. C-More Systems,Inc.	U.S. v. Kim	U.S. v. Buffin	U.S. v. Frena	U.S. v. Degroot
Casenumber	1:06-cr-00925-SWK-1	1:08-cr-00139-SO-1	1:06-cr-00031-CAB-1	2:05-cr-00039-DSC-1	2:05-cr-00151-RTR-4
Filingdate	10/06/10	03/27/12	01/24/10	02/15/09	06/15/09
Termdate	01/11/11	11/21/12	05/20/10	05/24/09	02/21/11
District	S.D.NY	N.D.OH	N.D.OH	W.D.Pa	E.D.WI
Conviction	1832	1832	1832	1832	1
Individual		1	1	1	3
Corporate	1				
Relation	Competitor	Ex-employee	Ex-employee		Ex-employee
Outsider	1	0	0		0
Patentable	1	1	0	0	0
Copyright	0	0	0	0	0
Incarceration		19		6	
Probation	60	36	24	36	18
Special Assessment		300	100	100	25
Fine	50,000	2,000	5,000		
Forfeiture					
Restitution		188,700			1,400,000
Victim	Colt's Manufacturing	Lubrizol	Permco	0	DualTemp
Vticker		LZ			
SIC	3484	2860	3594		5078
Manufacturing	1	1	1	0	0
Services	0	0	0	0	0
SBDummy	1	0	1		1
Vworkers	925	6,900	140		80
Vsales	53,000,000	4,499,000,000	25,000,000		8,100,000
Foreign	0	0	0	0	0
Salesprice		170,000			
MethodL		AD	O		
MethodH		AD	AD		
Low		28,375	26,429		
High		787,353	100,431		
Xref		70,000		5,000	
Category	Technical information	Technical information	Confidential business information	Misc	Confidential business information

ID	86	87	88	89	90
Casename	U.S. v. Koval	U.S. v. Ribeiro	U.S. v. Schetty	U.S. v. Alarcon	U.S. v. Helrigel
Casenumber	2:04-cr-00061-LA-1	2:07-cr-00942-FSH-1	2:07-cr-00582-SJF-1	1:07-cr-00454-RJD-JMA	1:02-cr-00666-NGG
Filingdate	03/17/08	11/29/11	07/18/11	06/05/11	06/06/06
Termdate	09/25/08	05/22/12			05/08/08
District	E.D.WI	NJ	E.D.NY	E.D.NY	E.D.NY
Conviction	1832	1832	1832		1832
Individual	1	1	1	1	1
Corporate					
Relation		Ex-employee	Ex-employee	Ex-employee	
Outsider		0	0	0	
Patentable	0	1	1	0	0
Copyright	0	0	0	1	0
Incarceration		14			
Probation	24	24	12		24
Special Assessment	100	100	100		100
Fine	1,000		100,000		
Forfeiture					
Restitution			15,536		
Victim	0	Atlas Refinery	Rohm & Haas	Acupay System LLC (Bondholder Communication s LLC)	0
Vticker			ROH		
SIC		2843	2821	8721	
Manufacturing	0	1	1	0	0
Services	0	0	0	1	0
SBDummy		1	0	0	
Vworkers		40	15,710		
Vsales		7,000,000	8,897,000,000		
Foreign	0	1	0	0	0
Salesprice					
MethodL			AD		
MethodH			RD		
Low			15,931		
High			271,736,109		
Xref		30,000			
Category	Misc	Technical information	Technical information	Source code	Misc

ID	91	92	93	94	95
Casename	U.S. v. Case	U.S. v. Rashidi	U.S. v. Pani	U.S. v. West	U.S. v. White
Casenumber	3:06-cr-00210-WHB-JCS-1	4:05-cr-00744-MJJ	1:08-mj-00113-LTS-1	5:08-cr-00709-JW-1	1:08-mj-02332-UA-1
Filingdate	12/21/10	11/19/09	08/29/12	10/10/12	10/25/12
Termdate		05/26/10			
District	S.D.MS	N.D.CA	MA	N.D.CA	S.D.NY
Conviction		1832			0
Individual	5	1	1	1	2
Corporate					
Relation	Ex-employee	Ex-employee	Ex-employee	Ex-employee	Ex-employee
Outsider	0	0	0	0	0
Patentable	1	1	1	1	0
Copyright	0	0	0	0	1
Incarceration		10			
Probation		48			
Special Assessment		100			
Fine		6,000			
Forfeiture					
Restitution					
Victim	Eaton corporation	BioGenex Laboratories	Intel Corporation	Phillips (phillips lumileds lighting company)	ENK International
Vticker			INTC	PHG	0
SIC	3590	3841	3674	3648	7389
Manufacturing	1	1	1	1	0
Services	0	0	0	0	1
SBDummy	0	1	0	0	0
Vworkers	60,100	120		470	100
Vsales	13,033,000,000	20,600,000	38,334,000,000	40,300,000	0
Foreign	0	0	1	0	0
Salesprice					
MethodL					
MethodH					
Low					
High					
Xref		10,000			
Category	Technical information	Technical information	Technical information	Technical information	Confidential business information