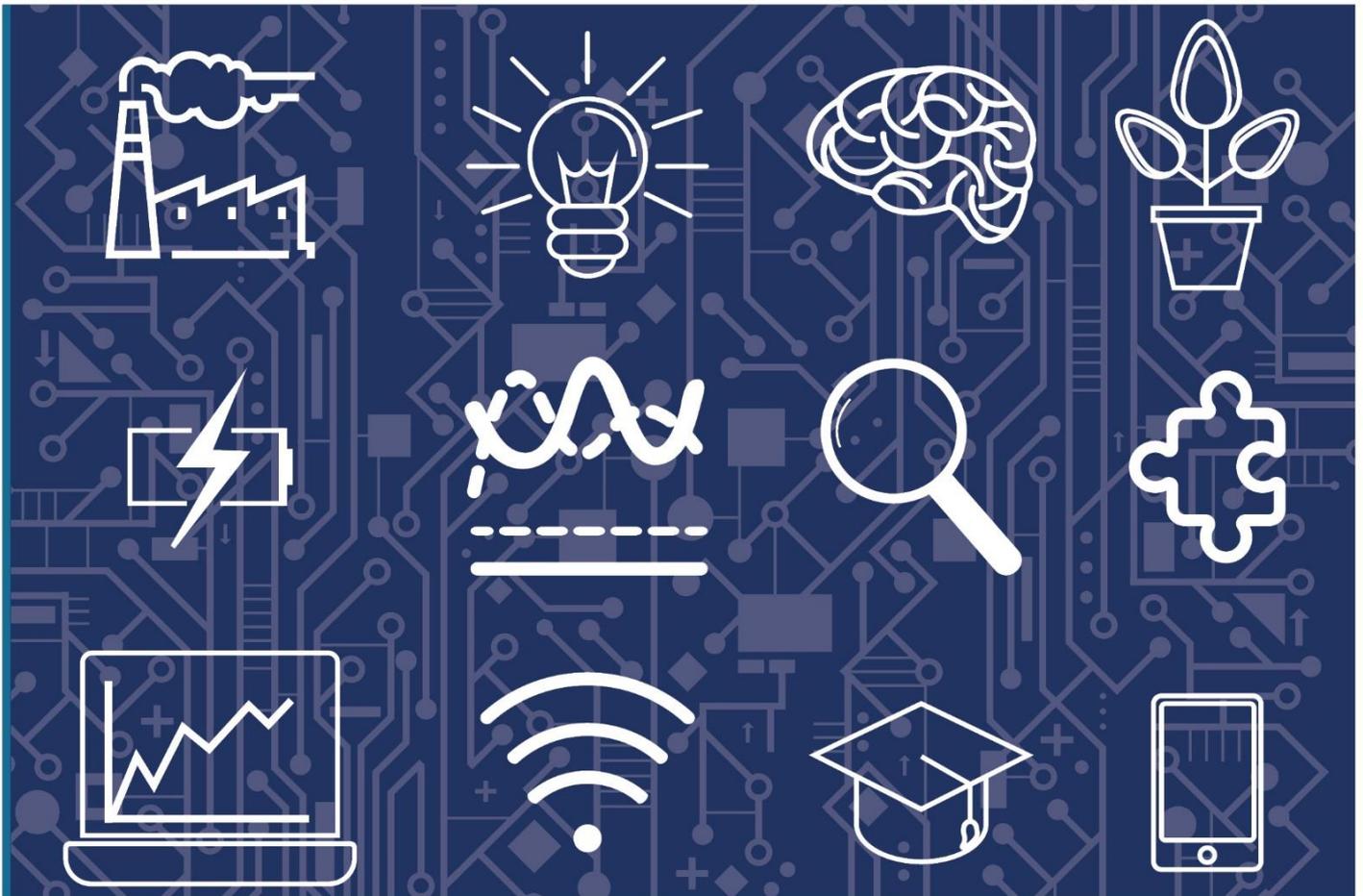




Intellectual
Property
Office

The Economic and Innovation Impacts of Trade Secrets



Dr. Nicola Searle is an EPSRC Digital Economy Fellow and Senior Lecturer at Goldsmiths, University of London.

An economist who specialises in the economics of intellectual property and the creative industries, Dr. Searle has authored two books on the economics of intellectual property and regularly engages with policymakers and practitioners.

She previously held appointments with the UK Government, the universities of Abertay and St Andrews, and Goldman Sachs. Dr. Searle holds a Bachelor's from Georgetown University and both a Master's and a Doctorate from the University of St Andrews.

Acknowledgements:

Many thanks to Tanya Aplin, Suma Athreye, Atin Basuchoudary, Rosie Burbidge, Muthu DeSilva, Jorge Novais Gonçalves, David Humphries, Nari Lee, Nirojan Pathmanathan, Sharon Sandeen, Taffy Yiu, the UK IPO Research Expert Advisory Group and anonymous experts for their comments, knowledge and research.

ISBN: 978-1-910790-39-7

The Economic and Innovation Impacts of Trade Secrets

Published by The Intellectual Property Office February 2021

1 2 3 4 5 6 7 8 9 10

© **Crown Copyright 2021**

You may re-use this information (excluding logos) free of charge in any format or medium, under the terms of the Open Government Licence. To view this licence, visit

<http://www.nationalarchives.gov.uk/doc/open-government-licence/>

or

email: psi@nationalarchives.gsi.gov.uk

Where we have identified any third party copyright information you will need to obtain permission from the copyright holders concerned.

Any enquiries regarding this publication should be sent to:

The Intellectual Property Office
Concept House
Cardiff Road
Newport
NP10 8QQ

Tel: 0300 300 2000

e-mail: information@ipo.gov.uk

This publication is available from our website at www.gov.uk/ipo

Table of Contents

Executive Summary	3
Introduction	4
Context and Trends.....	5
Economic construction	7
Economic and Empirical research: Themes.....	8
Analysis of Economic and Empirical Literature	11
Who uses trade secrets? Sectors and Firms Characteristics.....	12
What are trade secrets? Types of trade secrets and their value	15
Why use trade secrets? Firm decision making, disclosure and costs	17
How are trade secrets used?	20
Analysis and Recommendations	23
References.....	25

Executive Summary

Trade Secrets are a flexible innovation tool that are used across sectors and types of firms. This report summarises and critiques the publicly available economic research on trade secrets and highlights key innovation aspects.

A trade secret is knowledge that is secret, valuable and reasonably protected. Misappropriation or theft of trade secrets, according to industry estimates, is said to cost between 1-3% of GDP in developed economies (Passman, 2014). Enshrined in the WTO's 1996 Trade Related Aspects of Intellectual Property (TRIPS) agreement, trade secrets are an increasingly important innovation policy. The US, EU and Japan have all recently made major changes to trade secrets policy.

Key findings on economic and innovation impact:

Trade secrets are a preferred strategy for innovative UK firms. 70% of UK firms who develop product and process innovations use trade secrets to protect these innovations (Hall, Helmers, Sena & Rogers, 2012). Trade secrets are particularly important to UK firms in the R&D services, tech, and across manufacturing and non-manufacturing sectors. Larger firms rely on trade secrets more than smaller firms.

Trade secrets can be highly valuable firm assets, although most trade secrets are not. Trade secrets have a wide scope of coverage and support the innovation ecosystem by protecting process, product, market and organisational innovations, and by providing a key complement and support to other IP.

Firms choose trade secrets to maintain a competitive advantage by avoiding the disclosure associated with other types of IPR. However, trade secrets are vulnerable to reverse engineering and misappropriation or theft. Cybertheft and economic espionage are increasing concerns. Trade secrets are often a lower cost alternative to other IPR, although enjoy relatively weaker protection.

Trade secrets serve as a substitute or complement to patents. UK Patenting firms are more likely to protect a larger proportion of their innovations using secrecy than non-patenting firms.ⁱ Patents are preferred for product innovations, and trade secrets for process innovations. Most trade secrets cover non-patentable innovation such as marketing and organisational innovations.

Trade secrets support innovation but also restrict knowledge flows and labour mobility. Stronger policy benefits existing trade secrets holders and encourages investment in R&D, yet reduces future innovation and creates barriers to entry. There is a balance to be struck between trade secrecy that encourages innovation, and trade secrecy that blocks innovation.

However, many questions remain and the empirical evidence base for trade secrecy is weak. This report finds that further work is needed to develop an evidence base for trade secrets, and that exploration of key themes such as the interaction of trade secrets with patentability could better inform policy.

Introduction

The last two decades have seen a growing emphasis on the role of trade secrets as an intellectual property (IP) protection mechanism. Trade secrets are a preferred means of protection for innovative firms. Global legal and economic trends suggest that growth in the use of trade secrets is outpacing that of patents. The theft or misappropriation of trade secrets may translate to an annual cost of 1-3% of GDP in advanced industrial nations (Passman, 2014). The EU, US and Japan have all enacted major trade secret policy changes in the last five years. However, relatively little is understood about this important intellectual property right (IPR) and its economic impacts. This paper brings together key strands of economic analysis of IP, based on a literature review of academic and policy research and informed by experts' understanding.

The UK is ranked above average for trade secrets protection (Barbe & Linton, 2016). Global litigation trends, for example the 14% annual growth rate in US trade secret litigation from 2001-2012 (Elmore, 2016), suggest that trade secrets will become increasingly important for the UK economy. However, empirical evidence for trade secrets is fraught by significant methodology challenges as it requires estimating a subject that it, by definition, secret. Thus, relatively little is understood about this important mechanism for firm strategy and innovation.

This report seeks to provide a comprehensive review of academic (since 2000) and grey literature (since 2012).ⁱⁱ It is restricted to economic, management and empirical analysis of trade secrets.ⁱⁱⁱ The report proceeds as follows: an explanation of trade secrets and their context, economic themes of trade secrets, a critical analysis of the literature that looks at the who, what, why and how of trade secrets, and, finally, analysis and recommendations for policymakers.

Context and Trends

As stipulated in the WTO Trade Related Aspects of Intellectual Property (TRIPS) 1996 agreement, the accepted definition of trade secrets is information that must meet three criteria:

1. it must be secret.
2. it must be reasonably protected.
3. it must derive value from its secrecy.

The classic example of a trade secret is the Coca-Cola formula, or recipes such as the Irn Bru and Lea & Perrins recipes. Trade secrets can encompass a very broad scope of subject matters, from business confidential information such as customer lists, source code for software to chemical production processes. Large pharmaceutical companies like GSK and AstraZenca may use trade secrets to protect test results. Trade secrets are used in all sectors of the economy. Trade secrets can serve as complements or substitutes to patents, and can be used alongside other rights such as copyright, trade marks and design rights, and at any point of the R&D cycle. They do not require registration and generally retain their protection, as long as they remain secret. As such, they are a very flexible IP protection mechanism.

Advantages to trade secrets ownership are the ability to protect innovations that might not qualify for other IP, the flexibility of trade secrets, the lack of need to formally register the trade secret, the potentially lower cost of protection compared to IP, the potential for trade secrecy protection to last indefinitely, and, perhaps most importantly, the lack of disclosure. The trade secret, as a secret, provides little information to competitors.

Disadvantages of trade secrets, for trade secret owners, is that their protection may be relatively weak. Once public, the trade secret is no longer a trade secret. Trade secrets are vulnerable to misappropriation, independent discovery and reverse engineering.^{iv} With the rising connectedness of firms and the increasing use of digital means for storing trade secrets, trade secrets are now a popular target of cyber crime.^v Additionally, it is not given that their protection is cheaper than patents, and the enforcement of rights may be equally costly, with litigation resulting in further loss of secrecy and with unclear remedies and damages.

Do trade secrets support innovation? Innovation can be categorised into four types where the subject is new or significantly improved: product (good or service), process (production or delivery method), marketing (product design or packaging, product placement, product promotion or pricing) and organisational (business practices, workplace organisation or external relations) (DATA, 2005). Trade secrets are more popular with process than product innovations. This is largely due to the disclosure requirement of other forms of IP protection, such as patents. Processes may also be beyond the scope of patentability, particularly those associated with marketing and organisational innovations; it is also difficult for firms to monitor infringement of process patents. The principle of disclosure is that the knowledge or content protected by the IP must be public in order for it to benefit from protection. Product innovations may be more obvious to competitors and therefore more susceptible to reverse

engineering. However, process innovations can be opaque and therefore the lack of disclosure offered by trade secrets make trade secrets an attractive protection mechanism. Know-how, which supports both process and product innovations, often benefits from trade secrecy.

Trade secrets are a crucial form of protection for business confidential information, some of which can fall under marketing and organisational innovations. Customer lists, bidding information and other information assets can all qualify for trade secrecy. For marketing and organisational innovations, trade secrecy is an obvious business and policy tool to support and incentivise innovation. For information assets that fall into the grey area, where they may not strictly be considered innovation, the relationship between these trade secrets and innovation is less clear. However, these business critical assets may represent innovation internal to the firm and underpin the aspects of the wider innovation ecosystem for firms. These trade secrets provide foundations for contracts such as Non-Disclosure-Agreements (NDAs) and employment contracts, and protect development and market strategies such as lead time advantages. Without the foundations of trade secrets, firms would have to divert significant resources to protecting such intangible assets.

Policy Context

Trade secrets are global rights, although their legal construct varies by jurisdiction. They are included in TRIPS Article 39, and therefore enjoy at least minimum protections across World Trade Organisation (WTO) member states. In the UK, trade secrecy protection largely sits within civil law under tort and contract law. Not all jurisdictions or scholars recognise trade secrets formally under the banner of IPR (Martinis, Gaudino, & Respass, 2013). In some jurisdictions misappropriation or theft can be a criminal act, although this criminalisation is controversial (Clough, 2011).

Major developed economies have modified their trade secrets law since 2016. The European Union sought to clarify and harmonise trade secrecy protection across member states with the Trade Secrets Directive of 2016. The United States has adopted an expansionist approach, criminalising the theft of trade secrets in 1996 with the Economic Espionage Act (EEA) and harmonising and expanding protections in 2016 with the Defend Trade Secrets Act (DTSA). In 2018, Japan revised its Unfair Competition Act to provide civil and criminal remedies for trade secrets. Trade secrets are currently included in pending multilateral trade agreement negotiations. For example, the 2018 United States- Mexico-Canada Agreement (USMCA) revision of the North Atlantic Free Trade Agreement (NAFTA) includes provisions for the expansion of trade secrets protection and the criminalisation of trade secrets misappropriation.

Economic construction

The core economic justification for IPR is that they provide incentives to innovate. Under incentive to innovate, also known as the social contract theory of IP, society grants innovators exclusive rights to their innovations. This allows innovators to reap the rewards of their innovative efforts, recoup their investment in innovation and continue innovating. Society benefits with continued innovation and the disclosure of knowledge to spur further innovation. To avoid long-term monopolies and encourage further innovation these rights have an expiration, at which point the knowledge protected by the IPR can be freely used. IP introduces a static inefficiency (the monopoly of IPR) in exchange for a dynamic efficiency (continued innovation.) IPR such as copyright and patents fit this model nicely.

Trade secrecy largely fits this incentive model but with two caveats: the lack of disclosure and the lack of a predetermined expiration of protection. Trade secrets are, by definition, not disclosed and can theoretically last forever. This leads to criticism that trade secrets restrict the acquisition of ideas, unacceptably restrict labour mobility, and stifle competition (Hettinger, 1989). This limits R&D spillovers (an exchange of ideas external to a R&D project), and leads to reduced innovation and lower productivity growth. These aspects are mitigated by the fact that trade secrets generally enjoy weaker protection than patents and copyright by offering no protection against reverse engineering and independent discovery. There is a trade-off between the strength of trade secrets protection and its innovation aspects, as discussed later. There is, however, a very important non-economic justification for trade secrets: the disclosure requirement of the IPR system implicitly suggests a right not to disclose (Paine, 1991). Thus the economic justification of disclosure for patents, copyright and other IPR, counterintuitively lays the foundation for trade secrecy.

In addition to incentive aspects, trade secrets policy complements investments in physical protections and cybersecurity, reducing the need for firms to over-invest (Martinis et al., 2013) and consequently freeing up investment for other purposes such as R&D. However, an important counterpoint to this argument is that cybersecurity itself is an important font of innovation, thus investment in cybersecurity for trade secret protection translates into funds for cybersecurity R&D.

Policy makers and firms recognise the value of trade secrets. Significant policy changes in the last five years suggest that trade secrets are, and will continue to be, a crucial fixture in the innovation landscape. However, while trade secrets are very important in practice, economic understanding of their use, the impact on innovation, and other aspects is relatively underdeveloped.

Economic and Empirical research: Themes

In US and EU policy debates, the emphasis is on the economic impact of trade secrets. However, this emphasis has not yet been matched by research interest, in part due to the relative paucity of data, although this is changing (Arundel, 2001) (Almeling, 2012), (Morikawa, 2019). This section identifies key themes in the existing economic and empirical literature and popular methodologies. The core narrative in the economics literature is trade secrets as a means to provide a legal structure for innovators to appropriate the returns to their innovation. This literature falls under the economics of Industrial Organisation and Innovation, with a strong emphasis on IP aspects of trade secrets. Given the dearth of data associated with trade secrets, which are by nature secret, empirical work is scant; likewise, theoretical models of trade secrets are also limited, particularly in comparison to the well-developed literature on patents.

Two key themes in economic research of trade secrets are firms' preferences for trade secrets as a protection mechanism and trade secrets in contrast to patents.

Conventional wisdom has dictated that patents are the gold standard of IP protection, particularly in manufacturing. However, research over the last two decades has instead found that trade secrets are the preferred mechanism for protection (Cohen et al., 2000; Arundel 2001, Anton & Yao 2004; Png 2012, 2015; Crass et al., 2016, among others). For example, in a study of US manufacturing firms on their process and product innovations, Cohen, Nelson & Walsh (2000) find that both secrecy and lead-time to market were preferred to patents for both types of innovations. In light of these findings, trade secrets take a bigger and more important role in the practice and policy innovation environment for firms and economies. Patents and other formal IPR may be less important than originally thought.

Methodologies

Despite evidence that trade secrets are an important mechanism for innovators, their secrecy means we have only limited knowledge of their function in practice. Research methodologies align along two approaches: theoretical and empirical. As noted by (Hall, Helmers, Rogers, & Sena, 2014), theory models often focus on patents versus secrecy where an invention is the unit of analysis, and where empirical methods tend to address data at the firm level. This difference makes theory difficult to test with empirics, as virtually no information is available at the invention or innovation level. These approaches enjoy strengths and weaknesses in developing useful findings for policy and managers.

Theoretical approaches to economic analysis of trade secrets are generally mathematical models that apply game theory in the context of competition. These models often describe the behaviour of innovative firms (agents) competing with each other, and examine the role of trade secrets (e.g. in firm decision-making, profit maximisation, policymaking or impact on social welfare). This approach necessarily requires a number of assumptions about reality, e.g. there are only two firms operating in a particular market, and therefore is open to criticism that they do not capture reality and are difficult to test. Theoretical models generally focus on single innovations, as opposed to groups of innovations or macroeconomic analysis. However, these theoretical models are crucial for theory development, and offer both positive

(identifying facts) and normative (suggesting how things should be) findings. They may provide theory to shape policymaking, but are relatively poor at offering evidence to support such theories.

Empirical Methodologies

Empirical approaches can test or develop theory, and generally focus on groups of innovations or economy-wide impacts. Data is scarce. The measurement of trade secrets is challenging as these are secret and intangible rights, and firms are often reluctant to disclose information for fear of revealing information and strategies. Defining the size of a trade secret, in economic terms, is akin to answering the question, 'how long is a piece of string?'. It is also difficult to match innovations on a like-for-like basis, e.g. some innovations will be patentable, others will not. As discussed in this section, common empirical approaches for trade secret research are innovation surveys, other self-reporting surveys, semi structured interviews, natural experiments and litigation data.

Surveys offer appealing evidence for trade secrets as they can provide relatively concrete numbers and findings. Surveys generally seek to collect data via questionnaires of a sample population. Large-scale, regular surveys include the biennial EU Community Innovation Survey (CIS). However, these surveys rely on self-reporting, which is subject to recollection and bias problems. These problems are amplified in trade secrets research as firms are often loathe to report their trade secret strategy, or even the existence of trade secrets, for fearing of disclosing information which could be valuable for competitors. There are also additional incentives not to report the misappropriation of trade secrets as they may have reputational impacts. Anecdotal evidence and low response rates in some surveys confirm this.

Semi-structured interviews, similar to surveys, involve posing questions to a sample. However, they generally have a smaller sample size and are less prescriptive. The main advantage of this approach is the richness of the resulting data, however the necessarily small sample size is highly susceptible to bias. Semi-structure interviews in trade secrets are not very popular in economic research, as they provide a weaker basis for generalisation.

Natural experiments^{vi} in trade secret analysis, usually based on changes in policy, offer a fairly robust method to test the impact of trade secrecy. Natural experiments examine the impact on a population of a test variable, in this case a change in trade secrets laws, in contrast to a control population which has not been subject to the change. For example, the uneven introduction of the misleadingly titled Uniform Trade Secrets Act (UTSA) in the US has provided means for researchers to test the impact of changes to state law. While natural experiments offer a means to robustly test the impact of changes that would otherwise be impossible to test (e.g. it would be inappropriate to place firms in the same jurisdiction under different legal regimes for testing purposes), they are open to spurious correlations as the two populations under study may have unobserved differences. Additionally, the availability of data to perform such analysis is limited.

A final means for empirical investigation of trade secrets is litigation data. This involves collecting data from civil or criminal courts in trade secrets disputes. An advantage of this data is it includes information on trade secrets that might not be

captured otherwise, such as the trade secret itself. However, this data suffers from two main challenges: access and identification, and sample selection bias. Trade secrets disputes may be difficult to identify in jurisdictions where there is not a specific statute, such as the UK; and access to court records varies. Additionally, only a sub-section of disputes reach court, and therefore court data does not capture disputes settled out of court and trade secrets in general. Caution should be taken when attempting to generalise from litigation data.

There is no clear frontrunner in the robustness of empirical data for trade secrets. This creates a challenge for policymakers, as it is difficult to identify the relevant market failures and understand the potential impact of various policy options. However, both empirical and theoretical findings all point to an innovation system in which trade secrets are important, and potentially more important than alternative IPR. The next section looks at these findings more specifically.

Analysis of Economic and Empirical Literature

Economic research on trade secrets is growing and governments are increasingly commissioning trade secrets-related research. This section of the report provides an analysis of key academic research since 2000 and policy research since 2012. Academic papers were identified using online databases following the traditional method of literature review. Policy papers were identified using a combination of online research, building on the author's existing work and in consultation with UK IPO trade secrets experts. Five policy reports were particularly useful: two UK IPO reports using survey evidence to investigate firms (Arora, Athreye & Huang, 2013; Hall, Helmers, Sena & Rogers, 2012); two reports from the European Commission (EC) – one a large survey on trade secrets and innovation (Martinis et al., 2013) and the other on cyber theft (Georgescu, 2018); and finally a report on litigation by the EU Intellectual Property Office (EUIPO) (Wajsman & García-Valero, 2017). Where deemed relevant, papers in the management discipline and empirical legal approaches were included.vii

The economics literature focuses on the interactions of agents within an economy and how changes can affect these interactions. This section is structure around four key questions:

1. Who uses trade secrets? Characteristics of firms and sectors in relation to trade secrets.
2. What are trade secrets? Types of trade secrets and their value.
3. Why use trade secrets? Firm decision making and preferences.
4. How are trade secrets used? With other IPR, in firms and in economies.

Who uses trade secrets? Sectors and Firms Characteristics

Firms may not always be forthcoming about their use of trade secrets, but survey evidence points to trends in the popularity of trade secrets among different sectors, particularly manufacturing, and the types of firms. Innovative firms are heavier users of trade secrets than non-innovative firms, and larger firms heavier than small.

Sectors

The importance of trade secrets for the manufacturing sector, a sector that benefits from a long history of innovation analysis, is well-established. More granular research suggests some manufacturing sectors use trade secrets more than others. Some indicative findings:

- Older firms in mechanical and materials engineering prefer process technologies protected by trade secrets, to product patents for competitiveness; younger firms exhibit lower patent competence (internal resources and knowledge) (Sweden) (Holgersson, 2013).
- Semiconductor manufacturing and manufacturers with software applications are the two most commonly observed sectors in trade secret theft cases (US) (Searle, 2012).
- Textiles, apparel & leather, and chemicals, rubber & plastic rank secrecy as an important appropriation method more so than other sectors (Finland) (Leiponen & Byma, 2009).
- Secrecy is observed to be particularly important to the chemicals, metal, and drugs sectors (US) (Cohen et al., 2000).

Sectors are also found to have specific concerns about the threat of loss of trade secrecy. The EC report (Martinis et al., 2013) finds that the chemical and pharmaceutical sectors particularly believe that the risk of trade secret misappropriation has increased, while the motor vehicle and pharmaceutical industries are concerned about industrial espionage. While generally confirming the importance of trade secrecy for the manufacturing sectors, the high heterogeneity of the sector-specific findings suggest a particular sector's preferences vary by time, country and survey.

Trade secrets are also important to the service sector, as they provide protection for key service processes and business confidential information such as customer lists. The importance of trade secrets for services, and wholesale and retail trade, is less well-evidenced (Martinis et al., 2013), although Searle (2012) observes that 17% of US federal criminal trade secrets cases from 1996-2008 involved firms in the service sector. In a study of Japanese firms, the percentage of manufacturing and service sectors holding trade secrets is roughly the same (1/3), with 51% of R&D active service sector firms also holding trades (12% higher than the same type of firm in the manufacturing sector) (M. Morikawa, 2019). Further, service firms use secrecy when their sector has high technological uncertainty (Crass, Garcia Valero, Pitton &

Rammer, 2019). Given the breadth of trade secret protection, it is not surprising that the service sector finds them useful.

Firm Size

Generally, the literature finds that larger firms use trade secrets more than smaller firms. However, “more” varies by definition and these findings are dominated by self-report survey methodologies. Small firms have notoriously low awareness and knowledge of IP (Burrone, 2005; Hynynen, 2013; Petit, Dubois, Harand & Quazzotti, 2011; Sukarmijan & Sapong, 2014). In the UK, SMEs are largely unaware of the IP system, confirmed in both 2006 (Pitkethly, Lewis & House, 2006) and 2010 (Pitkethly, 2010). As a result, small firms may be less aware and articulate about their innovation protections, and therefore under-report their use of trade secrecy. Despite this challenge, the literature is fairly consistent in finding that larger firms use trade secrets more, and that large and small firms may prefer trade secrets to other forms of IPR.

In the UK, as per Table 1, one estimate finds that roughly 30% of firms use trade secrets and this use is higher in large firms (59% of those who use trade secrets) versus small firms (28%) (Hall, Helmers, Sena, Rogers, 2012). Similar international findings:

- Large innovating firms use both trade secrets and patents more than innovating SMEs, as a measure by percentage of firms, in the UK, Germany, Finland and Italy (Wajzman & García-Valero, 2017); this is further confirmed for Germany in (Crass et al., 2019).
- Globally, larger firms in the international wine industry prefer trade secrets more than smaller firms (Beukel, Tyler, Fernandez, Cruz & Lahneman, 2018).
- In Germany large firms use trade secrets more than patents, but rate patenting as more effective than secrecy; medium size firms view patents and secrets as equally effective; small firms rate secrecy as more effective than patenting (Crass et al., 2019).
- In Finland smaller firms prefer trade secrets to patents (Leiponen & Byma, 2009).
- In the US the smaller the firm, the more intensive the use of trade secrets (Searle & Reid, 2012).

The use of trade secrets in small firms may be more vulnerable. For example, “SMES are more exposed than large companies to the threat of cyber theft of trade secrets” because of lack of knowledge of threat and cyber breaches, insufficient funds for cybersecurity investment (Martinis et al., 2013, p. 33-34). Small firms are less able to pursue trade secret misappropriation, as they have less resources and IP knowledge at their disposal. However, the loss of a trade secret can be devastating for a small firm, which may have few other innovations.

UK Community Innovation Survey (CIS) (1998-2007):

- 67.8% of UK firms don't use secrecy
- Use is higher in innovative firms:
 - 70% of firms who innovate both product and process use trade secrets
 - 55% of product only innovators
 - 44% of process only innovators
- Use is higher in larger firms (59%) than small firms (28%)
- Use is higher in firms who patent (82%) than those who do not

What are trade secrets? Types of trade secrets and their value

The secrecy of trade secrets makes their value and contents difficult to understand. Trade secrets can be extremely valuable, such as the Coca-Cola formula, or mundane, such as the contents of a presentation to potential investors.

Value

As with many types of IPR, valuing and defining an individual trade secret can be difficult. As intangible assets, there are no clear definitions of the scope (with, to a degree, the exception of patents), market, and value. These are compounded by the secret nature of trade secrets. Some trade secrets are very valuable, but most are not (Reid, Searle & Vishnubhakat, 2014). This is consistent with other types of intellectual property.

Valuation methods for trade secrets, as with other types of IP and assets, generally fall under three categories: market, income, and cost (Searle & Brassell, 2016). The market approach is an estimation of the fair market value of a trade secret; this is a challenging approach as sales of trade secrets are often confidential. Using income to value a trade secret involves analysing the associated cash flows, such as sales or royalties. In the case of a dispute, income methods can be used to estimate the lost profits of the trade secret owner, the unjust enrichment of the alleged misappropriator or potential reasonable royalties. Cost approaches look at the costs to develop or replicate the secret, such as the R&D cost used originally, or the cost to reverse engineer or independently develop a secret.

Concrete valuations of trade secrets are difficult. (Hall, Helmers, Sena & Rogers, 2012) note that a 2011 US court valued DuPont's misappropriated trade secrets at nearly USD\$1 Billion, working out to USD\$6.3M per secret. Yet different methodologies provide different results, and even then it is difficult to unpack the incremental value of the trade secret from the innovation in question. For example, court documents in *US v. Zhang*,^{viii} a criminal case alleging the theft of trade secrets present a range of USD\$3M-\$65M for valuations of the trade secret. These were: USD\$25-65M in potential lost profits, development costs of USD\$55M, and future sales of USD\$3-18M. Valuations should be appropriately scrutinised, as they are debatable and variable.

Types of trade secrets

Trade secrets can encompass a wide scope of innovation, know-how and business information. There is little study on the breakdown of what trade secrets protect in practice. Generally, trade secrets are used more to protect processes than product innovations (Arundel, 2001; Cohen et al., 2000; Crass et al., 2019; Leiponen & Byma, 2009); although Morikawa (2019) finds this is only true in the manufacturing sector. In the EC study, the top three assets protected by trade secret are: commercial bids and contracts, and contractual terms; customer or supplier lists and related data; and financial information and business planning (Martinis et al., 2013). Firms in this study also view trade secrets as valuable for protecting the following: R&D data, process know-how and technology, formulae and recipes, product technology, and marketing

data and planning. In a study of 200 US criminal court cases (on file with author), the most popular types of trade secrets are: business confidential information, software/source code, miscellaneous technical information and a combination of technical and business confidential information.

There are also 'negative' trade secrets – trade secrets in knowing what does not work. A failed avenue of research allows a firm to avoid incurring further costs; competitors however, may invest significant resources to end up with the same failure. Software vulnerabilities can also be trade secrets. The ability to keep these types of information secret conveys competitive advantages.

Despite the lack of detail on trade secrets in practice, it is clear they are used for a wide scope of information assets. However, a key unanswered question for policymaking is the balance between trade secrets that are defined as innovations as per categories in (DATA, 2005), and those that are not but still form a key part of the innovation ecosystem.

Why use trade secrets? Firm decision making, disclosure and costs

Trade secrets are a strategic tool to appropriate the rewards of a firm's innovations. Disclosure is a key factor in the decision to use trade secrets. However, trade secrets come with costs and their protection is not given. This section discusses aspects on why firms use trade secrets.

Disclosure

In contrast to other forms of IPR, trade secrets do not involve disclosure. This is a key advantage to trade secrecy for the innovating firm as it limits the information competitors glean about a firm's innovations. The product or service itself may disclose information and affect the degree of imitability, hence the relative preference for protecting processes with trade secrets as they are less imitable. The benefits of the lack of disclosure are greater when competitors are better able to imitate. At the same time, disclosure can be used strategically to signal information to other firms in the market, or to make information public and consequently thwart the patenting of the innovation (Hayter & Link, 2018). Given that the lack of disclosure is important in practice, for example, 52% of firms in the EC study cite avoiding the disclosure of confidential information as the most important use of trade secrecy (Martinis et al., 2013), research generally focuses on this aspect of trade secrets.

Theoretical models provide insights as to why this might be the case. A key model by Anton & Yao, (2004) based on disclosure, argues firms use patents for small innovations and trade secrets for larger innovations. They argue that this is particularly the case when innovation protections, such as IPR, are weak. Similarly, firms are also more likely to use trade secrecy when the threat of knowledge leakage is higher, and patents when this threat is lower (Bhattacharya & Guriev, 2006). However, the lack of disclosure has implications for knowledge flows. For example, trade secrecy can limit innovation under an Open Science model (Mukherjee & Stern, 2009).

Costs

The direct costs of trade secrecy involve insuring it is reasonably protected. This involves a combination of handling and access protections (Hannah, 2005), such as non-disclosure agreements and computer security (see Bos, Broekhuizen & de Faria, 2015 for a literature review). In general, these are costs likely already incurred as good practice in terms of physical security, cyber security and information handling. Trade secrets are therefore considered a relatively cost-effective measure for IP protection. However, the indirect costs of enforcing trade secrecy, including detection of misappropriation and theft, and the subsequent legal costs, can be high. For small firms, it may be prohibitively costly, which weakens protection. Furthermore, cybersecurity by firms is often suboptimal, e.g. the EU lags behind in terms of detection of cyber breaches (Georgescu, 2018), and IT departments do not necessarily include trade secrets in their decision-making. It should not be taken for granted that trade secrecy is cost-effective.

An indirect cost of trade secrecy is on the knowledge flows within the firm (James, Leiblein & Lu, 2013; King, 2007). Innovation requires knowledge, and restrictions of

the spread of knowledge can hamper a firm's R&D efforts. Firms must balance knowledge protection and the need for that knowledge to be copied and shared (Hurmelinna, Kyläheiko, & Jauhiainen, 2007). Yet, employees do not like having limited access to firm knowledge, and this can affect company culture. A culture of trust within the firm encourages employees to protect trade secrets (Hannah, 2005; Shore et al., 2004; Taylor & Tekleab, 2004). Thus, paradoxically, a reliance on trade secrets can undermine a firm's innovation, particularly in firms with low levels of trust.

Loss of trade secrecy: Means and costs

The decision to use trade secrets necessarily involves accepting a risk of the loss of this secrecy. A trade secret can lose its protection if it fails to remain secret, valuable or reasonably protected. Of these three, secrecy is the biggest threat to the loss of protection, or at least a loss of the exclusivity of this protection. This can happen in a relatively benign manner, such as reverse-engineering or independent discovery, or in malicious circumstances such as misappropriation or theft. Accidental loss of secrecy can also happen, for example, when employees inadvertently leak knowledge (Ritala, Olander, Michailova & Husted, 2015). Reverse-engineering by competitors, which is more difficult to do with processes than products, can also undermine the value of a trade secret. There is little a firm can do to prevent independent discovery. However, while a competitor may gain knowledge of the innovation, it does not necessarily translate that a competitor will then disclose it. In which case, the trade secret remains a secret, but the firm no longer has exclusive ownership.

Theft and misappropriation,xi however, present a threat to the economic success of trade secrets as a protection mechanism in both practice and policy. Theft can represent a strategic loss for the firm (Argento, 2013), and, at the national level, economic espionage creates national competitiveness concerns. The majority of theft is by insiders (Searle, 2012), but theft may go undetected or unreported, in which case the picture is unclear. There are multiple incentives not to report a theft, including: failure to detect the misappropriation, inability to identify the perpetrator, embarrassment, concern about disclosing the trade secret, business diplomacy, and convenience (Argento, 2013). Another challenge of pursuing theft or misappropriation is the risk of further disclosure of the trade secret in court proceedings.

Not all firms or countries are victims of theft; some are perpetrators. Other people's IP is valuable. East German economic espionage significantly benefitted the economy of East Germany (Glitz & Meyersson, 2017) and many developed economies have histories of using economic espionage as part of a growth strategy. As with patents, there are headline cases of large American innovative firms suing and counter-suing each other over trade secret misappropriation. The liability of trade secret theft or misappropriation depends on the jurisdiction, for example the UK's reliance on NDA shifts liability to employees rather than firms.

The costs of trade secrets theft are both strategic and concrete. The impact of theft has less to do with the immediate theft, and more the losses arising from the loss of the secret (Lee-Makiyama, 2018). Survey evidence and industry reports suggest these include financial, goodwill, and innovation impacts on the firm (Passman, 2014). The EC report (Martinis et al., 2013), via a survey, identifies the following costs to business:

1. loss of sales
2. costs for internal investigation
3. increased expenditure for protection
4. costs for negotiating settlements
5. costs for prosecuting and litigating

Trade secret theft can affect firm performance. The announcement of the theft of trade secrets negatively impacts the stock market price of the trade secret owner (Carr & Gorman, 2001; Cavusoglu, Mishra & Raghunathan, 2004). Equally, a strengthening of trade secrets via court rulings, for example, confirmation of the US inevitable disclosure doctrine (IDD), may lead to positive abnormal returns (Klasa, Ortiz-Molina, Serfling & Srinivasan, 2018). However, trade secret theft is increasingly a cyber crime, and recent literature on cyber crime suggest that the impact on firm performance is relatively small or ambiguous (Arcuri, Brogi & Gandolfi, 2017; Hilary, Segal & Zhang, 2016).

Firms must weigh the direct and indirect costs of trade secrecy protection against the benefits, and the risk of the loss of trade secrecy. Striking the right level of IT investment, handling and access controls is not a straightforward task, and is particularly difficult given that assessing the benefits, i.e. valuing a trade secret, is difficult.

How are trade secrets used?

At the innovation, firm and economy levels, trade secrets support R&D and economic growth. They are an important fixture in the innovation landscape, and are often used with other IPR. However, trade secrets can also limit innovation by restricting the knowledge flows, and face a growing threat from economic espionage and cybercrime.

Trade Secrets and other IPR

Current literature uses patents to frame trade secrets as a means to protect innovation. This analysis starts with individual firm decision-making, and draw policy conclusions from these findings. The literature offers some insights into the choice to use trade secrets using economic models, such as Anton & Yao (2004) who determine that trade secrets can be preferred to patents, depending on the 'size' of the innovation. Other authors also use models to investigate the decision between trade secrets and patents (Bhattacharya & Guriev, 2006; Bulut & Moschoni, 2006; Ottoz & Cugno, 2006, 2008; Kultti, Takalo & Toikka, 2007; Mosel, 2011; Kwon, 2012; Panagopoulos & Park, 2015); or disclosure versus secrecy (Mukherjee & Stern, 2008). These models frame trade secrets as either complements or substitutes to patents.

At a policy level, these dynamics can inform policy development. For example, stronger patent protection has positive effects on economic growth if trade secrets face a high risk of leakage; however, if this risk is low, stronger patent protection inhibits such growth (Suzuki, 2015). Empirical analyses of these dynamics offers insights into the use of trade secrets and patents in practice. Using UK data via Survey on Innovation and Patent Use (SIPU), Arora et al. (2013) find the following for UK firms:

- UK Patenting firms are more likely to protect a larger proportion of their most valuable innovations using secrecy than non-patenting firms.xii
- UK Firms without novel innovations, or firms that fear infringement, have a smaller share of innovations protected by trade secrets
- UK Sectors that have high shares of secrecy do not show high shares of patenting

These UK findings are confirmed by wider empirical work that demonstrates that innovating firms use both patents and secrets (Wajzman & García-Valero, 2017). A natural experiment analysing strengthening in trade secret laws in some US states led to a nearly 40% decrease in patents in the following year^{xiii} (Png, 2017b), suggesting that trade secrets are largely substitutes to patents. We can thus be fairly confident that patents can impact the decision to use trade secrecy, which has implications for both patent and trade secret policy.

However, this patent-focused framing of trade secrets suffers from a key weakness: much of commercially relevant research cannot be patented (Lee-Makiyama, 2018). The literature has established that firms use trade secrets to protect non-patentable innovations such as marketing and organisational innovations; it is observed that misappropriated trade secrets are often software, in which case copyright is the

alternative IPR. Marketing innovations may be supported by trade secrets and trade marks; many design rights will have started out as trade secrets. In heavily regulated industries such as pharmaceuticals and defence, regulations on disclosure may affect the choice of IP. The dominance of patents in the trade secrets literature means that much of trade secrecy in practice, and its relationship with other types of IPR, is not well captured by existing research.

Knowledge spill overs, flows and signalling

In the incentive-to-innovate, social contract framing of the IPR system, disclosure is fundamental to the flow of knowledge. Trade secrets inhibit this flow, both within and between firms. High levels of knowledge flows and spillovers in Silicon Valley, thanks to a culture and network that encouraged the sharing of ideas, is credited for the area's current technological and economic dominance (Syed, 2019). Trade secrets, and the cost to protect them, can act as a barrier to entry (Henry & Ruiz-Aliseda, 2016). There are arguments that trade secrets reduce competition in the biosimilar market, and that the combination of regulation and trade secrets blocks fundamental knowledge generation (Price & Rai, 2015). 25% of respondents in work by Martinis et al. (2013) believe that trade secrets owners would use secrets to raise barriers to entry in their markets via aggressive litigation and other behaviours towards competitors. There is also a delicate balance between trade secrecy that encourages investment in R&D, and that which limits knowledge spillovers (leakage) (Png, 2017a; Ganglmair & Reimers, 2019). Negative trade secrets create environments in which competitors waste R&D investments on research avenues known elsewhere to be failures. These dynamics clearly impact economic growth.

Strong trade secrets laws limit employee mobility (Png & Samila, 2013; Reder & O'Brien, 2011; Selmi, 2014). Restrictions on employee mobility are detrimental to innovation, however such restrictions improve the appropriability of trade secrets (Delerue & Lejeune, 2010). In comparison, weaker trade secret laws can foster mobility; in the US, rulings against the IDD are associated with a 10% higher mobility of university-educated workers (Png & Samila, 2013). Yet firms generally benefit from the reduction in competitive threats associated with the recognition of IDD (Klasa et al., 2018). This may benefit the holder of the trade secret, the employer, but the impact of this is reduced knowledge flows and hence reduced innovations (Contigiani, Hsu & Barankay, 2018). Restrictions on employee mobility appear to provide short-term gains to trade secrets owners, at the cost of long-term gains for innovation.

Cybersecurity

An emerging area of investigation is the 'silent crime' (Greiman, 2018) of trade secrets in cyberspace. In the EC cyber report (Georgescu, 2018) all interviewees agree the theft of trade secrets through cyber means is a 'concrete and growing threat.'

Cybercrime already leads to business disruption, increased costs and, in some cases, payments of ransoms – all of which divert resources away from R&D. In a cyber theft of trade secrets, only 10% of costs are the immediate and direct impacts, the remaining 90% is a longer-term loss of know-how, competitive advantage and jobs (PWC, 2018). Cybercrime is the preferred method for many of those engaged in industrial espionage (NCSC, 2018). At both the firm level and national level, the organised theft of trade secrets can compromise competitiveness.

In the UK, the financial sector suffers the most intrusions (Martinis et al., 2013). In contrast, the highly regulated defence industry was an early adopter of incorporating trade secrecy in cyber strategies (Hermeneut, 2019). For cyber breaches as a whole, Europe does not compare favourably to the rest of the world: the time lag between the breach and detection is three times longer in Europe (PWC, 2018). As cyber security benefits from network effects (a kind of 'herd immunity,' the better the individual firm is protected, the better all firms are protected), policies to encourage investment in cybersecurity could decrease the impact of industrial and economic espionage. The diversion of R&D investments into the cybersecurity sector increases R&D investment in that sector; thus the loss of R&D investments is mitigated.

Unfortunately, there are significant disincentives to report cyber breaches and economic espionage as a whole, as firms may not want to damage their reputation, acknowledge the existence and subsequent loss of secrets, or disrupt their relationships with governments (Basuchoudhary & Searle, 2019). As such, empirical evidence for cyber theft of trade secrets is scarce, although it is likely most thefts of trade secrets involve a breach of cybersecurity. In a study of 200 trade secrets in the US virtually all cases have a cyber aspect (on file with author.) The cyber theft of trade secrets poses an immediate, but unfortunately opaque, threat to localised innovation.

Analysis and Recommendations

Trade secrets clearly represent an important and flexible innovation tool for firms and policymakers. However, little is known about their economic and innovation impacts in practice. As this report has shown, trade secrets are used by many sectors, may be used more in larger firms, and often provide a relatively low-cost protection mechanism. Trade secrecy is generally preferred to patents for process innovations, whereas product innovations generally benefit from patents. Trade secrecy also encompasses a wide range of marketing and organisational innovations, and knowledge that may fall outside the scope of traditional definitions of innovation.

A key aspect of trade secrets is the relationship between innovation and trade secrecy. As with most forms of IPR, trade secrets serve to incentivise innovation by helping firms reap the rewards of their innovation and invest more in R&D. Yet trade secrets lack a key requirement common to other IPR: disclosure. Consequently, trade secrets also limit the flow of knowledge and labour, which can reduce future innovation. While strengthening trade secret protection may benefit existing trade secrets owners and encourage investment in R&D, it may come at the cost of long-term innovation.

The research points to key themes to consider in policymaking:

- a. Only a subset of trade secrets is potentially patentable; care should be taken that trade secret policy is not built on an implicit relationship with patents. Instead, trade secrets should be considered in the context of their wide scope of applicability, their interaction with process, product, marketing and organisational innovation, and their appeal to a variety of sectors.
- b. Encouraging investment in cyber security may be a good long-term solution to promoting a healthy trade secret environment. As a preventative tool, it proactively stops theft rather reactively address its fallout, and minimises the use of public resources.
- c. Trade secret awareness is likely weak. This is particularly the case for SMEs and may be the case in cybersecurity departments. Awareness and business support in this area could encourage efficient use of trade secrets and improve its positive innovation impacts.
- d. Further research is needed. The empirical evidence base needs expanding, and there are significant legal, management and economic questions.

As discussed throughout this report, there is little empirical evidence to provide robust analysis for these themes. Four empirical approaches can help address this gap. To start further, trade-secret specific evidence should be collected through surveys. This evidence collection would benefit from a panel approach and could be achieved by working with existing surveys such as SIPU. Second, exploiting opportunities for natural experiment could discover insights free from the self-reporting challenges of surveys. Sector-specific natural experiments, where a software company may have released source code into the market, could provide further insight into the knowledge flow impact of trade secrets. At the national level, recent policy changes in major economies also provide opportunities; data collection in these jurisdictions should be

encouraged. There is also unexplored data in related areas. The role of trade secrets in employment, particularly the UK's reliance on contract law, could be further explored using labour economics and employment data. Finally, experimental economics using controlled lab-based experiments could provide insights into firms' decision-making process for IPR. This could inform policy to support the efficient use of trade secrecy.

The growing threat of cybercrime for trade secrets poses, however, a fresh challenge. These incidents are largely unreported and therefore building an evidence base is difficult. Mandatory or voluntary reporting requirements may be poorly used or result in over-reporting. Empirical evidence through carefully executed surveys and litigation data are potential methodologies on which to build an evidence base. Better understanding the scale and impact of these thefts and economic espionage will be important for developing appropriate trade secrets policy.

Important questions remain. For example, what is the economic impact of the patentability of an existing trade secret? The research has only begun to address trade secret decision-making within firms. How is the choice to use trade secrets influenced by factors such as novelty, costs, competitors' ability to imitate and barriers to competition? Informal discussions with experts suggest that there are potential gaps in trade secret management within firms. How do firms identify and protect trade secrets? What is the interaction between R&D staff, business staff, lawyers, and IT staff in protecting trade secrets? Competing priorities and incentives within firms may leave trade secrets unprotected. Legal questions abound. For example, investigations are needed in trade secrets in the tech sector, transparency, regulation and privacy – particularly in the context of the EU General Data Protection Regulation (GDPR, 2016.) This potential list of topics only scratches the surface of the important role of trade secrets in developed economies.

References

Almeling, D. S. (2012). Seven reasons why trade secrets are increasingly important. *Berkeley Technology Law Journal*, 1091–1117.

Anton, J. J., & Yao, D. A. (2004). Little patents and big secrets: managing intellectual property. *RAND Journal of Economics*, 1–22.

Arcuri, M. C., Brogi, M., & Gandolfi, G. (2017). How Does Cyber Crime Affect Firms? The Effect of Information Security Breaches on Stock Returns.

Argento, Z. (2013). Killing the Golden Goose: The Dangers of Strengthening Domestic Trade Secret Rights in Response to Cyber-Misappropriation. *Yale JL & Tech.*, 16, 172.

Arora, A., Athreye, S., & Huang, C. (2013). Innovation, Patenting and Licensing in the UK: Evidence from the SIPU survey. Citeseer.

Arundel, a. (2001). The relative effectiveness of patents and secrecy for appropriation. *Research Policy*, 30(4), 611–624. [https://doi.org/10.1016/S0048-7333\(00\)00100-1](https://doi.org/10.1016/S0048-7333(00)00100-1)

Barbe, A., & Linton, K. (n.d.). Trade Secrets: International Trade Policy and Empirical Research. In *oecd.org*. Retrieved from <https://ustr.gov/trade-agreements/free-trade-agreements/trans-pacific->

Basuchoudhary, A., & Searle, N. (2019). Snatched secrets: Cybercrime and trade secrets modelling a firm's decision to report a theft of trade secrets. *Computers & Security*, 87, 101591.

Beukel, K., Tyler, B., Fernandez, E. M. G., Cruz, A. D., & Lahneman, B. (2018). Proactiveness and the use of secrecy in family and nonfamily smes: evidence from the wine industry. DRUID Society Conference.

Bhattacharya, S., & Guriev, S. (2006). Patents vs. Trade Secrets: Knowledge Licensing and Spillover. *Journal of the European Economic Association*, 4(6), 1112–1147. <https://doi.org/10.1162/JEEA.2006.4.6.1112>

Bos, B., Broekhuizen, T. L. J., & de Faria, P. (2015). A dynamic view on secrecy management. *Journal of Business Research*, 68(12), 2619–2627. <https://doi.org/10.1016/j.jbusres.2015.04.009>

Burrone, E. (2005). Intellectual Property Rights and Innovation in SMEs in OECD Countries. *Journal of Intellectual Property Rights*, 10, 34–43.

Carr, C., & Gorman, L. (2001). The revictimization of companies by the stock market who report trade secret theft under the Economic Espionage Act. *The Business Lawyer*, 25–53.

Cavusoglu, H., Mishra, B., & Raghunathan, S. (2004). The Effect of Internet Security Breach Announcements on Market Value : Capital Market Reactions for Breached

Firms and Internet Security Developers. *International Journal of Electronic Commerce*, 9(1), 69–104.

Clough, J. (2011). Data Theft? Cybercrime and the Increasing Criminalization of Access to Data. *Criminal Law Forum*, 22(1–2), 145–170.
<https://doi.org/10.1007/s10609-011-9133-5>

Cohen, W., Nelson, R., & Walsh, J. (2000). Protecting their Intellectual Assets: Appropriability conditions and why firm patent and why they do not in the American manufacturing sector. NBER Working Paper, 7552.

Contigiani, A., Hsu, D. H., & Barankay, I. (2018). Trade secrets and innovation: Evidence from the “inevitable disclosure” doctrine. *Strategic Management Journal*, 39(11), 2921–2942. <https://doi.org/10.1002/smj.2941>

Crass, D., Garcia Valero, F., Pitton, F., & Rammer, C. (2019). Protecting Innovation Through Patents and Trade Secrets: Evidence for Firms with a Single Innovation. *International Journal of the Economics of Business*, 26(1), 117–156.
<https://doi.org/10.1080/13571516.2019.1553291>

DATA, I. I. (2005). Oslo Manual.

Delerue, H., & Lejeune, A. (2010). Job mobility restriction mechanisms and appropriability in organizations: The mediating role of secrecy and lead time. *Technovation*, 30(5–6), 359–366.
<https://doi.org/10.1016/J.TECHNOVATION.2010.01.002>

Dreyfuss, R. C., & Lobel, O. (2016). Economic espionage as reality or rhetoric: Equating trade secrecy with national security. *Lewis & Clark L. Rev.*, 20, 419.

Elmore, J. (2016). A Quantitative Analysis of Damages in Trade Secrets Litigation. *Willamette Forensic Analysis Insights*, Spring.

Ganglmair, B., & Reimers, I. (2019). Visibility of technology and cumulative innovation: Evidence from trade secrets laws. ZEW-Centre for European Economic Research Discussion Paper, (19–035).

Georgescu, A.-A. E. P. (2018). The Scale and Impact of Industrial Espionage and Theft of Trade Secrets Through Cyber. Retrieved from <https://op.europa.eu/en/publication-detail/-/publication/b3b5fcfb-4541-11e9-a8ed-01aa75ed71a1/language-en/format-PDF/source-90181868>

Glitz, A., & Meyersson, E. G. (2017). Industrial Espionage and Productivity. Retrieved February 24, 2020, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3003864

Greiman, V. (2018). Cyber Espionage: The Silent Crime of Cyberspace. ICCWS 2018 13th International Conference on Cyber Warfare and Security, 245. Academic Conferences and publishing limited.

Hall, Helmers, Sena, Rogers. (2012). The use of alternatives to patents and limits to incentives - GOV.UK. Retrieved February 20, 2020, from UK IPO website:

<https://www.gov.uk/government/publications/the-use-of-alternatives-to-patents-and-limits-to-incentives>

Hall, B., Helmers, C., Rogers, M., & Sena, V. (2014). The choice between formal and informal intellectual property: a review. *Journal of Economic Literature*, 52(2), 375–423.

Hannah, D. R. (2005). Should I Keep a Secret? The Effects of Trade Secret Protection Procedures on Employees' Obligations to Protect Trade Secrets. *Organization Science*, 16(1), 71–84. <https://doi.org/10.1287/orsc.1040.0113>

Hayter, C. S., & Link, A. N. (2018). Why do knowledge-intensive entrepreneurial firms publish their innovative ideas? *Academy of Management Perspectives*, 32(1), 141–155. <https://doi.org/10.5465/amp.2016.0128>

Henry, E., & Ruiz-Aliseda, F. (2016). Keeping secrets: the economics of access deterrence. *American Economic Journal: Microeconomics*, 8(3), 95–118.

Hermeneut. (2019). White paper on cybercrime and cyberterrorism - IP-intensive | Hermeneut. Retrieved from <https://www.hermeneut.eu/download/cybercrime-ip-intensive-industries/>

Hettinger, E. C. (1989). Justifying Intellectual Property. *Philosophy & Public Affairs*, 18(1), 31–52. Retrieved from <http://www.jstor.org/stable/2265190>

Hilary, G., Segal, B., & Zhang. (2016). Cyber-Risk Disclosure: Who Cares? Georgetown McDonough School of Business Research Paper No. 2852519.

Holgersson, M. (2013). Patent management in entrepreneurial SMEs: a literature review and an empirical study of innovation appropriation, patent propensity, and motives. *R&D Management*, 43(1), 21–36. <https://doi.org/10.1111/j.1467-9310.2012.00700.x>

Hurmelinna, P., Kyläheiko, K., & Jauhiainen, T. (2007). The Janus face of the appropriability regime in the protection of innovations: Theoretical re-appraisal and empirical analysis. *Technovation*, 27(3), 133–144. <https://doi.org/10.1016/J.TECHNOVATION.2005.09.011>

Hynynen, J. (2013). Supporting invention and innovation in Central Finland: Inspiring IP awareness. *World Patent Information*, 35(2), 105–109. <https://doi.org/10.1016/j.wpi.2013.01.006>

James, S. D., Leiblein, M. J., & Lu, S. (2013). How Firms Capture Value From Their Innovations. *Journal of Management*, 39(5), 1123–1155. <https://doi.org/10.1177/0149206313488211>

Khoury, A. H. (2013). The Case Against the Protection of Negative Trade Secrets: Sisyphus' Entrepreneurship. *IDEA*, 54, 431.

King, A. W. (2007, January 1). Disentangling interfirm and intrafirm causal ambiguity: A conceptual model of causal ambiguity and sustainable competitive advantage.

Academy of Management Review, Vol. 32, pp. 156–178.
<https://doi.org/10.5465/AMR.2007.23464002>

Klasa, S., Ortiz-Molina, H., Serfling, M., & Srinivasan, S. (2018). Protection of trade secrets and capital structure decisions. *Journal of Financial Economics*, 128(2), 266–286. <https://doi.org/10.1016/J.JFINECO.2018.02.008>

Lee-Makiyama, H. (2018). Stealing thunder: Cloud, IoT and 5G will change the strategic paradigm for protecting European commercial interests. Will cyber espionage be allowed to hold Europe back in the global race for industrial competitiveness? ECIPE Occasional Paper.

Leiponen, A., & Byma, J. (2009). If you cannot block, you better run: Small firms, cooperative innovation, and appropriation strategies. *Research Policy*, 38(9), 1478–1488. <https://doi.org/10.1016/j.respol.2009.06.003>

Levine, B. L., & Flowers, T. C. (2014). Your Secrets Are Safe with Us: How Prosecutors Protect Trade Secrets During Investigation and Prosecution. *Am. J. Trial Advoc.*, 38, 461.

Lindblom, L. (2007). Dissolving the moral dilemma of whistleblowing. *Journal of Business Ethics*, 76(4), 413–426.

Martinis, L. de, Gaudino, F., & Respass III, T. S. (2013). Study on Trade Secrets and Confidential Business Information in the Internal Market. Prepared for the European Commission. sn.

Miller, Y. (1981). India's Regulation of Direct Foreign Investment: Article 29 of the 1973 Foreign Exchange Regulation Act. *BC Third World LJ*, 2, 65.

Morikawa, M. (2019). Innovation in the service sector and the role of patents and trade secrets: Evidence from Japanese firms. *Journal of the Japanese and International Economies*, 51, 43–51. <https://doi.org/10.1016/j.jjie.2018.10.003>

Mukherjee, A., & Stern, S. (2009). Disclosure or secrecy? The dynamics of open science. *International Journal of Industrial Organization*, 27(3), 449–462.

NCSC. (2018). Foreign Economic Espionage in Cyberspace. In US National Counterintelligence and Security Center. Retrieved from <https://www.dni.gov/files/NCSC/documents/news/20180724-economic-espionage-pub.pdf>

Paine, L. S. (1991). Trade Secrets and the Justification of Intellectual Property: A Comment on Hettinger. *Philosophy & Public Affairs*, 20(3), 247–263. Retrieved from <http://www.jstor.org/stable/2265433>

Pasquale, F. (2011). The troubling consequences of trade secret protection of search engine rankings. *The Law and Theory of Trade Secrecy: A Handbook of Contemporary Research*, 381–405.

Passman, P. (2014). The Economic Impact of Trade Secret Theft.(CREATe. org).

Petit, C., Dubois, C., Harand, A., & Quazzotti, S. (2011). A new, innovative and marketable IP diagnosis to evaluate, qualify and find insights for the development of SMEs IP practices and use, based on the AIDA approach. *World Patent Information*, 33(1), 42–50. <https://doi.org/10.1016/J.WPI.2010.03.001>

Pitkethly, R., Lewis, C., & House, C. (2006). UK intellectual property awareness survey 2006. UK Intellectual Property Office, 11.

Png, I. P. L. (2017a). Law and innovation: evidence from state trade secrets laws. *Review of Economics and Statistics*, 99(1), 167–179.

Png, I. P. L. (2017b). Secrecy and patents: Theory and evidence from the Uniform Trade Secrets Act. *Strategy Science*, 2(3), 176–193.

Png, I. P. L., & Samila, S. (2013). Trade secrets law and engineer/scientist mobility: Evidence from “Inevitable Disclosure.” WP Nat. U. Singapore.

Price, W. N., & Rai, A. K. (2015). Are trade secrets delaying biosimilars? *Science*, 348(6231), 188–189.

PWC. (2018). Study on the Scale and Impact of Industrial Espionage and Theft of Trade Secrets through Cyber. Retrieved from <https://www.pwc.com/it/it/publications/docs/study-on-the-scale-and-Impact.pdf>

Ram, N. (2017). Innovating Criminal Justice. *Northwestern University Law Review*, 112. Retrieved from <https://heinonline.org/HOL/Page?handle=hein.journals/illlr112&id=697&div=26&collection=journals>

Reder, M. E. K., & O’Brien, C. N. (2011). Managing the risk of trade secret loss due to job mobility in an innovation economy with the theory of inevitable disclosure. *J. High Tech. L.*, 12, 373.

Reid, G. C., Searle, N., & Vishnubhakat, S. (2014). What’s It Worth to Keep a Secret. *Duke L. & Tech. Rev.*, 13, 116.

Rigi, J. (2014). Foundations of a Marxist Theory of the Political Economy of Information: Trade Secrets and Intellectual Property, and the Production of Relative Surplus Value and the Extraction of Rent-Tribute. *TripleC: Communication, Capitalism & Critique. Open Access Journal for a Global Sustainable Information Society*, 12(2), 909–936–909–936. <https://doi.org/10.31269/triplec.v12i2.487>

Ritala, P., Olander, H., Michailova, S., & Husted, K. (2015). Knowledge sharing, knowledge leaking and relative innovation performance: An empirical study. *Technovation*, 35, 22–31. <https://doi.org/10.1016/j.technovation.2014.07.011>

Searle, N., & Brassell, M. (2016). Economic Approaches to Intellectual Property. Retrieved from https://books.google.co.uk/books?id=_DUdswEACAAJ

Searle, N. (2012). The Criminalization of the Theft of Trade Secrets: An Analysis of the Economic Espionage Act. *2 IP Theory* 33 (2012), 2(2). Retrieved from <https://www.repository.law.indiana.edu/ipt/vol2/iss2/2>

Searle, N., & Reid, G. C. (2012). Firm size and trade secret intensity: evidence from the Economic Espionage Act. Scottish Institute for Research in Economics (SIRE).

Selmi, M. (2014). Trending and the Restatement of Employment Law's Provisions on Employee Mobility. *Cornell L. Rev.*, 100, 1369.

Shore, L. M., Tetrick, L. E., Taylor, M. S., Coyle Shapiro, J. A. M., Liden, R. C., Parks, J. M. L., ... Dyne, L. Van. (2004). THE EMPLOYEE-ORGANIZATION RELATIONSHIP: A TIMELY CONCEPT IN A PERIOD OF TRANSITION. *Research in Personnel and Human Resources Management*, Vol. 23, pp. 291–370.
[https://doi.org/10.1016/S0742-7301\(04\)23007-9](https://doi.org/10.1016/S0742-7301(04)23007-9)

Sukarmijan, S. S., & Sapong, O. D. V. (2014). The Importance of Intellectual Property for SMEs; Challenges and Moving Forward. *UMK Procedia*, 1, 74–81.
<https://doi.org/10.1016/J.UMKPRO.2014.07.010>

Suzuki, K. (2015). Economic growth under two forms of intellectual property rights protection: patents and trade secrets. *Journal of Economics*, 115(1), 49–71.

Syed, M. (2019). *Rebel Ideas: The Power of Diverse Thinking*. Hachette UK.

Taylor, M. S., & Tekleab, A. G. (2004). Taking stock of psychological contract research: Assessing progress, addressing troublesome issues, and setting research priorities. *The Employment Relationship: Examining Psychological and Contextual Perspectives*, 253, 283.

Turilli, M., & Floridi, L. (2009). The ethics of information transparency. *Ethics and Information Technology*, 11(2), 105–112. <https://doi.org/10.1007/s10676-009-9187-9>

Wajzman, N., & García-Valero, F. (2017). Protecting Innovation through Trade Secrets and Patents: Determinants for European Union Firms. European Union Intellectual Property Office. European Observatory on Infringements of Intellectual Property Rights

Concept House
Cardiff Road
Newport
NP10 8QQ

Tel: 0300 300 2000

Email: information@ipo.gov.uk

Web: www.gov.uk/ipo

Facebook: TheIPO.UK

Twitter: @The_IPO

YouTube: ipogovuk

LinkedIn: uk-ipo

For copies in alternative formats please contact
our Information Centre.

**When you no longer need this booklet, please
recycle it.**

© Crown copyright, 2021

This document is free for re-use under the terms
of the Open Government Licence.

Published: March 2021

