The protection of innovations

Empirical studies on its determinants and relationship to firm performance in the Netherlands

Mischa Clement Mol
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Mischa Clement Mol

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prof.dr. H. L. F. de Groot
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After finishing my Master’s degree in business administration, I considered applying for a PhD position but decided not to do so. Some five years later, after I became a lecturer at Windesheim University of Applied Sciences, I ran into Enno Masurel who made me think again about research. After much consideration, I decided to take up the challenge, and it has been an extremely interesting path since.

Looking back at these ten years, I must say that, although it was sometimes extremely difficult to combine the demands of research with my family and a rather busy job, I am glad that I took this challenge. I cannot begin to describe how much I have learned over the past few years, not only on the subject of this dissertation, but also on motivating myself, and dividing and prioritising my time.

First of all, I would like to thank my supervisors Enno Masurel, Henri de Groot, and, the sadly late, Piet Rietveld for their extremely useful ideas, suggestions, comments, and extraordinary patience. I have learned an enormous amount from all three of you, and I wish Piet was still among us to see the result. I would also like to thank Windesheim University of Applied Sciences and especially Ineke van der Wal for giving me this opportunity. My thanks also go out to Statistics Netherlands, the Dutch Patent Office, Frank den Hartog of ‘Dienstencentrum’, and all the respondents who made time in their busy schedules to talk to me.

Finally, I would like to thank my wife Caroline for keeping me motivated, taking on the (undoubtedly sometimes extremely boring) task of discussing my results, and reading my articles. Without you I would probably never have started and certainly not finished this PhD dissertation.

In memory of my father.

Mischa Mol
Zwolle, December 2016
1 Introduction

‘We think we have solved the mystery of creation.
Maybe we should patent the universe and charge everyone royalties for their existence’
(Stephen Hawking, TED talks 2008)

Since the beginning of time, man has innovated. First it started with inventions to keep human beings alive, like houses, clothes, and weapons. Later on, man also started to come up with other kinds of inventions, such as new ways of production and new forms of organizing and doing business. What all these inventions have in common is that they originated from ideas, which were often the result of many years of research. Ideas are non-rivalrous (Romer, 1990); that is, by using an idea one cannot exclude someone else from using the same idea. This non-rivalrous nature of ideas makes it possible for any competitor to copy an idea without having to incur any investments, and therefore be able to sell the innovation at a lower price than the inventor. This phenomenon, generally known as the ‘free-rider problem’ (Olson, 1965), would result in a lack of incentives for any firm or individual to invest in inventive activities, and would eventually lead to a suboptimally low rate of technological progress.

Capitalism needs continuous technological progress to function (Marx and Engels, 1906; Schumpeter, 1947), and ‘technological change ... arises from intentional investment decisions made by profit-maximizing agents’ (Romer, 1990, p. 71). Therefore, it is clear that a solution for the above-mentioned free-rider problem is of the utmost importance. A way to overcome this problem is by creating a temporary market imperfection: a monopoly just long enough for any inventor to recover his fixed costs of creating the invention, but also short enough to prevent him from limiting future technological progress. This is generally achieved by providing inventors the possibility to apply for a patent1 or another kind of registered type of formal protection (see Section 1.2.3).

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1 The word ‘patent’ originates from the Latin word ‘patère’ which translates as ‘to be open’, referring to the fact that after a limited lapse of time the knowledge or idea captured by the patent will be made public.
According to Frumkin (1945), the oldest reference to something we would nowadays call a patent is by the ancient Greek writer Athenaeus (300 AD), who wrote in his Deipnosophistae about culinary competitions in the city of Sybaris, that took place several centuries earlier. The winner was given an exclusive right to prepare his dish during the course of one year (Frumkin, 1945). However, it took several centuries before a more systematic approach to protect intellectual property was developed. According to North (1981), ‘The failure to develop systematic property rights in innovation up until fairly modern times was a major source of the slow pace of technological change’ (p. 164). Jones (1998) states that ‘The increasing scale of population along with the development of intellectual property rights — and of property rights more generally — combined to play a critical role in sparking the Industrial Revolution and the sustained economic growth that has followed’ (p. 95).

Nowadays, firms and governments in their attempts to increase competitiveness and economic growth are still trying to be more innovative than their competitors. This has resulted in many public initiatives to promote innovation, like the Lisbon Treaty (2000), and, more recently (2010), the European Commission, which states that (among other targets) by 2020 the research and development (R&D) investments of its Member States (which are currently below 2% on average) should increase to at least 3 per cent of their gross domestic product (European Commission, 2010). To facilitate these increased R&D investments, national and European programmes are being initiated to promote innovation in key areas (like health, transport and energy-friendly production systems), and the current intellectual property system is being modernised by introducing one unitary patent for the European Union (EU).²

1.1 Innovation

Although the concept of innovation, which is generally considered to be the commercialisation of an invention, has received much scholarly attention over the years, the foundations of modern thinking in the field of innovation were laid by Schumpeter (Schumpeter, 1947) when he introduced the concept of ‘creative destruction’. This concept of creative destruction can be roughly explained as the replacement of the existing with

² As part of the EU 2020 targets, one unitary European Patent is being created. Currently (i.e. in 2016), this unitary patent is in the process of being ratified by the Member States.
something new and better. More specifically, Schumpeter made a distinction between five different kinds of innovation:

‘The concept [...] covers the following five cases: (1) The introduction of a new good — that is one with which consumers are not yet familiar — or of a new quality of a good. (2) The introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new, and can also exist in a new way of handling a commodity commercially. (3) The opening of a new market, that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before. (4) The conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created. (5) The carrying out of the new organisation of any industry, like the creation of a monopoly position (for example through trustification) or the breaking up of a monopoly position’ (Schumpeter, 1934, p. 66).

However, this taxonomy focuses on innovations regarding product, process, market, source, and organisation. Nowadays, the introduction of a new service is also generally regarded as an innovation. This could be considered a sixth type of innovation.

To make some kind of differentiation between the degree of innovativeness of different innovations, scholars generally also make a distinction between ‘incremental’ and ‘radical’ innovations. Garcia (2010) defines incremental innovations as ‘...the refinement, improvement, and exploitation of existing innovations. Incremental innovations build on and reinforce the applicability of existing knowledge, and subsequently strengthen the dominance and capabilities of incumbent firms and the dominant design’ (p. 91). As examples of incremental innovations, Garcia (2010) mentions the video iPod, whitening toothpaste, and Windows Vista. Although one could argue that all innovations basically come down to the refinement, improvement, and exploitation of existing innovations, and therefore could be considered incremental innovations, scholars also distinguish radical innovations. Radical
innovations are much rarer. Garcia (2010) defines them as ‘...innovations with features offering dramatic improvements in performance or cost, which result in transformation of existing markets or creation of new ones. They involve fundamental technological discoveries for the firm, and thus are new to the firm and/or industry, and offer substantial new benefits and higher performance to customers’ (p. 91). As examples of radical innovations, Garcia (2010) mentions magnetic resonance imaging (MRI), personal computers, the Internet and cell phones.

Nowadays, innovation and innovation processes are changing: the rate of innovation is increasing (Florida, 2002); the mobility of knowledge workers is growing (Chesbrough, 2003); and the availability of private venture capital is rising (Chesbrough, 2003). As a result, the role of protective mechanisms like patents is changing (Artz et al., 2010). One example of such a change in innovation and innovation processes is the high adoption rate of open innovation principles. This concept, described by Chesbrough (2003), refers to a business model in which a firm not only relies on its own expertise and knowledge, but also includes external parties in the innovation process. A famous example is the Senseo coffee machine, developed in collaboration between Philips and Sara Lee. In this collaboration, Philips contributed its expertise in building coffee makers, while Sarah Lee was able to add its extensive knowledge of coffee. Regarding the protection of intellectual property in open innovation, Chesbrough et al. (2006) state that: ‘In open innovation, intellectual property represents a new class of assets that can deliver additional revenues to the current business model...’ (p. 5). Although the value of the protection of intellectual property seems clear, according to Paasi et al. (2010) it is not (joint) patents, but the much less formal confidentiality clauses that are typically used in open innovation processes.

Another example of such a change in innovation and innovation processes originated in the software industry and is called open source software. Although originating from software development, the concepts behind open source software have recently also been adopted in other areas (like microchip design, 3D printers, and speakers), which would probably make the term ‘open source innovation’ more accurate. Open source innovations consist of innovations the source code or design of which is publicly available. This public availability is limited by a licence that roughly states (at least in the most common open source licence) that any firm or individual can use the innovation and if necessary make
improvements. However, all changes have to be made public again under the same open source licence. As a result, firms committed to open source innovation do not have a unique product or other result of the innovation to sell (any other firm can sell the same since the innovation is freely available), but generally rely on a business model that ‘...depends on selling complementary goods or services to capture value’ (West, 2007, p. 4). Possible examples would be selling support or complementary innovations that are necessary for an innovation to function, and which are protected in a more traditional sense.

1.2 Protecting an innovation

Nowadays, a firm can choose from a wide range of informal and formal ways to protect an innovation, such as investing in a relationship based on trust; various technological means such as digital rights management (DRM) and anonymous chips; confidentiality clauses; trademarks; registered designs; and patents (see Table 1.1 for an overview). Recently, however, there has been much debate about patents and related protective actions (e.g. Jaffe and Lerner, 2011), as a result of the large increase of the number of patent applications (see Figure 1.1) and the even faster increase in related lawsuits (see Figure 1.2). As a consequence, it sometimes seems that patents and relative protective actions are more and more about strategy and promotion and hardly seem to be related to innovative activities as such (Artz et al., 2010).
Chapter 1

Figure 1.1 Patent applications at the European Patent Office and the US Patent Office

Sources: European Patent Office (2014) and USPTO Technology Monitoring Team (2014).
Note: In the US, patents are referred to as ‘utility patents’ (see Section 1.2.3).

Figure 1.2 Annual number of US Patent cases filed at the US Courts

Note: Comparable recent European data are not available because many EU Member States do not publish these data, or only publish them after a case is ruled by a judge or settled along the way, which sometimes takes many years (see, among others, Cremers et al., 2013).
Intellectual property rights, like patents, registered designs, and registered copyrights, can be used with different strategic intentions. First, patents can be used offensively (by covering inventions likely to be needed by competitors), or defensively (by covering inventions the firm wants to exploit itself). Gilardoni (2007) classifies the latter in three different intentions. The first defensive intention is to make money by licensing, selling the patent, creating strategic alliances, or exploiting the innovation directly. The second defensive intention is to increase the firm’s bargaining power for cross-licensing arrangements (exchanging licences with each other’s patents). The third defensive intention is to patent for promotional reasons.

However, patents are not the only way to protect an innovation. Nowadays, a firm that has innovated has the possibility to choose from a wide range of (combinations of) protective actions. An overview of possible protective actions with an increased level of formality, based on Kitching and Blackburn (1998), is shown in Table 1.1. The distinction between informal, non-registered formal and registered formal protection will be addressed in the following subsections.

### Table 1.1 A continuum of intellectual property protection practices

<table>
<thead>
<tr>
<th>Type of protection</th>
<th>No protection</th>
<th>Informal protection</th>
<th>Non-registered formal protection</th>
<th>Registered formal protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples</td>
<td>No protective actions</td>
<td>High trust relations</td>
<td>Confidentiality clauses in contracts</td>
<td>Patents</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintaining lead-time advantages</td>
<td>Licensing</td>
<td>Registered designs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Technological copy protections</td>
<td></td>
<td>Trademarks</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Actions to ‘keep things quiet’</td>
<td></td>
<td>Registered copyrights</td>
</tr>
</tbody>
</table>

Increasing degree of legal formality ➔

*Source: Freely adapted from Kitching and Blackburn (1998, p. 329).*
1.2.1 Informal protection

A firm seeking protection can decide to invest in informal protective actions. The amount of protection differs from case to case, and mainly depends on how much time and money a firm is willing to invest. Possible examples of informal means of protection would be investing in a relationship based on trust (e.g. by getting to know each other), or including some kind of technological copy protection (e.g. by using undocumented chips, or a digital rights management system). Another informal means to protect an innovation is to invest in maintaining lead-time advantages: to be that far ahead of any competitors, that by the time they have copied the idea, the firm is already one or two innovations further down the line. The latter is, according to Brouwer and Kleinknecht (1999) and Cohen et al. (2000), considered by the majority of firms to be one of the most effective ways to protect an innovation. A final example of informal means of protection would be actions to ‘keep things quiet’, like dividing information or just not telling anyone what you are doing.

1.2.2 Non-registered formal protection

More legally-oriented than the informal means to protect an innovation, but in general still much cheaper than the registered formal protective actions, are the non-registered formal protective actions. Many firms (also the ones that patent) include a paragraph in their employment contracts that prohibits an employee from sharing vital information with a competitor. Similar to this, many firms ask other involved parties to sign a confidentiality agreement or clause. Although these kinds of confidentiality clauses are generally limited in terms of the protection they offer (for example, it is hard to prove from where a competitor has acquired the information), they are rather popular due to the ease of use and low costs involved (Kitching and Blackburn, 1998). Sometimes a firm wants another firm to do the production and/or sale of the innovation, or has another reason to include other firms or individuals. A common way to prevent these firms or individuals from copying this innovation is by using a licence. Licensing usually means, that for a certain fee, a firm or person obtains the right to use or produce another firm’s innovation, under certain conditions and for a limited period of time. Licences are rather common among large firms with extensive patent portfolios and in the software industry.
1.2.3 Registered formal protection

Finally, we come to the most formal ways to protect an innovation, viz. patents, registered designs, trademarks, and registered copyrights. These protective actions differ from the non-registered formal protective actions by being registered with an independent third party, like a patent office or notary.

In most countries, patents (in the US called ‘utility patents’) are used to acquire a 20-year monopoly on a product or process that is new, innovative and industrially applicable. A firm that decides to patent can apply for a patent that is only valid in the country of origin; that is valid in a selection of European countries under the European Patent Convention (EPC); that is valid in other regional conventions for Africa, south-east Asia, part of the former Soviet Union; or that is valid in a selection of the 147 countries that signed the Patent Cooperation Treaty (PCT). However, these EPC and PCT applications do not result in one patent for all included countries; they standardise application procedures, but result in a single patent per included country that still requires translation and is subject to national law. After a firm has applied for a patent, a novelty search is carried out. On the basis of the results of this novelty search, an applicant can decide to continue with the procedure or not. Whether or not a patent is granted depends on the subject of the patent, and differs between countries and sometimes even between patent offices in the same country. The time between the date of filing and the final decision on whether or not a patent is granted can sometimes take many years, especially for European and other multinational patents that are subject to different national laws and requirements. In most countries (including the Netherlands), 18 months after the application, the patent application is made public by publishing it in the patent database, regardless of whether the patent is already granted or still somewhere in the application procedure. This publication is done for two reasons: first, it helps other inventors

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3 Most of the information in this section on patents, registered designs, trademarks, and registered copyrights can be found on the website of the Netherlands Enterprise Agency (www.rvo.nl).

4 Until 2008, the Netherlands also offered a 6-year patent specifically tailored for small and medium-sized enterprises. Contrary to the 20-year patent, the 6-year patent did not include a novelty search. Therefore, the 6-year patent was cheaper than a 20-year patent, but also introduced a lot of legal uncertainty, which eventually led to its abolition.

5 Patent offices do not publish the percentage of granted patents, only the number of patent applications and granted patents in a specific year. However, due to complex and slow application procedures, based on these numbers of patent applications and granted patents in a specific year it is hard to determine how many applications finally are granted. As a consequence, generally the number of patent applications is used instead of the number of granted patents.

6 Applicants can also choose to have their patent published earlier, generally for promotional reasons.
to check whether they are violating any (future) patents; second, it also stimulates others to innovate ‘around’ an invention, and thereby speeds up technological progress. According to the Netherlands Enterprise Agency (2014), the costs for a patent consist of: the fees for the Patent Office (less than 500 euros for a Dutch patent); the fees of the patent attorney to describe the invention in legal terms (between 2,000 and 10,000 euros for a Dutch patent); and the annual fees (starting in the fourth year, and increasing from 40 euros to 1,400 euros in the twentieth year). However, this does not include any potential enforcement costs in case of a conflict (average between 20,000 and 70,000 euros for a Dutch patent). The costs of patents valid in the European Union (EU), or in other parts of the world, are generally much higher and largely determined by the number of included countries.

Registered designs (also called ‘industrial designs’ or in the US ‘design patents’) can be used to protect the external appearance (colours, shapes, or materials) of an object for a period up to 25 years (within the EU). A firm in the Netherlands can apply for a registered design at the Benelux Office for Intellectual Property for Belgium, the Netherlands, and Luxemburg; the Office for Harmonization in the International Market for European designs; or the World Intellectual Property Organization for protection in all the 43 countries that signed the treaty. For a design to be registered, it has to be novel and must not stem from its function (e.g. not be a round shape for a wheel). Registered designs are generally not checked for novelty at registration, and therefore basically all applications are granted. European registered designs are made public after 30 months. Costs involved in obtaining a registered design are comparable to those of patents.

Trademarks are used to protect a brand name or logo that distinguishes products or services for a period of 10 years (within the EU), and can be renewed indefinitely. A firm in the Netherlands can apply for a trademark at the Benelux Office for Intellectual Property for Belgium, the Netherlands, and Luxemburg; or the Office for Harmonization in the International Market for European trademarks. Trademarks outside of Europe for those countries (currently 75) that signed the Treaty of Madrid are also applied for at the Benelux Office for Intellectual Property, but are actually dealt with by the World Intellectual Property Organization. Trademarks generally have to be new, distinctive, not deceptive, and not contrary to public morale. However, most of these criteria are not checked upon registration, resulting in almost all trademarks being approved. Trademarks are published as soon as they
are registered. Registration costs for a trademark are 240 euros for a Benelux trademark and 1,600 euros for a European trademark (Netherlands Enterprise Agency, 2014).

While patents, registered designs, and trademarks each focus on the protection of a different aspect of an innovation (technology, appearance, brand name, or logo), copyrights can, to a certain extent, also be used to protect the above-mentioned aspects of an innovation. However, compared with patents, registered designs, and trademarks, the protective usability of copyrights is low, since just a minor change of the original would be sufficient to create a new original work with accompanying copyright. Copyrights in the Netherlands protect up to 70 years after the death of the creator, and originate automatically when an original work is created. However, copyrights originate automatically by simply coming up with something new, and do not require any kind of registration, which makes it sometimes hard to determine who created something first. Therefore, most countries offer an option to register a copyright (e.g. at a notary office or the tax office) for a fee of around 100 euros. Although this still not prevents a competitor from copying an idea (with a minor adjustment), it does provide a certified proof that a firm invented something first and therefore can be used to defend against any patent infringement law-suits.

1.3 Determinants of protective actions

Most of the literature on determinants of protective actions focuses on patents and predominantly neglects alternatives, such as registered designs, registered copyrights, and confidentiality clauses. Regarding patents, scholars agree that the probability of the application for a patent increases with firm size (Amara et al., 2008; Arundel and Kabla, 1998; Baldwin et al., 2001; European Patent Office, 1994). In other words, small and medium-sized enterprises (SMEs) do not apply for a patent to protect their innovations with the same frequency as large firms do. According to the European Patent Office (1994), as much as two-thirds of the SMEs in the ‘production industries’ that conduct R&D do not

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7 SMEs are firms that ‘…employ fewer than 250 persons and which have an annual turnover not exceeding 50 million euro, and/or an annual balance sheet total not exceeding 43 million euro.’ (European Commission, 2005, p. 5).
8 Production industries are defined as follows: ‘Energy, mining, quarrying, earth moving’; ‘Chemical/pharmaceutical industry’; ‘Manufacture of metal products’; ‘Machines, vehicle building, components’; ‘Electrical engineering, manufacture of office machines, data processing equipment and facilities’; ‘Precision mechanics, optics’; ‘Food and luxury food industry’; ‘Textiles/clothing, leather, shoes, wood, paper’ (European Patent Office, 1994).
apply for patents. Kitching and Blackburn (1998) state that: ‘For many SME owners the high cost of acquiring formal intellectual property rights in terms of money and time means that informal protection methods are often preferred.’ (p. 328).

The effect of firm size on the use of other protective actions remains under-investigated. However, Amara et al. (2008) found a positive relationship between the firm size in terms of number of employees of Canadian knowledge-intensive business services (KIBS) and registered designs and trademarks, but not between firm size and any of the other included protective actions (registered copyrights, confidentiality agreements, secrecy, complexity of designs, and lead-time advantages).

Scholars also agree that the level of R&D investments is not only related to the probability of a firm introducing an innovation (e.g. Smit, 2010), but also to the probability of the application for a patent (e.g. Amara et al., 2008; Brouwer and Kleinknecht, 1999; European Patent Office, 1994). A firm that has invested an extensive amount of resources in R&D has a higher probability to come up with a patentable invention (e.g. Scherer, 1983). Such a firm would probably also be more interested in securing these high investments by some kind of protection. However, this relationship between R&D and the probability of a firm applying for a patent was not confirmed by Arundel and Kabla (1998) for innovations by Europe’s largest manufacturing firms. Furthermore, regarding the effect of R&D investments on the application for other protective actions, Amara et al. (2008) found the level of R&D investments of Canadian KIBS to be positively related to trademarks, secrecy, complexity of designs, and lead-time advantages, but not to registered designs and registered copyrights.

A third factor that is generally considered to be related to the probability of the application for one or more patents is the sector in which a firm operates (Arundel and Kabla, 1998; Brouwer and Kleinknecht, 1999; European Patent Office, 1994). Innovative firms operating in sectors in which the costs of innovation are high, and the costs of imitation are low, are more inclined to seek patent protection (Brouwer and Kleinknecht, 1999; Cohen et al., 2000). Brouwer and Kleinknecht (1999), as well as Arundel and Kabla (1998), found ‘chemicals and pharmaceuticals’, ‘mechanical engineering’, ‘office and computing equipment’, ‘electrical equipment’, and ‘precision instruments’ most patent-intensive for product innovations and ‘chemicals and pharmaceuticals’, and ‘rubber and plastics’ to be
most patent-intensive for process innovations. Again, the relationship between sector and other protective actions remains largely unclear.

Fourth, according to Brouwer and Kleinknecht (1999), collaboration increases the propensity to patent. However, according to Paasi et al. (2010), not patents, but confidentiality clauses are typically used in open innovation processes.

A final factor that is commonly accepted as being related to the probability of the application for (or owning of) one or more patents is the type of innovation. According to Arundel (2001), Cohen et al. (2000), and Levin et al. (1987), in the manufacturing sectors (other sectors were not included by these scholars), product innovations are more often protected by patents than process innovations. According to Cohen et al. (2000), this is because: ‘Process innovations are less subject to public scrutiny and thus can be kept secret more readily’ (p. 10).

Scholars who also include other forms of protection found that many firms consider patents as one of the least effective ways to protect an innovation (Brouwer and Kleinknecht, 1999; Cohen et al., 2000). Especially SMEs favour informal ways of protection (Kitching and Blackburn, 1998). SMEs differ substantially from large firms, which is caused by what Welsh and White (1981) describe as ‘resource poverty’: the lack of people, money, knowledge, and skills. The discussion on the difference between innovation in small entrepreneurial firms and larger, more routinised, firms dates back to Schumpeter, but was described in detail by Nooteboom (1994). According to Nooteboom (1994), this lack of resources of SMEs leads to a different kind of innovations: SMEs are not really suitable for radical innovations (which generally require many resources), but due to their relatively small size are more flexible, motivated (in terms of commitment) and original than larger firms. According to Nooteboom (1994), this makes SMEs extremely well-suited for incremental innovations.
1.3.1 SMEs and protection

As described at the beginning of this section, many SMEs do not apply for patents. A few telephone conversations with acquainted owner-managers of SMEs at the beginning of this research revealed reactions varying from: ‘Life is too short’ to ‘Patents do not apply for me, because I am only the owner of a small firm.’ Next to this reluctance, perhaps due to a lack of knowledge or understanding, there are also other barriers that prevent SMEs from applying for a patent.

One owner of a medium-sized firm stated that he wanted to set an example for the industry and therefore decided not to protect his innovation at all: ‘a shroud has no pockets, so why make a lot of money you cannot spend’ (see Appendix 2.A).

First of all, incremental innovations are sometimes hard to patent, since they do not always meet the formal requirements of being new and innovative. Furthermore, for the incremental innovations that do meet the formal patent requirements, sometimes it is not necessarily cost-effective to apply for a patent. For example, why would a small or medium-sized firm apply for 20 years of protection for a product that is only expected to sell for one or two years? Second, patents may also lead to expensive legal conflicts that many SMEs cannot afford. To cite one of our respondents: ‘If you protect something, you also need the time and money to back it up in a court of law!’ As a consequence, SMEs favour less formal ways of protection (Kitching and Blackburn, 1998), like confidentiality clauses, investing in trust relationships, technological copy protections, and investing in maintaining a lead-time advantage.

The owner of a medium-sized firm mentioned that in the case of a conflict over a patent, the old Dutch saying ‘Wie pleit om een koe, geeft er één toe’ applies. This roughly translates as: ‘who pleads for a cow, loses one’. According to him, this saying means that, while two parties are fighting over a patent (cow), the profits (milk) end up with the lawyers (see Appendix 2.A).
How SMEs make the decision whether or not to apply for a certain kind of protection is also an interesting question, especially because a substantial part of the SMEs do not have an intellectual property strategy (Blind and Ebersberger, 2007). The owner of a small or medium-sized firm has a major impact on his firm (Fassin et al., 2011). Therefore, we expect him to play a key role in the decisions regarding the protective actions. As a consequence, deeper insight into the background and experience of the entrepreneur is of importance.

The owner of a medium-sized firm in the manufacturing sector used as a rule of thumb that anything that would not fit on the back of a beer mat was too complex to patent, and therefore would not hold in case of a conflict (see Appendix 2.A).

1.4 The relationship between protection and firm performance

Next to knowing which factors determine whether or not a firm decides to protect its innovation by means of a patent, registered design, trademark, and/or registered copyright, it is also of importance to determine the effect of the above-mentioned registered formal protection on the performance of the firm. Any firm willing to invest time and money in a form of registered formal protection would like to know what the effect will be, and whether or not the benefits outweigh the costs.

Patents and other registered formal protective actions are meant to give an inventor an advantage over his direct rivals by securing a temporary monopoly on the exploitation of whatever is protected. However, as discussed in Section 1.2, owing to the large increase of the number of innovations and lawsuits, it seems that nowadays registered formal protection is more and more about strategy and promotional reasons and, as suggested by Artz et al. (2010), is ‘...only distantly related to a firm’s innovation efforts ’ (p. 736).

The literature on this subject suggests a positive effect of patents (and to a lesser extent, registered designs and trademarks) on the market value of (large) publicly traded firms. However, first of all, using market value as an indicator of firm performance incorrectly assumes the stock market to work efficiently (Griffiths et al., 2005). Second, most firms are not publicly traded. On the contrary, in the Netherlands only around 100 of the

9 Throughout this dissertation every time we use ‘his’ or ‘he’ please also read ‘her’ or ‘she’.
860,000 firms are publicly traded (Frentrop, 2012). As a consequence, although these findings may be applicable to publicly traded firms, this may not be the case for the majority of firms.

1.5 Research questions and design

To summarise the above, innovation is of vital importance for capitalism to function successfully. However, a firm is only willing to invest in innovation if it expects to benefit from it. In order to achieve this, the innovative firm wants to prevent competitors from copying its innovation. This is why our current intellectual property system eventually came into existence, enticing firms to innovate by offering them a temporary monopoly secured by a patent, registered design, trademark, or registered copyright. However, the literature in this field of research suggests that many innovative firms, particularly SMEs, do not protect their innovations with patents or other forms of registered formal protection. They generally prefer to protect their innovations in less formal ways, or choose not to protect their innovations at all. However, which specific alternative protective actions they choose, and which factors determine the decision to use an alternative form of protection remains insufficiently studied. Finally, as modern innovation seems to differ from innovation in the past (see Sections 1.1 and 1.2), we need to determine whether or not protecting with a patent, registered design, trademark, or registered copyright is still positively related to firm performance at all.

This thesis aims to fill the research gaps discussed above by presenting new insights into the protective behaviour of both SMEs and large firms in the Netherlands. This is achieved by answering the following three research questions:

(i) How do firms protect their innovations?
(ii) Which factors determine the choice of a specific form of protective action?
(iii) Is the use (of a specific form) of registered formal protection related to firm performance?

The empirical research was conducted in the Netherlands, which, in spite of its relatively small size, can be considered a rather innovative country based on its top-10 position in both academic ranking (Center for World-Class Universities, 2013) and patent applications (World Intellectual Property Organization, 2012). An overview of the research design is presented in Figure 1.3.
Since most of the literature only focuses on patents and large firms, and not so much on the protective behaviour of SMEs, we decided to start in Chapter 2 with 20 exploratory interviews with owner-managers of SMEs, and make a comparison between the patent data of SMEs and the patent data of large firms in the north-east of the Netherlands (obtained from the Netherlands Patent Office). The results, although limited generalizable, give us some first insight into how SMEs protect their innovations as compared with large firms (research question i), and which factors determine this decision (research question ii). After this combination of interviews and an analysis of the patent data, we decided to gain more in-depth insight by conducting six case studies among SMEs from the manufacturing and IT sector. These case studies, the results of which are presented in Appendix 2.A, deal with all the above-mentioned research questions i, ii, and iii, specifically for SMEs.

To gain more sector-specific insight into the protective behaviour of SMEs, in 2009–2010 we collaborated with multiple Dutch sector associations (representing the rubber and plastics industry; the metal industry; the furniture industry; the installation industry; the
supplying industry; and the printing industry) to send a survey to their members. The aim of this study was to gain more insight into what determines the degree of formality of the protection (research questions i and ii). However, with the exception of the printing industry, the response to our survey was very low even after multiple reminders. Therefore, we decided to omit the respondents from the other industries and focus solely on the printing industry. This study, whose results are presented in Chapter 3, consisted of questions on the firm, a recent product and/or process innovation, and how and why the respondents decided to protect it.

The study of the literature (mostly on large firms) and the studies on the protective behaviour of SMEs, as described in Chapters 2 and 3, give us insights (although somewhat biased by being sector- and/or region-specific) into the protective behaviour of SMEs and what determines the degree of formality of the protection. Because registered copyrights cost less and also offer less protection than patents and registered designs (see Section 1.2.3), we used the data of 3,341 innovative firms (firms engaged in innovation activities) from the Dutch 2006 Community Innovation Survey (CIS) to investigate in Chapter 4: (a) whether registered copyrights and patents/registered designs have an ordinal setting; and (b) whether the known determinants of the application for patents also apply on registered designs and registered copyrights. The outcomes provide more quantitative insights on research questions i and ii, including both large firms and SMEs.

In Chapter 5, we take the 3,163 firms from the Dutch 2006 CIS that actually introduced an innovation, and match these with survival records, employment records, and sales records from the Dutch General Business Register (Algemene Bedrijven Register) and Production Statistics (Productie Statistiek) for the years 2006–2009. The aim of this study was to determine whether or not protecting with a patent, registered design, trademark, or registered copyright is related to firm survival and growth (research question iii).

Finally, in Chapter 6 we combine and discuss our results from the previous chapters, and present answers to the previously discussed research questions.

10 Although trademarks were also part of the 2006 CIS, we did not include trademarks in Chapter 4 for two reasons: (a) trademarks do not fit in our potential ordinal setting; (b) many of the firms that applied for a patent or registered a design or copyright also registered a trademark and, owing to privacy regulations by Statistics Netherlands, we had no option to deal with all combinations of protective actions separately.
2 Innovation protection by SMEs in the north-east of the Netherlands\textsuperscript{11}

2.1 Introduction

During the last few decades, the European economies have been striving to become the most competitive, dynamic and knowledge-intensive in the world. This has led to many public initiatives to promote innovation and R&D, such as the Lisbon Treaty (European Council, 2000) and the Europe 2020 targets (European Commission, 2010). However, although Europe is among the top of the world when it comes to research and education, somehow European businesses fail to commercialise this, which is evidenced by their lack of R&D investments and patents (European Council, 2000). An interesting group of enterprises that rarely apply for patents are the small and medium-sized enterprises (SMEs). According to the European Patent Office (1994), as much as two-thirds of the SMEs in the production industries that conduct R&D do not apply for patents.

This chapter discusses the results of an analysis of all (granted) patent applications between January 1995 and July 2005 (publicly available by August 2005) in the Zwolle Chamber of Commerce region (located in the north-east of the Netherlands), which is a region that contains relatively many SMEs (see Section 2.3). In order to also gain insight into the alternative protective actions that SMEs use and the factors that determine whether a firm applies for a patent or uses another kind of protection, these results of the analysis of the patents from the Zwolle Chamber of Commerce region are combined with 20 exploratory interviews (conducted in 2006 and 2007). These interviews were conducted with owner-managers of SMEs in the north-east of the Netherlands. These interviews focused not only on the way in which SMEs protect their innovations, but also on the relationship between the innovation, the firm, and the protection. In Section 2.2 the literature regarding SMEs and

\textsuperscript{11} This chapter is based on Mol and Masurel (2011), but has been partly rewritten to increase consistency throughout this thesis, and to add a number of clarifications.
protection is reviewed, followed by a description of the characteristics of the region in Section 2.3. Section 2.4 deals with the methodology. Section 2.5 analyses the patent data of the region, and Section 2.6 discusses the results of the 20 interviews with the owner-managers of SMEs on their firms, innovations, and protection. Finally, our conclusions are presented in Section 2.7.

### 2.2 Theoretical framework

This section discusses the literature on SMEs and what makes them different from large enterprises. The consequences of these characteristics for the innovation process are discussed, after which the reasons SMEs have for not using patents to protect their innovations are explored, and the alternative methods of protection that SMEs use are presented.

#### 2.2.1 Innovation and SMEs

According to the resource-based view (e.g. Barney, 1991), firms gain competitive advantage through the application of valuable resources. To achieve this competitive advantage, according to Barney (1991), firms need to focus on those resources that are valuable, rare, imitable, and non-substitutable. Patents and other kinds of protection are supposed to increase the inimitable level of intellectual property.

Innovation in SMEs differs substantially from innovation in large enterprises. According to Welsh and White (1981), the main reason for this difference is the ‘resource poverty’ of SMEs. Nooteboom (1994) described in detail how this lack of resources for SMEs leads to a different kind of innovation: SMEs are not really suitable for radical innovations that require many resources, but due to their relatively small size SMEs are more flexible, motivated (in terms of commitment), and original than larger firms. These characteristics make SMEs, according to Nooteboom (1994), more suited for incremental innovations than large firms.

Since many incremental innovations are not cost-effective to patent, or are not patentable due to legal boundaries (see Section 1.2.3), the innovativeness of SMEs is unlikely to be measured correctly by patents. Patents as an innovation indicator ‘...underestimate the rate of small firms that innovate’ (Kleinknecht et al., 2002, p. 113). The same holds for R&D

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12 The issues addressed in this section have already been discussed in detail in Sections 1.2, 1.3 and 1.4.
investments: ‘...standard R&D surveys tend to severely underestimate the small-scale and often informal R&D activities in smaller firms.’ (Kleinknecht et al., 2002, p. 111). Therefore, SMEs are probably more innovative than one would conclude when looking only at patents and R&D investments.

2.2.2 Patents and SMEs
The use of patents has been the subject of much research. One common conclusion is that there is a positive relationship between firm size and the probability of a firm to apply for one or more patents to protect an innovation (Amara et al., 2008; Arundel and Kabla, 1998; Baldwin et al., 2001; European Patent Office, 1994). According to the European Patent Office (1994), as much as two-thirds of the SMEs in the production industries that conduct R&D do not apply for patents. A second factor that is positively related to the probability of a firm applying for a patent to protect an innovation is the level of R&D investments (e.g. Amara et al., 2008; Brouwer and Kleinknecht, 1999; European Patent Office, 1994). Firms that invested more in R&D are also more inclined to seek protection through patents. According to the European Patent Office (1994), Brouwer and Kleinknecht (1999) and Arundel and Kabla (1998), a third factor is the sector in which the firm operates. According to both Arundel and Kabla (1998) and Brouwer and Kleinknecht (1999), firms operating in the following sectors are more inclined to apply for patents to protect their innovations: ‘chemicals and pharmaceuticals’; ‘rubber and plastics’; ‘mechanical engineering’; ‘office and computing equipment’; ‘electrical equipment’; and ‘precision instruments’. Another result is that product innovations are more often protected by patents than process innovations (Arundel and Kabla, 1998; Cohen et al., 2000; Levin et al., 1987). Furthermore, Masurel (2005) found that, among innovative SMEs, higher-educated managers are more inclined to use patent information. Finally, Van der Panne (2004), who focused on young entrepreneurial firms that had recently introduced an innovation, found the age of the firm to be positively associated with the propensity to patent an innovation.

2.2.3 Other forms of protection and SMEs
The literature on innovation protection by SMEs mainly focuses on the reasons for not choosing to patent, while the reasons for preferring one alternative over another are insufficiently studied. Also the possible relationships between the characteristics of SMEs and
their owner-managers or between the innovation itself, on the one hand, and the adopted forms of protection, on the other, are insufficiently studied.

Based on Kitching and Blackburn (1998), the methods of intellectual property protection can be divided into four groups with an increasing level of legal formality. The first is taking no conscious protective actions at all. The second group includes the informal protective actions, such as secrecy, developing high-trust relations (with customers, and/or suppliers, and/or employees), technical copy protection, and maintaining lead-time advantages. The third group consists of non-registered formal protective actions: for example, licensing or confidentiality clauses with customers, suppliers, and employees. The fourth and last group consists of the registered formal protective actions, i.e. patents, registered designs, trademarks, and registered copyrights. Regarding the effectiveness of different protective actions, Cohen et al. (2000), in their research on US manufacturing firms with at least 5,000,000 US dollars in annual sales or at least 20 employees, showed large differences between manufacturing sectors, but in all of them patents are considered to be one of the least effective forms of protection in both product and process innovations. Similar results were found by Brouwer and Kleinknecht (1999). According to their respondents, maintaining lead-time advantages, keeping qualified people in the firm and secrecy are more effective than patents in both product and process innovations.

Specifically on the protective actions of SMEs, Kitching and Blackburn (1998) argued that SMEs favour informal and non-registered formal protective actions over registered formal protective actions. In particular, trust relations, maintaining lead-time advantages, and confidentiality clauses are the protective actions most favoured by SMEs. According to Kitching and Blackburn (1998), the reasons for using these kinds of protection instead of registered formal protective actions are primarily that these alternatives are cheaper and are generally already a part of (or embedded more easily into) a firm’s routine business practices.

2.3 The study region
Due to data availability, this study focuses on the Zwolle Chamber of Commerce (or NUTS-3) region (see Figure 2.1), which is located in the north-east of the Netherlands. This region has one municipality with more than 100,000 inhabitants, viz. Zwolle. The other municipalities, such as Steenwijk, Hardenberg, and Kampen, have less than 50,000
Inhabitants (Statistics Netherlands, 2011). The trade register of the Dutch Chamber of Commerce (2006) shows the region to have relatively many SMEs (based on the number of employees\textsuperscript{13}): around 26,500 compared with 26 large firms (0.1 per cent). This makes the percentage of large firms in this region around three times lower than the 0.3 per cent for the Netherlands as a whole (Statistics Netherlands, 2014). Looking at the employment per sector we find, with the exception of a high concentration of the cleaning industry, the region to be rather comparable to the Netherlands as a whole (De Dominicis et al., 2008). Wages are slightly below the national average, although a substantial part (around half) can be explained by the lower average educational level which characterises the region’s workforce (Groot et al., 2014).

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Figure_2_1.png}
\caption{The case study region (in grey)}
\end{figure}

\textsuperscript{13} Throughout this thesis, in line with the literature, we tend to use the term ‘employee’. However, in all the chapters this also includes employed owners and family members.
2.4 Methodology
The methodology in the research for this chapter is twofold. First, we looked at the patent data of the region (obtained from the Dutch Patent Office) to see how many of all the patents in the region are owned by SMEs. The data consisted of both Dutch and European Patents (valid in the Netherlands) that were applied for during the period January 1995–July 2005 and that were granted.\footnote{Since patents are kept secret for 18 months (unless the holder chooses otherwise, generally for promotional reasons), our data set contained all the granted patents for the years 1995–2003 and 38 granted patents that were applied for after January 2003, but were made public before July 2005 at the request of the holder.} After cleaning up the data,\footnote{Our patent data had a number of misspelling issues, which were manually corrected. Furthermore, a number of patents occurred multiple times, naming different firms that were all part of the same holding. Every time this was discovered, double records were deleted keeping only the one holding.} we determined whether the remaining patents belonged to a small or medium-sized firm or to a large firm, by matching the names of the businesses with the data kept by the local Chamber of Commerce.\footnote{Since employment records kept by the Chamber of Commerce are not frequently updated, instead of distinguishing many firm sizes, we chose only to determine whether the patent was applied for by an individual, a firm that employs less than 250 persons, or a large firm.}

After the analysis of the patent data, the results of 20 interviews with owner-managers of SMEs in the region are discussed in order to gain insight into the use of alternative protective actions and the reasons for specifically choosing this or these protective action(s). The interviews also contained questions on the demographics of the firm, the owner-manager, and the innovation. These interviews were conducted by seven interviewers, who were centrally briefed by the authors and were handed out a survey they had to fill out during the interviews (see Appendix 2.B). The owner-managers were selected by the interviewers from the network of Windesheim University of Applied Sciences. The selection was based on their firms’ innovativeness (according to the interviewer) and active engagement with student internships.

2.5 Analysis of the regional patent data
This section starts with a short introduction on patents in the Netherlands, followed by a discussion of the results of an analysis of the patents owned by SMEs and large firms within the region.
2.5.1 Patents in the Netherlands\textsuperscript{17}

Besides 20-year Dutch and European patents (valid in the Netherlands), the Netherlands also used to offer a 6-year Dutch patent (abolished in 2008: see Section 1.2.3), which was basically a cheaper short-term version of the regular patent.

For a patent (both a 6-year and a 20-year patent) to be valid, it needs to meet three requirements: it needs to be new; innovative; and industrially applicable. A few categories such as software, books, formulas and paintings are excluded from patents. Although both 20-year Dutch and European patents are checked against these three requirements, the situation was different for 6-year Dutch patents. After a firm filed for a 6-year Dutch patent, it was granted without any investigation. An investigation with respect to these three criteria was only conducted in case of a conflict.

2.5.2 Patents in the region

Analyses of the patent data of the Zwolle Chamber of Commerce region show that 652 patents were granted to 213 businesses between 1995 and 2005. As we can see in Table 2.1, 29.3 per cent (191) of these patents are owned by nine large firms (on a total of 26 large firms); and 17.0 per cent (111) of these patents are owned by individuals or by firms that have been dissolved. The remaining 53.7 per cent (350) of these patents are owned by 140 SMEs (0.5 per cent of a total of 26,000). Apparently, 99.5 per cent of the SMEs use alternative protective actions, use none at all, or did not innovate, which confirms the findings from the literature (see Section 2.2.2) of SMEs owning few patents.

Comparable data for the Netherlands as a whole are hard to find. However, Statistics Netherlands does provide the percentage of patent applications for firms employing, over the years 2000–2005, between 0 and 200 employees and for firms employing over 200 employees (instead of the more common definition according to which firms smaller than 250 employees are classified as SMEs). When we compare these percentages with our results, we find the percentage of patents owned by SMEs in the Zwolle Chamber of Commerce region (53.7 per cent of the total of 652 patents) to be higher than the national percentage of around 25 per cent of all patents being applied for by SMEs (Statistics Netherlands, 2014). The percentage owned by individuals or dissolved firms (17.0 per cent of 652 patents) is close to the national number of 13 per cent of all patents that are applied for by individuals (the 4 per cent

\textsuperscript{17} The issues addressed in this subsection have already been discussed in detail in Section 1.2.3.
difference possibly being the dissolved firms). Finally, the percentage of patents owned by large firms in the Zwolle Chamber of Commerce region (29.3 per cent of the total of 652 patents) is lower than the national percentage of around 62 per cent of all patents being applied for by large firms (Statistics Netherlands, 2014). However, when we take the low number of large firms in the region into account (0.1 per cent instead of 0.3 per cent for the Netherlands as a whole), these percentages are actually much closer to the national average.

| Table 2.1 Patents by different types of businesses in the Zwolle Chamber of Commerce region |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
|                                 | 6-year Dutch Patent | 20-year Dutch Patent | 20-year European Patent | Total          |
| Large firms                     | 6.3% (12)         | 50.8% (97)        | 42.9% (82)           | 100% (191)     |
| SMEs                            | 18.9% (66)        | 42.0% (147)       | 39.1% (137)          | 100% (350)     |
| Individuals/Dissolved firms     | 32.4% (36)        | 41.4% (46)        | 26.1% (29)           | 100% (111)     |
| Total                           | 17.5% (114)       | 44.5% (290)       | 38.0% (248)          | 100% (652)     |

*Note: The total number of patents is presented in parentheses.*

When we look at the differences between the three types of patents in Table 2.1, we find that 6.3 per cent of the patents that are owned by large firms are 6-year Dutch patents, while the dominant types are 20-year Dutch patents (50.8 per cent) and European 20-year patents (42.9 per cent). SMEs are, compared with large firms, more willing to opt for a 6-year patent (18.9 per cent) instead of the longer-lasting 20-year patents (42.0 per cent 20-year Dutch and 39.1 per cent 20-year European patents), which could be explained by their more incremental kind of innovations (with a resulting shorter ‘life span’), their more short-term focus, 6-year patents being cheaper, or the slightly easier way of application due to a lack of novelty search.

Another difference between large firms and SMEs can be found looking at the number of patents that were left to expire by their holders (by not paying the annual fee, or not delivering the translation obliged for European patents) before their 6 or 20 years had passed (see Table 2.2). Looking at the 6-year Dutch patents, we find that 6 out of 12 (50.0 per cent) of the 6-year Dutch patents owned by large firms expired. This is slightly higher than the 27 out of 66 (40.9 per cent) of the 6-year Dutch patents owned by SMEs that expired before their 6 years had passed. However, when we look at the 20-year Dutch and European patents in Table 2.2, we find that the percentage of patents owned by large firms that expired before their 20 years have passed is about double that of SMEs. Apparently, SMEs that own the more expensive 20-year patents seem to value these patents more than large firms do.
Table 2.2 Percentage of patents that prematurely expired, by different types of businesses in the Zwolle Chamber of Commerce region

<table>
<thead>
<tr>
<th></th>
<th>6-year Dutch Patent</th>
<th>20-year Dutch Patent</th>
<th>20-year European Patent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large firms</td>
<td>50.0% (6/12)</td>
<td>51.5% (50/97)</td>
<td>34.1% (28/82)</td>
<td>44.0% (84/191)</td>
</tr>
<tr>
<td>SMEs</td>
<td>40.9% (27/66)</td>
<td>25.9% (38/147)</td>
<td>13.1% (18/137)</td>
<td>23.7% (83/350)</td>
</tr>
<tr>
<td>Individuals/Dissolved firms</td>
<td>38.9% (14/36)</td>
<td>47.8% (22/46)</td>
<td>41.4% (12/29)</td>
<td>43.2% (48/111)</td>
</tr>
<tr>
<td>Total</td>
<td>41.2% (47/114)</td>
<td>37.9% (110/290)</td>
<td>23.4% (58/248)</td>
<td>33.0% (215/652)</td>
</tr>
</tbody>
</table>

2.6 Results of the interviews

This section discusses the results of 20 interviews with owner-managers of SMEs, selected from the network of Windesheim University of Applied Sciences. First, the characteristics of both the small or medium-sized firm and the owner-manager are summarised. Secondly, the results of the questions on the subject of innovation are presented. Thirdly, the protection of innovations is discussed. Finally, the relationship between the characteristics of the innovation, the small or medium-sized firm, and the owner-manager, on the one hand, and the protective actions on the other hand, are discussed.

2.6.1 The SMEs and the respondents

The SMEs have an average size of 55 employees (the standard deviation was 53). Most of them were founded after 1970. 13 of the SMEs operate in the manufacturing sector, while the remaining seven SMEs are active in the services sector. 55 per cent of the respondents have a Bachelor’s or Master’s degree, which is higher than the 40.3 per cent of owner-managers of SMEs with a Bachelor’s or Master’s degree that was found by Van Essen (2008). This higher educational level could be caused by the low number of respondents and/or by selecting only owner-managers of SMEs from the network of Windesheim University of Applied Sciences who were considered innovative (by the interviewers), which may include a large number of higher-educated respondents.

2.6.2 The innovations by the SMEs

On the subject of innovation, all respondents consider their company to be innovative or very innovative. However, almost all respondents want to improve the innovativeness of their company. The average level of R&D expenditures of 107,000 euros during the last year varies substantially among the different SMEs (the standard deviation is 182,000 euros). Six of the
owner-managers did not know how much they have spent on innovation. Most of the innovations are new or improved products and new or improved processes (see Figure 2.2).

Figure 2.2 Types of innovations (multiple answers possible)

2.6.3 The protection of the innovations by the SMEs
The questions on the subject of innovation protection shows that seven of the 20 SMEs use a form of registered formal protection, mostly patents. Five firms use one or more forms of non-registered formal rights (mostly confidentiality clauses) as their most formal protection. Three firms use an informal form of protection as their most formal adopted form of protection, and five of the respondents do not use any form of protection at all (see Figure 2.3). This does not confirm the findings of Kitching and Blackburn (1998), who found informal protection to be most popular. This difference again may have been caused by the low number of respondents and/or including only respondents from the network of Windesheim University of Applies Sciences who were considered innovative (by the interviewers).
Two of the interviewed owner-managers mentioned that they considered patents to be reasonably effective, but they found them expensive, and therefore they considered alternatives every time they innovated. One owner-manager argued that the market changes so rapidly that any form of protection would be entirely useless. Another owner-manager said that they were operating in such a niche market that protection would be of little avail, or that any form of protection would be a waste of time, energy and money. A final interesting remark on the matter of patents came from an owner-manager who usually withdrew the application after the 18-month secrecy period, because, in his view, it is not of much use after that period.

2.6.4 The relationship between the SMEs and the degree of formalisation

The differences between the degree of formalisation of the protection, on the one hand, and the age of the firm; the level of R&D expenditures (x €1,000); the firm size in terms of number of employees (in full time equivalents); the type of innovation; and the educational level of the owner-manager, on the other, are visualised in Figures 2.4–2.8. Looking at the results, with the exception of the educational level of the owner-manager and the type of innovation, our variables increase with the degree of formality of the protection. This
confirms our expectations that there is a positive relationship between our independent variables and the formality of the protection.

**Figure 2.4 Average age of the firms (in years) for different degrees of formality of protection**

![Average age of the firms](image)

**Figure 2.5 Average level of R&D investments (x €1,000) for different degrees of formality of protection**

![Average level of R&D investments](image)
**Figure 2.6 Average size of the firms (in employees) for different degrees of formality of protection**

![Bar chart showing average size of firms for different types of protection](chart1.png)

**Figure 2.7 Counts of type of innovation for different degrees of formality of protection**

![Bar chart showing counts of types of innovation](chart2.png)
Figure 2.8 Educational level of the owner-manager for different degrees of formality of protection

Because the decision for a certain kind of formalisation of the protection is generally determined by a combination of these (and probably even more) factors and not by a single one of them, we decided to also include an exploratory multivariate ordered probit analysis (despite the admittedly very low number of respondents). The aim was to determine whether or not the age of the firm (Age); the level of R&D investments (R&D); the size of the firm in number of employees (Size); whether or not the innovation is a product innovation (Product); and whether or not the owner-manager completed higher education (Edu) are statistically significantly related to the degree of formalisation of the protection (defined as: 0 no protection; 1 informal protection; 2 non-registered formal protection; 3 registered formal protection). This resulted in the following ordered probit model:18

\[ Y_i^* = \alpha_i + \beta_1 Age_i + \beta_2 R&D_i + \beta_3 Size_i + \beta_4 Product_i + \beta_5 Edu_i + \varepsilon_i \] (2.1)

18 Ordinal regression models, such as ordered probit and logit models, assume the ordinal dependent variable \( Y \) to be generated by an unobserved continuous variable \( Y^* \). The values of \( Y \) (no protection; informal protection; non-registered formal protection; registered formal protection) depend on whether or not \( Y^* \) has crossed a certain threshold value (Greene, 2003).
Although the results presented in Table 2.3 are limited by only having 20 observations, they confirm our expectations based on both the literature and Figures 2.4, 2.5 and 2.7 by showing a statistically significant relationship between the formalisation of the protection, on the one hand, and the age of the small or medium-sized firm, the level of R&D expenditures, and the product innovation dummy, on the other. However, contrary to our expectations based on both the literature and Figure 2.6, firm size is not statistically significantly related to the degree of formalisation of the protection. This lack of a statistically significant relationship could be caused by the low variance in size (the average size was 55 employees, and the standard deviation was 53). As we already expected based on Figure 2.8, we also find no statistically significant relationship between whether the owner-manager has a Bachelor’s or Master’s degree, on the one hand, and the formality of the protection on the other. This difference may have been caused by selecting only owner-managers of SMEs that were considered innovative, as these respondents are more focused on innovation and therefore may also be better informed on related subjects such as patents and other registered formal forms of protection.

**Table 2.3 Determinants of the degree of formalisation**

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.066*</td>
<td>0.039</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>0.160**</td>
<td>0.008</td>
</tr>
<tr>
<td>Size</td>
<td>−0.011</td>
<td>0.013</td>
</tr>
<tr>
<td>Product innovation</td>
<td>3.299**</td>
<td>1.571</td>
</tr>
<tr>
<td>Higher education</td>
<td>1.167</td>
<td>0.913</td>
</tr>
<tr>
<td>Number of observations</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>McFadden’s pseudo $R^2$</td>
<td>0.432</td>
<td></td>
</tr>
</tbody>
</table>

*Notes:* * significant at the 10% level; ** significant at the 5% level.
2.7 Conclusions

The analyses of the patent data of the Zwolle Chamber of Commerce region have confirmed the national and European findings that SMEs do not own many patents. SMEs that do own patents, own relatively more short-term (6-year) patents than large enterprises, but both types of firms still own more 20-year Dutch and European patents. Although the fact that the majority of the SMEs favour the 20-year patents strengthens the case for the abolition of the 6-year patent, it still remains to be seen whether the 17.5 per cent of the firms that have applied for a 6-year patent would also have applied for a 20-year patent. Furthermore, the percentage of patents owned by SMEs that expired prematurely is about half that of large firms. This seems to confirm that, maybe due to scarce resources, SMEs are more selective than larger firms regarding which innovations to protect with an expensive patent.

Although the results of our interviews may be biased by the low number of respondents and/or by selecting only (on average) higher-educated owner-managers of SMEs that were considered innovative from the network of Windesheim University of Applied Sciences, a number of interesting observations can be made. First of all, although our sample may not be representative for SMEs in general, the interviews confirm that most owner-managers of SMEs (13 out of 20) prefer other forms of protection than registered formal protection. The results of the interviews also confirm that the age of the small or medium-sized firm, the level of R&D investments, and the type of innovation, all show a positive statistically significant relationship with the degree of formalisation of the protection. We are unable to confirm a statistically significant relationship between the educational level of the entrepreneur and the formality of the protection, and between the size of the firm and the formality of the protection. However, this lack of statistically significant results for size and educational level seems to be caused by the low number of respondents, the low variance in size, and the selection of owner-managers from the network of Windesheim University of Applied Sciences.
Appendix 2.A Six case studies on innovation protection by SMEs

2.A.1 Introduction

A group of enterprises that has received much attention in recent years are the small and medium-sized enterprises (SMEs), which are, according to Nooteboom (1994), good at incremental innovations. However, the R&D investments and patent portfolios of SMEs are relatively small. According to the European Patent Office (1994), two-thirds of the SMEs in the production industry that conduct R&D do not apply for patents. Earlier research by the European Patent Office (1994), Hall et al. (1999, 2000), Kitching and Blackburn (1998), Brouwer and Kleinknecht (1999), Masurel (2002), and many others has shown that innovative SMEs prefer alternative forms of protection rather than applying for an expensive patent. Possible alternatives are: confidentiality clauses; investing in trust relationships; technological copy protections; maintaining lead-time advantages; etc. The literature on innovation protection by SMEs mainly focuses on the reasons for not choosing a patent, while the reasons for preferring one alternative over the others remain insufficiently studied. Also, hardly anything has been written on the effects of different protective actions on the performance of an innovation. Based on Kitching and Blackburn (1998), we define four groups of protective actions, each with an increasing level of formality: (1) no protective actions at all; (2) informal protection; (3) non-registered formal protection; and (4) registered formal protection (see Table 1.1).

Since the owner of a small or medium-sized enterprise usually takes a dominant position within the firm (Fassin et al., 2011; Verhees and Meulenberg, 2004), it is safe to assume that the decision to choose a particular form of protection is mainly an individual decision of the entrepreneur(s). Beach and Mitchell (1978) argue that individual decision-making depends on three factors: namely, the decision problem (the innovation); the decision environment (the firm); and the decision maker (the owner-manager). According to Simon (1979), the decision maker displays a bounded rationality, which results in something he calls ‘satisficing’ (choosing a solution that is satisfactory, but not necessarily the optimum). If the owner-manager of a small or medium-sized firm has chosen his protective actions, then what are the consequences of this choice for the performance of the innovation? Performance of an

This Appendix is based on Mol (2009), but has been partly rewritten to increase consistency throughout this thesis, and to add a number of clarifications.
innovation can be measured by increased profit; increased market share; growth in number of employees; etc. To gain more in-depth insights, six case studies were conducted in 2007 with owner-managers of SMEs. These owner-managers were selected from the network of the author, and were located in the north-east of the Netherlands. Three of them were active in the Information Technology sector, and three of them in the manufacturing sector. These two sectors were selected, because the manufacturing sector is rather patent-intensive, whereas in the IT sector patents on software per se are not allowed. The case studies consisted of two in-depth interviews with the owner-manager of each small or medium-sized firm, or in one case the head of the product development department together with the head of the software development department.

The first interview focused on a recent innovation, and tried to determine why a certain form of protection was selected by looking at the internal and external surroundings, the innovation itself, and the decision maker. The second interview focused on an earlier innovation, the experiences of the respondent with the chosen protective actions, and the effect of these actions on the performance of the innovation.

2.A.2 Case IT1

Firm characteristics
IT1 is an almost 30-year-old small manufacturer of Enterprise Resource Planning (ERP) software that employs 18 persons in the Netherlands and 6 persons in Romania. Its turnover in 2006 was around 1,500,000 euros. The owner sees his company as a somewhat hierarchical and financially healthy firm. The choice for a protective action is, according to the respondent, influenced by the employees and customers. The company aims its products at wholesalers. In this market, IT1 is a small player. It tries to distinguish itself by focusing on the telecom and logistics wholesalers. Most of the market is divided among two or three players; the rest of the players just have a minor share. Lately, a new competitor has appeared in the form of Microsoft entering the ‘business solutions’ market with its Dynamics software. To react to this threat, the company decided to extend its product range from only its own ERP software to also selling Microsoft Dynamics, and the accompanying support and consultancy.
Innovation characteristics
An innovation currently being worked on, alongside the introduction of selling Microsoft Dynamics, is the development of a new version of IT1’s own ERP software. The previous version was starting to become outdated, and was developed by building extension on extension, which resulted in a big and complex system that was hard to manage and poorly documented. The new version is being designed, documented, and built from scratch, and aims to solve the known problems and shortcomings of the prior version. After investing around 600,000 euros, mostly in man-hours, these investments will result in a difficult-to-imitate (however, since it is software, easy-to-copy) product innovation with an expected economic lifespan of approximately five years.

Decision maker characteristics
The decision maker is the owner-manager of the firm. He is a 51-year-old male, who was educated at Bachelor level but does not have a Bachelor’s degree. He has experience with trademarks; confidentiality clauses; technological copy protection; and licensing. However, he is not that satisfied with the usefulness of trademarks, and therefore does not intend to prolong his current trademark.

Protection
The owner-manager is still considering several options to protect the innovation. However, he states that it will probably be comparable to the way the previous version was protected: viz. a mix of confidentiality clauses in the employment contracts; technological copy protections in the form of a limitation of the number of users; a scrambled licence file; and the name of the licensee on all the screens and prints. The respondent also states that this only works to protect customers from using the software for other purposes than what they have paid for. It does not prevent other competitors from ‘stealing’ ideas. According to him, the only way to protect a firm from competitors using its ideas is maintaining a lead-time advantage.

Looking back at an earlier innovation
The earlier innovation was the previous version of the same Enterprise Resource Planning Software. It was developed around 10 years ago. At that time, the company was much smaller
(around 11 employees), and had little financial resources. To survive, the company introduced a new, more professional, way of working and created a new version of its software that contained some functionalities that were new to the market. The innovation was protected by a mix of protective measures: confidentiality clauses in the employment contracts; technological copy protections in the form of a limitation of the number of users; a scrambled licence file; and the name of the licensee on all the screens and prints. This innovation is currently responsible for 100 per cent of the turnover, and managed to replace the previous version; was introduced on new markets; increased IT1’s market share; and generated an increase in profit. However, according to the owner-manager, these considerable effects of the innovation are not due to the protective actions. Other software businesses have still managed to copy the ideas behind this innovation. According to the owner-manager, this cannot be prevented regardless of the protection, so it is important to focus on maintaining a lead-time advantage.

2.A.3 Case IT2

**Firm characteristics**

IT2 produces retail automation software. This includes stocktaking, cash registers, label printing, and purchasing. 20 years after it was founded, IT2 now employs 13 persons, and has an annual turnover of 1,500,000 euros. The respondent considers his firm as hierarchically flat and healthy. The selection of protective actions is, according to the respondent, influenced by the accountant, the customers, the shareholders, and one of the commissioners. This software company is specialised in software for the retail market, in particular the gardening retailers and photo shops. The respondent sees IT2 as a middle-sized or big player in this market. The market is divided among about 150 competitors, but only 10 of them have a considerable market share. The respondent places IT2 in the top 3 of these 10 competitors.

**Innovation characteristics**

IT2 has recently introduced a new version of its retail automation software. The most innovative aspect of this new version is that it made the move from a standalone Windows application to a software-as-a-service concept. Instead of selling software, the company has started to deliver a service. This change is currently a hot item in the software industry, but new to the retail market. After spending between 600,000 and 700,000 euros, IT2 has
introduced a new and innovative concept, of which the core functionality is expected to last around 10 years. Because of the service nature of this innovation, it is much harder to imitate or copy.

**Decision maker characteristics**

The decision maker is the technical director of the firm. Together with the general director and a third person, they own the company. The respondent is a 35-year-old male, who completed part of a Bachelor’s degree. He has prior experience with trademarks; confidentiality clauses; licensing; and all kinds of technological forms of protection. He is extremely satisfied with the use of trademarks and confidentiality clauses. According to him, licensing and technological ways of protection are also useful, but not as useful as the first two.

**Protection**

The decision maker states that the innovation will be protected by a mixture of confidentiality clauses in employment contracts; a trademark; licensing; technological copy protections in the form of licence keys; and the encryption of the source code to prevent ‘decompilation’. More formal protective actions have not been taken into consideration due to the costs involved. According to the respondent, having a unique idea and the resulting lead-time advantages are more important than any defensive form of protection.

**Looking back at an earlier innovation**

An earlier innovation was the prior version of the retail automation software, developed around 7 years ago. This prior version was a successor of an even older version, which was considered more a hobby project than a ‘serious’ application by the owner-manager. With this prior version, IT2 intended to make a new start as a serious partner for retail software. It had no concepts new to the market, but the latest developments in hardware were included, resulting in a less complex application. At that time, IT2 was a small, but financially healthy company, with a minor market share. Protective actions for this prior version were: registering a trademark; minor technological copy protections; and licensing. This prior version:

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Software is written in ‘human readable’ source code, and is generally compiled to binary code. The reverse process is also to some extent possible, and is called ‘decompilation’.

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version of the retail automation software, which is currently responsible for somewhere between 80 and 90 per cent of the turnover, increased the market share and profit. Parts of this innovation have been copied by others. According to the respondent, protection is necessary, but does not have a significant influence on the effect of the innovation on the performance of the firm.

2.A.4 Case IT3

Firm characteristics
After starting as a developer of board games, about 10 years ago IT3 started making software. IT3 employs 3 persons, and has an annual turnover of 150,000 euros. The respondent considers his firm to be financially healthy, with almost no hierarchy. The decision how to protect an innovation is solely a decision of the owner-manager, and is not influenced by others. IT3 specialises in software to generate a paper catalogue from a product database, and custom-made software for wholesalers in the non-food sector. In this niche market with three or four serious competitors, the respondent considers IT3 to be a small to average player.

Innovation characteristics
IT3 is currently developing an online web catalogue with leafing functionality, which is directly connected to a web shop. A visitor to the website can leaf through the online catalogue as if it were an ordinary paper catalogue, and order an item just by clicking on it. This easy-to-imitate product, which is new to the market, has an expected economic lifespan of 2 years. The investment in this product was around 80 hours of work, with a total value of around 6,000 euros.

Decision maker characteristics
The owner-manager is a 47-year-old male with a Bachelor’s degree. He has prior experience with confidentiality clauses initiated by customers. However, he does not initiate or even like such clauses himself. From his history as a creator of board games, he also has experience with the registration of a copyright, which helped him in a ‘prior art’ conflict a few years ago.
Protection

After considering trademarks and technological copy protections, the owner-manager decided not to use any formal protection at all. According to the respondent, his relationships with his customers are based on mutual trust. This, in combination with innovating and maintaining a lead-time advantage, is sufficient in his view. He considers any formal form of protection to be a waste of money.

Looking back at an earlier innovation

After seven years of building customer-specific software and being in an unstable financial situation, IT3 decided to start delivering more standardised software with less customisation. One of the most successful innovations is the development and introduction of a computer program that can read a product database and create a document ready to go to the printing house. Using this software, wholesalers can easily update their paper catalogue by importing a new product database and printing a new version. The above-mentioned innovation is not protected by any formal form of protection. Again, relationships based on trust and maintaining lead-time advantages are considered sufficient by the respondent. Any formal protection is considered useless. This product innovation is new only to this company, not to the market. It resulted in more profit; an increased variety of products; an increased market share; and was introduced on new markets. Currently 50-60 per cent of the company’s turnover comes from this product. It also functions as a means to attract new customers who also buy other, mostly customer-specific, software products. According to the respondent, the parts of the innovation that are specific for IT3 are not imitated or copied by others, so protecting it would not have made any difference.

2. A. 5 Case MAN1

Firm characteristics

MAN1 is a producer of automated welding machines, mostly on an engineer-to-order basis. The company employs 160 people, distributed over two branches. MAN1 has an annual turnover of 28,000,000 euros. Since the owner-manager had other engagements, the head of the product development department and the head of the software development department acted as the respondents in the interviews. The respondents consider MAN1 as a firm with a medium level of hierarchy and a result-oriented culture. MAN1 specialises in automated
metal-connecting machines, like welding or riveting machines. Its customers are mostly suppliers of the automotive industry, especially those who produce car seats. In this market, MAN1 acts as a medium-sized player among 10 to 20 others.

**Innovation characteristics**
MAN1 has recently introduced a low-cost modular welding cell, aimed to enter a more low-cost market. The development of this entirely new standardised welding cell is the first time MAN1 has developed a welding cell from a supply perspective instead of a demand perspective. This easy-to-imitate product is new to the company. The R&D costs were around 50,000 euros. The respondents expect to sell 10 to 20 of these welding cells a year for the next 10 to 15 years. Formal protection would be hard, since, except for the locking mechanism, it is not new.

**Decision maker characteristics**
The decision how to protect this innovation is currently being made by the owner-manager, influenced by the head of the product development department and the head of the software department.\(^\text{21}\)

**Protection**
After considering a registered design and trademark, the owner-manager decided not to use any formal protection at all. However, formal protection will be reconsidered for future innovations. The main reasons for not protecting this innovation are the company’s open culture and the costs of formal protection. Another factor is that there is hardly anything new to the innovation. The respondents also state that it is company policy to compete on price, which leaves little room for costly protective actions.

**Looking back at an earlier innovation**
Around five years ago, MAN1 decided to take its first steps in producing standard welding robots instead of custom-made ones. Both the financial and the market position were slightly less positive compared with the current situation. The main difference with the innovation

\(^{21}\) Since the owner-manager had other engagements, we do not have data on the decision maker characteristics.
described above is that this prior welding cell was not developed as a low-cost solution. This innovation, which was new to the company, was not protected at all. The reasons were the same as described above. This product innovation is currently responsible for 50 per cent of the annual turnover, and has increased the profit; increased the product range; increased the market share; was introduced on new markets; increased the quality of the product; and made the whole process of building welding cells more manageable. According to the respondents, the idea has been partly imitated by three others, who came in contact with the innovation via their shared customers. However, any kind of protection would probably not have influenced the success of this innovation.

2.A.6 Case MAN2

Firm characteristics
MAN2 is a producer of drive systems for the agricultural market (e.g. to open the roof of a greenhouse). After being founded in 1953, the original company was split up into two firms: MAN2 that employs around 100 persons with an annual turnover of 25,000,000 euros and a software company that employs 45 persons. MAN2 has a philosophy of continued investment in practical innovations. This is accomplished by innovating themselves and sometimes by buying an innovation or innovative company. The respondent considers his company as having an intermediate level of hierarchy. The decision to choose a form of protection is influenced by employees, friends, and sometimes by experts, branch organisation, or a patent lawyer.

MAN2 specialises in drive systems for the agricultural market, especially for greenhouses and cattle breeding. In this market, MAN2 is the market leader with two competitors in the Netherlands and a world-wide total of around 10 competitors.

Innovation characteristics
Together with a partner specialised in control systems, MAN2 has recently introduced a drive system for greenhouses with integrated control logic. Formerly, the drive system was controlled by a number of electronic regulation devices. In this new version, most of the logic is integrated, and the number of electronic regulation devices has been reduced. Spending around 600,000 euros on R&D resulted in a difficult-to-copy product, which is new to the
world, and has an expected lifespan of 10 years. However, due to the combination of software, electronics and machinery, successfully applying for a patent would be difficult.

**Decision maker characteristics**

The decision how to protect the innovation was made by the owner-manager, who is a 50-year-old male with a Bachelor’s degree. The respondent has prior experience with trademarks; confidentiality clauses; licensing; registration at notary office; and patents. He is rather positive about trademarks, confidentiality clauses, and patents. However, he mentioned that, in the case of a conflict over a patent, the old Dutch saying ‘Wie pleit om een koe, geeft er één toe’ applies, which roughly translates as ‘Who pleads for a cow, loses one’. According to him, this saying means that, while two parties are fighting over a patent (the cow), the profits (milk) end up with the lawyers.

**Protection**

The integrated drive system will be protected by a trademark and confidentiality clauses with the partner, and, most importantly, by maintaining a lead-time advantage. The respondent also considered applying for a patent to protect this innovation. However, because of the nature of this innovation, he decided not to. The main reason for doing this was its non-compliance with a rule of thumb he uses, which states that anything that would not fit on the back of a beer mat is too complex to patent. A secondary reason why he chose not to apply for a patent was the difficulty of obtaining a patent for a combination of software and hardware.

**Looking back at an earlier innovation**

A few years ago, MAN2 introduced a high speed roll-up door, which is an electronically operated door especially designed to open and close quickly. This specific model was driven by a drum motor. The use of this kind of engine for opening doors was new to the agricultural market. Because of severe technological difficulties and the discontinuation of the production of the engines used, this innovation never achieved the expected success. However, development of this kind of door is still continuing, but now with a different kind of engine. At that time (of the previous innovation), the situation of MAN2 was similar to the current situation. This prior innovation has slightly increased the firm’s market share, but this has not
resulted in any kind of increased profit. On the contrary, until now it has only cost money. Because the innovation was only new to the agricultural market, the owner-manager decided not to protect the innovation. However, according to the respondent, the lack of success of this innovation was not influenced by this decision. Similar innovations in the future will also not be protected.

2.A.7 Case MAN3

Firm characteristics
MAN3, a producer of aluminium parts on an engineer-to-order basis, was founded in 1976. It delivers mostly to manufacturers of copiers, medical machinery, and the air and space travel industry. MAN3 has an annual turnover of 4,000,000 euros, and employs 25 persons. MAN3 has a strategy aimed at relationships. According to the owner, the hierarchy of the firm is extremely flat. The owner-manager sees his company as a relatively small player in this market. The company tries to distinguish itself from its competitors by being a front-runner in adopting new technologies and ideas.

Innovation characteristics
In the last few years, the respondent has been thinking, planning, and investing in a fully-automated factory. Not only will the production process be automated, but also the selection and preparation of the necessary bulk materials. This process innovation, which is at least new to the country, and probably to the world, will cost around 10,000,000 euros, which will be partly subsidised by the EU. The expected lifespan of the factory in this form is between 15 and 20 years.

Decision maker characteristics
The decision maker is the owner-manager of the company. He is a 54-year-old male, who received education at Bachelor level. The decision how to protect the innovation is made by him alone. He has prior experience with patents and confidentiality clauses. However, in his opinion, they are often a waste of time and money. According to him, the most important part of doing business is trusting each other, being innovative, having fun, and spending time together.
Protection
The new, fully-automated factory will not be protected by any means. The respondent wants to show the region, country, and world what is possible, and does not focus on making money out of this. He states that: ‘a shroud has no pockets, so why make a lot of money you cannot spend.’ He even hopes that he can set an example for the whole industry, and that many of his competitors will copy his ideas. Furthermore, he also states that any formal protection would still be much less efficient than maintaining lead-time advantages.

Looking back at an earlier innovation
The earlier innovation named by the respondent is an aluminium ‘plotter frame’, developed 5 years ago, together with and commissioned by a printer and copier multinational. This frame is part of a range of plotters sold by the multinational. The only protection used in this collaboration was mutual trust. In order to produce this innovation, the production process had to be renewed. This resulted in both higher quality goods and the ability to produce more complex goods, which led to a doubling of turnover over the last 5 years.

2.A.8 Conclusions
Although these results are hard to generalise, this research gave us some interesting insights into how owner-managers decide what kind of protection to use for an innovation. All the interviewed owner-managers of SMEs in both the IT and the manufacturing sector consider maintaining lead-time advantages (an informal protective action) the most useful protective action. Confidentiality clauses (a non-registered formal protective action) are considered useful by three out of five owner-managers (the respondents of MAN2 were not owner-managers). All five of them have experience with registered formal protective actions, but generally do not consider them of much use. Other protective actions are only considered useful by one or two of the respondents. The decision how to protect the innovation turns out to be primarily one of the owner-manager, and seems mostly based on prior experiences with protective actions that ‘worked’. If others do influence the owner-manager in his decision, this is mostly done by the employees of the SME.

All the respondents said that they had an increased market share after implementing the earlier innovation, but this did not always result in increased profit or turnover.
Interestingly, they do not consider protection of the innovation to be of any influence on the performance of the innovation.
Appendix 2.B Survey questions

This appendix presents the set of questions the interviewers received during the briefing and had to fill out during the interviews.

A. Demographics

1. Zip code (4-digit) of main place of business:

2. Main sector of operations:
   a. Agriculture and fishery;
   b. Industry;
   c. Building and construction;
   d. Wholesale;
   e. Retail;
   f. Hospitality;
   g. Transport;
   h. Finance;
   i. Advisory services;
   j. Facility services;
   k. Personal services;
   l. General services;
   m. Business management;
   n. Other, namely ….

3. Number of branches at this moment?

4. Size in terms of employees (full time equivalent)?

5. Founding year?

6. Does your company currently use the services of one or more:
   a. Commissioner(s) (0/1); \(^{23}\)
   b. Counsellor(s) (0/1);
   c. Someone else, namely …(0/1).

---

\(^{22}\) This is an English translation of the original Dutch survey that was filled out by the interviewers during the interviews.

\(^{23}\) A commissioner has an official responsibility and accountability regarding the firm, whereas a counsellor has an advisory role and does not have any formal status.
7. Is your firm part of an enterprise group?
   Yes; No.
8. What determines the success of your firm? (open)

B. Respondent
1. Are you also shareholder?
   a. Yes, I am the only shareholder;
   b. Yes, together with one or more others;
   c. No.
2. Age (in years)?
3. Gender (Male; Female)?
4. Highest completed educational level:
   a. Master’s degree;
   b. Bachelor’s degree;
   c. Intermediate vocational education;
   d. Lower vocational education;
   e. Secondary education;
   f. Primary education;
   g. Other, namely …
5. At which institution:
   a. Windesheim (0/1);
   b. Other, namely … (0/1).

C. Experience with knowledge institutions
1. Between 2000 and 2005, did your company use the services of one or more public
   knowledge institutions? (If not, go to question D.1.)
   a. Universities (0/1);
   b. Universities of applied sciences (0/1);
   c. Institutions of intermediate vocational education (0/1);
   d. Other, namely… (0/1).
2. Of which institution?
   a. Windesheim (0/1);
   b. Other, namely … (0/1).

3. How satisfied are you with this relationship?
   a. Extremely satisfied;
   b. Satisfied;
   c. Neutral;
   d. Dissatisfied;
   e. Extremely dissatisfied.

D. Innovation

We choose to use a broad definition of innovation: an innovation is what the entrepreneur thinks an innovation is. From the perspective of the firm this could be new or improved products or services brought into the market, and/or renewal or improvement of the internal processes of the firm. We ask specific attention for improvements (incremental innovations).

1. How innovative do you generally consider your firm to be?
   a. Not;
   b. Hardly;
   c. Moderately;
   d. Very.

2. How much did you spent on innovation in 2005 (out of pocket, in Euros) (open).

3. What kind of innovations?
   a. New or improved products (0/1);
   b. New or improved services (0/1);
   c. New or improved processes (0/1);
   d. New markets (0/1);
   e. Other, namely… (0/1).
4. To which extent were these innovations sustainability innovations?24
   a. Not at all;
   b. Moderately;
   c. Only sustainability innovations.
5. Do you wish to improve the innovation performance of your firm?
   a. Yes;
   b. No;
   c. Don’t know.
6. Regarding your firm’s innovations, to which extent does your firm use innovations by others?
   a. Not;
   b. Hardly;
   c. Sometimes;
   d. Often;
   e. Don’t know.
7. Where do these innovations come from?
   a. Foreign firms;
   b. Dutch firms outside the region;
   c. Regional firms;
   d. Foreign knowledge institutions;
   e. Dutch knowledge institutions outside the region;
   f. Regional knowledge institutions;
   g. Other, namely … .

---

24 Sustainability innovations focus on social and/or environmental aspects.
E. Sources of innovation

1. How do you acquire the knowledge to innovate?
   a. Sector association (0/1);
   b. Customer(s) (0/1);
   c. Competitor(s) / colleague(s) (0/1);
   d. Supplier(s) (0/1);
   e. Public knowledge institution(s) (0/1);
   f. Chamber of Commerce (0/1);
   g. IMK / Syntens (0/1);
   h. Research institution(s) (0/1);
   i. Accountancy firm(s) (0/1);
   j. Consultancy firm(s) (0/1);
   k. Government (0/1);
   l. Patent office (0/1);
   m. Other, namely …(0/1).

F. Obstacles for innovation

1. Which obstacles do you experience regarding innovation?
   a. Lack of Money (0/1);
   b. Lack of time myself (0/1);
   c. Lack of time employees (0/1);
   d. Lack of experience (0/1);
   e. Do not know how to organise (0/1);
   f. Lack of good ideas (0/1);
   g. Market risks (0/1);
   h. Lack of options to divide risks (0/1);
   i. The multidisciplinary nature of innovation (0/1);
   j. Resistance within the firm (0/1);
   k. Unable to compete with other firms (0/1);
   l. Other, namely …(0/1).
G. Protection of innovation

1. How do you generally protect your innovations?
   a. Patent (0/1);
   b. License (0/1);
   c. Registered design (0/1);
   d. Registered copyright (0/1);
   e. Copy protection (0/1);
   f. Confidentiality clauses (0/1);
   g. Relationships based on trust (0/1);
   h. Maintaining lead-time advantages (0/1);
   i. Other, namely … (0/1).

2. Why do you choose this (combination of) protective action(s)? (open)

3. Who are involved in determining how to protect your innovations?
   a. Employee(s) (0/1);
   b. Family (0/1);
   c. Friends (0/1);
   d. Accountant(s) (0/1);
   e. Bank (0/1);
   f. Counsellor(s) (0/1);
   g. Commissioner(s) (0/1);
   h. Customer(s) (0/1);
   i. Supplier(s) (0/1)
   j. Colleague(s) in other sector (0/1);
   k. Colleague(s) in the same sector (0/1);
   l. Sector association (0/1);
   m. Public knowledge institution, namely… (0/1);
   n. Syntens (0/1);
   o. Chamber of Commerce (0/1);
   p. Other, namely … (0/1).
4. How effective is this (combination of) protective measure(s)?
   a. Highly effective;
   b. Effective;
   c. Nor effective nor ineffective;
   d. Ineffective;
   e. Highly ineffective;
   f. Varying;
   g. Don’t know.

5. How efficient is this (combination of) protective measure(s)?
   a. Highly efficient;
   b. Efficient;
   c. Nor efficient nor inefficient;
   d. Inefficient;
   e. Highly inefficient;
   f. Varying;
   g. Don’t know.

H. Future innovation

1. Which role do you see for public knowledge institutions regarding future innovations of your firm?
   a. Student projects (0/1);
   b. More intensive supervision of student projects by the teachers (0/1);
   c. Training & education by teachers or other employees (0/1);
   d. Internships (0/1);
   e. Commercial activities by the public knowledge institution (0/1);
   f. Alumni meetings (0/1);
   g. Facilitation of laboratories and other accommodations (0/1);
   h. Meetings with entrepreneurs, under guidance of a teacher or other employee (0/1);
   i. Joint venture firm – knowledge institution (0/1);
   j. Other, namely …(0/1).
2. Can students other than from universities of professional education have an effect on innovation within your firm?
   a. Master students (0/1);
   b. Intermediate vocational education students (0/1);
   c. Lower vocational education students (0/1);
   d. Other students, namely … (0/1);
   e. No (0/1).

3. From which discipline? (open)

I. Innovation case
Describe a possible future innovative student assignment during the year 2006-2007. This could be an internship, bachelor thesis, student project, etc. Focus on the following aspects:

- Short description, including planning and intended results.
- Sustainability aspects.
- How the firm profits from the innovation.
- Resistance against the innovation (internal, external).
- The use of innovations by others.
- Secrecy.
- Public funding options.
- Kind of project (internship, bachelors thesis, project, etc.).
- What kind of students (discipline, year, etc.).
- The role of the student.
- The role of the supervising teacher.
- The role of the entrepreneur.
- The role of the rest of the firm.
- The role of others (external).
- Obstacles (internal and external).
- Protection of the innovation.
- When will the project take place.
- How to inform other (ed) teachers.
J. New respondents?

1. Do you know any other firms (preferably SMEs) that may also want to participate in this research?
   a. Yes;
   b. No.

2. If so, do you happen to know who to contact?

3. How did you perceive this survey?

4. Improvements?

5. Website address?
3 Protective actions in the Dutch printing industry

3.1 Introduction

Since the 1930s there have been three main drivers of innovation in the printing industry, which characterise the sector as one that is continuously challenged to reinvent itself. First, the sector has transformed from a blue-collar craftsman industry to a more computerised sector, which has led to increased outputs, and more importantly, to a decrease in the demand for skilled blue-collar workers (Wallace and Kalleberg, 1982). Second, due to the (inevitable) use of ink, chemicals, and other toxics, considerable attention has been paid to health issues among workers (see, among others, Bælum et al., 1982; Bulbulyan et al., 1999; Kristensen et al., 1993; Malker and Gemne, 1987; White et al., 1995); and to the environmental effects (see, among others, Masurel, 2007; Rothenberg and Zyglidopoulos, 2007; Vachon and Klassen, 2006). This has resulted in all kinds of governmental regulations and sector-initiated certificates, all of them aimed to make the sector more sustainable. Third, according to the Dutch sector association (KVGO, 2011), more recently the advent of home printing and e-reading has resulted in more changes in the sector. According to Smallbone et al. (2000), the introduction of new technologies and closer ties between customers and printers has fundamentally altered the structure of the industry. This has resulted in new products and services, ‘...and the creation of new markets for on-demand, short-run, colour printing, as well as database creation and management’ (Smallbone et al., 2000, p. 299).

Innovative firms that invest time and money to develop something new generally want to prevent any (potential) competitor from copying it. Nowadays, a variety of formal and informal protective actions can be applied. This has generated many publications on the subject of the protection of these innovations (see Section 1.2). However, the literature mainly focuses on the innovation characteristics and the firm characteristics as determinants of the

25 This chapter is based on Mol and Masurel (2014), but has been partly rewritten to increase consistency throughout this thesis, and to add a number of clarifications.
protective behaviour, and often ignores the role of the entrepreneur within the firm. The latter
has, according to Verhees and Meulenberg (2004), an extremely strong influence on
innovation within SMEs. Furthermore, the option to protect innovations by anything other
than patents is often overlooked in the literature. Finally, the difference between product and
process innovations is generally dealt with by including an explanatory dummy variable.
However, product innovations have a higher probability of being protected by a patent than
process innovations, because ‘Process innovations are less subject to public scrutiny and thus
can be kept secret more readily’ (Cohen et al., 2000, p. 10). Therefore, we decided to deal
with product and process innovations separately, to see whether the same determinants apply
for both of them.

This chapter discusses the results of a survey held among SMEs in the Dutch printing
industry, on both formal and informal protection of product and process innovations, by
focusing on determinants from the firm, the innovation, and the entrepreneur. Although the
results apply specifically to SMEs in the Dutch printing industry, we found many of the
general findings on the protective behaviour of SMEs confirmed.

First, we review the existing literature on these topics in Sections 3.2 and 3.3. This is
followed by the descriptive results in Section 3.4, and the results of a regression analysis of
the relationship between protective forms and their determinants in Section 3.5. Finally, the
discussion and conclusions are presented in Sections 3.6 and 3.7.

3.2 Setting the scene
This section discusses both the Dutch printing industry and the continuum of protective
actions for innovations.

3.2.1 The Dutch Printing Industry
The Dutch printing industry is considered a typical small business sector, with a large number
of small firms, low entry levels, and many family businesses (Masurel, 2007). According to
the Dutch sector association (KVGO and Kenniscentrum GOC, 2009), in 2009 the Dutch
printing industry consisted of 2,578 firms, of which almost two-thirds (62.4 per cent) had less
than ten employees, around one-third (35.8 per cent) had between 10 and 100 employees, and
only 45 firms in this sector (1.8 per cent) had more than 100 employees. According to
Statistics Netherlands (2012), 28 per cent of the firms (employing 10 or more people) in this
sector engaged in innovation activities (that is, activities or acquisitions specifically undertaken to develop and/or implement product or process innovations) between 2006 and 2008. This makes this sector slightly more innovative than the overall score of 25 per cent of all Dutch firms (employing 10 or more people) engaging in innovation activities (Statistics Netherlands, 2012).

3.2.2 Protection

To protect their innovations, firms can not only choose from a number of formal forms of protection, like patents and registered copyrights, but they may also consider all kinds of less formal forms, since these may be more suitable for their innovations. Based on Kitching and Blackburn (1998), four groups of protection practices can be defined: (1) no protective actions at all; (2) informal protection; (3) non-registered formal protection; and (4) registered formal protection (see Table 3.1). The main difference between the last two is that registered formal protection requires external registration, for example at a notary office or patent office. This results in a stronger legal position, because an external independent party certifies the registration.

<table>
<thead>
<tr>
<th>Type of protection</th>
<th>No protection actions</th>
<th>Informal protection</th>
<th>Non-registered formal protection</th>
<th>Registered formal protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examples</td>
<td>High trust relations</td>
<td>Maintaining lead-time advantages</td>
<td>Confidentiality clauses in contracts</td>
<td>Patents</td>
</tr>
<tr>
<td></td>
<td>Technological copy protections</td>
<td>Licensing</td>
<td>Registered designs</td>
<td>Trademarks</td>
</tr>
<tr>
<td></td>
<td>Actions to ‘keep things quiet’</td>
<td>Registered copyrights</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Increasing degree of legal formality


26 The issues addressed in Section 3.2.2 have already been discussed in more detail in Section 1.2.
First, we consider the informal protective actions. These consist of the following protective measures: building relationships based on trust; technological copy protections; ‘keeping things quiet’; and continuously innovating to maintain lead-time advantages. Investing in building high-trust relationships can be activities aimed at getting to know each other better, like playing golf together or inviting business partners to dinner. Technological copy protections are mostly used in the entertainment industry (DVDs, CDs, games) and in the software industry, since these ‘products’ are extremely easy to copy. ‘Keeping things quiet’ is nothing more than just not telling any potential competitor what a firm is doing. Finally, investing in maintaining lead-time advantages consists of making sure that, by the time a competitor has copied the idea, the firm has already innovated ahead, and it is therefore of no serious threat. Although, technically, it is not really a protective action, investing in maintaining a lead-time advantage is generally considered one of the most effective protective mechanisms for innovations (e.g. Amara et al., 2008; Brouwer and Kleinknecht, 1999; Cohen et al., 2000; Kitching and Blackburn, 1998; Levin et al., 1987).

The non-registered formal protective actions consist mainly of confidentiality clauses and licensing. Confidentiality clauses are parts of contracts, which roughly state that all information is confidential. These could be between firms and other organisations, but also between the firm and its employees. Licensing is often used in the software industry, where most of the time a customer does not buy the software, but only the right to use it. Licensing can also be used to give competitors the right to use, produce, and/or sell (the result of) an innovation instead of having to come up with their own innovations.

The registered formal protective actions consist of patents, registered designs, trademarks, and registered copyrights. In most countries, patents can be used to claim a 20-year period of monopoly on an invention that is new, innovative, and industrially applicable. “New” means that it has not been around before; “innovative” means that it is not obvious for anyone in the same industry; and “industrially applicable” means that it can be made. Registered designs claim a 25-year monopoly on the visual aspects of an innovation. Trademarks are slightly different, since they do not protect the innovation itself, but provide 10 years of protection (that can be renewed indefinitely) for a name or logo associated with a brand or an invention. Copyrights originate automatically by simply coming-up with an idea and can be used for almost any kind of work that is original and protect up to 70 years after
the creator has deceased. The protective usability of copyrights is low, since just a minor change of the original would be sufficient to create a new original work with accompanying copyright. Furthermore, because copyrights do not require any kind of registration, this makes it sometimes hard to determine who created something first. Therefore, most countries offer an option to register a copyright.

### 3.3 Determinants of protection

According to Beach and Mitchell (1978), three factors determine the decision-making process: namely, the decision problem, the decision environment, and the decision maker. In this case, the innovation itself and the question how to protect it can be seen as the decision problem; the firm and its surroundings can be regarded as the decision environment; and the owner-manager can be considered the decision maker.

#### 3.3.1 Innovation perspective

First, we take a closer look at the literature on the protection of innovations (which is mainly about patents) from the perspective of the decision problem. A well-known variable related to the probability of a patent application for an innovation is the amount of R&D investments by a firm (Amara et al., 2008; European Patent Office, 1994). Higher investments tend to be related to a higher propensity to patent. However, we must note that measuring R&D in SMEs is not always reliable, since a large part of the R&D conducted by SMEs is informal (Kleinknecht, 1989; Santarelli and Sterlacchini, 1990), and therefore not always measured by the small or medium-sized firm. The current discussion on open innovation (Chesbrough, 2003) has shown the importance of collaboration in the innovation process. According to Brouwer and Kleinknecht (1999), collaboration increases the propensity to patent. However, according to Paasi et al. (2010), not patents, but confidentiality clauses are typically used in open innovation processes. Finally, based on the results of Chapter 4, the scope of the intended geographical market and whether or not the firm has received public financial support for the innovation process are both also positively related to the degree of formality of the protection.

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27 Parts of the issues addressed in this section have already been discussed in more detail in Sections 1.3 and 1.4.
28 The analyses of Chapter 4 were undertaken partly simultaneously while designing the survey of which the results are presented in Chapter 3.
Earlier in-depth interviews with owners of SMEs (see Appendix 2.A) showed indications that the innovativeness, the newness, and the expected lifespan of the innovation (i.e. how long the firm expects to make a profit out of it) also have a positive effect on the degree of formality of the protection. Innovativeness and newness are legal requirements for obtaining a patent. The expected lifespan is included because patents and other registered formal forms of protection are generally aimed at long-term protection (see Section 1.2.3). This long-term protection may not make sense for an innovation that is going to be exploited for just a few years.

### 3.3.2 Firm perspective

The literature shows that firm size is positively related to the probability of a firm applying for a patent to protect an innovation (Amara et al., 2008; Arundel and Kabla, 1998; Baldwin et al., 2001; European Patent Office, 1994). Furthermore, we found indications (see Appendix 2.A) that the (positive) experience of the firm with earlier use of protective actions is positively related to the use of the same protective actions. Finally, although Smit (2010) found individual firm characteristics to have the strongest influence on the likelihood of a firm introducing a product innovation, also the spatial context of the firm was shown to matter. More specifically, he also found being located in an urban area to be positively related to the chance of the introduction of a product innovation. We expect a similar relationship between being located in an urban area and the use of formal protective actions.

### 3.3.3 Decision maker perspective

Since the owner-manager of a small or medium-sized firm has great impact on his firm (Fassin et al., 2011), we expect that he will play a key role in the decisions on the protective actions. We found indications (see Appendix 2.A) that previous (positive) experience with protective actions tends to lead the decision maker to use them again. This is not only in line with what is known on routinized innovation (see, among others, Nelson and Winter, 1982), but it also corresponds with Simon (1979) on the subject of human decision-making, who roughly states that people have a propensity to keep on using the options that they know to satisfy their needs, instead of looking for alternatives that may be better. Second, Masurel (2002) showed that the educational level of the decision maker positively influences the use of patents.
3.3.4 Combining the three perspectives

In the previous sections, we introduced three perspectives that determine the degree of formalisation of the protective actions: the innovation, the firm, and the decision maker within the firm. From each perspective we defined a number of variables that may determine the selection of protective actions. This leads us to Figure 3.1.

Figure 3.1 Protective actions and determinants

3.4 Descriptive results

To gain access to the respondents, we involved a consultancy firm (‘Dienstencentrum’) which is closely related to the sector association to ask 1,337 firms from the Dutch printing industry to complete an online questionnaire. This questionnaire consisted of 36 questions on the firm, the respondent, and (if applicable) both a recent product innovation and a recent process innovation. This resulted in a response of 93 firms (7.0 per cent), of which 82 had introduced one or more new products and/or processes. These innovative firms (the firms that had introduced one or more new products and/or processes) are on average larger in terms of number of employees than the average of the industry (see Table 3.2). This confirms that innovative firms are generally larger in number of employees (see, among others, Statistics Netherlands, 2014).
Three respondents employed more than 250 people, and hence did not fall within our definition of SMEs, so they were eliminated from our data set. This left us with a remaining data set of 79 SMEs that had introduced one or more new products, or processes, or both. Firms that introduced multiple product innovations were asked to select the most representative one for their firm, and answer the questions with respect to that innovation. The same procedure was used for firms that had introduced multiple process innovations. Respondents who had introduced both (one or more) product innovations and (one or more) process innovations were asked to answer the innovation questions for both the (most representative) product innovation and the (most representative) process innovation.

### 3.4.1 Protective actions

We asked the respondents to indicate the protective actions they were using (or planning to use) for the innovation (survey questions 26 and 36), and grouped these according to our protection model (see Table 3.1). Since most innovations are protected by a portfolio of protective actions, we decided to code them at the level of the most formal protective action that was used (e.g. an innovation protected by confidentiality clauses and patents was coded in the group ‘registered formal protection’; see Table 3.1).

In line with the results of Cohen et al. (2000), the most popular group of protective actions, for both product and process innovations, are the informal ones (see Table 3.3). Also in line with the findings of Cohen et al. (2000), we find product innovations to be more formally protected than process innovations.

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**Table 3.2** Size distribution (in number of employees) of the innovative firms compared with the sector as a whole (in percentages)

<table>
<thead>
<tr>
<th>Employees</th>
<th>Innovative firms</th>
<th>Sector$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1–9</td>
<td>17.1</td>
<td>62.4</td>
</tr>
<tr>
<td>10–49</td>
<td>39.0</td>
<td>31.5</td>
</tr>
<tr>
<td>50–99</td>
<td>23.2</td>
<td>4.3</td>
</tr>
<tr>
<td>≥100</td>
<td>20.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 3.3 Protection of product and process innovations (in percentages)

<table>
<thead>
<tr>
<th>Protective actions</th>
<th>Product innovations</th>
<th>Process innovations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registered formal protection</td>
<td>19.0</td>
<td>11.6</td>
</tr>
<tr>
<td>Non-registered formal protection</td>
<td>23.8</td>
<td>10.1</td>
</tr>
<tr>
<td>Informal protective actions</td>
<td>52.4</td>
<td>62.3</td>
</tr>
<tr>
<td>No protection</td>
<td>4.8</td>
<td>15.9</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

3.4.2 Innovation perspective

When we take a look at the innovation variables, we find that our SMEs have recently (in the last five years) introduced one or more product innovations (10), process innovations (37), or both (32). Since a large part of the R&D conducted by SMEs is informal, and therefore difficult to measure (Kleinknecht, 1989; Santarelli and Sterlacchini, 1990), we decided to leave the term R&D out of our survey, and just ask our respondents how much they invested in this innovation (including labor, materials, education, etc., see survey questions 22 and 33). The investments in these innovations (see Table 3.4) are typical for SMEs, as a substantial part of the respondents answered that they had not invested more than 50,000 euros.

Table 3.4 Investments in product and process innovations (in percentages)

<table>
<thead>
<tr>
<th>Investments</th>
<th>Product innovations</th>
<th>Process innovations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown</td>
<td>5.0</td>
<td>4.8</td>
</tr>
<tr>
<td>Less than €50,000</td>
<td>47.5</td>
<td>39.7</td>
</tr>
<tr>
<td>Between €50,000 and €100,000</td>
<td>15.0</td>
<td>28.6</td>
</tr>
<tr>
<td>Between €100,000 and €500,000</td>
<td>27.5</td>
<td>20.6</td>
</tr>
<tr>
<td>Over €500,000</td>
<td>5.0</td>
<td>6.3</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

A relatively low percentage (12.2 per cent) of the product innovations are partly financed with a form of public financial support (survey question 23). For process innovations this percentage is 17.5 per cent (survey question 34).

When we look at collaboration (survey questions 19 and 31), we find that a large part of the innovations (product 92.7 per cent; process 96.4 per cent) have been developed in collaboration with others. This is much higher than the 45 per cent for this sector reported by the 2010 Community Innovation Survey (Statistics Netherlands, 2011). We expect this difference to be caused by sending our survey via a firm closely related to the sector association. This may have resulted in respondents with a higher propensity to collaborate.
Another explanation could be that we, contrary to the Community Innovation Survey, also included firms that employ less than 10 employees. Due to their limited resources, these firms may be more inclined to collaborate.

The (results of the) product innovations are mostly sold (survey question 24) on the national market (61.0 per cent), while 24.4 per cent of the innovative respondents sell their product on the international market, and 14.6 per cent of the respondents only sell on the regional or local market (see Table 3.5). This makes registered formal protection, like patents, of interest for most of the respondents, since these forms of protection aim at national or international protection. The market of process innovations was not included in our survey, since process innovations are generally not sold on the market.

*Table 3.5 Geographical market of the product innovations*

<table>
<thead>
<tr>
<th>Market</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>2.4</td>
</tr>
<tr>
<td>Regional</td>
<td>12.2</td>
</tr>
<tr>
<td>National</td>
<td>61.0</td>
</tr>
<tr>
<td>International</td>
<td>24.4</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
</tbody>
</table>

When we take a look at the newness of the innovations (Table 3.6, survey questions 17 and 29), we find that most innovations are only new to the firm. As a consequence, many of the registered formal protective actions are probably not possible, since most of these firms did not invent the innovation themselves, but adopted an existing innovation. Although the innovations are predominantly only new to the firm, they are nevertheless mainly considered to be ‘moderately radical’ by the owner-managers (Table 3.7, survey questions 18 and 30). However, since these questions basically measure the perception of the respondent, the results are probably somewhat biased.

*Table 3.6 Newness of the innovation (in percentages)*

<table>
<thead>
<tr>
<th>Newness</th>
<th>Product innovations</th>
<th>Process innovations</th>
</tr>
</thead>
<tbody>
<tr>
<td>New to the firm</td>
<td>62.5</td>
<td>66.1</td>
</tr>
<tr>
<td>New to the region</td>
<td>10.0</td>
<td>9.7</td>
</tr>
<tr>
<td>New to the country</td>
<td>17.5</td>
<td>21.0</td>
</tr>
<tr>
<td>New to the world</td>
<td>10.0</td>
<td>3.2</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Table 3.7 Innovativeness of the innovation (in percentages)

<table>
<thead>
<tr>
<th>Innovativeness</th>
<th>Product innovations</th>
<th>Process innovations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not radical</td>
<td>4.9</td>
<td>4.8</td>
</tr>
<tr>
<td>Hardly radical</td>
<td>22.0</td>
<td>25.4</td>
</tr>
<tr>
<td>Moderately radical</td>
<td>63.4</td>
<td>50.8</td>
</tr>
<tr>
<td>Highly radical</td>
<td>9.8</td>
<td>19.0</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The expected lifespan of the innovation (i.e. how long is the firm expecting to make a profit out of it, survey questions 21 and 32) shows that the majority of both the product innovations (95.0 per cent) and the process innovations (81.0 per cent) have an expected lifespan of less than 6 years. This could be a confirmation of the incremental nature of most innovations by SMEs.

3.4.3 Firm perspective

The average firm size is 55.9 employees, with a standard deviation of 51.9 (see also Table 3.2, survey question 7). Looking at the location (survey question 10), we found that 77.4 per cent of the firms are located in an urban area, based on an area address density\(^\text{29}\) of 1,000 or higher (Statistics Netherlands, 2011). Finally, when looking at prior experiences (survey question 12), we find that only 5 per cent of the firms had no protective experience at all (Table 3.8); the experience of the rest of the firms was almost equally distributed over the different kinds of protective actions (multiple experiences coded with the highest level).

Table 3.8 Protective experience of the firm (in percentages)

<table>
<thead>
<tr>
<th>Protective actions</th>
<th>Firm experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registered formal protection</td>
<td>34.1</td>
</tr>
<tr>
<td>Non-registered formal protection</td>
<td>29.3</td>
</tr>
<tr>
<td>Informal protective actions</td>
<td>31.7</td>
</tr>
<tr>
<td>No experience with protection</td>
<td>4.9</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
</tbody>
</table>

3.4.4 Decision maker perspective

The results for our respondent experience variable (survey question 4) are exactly the same as for the firm experience variable (see Table 3.8). This basically confirms how intertwined the

\(^{29}\) The average number of addresses within a radius of 1 kilometre.
entrepreneur and his firm are, and how the prior experiences of the decision maker coincide with the prior experiences of the firm.

The majority of our respondents had completed a Bachelor’s or Master’s degree (survey question 3). More than one-third had only completed secondary education. None of the respondents had only completed primary education (see Table 3.9).

### Table 3.9 Educational level of the decision maker (in percentages)

<table>
<thead>
<tr>
<th>Education</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary education</td>
<td>0.0</td>
</tr>
<tr>
<td>Secondary education</td>
<td>39.7</td>
</tr>
<tr>
<td>Bachelor’s/Master’s degree</td>
<td>60.3</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
</tr>
</tbody>
</table>

#### 3.5 Regression results

Based on the variables above, a multivariate ordered probit model\(^{30}\) was constructed to determine the effect of these firm, innovation, and decision maker variables on the degree of formality of the protection of product and process innovations (see Table 3.10 for the definitions of the variables). Because the results for firm experience and respondent experience are exactly the same, we only included one variable named “experience”:

\[
Y^*_i = \alpha_i + \beta_1 Product_i + \beta_2 Investments_i + \beta_3 Support_i + \beta_4 Collaboration_i + \beta_5 Newness_i + \beta_6 Innovativeness_i + \beta_7 Lifespan_i + \beta_8 \ln (\text{Size}_i) + \beta_9 Urban_i + \beta_{10} Experience_i + \beta_{11} Education_i + \beta_{12} Product_i \ast Investments_i + \beta_{13} Product_i \ast Support_i + \beta_{14} Product_i \ast Collaboration_i + \beta_{15} Product_i \ast Market_i + \beta_{16} Product_i \ast Newness_i + \beta_{17} Product_i \ast Innovativeness_i + \beta_{18} Product_i \ast Lifespan_i + \beta_{19} Product_i \ast \ln (\text{Size}_i) + \beta_{20} Product_i \ast Urban_i + \beta_{21} Product_i \ast Experience_i + \beta_{22} Product_i \ast Education_i + \varepsilon_i
\]

\(^{30}\) Ordinal regression models, such as ordered probit and logit models, assume the ordinal dependent variable \(Y\) to be generated by an unobserved continuous variable \(Y^*\). The values of \(Y\) (no protection; informal protection; non-registered formal protection; registered formal protection) depend on whether or not \(Y^*\) has crossed a certain threshold value (Greene, 2003).
### Table 3.10 Definition and measurement scale of the variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Measurement Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dependent</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection</td>
<td>Degree of formality of the protection of the product or process innovation (multiple protective actions coded with the most formal form of protection)</td>
<td>0 No protection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Informal protection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Non-registered formal protection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Registered formal protection</td>
</tr>
<tr>
<td>Product</td>
<td>Type of innovation</td>
<td>1 Product innovation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 Process innovation</td>
</tr>
<tr>
<td>Investment</td>
<td>All investments in this innovation (including labour, materials, education, etc.)</td>
<td>1 Less than €50,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Between €50,000 and €100,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Between €100,000 and €500,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 More than €500,000</td>
</tr>
<tr>
<td>Support</td>
<td>Public financial funding</td>
<td>1 Support</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 No support</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Collaboration with other firms</td>
<td>1 Collaboration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 No collaboration</td>
</tr>
<tr>
<td>Market</td>
<td>Market scope of the innovation</td>
<td>1 Local market</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Regional market</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 National market</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 International market</td>
</tr>
<tr>
<td>Newness</td>
<td>Newness of the innovation</td>
<td>1 New to the firm</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 New to the region</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 New to the country</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 New to the world</td>
</tr>
<tr>
<td>Innovativeness</td>
<td>Innovativeness of the innovation from the perspective of the decision maker</td>
<td>1 Not innovative</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Hardly innovative</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Moderately innovative</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 Highly innovative</td>
</tr>
<tr>
<td>Lifespan</td>
<td>The period the firm expects to profit from the innovation (sell, use, or profit in another way; counted from the introduction of the innovation).</td>
<td>1 Less than 18 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Between 18 months and 6 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Between 6 and 20 years</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 More than 20 years</td>
</tr>
<tr>
<td><strong>InSize³</strong></td>
<td>Log of the number of employees (full time equivalent)</td>
<td>Continuous variable</td>
</tr>
<tr>
<td>Urban</td>
<td>Firm is located in an urban district (address density ≥ 1000)</td>
<td>1 Urban area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 No urban area</td>
</tr>
<tr>
<td>Experience</td>
<td>Earlier experience of both the firm or the decision maker with protective actions</td>
<td>0 No experience</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 Experience with informal protection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Experience with non-registered formal protection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Experience with registered formal protection</td>
</tr>
<tr>
<td>Decision maker</td>
<td>Educational level of the decision maker</td>
<td>1 Primary education</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 Secondary education</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3 Bachelor’s/Master’s degree</td>
</tr>
</tbody>
</table>

**Note:** a Since an increase of one employee has much more impact on a small firm than on a large firm, we compensated for this by taking the natural logarithm of the number of employees.
Although we would expect some cases of multicollinearity issues between the independent variables (e.g. between firm size and investments and between newness and innovativeness), Table 3.11 displays only relatively mild correlations.

Table 3.11 Correlations between the included variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
<th>(11)</th>
<th>(12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Product</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) Investment</td>
<td>0.02</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) Support</td>
<td>-0.07</td>
<td>0.18</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) Collaboration</td>
<td>-0.10</td>
<td>0.11</td>
<td>0.10</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) Market</td>
<td>(a)0.28</td>
<td>-0.40</td>
<td>0.17</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) Newness</td>
<td>0.07</td>
<td>0.19</td>
<td>0.01</td>
<td>-0.12</td>
<td>0.27</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(7) Innovativeness</td>
<td>-0.04</td>
<td>0.39</td>
<td>-0.04</td>
<td>-0.12</td>
<td>0.04</td>
<td>0.20</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(8) Lifespan</td>
<td>-0.11</td>
<td>0.11</td>
<td>-0.11</td>
<td>-0.37</td>
<td>0.16</td>
<td>-0.04</td>
<td>0.20</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(9) lnSize</td>
<td>-0.02</td>
<td>0.42</td>
<td>0.06</td>
<td>0.23</td>
<td>0.37</td>
<td>0.25</td>
<td>0.17</td>
<td>-0.02</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(10) Urban</td>
<td>0.03</td>
<td>-0.12</td>
<td>0.01</td>
<td>-0.12</td>
<td>0.06</td>
<td>0.01</td>
<td>0.12</td>
<td>-0.09</td>
<td>0.16</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(11) Experience</td>
<td>0.10</td>
<td>-0.13</td>
<td>0.07</td>
<td>-0.17</td>
<td>-0.19</td>
<td>0.26</td>
<td>0.01</td>
<td>-0.03</td>
<td>0.07</td>
<td>-0.07</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>(12) Education</td>
<td>-0.16</td>
<td>0.27</td>
<td>0.08</td>
<td>0.18</td>
<td>0.33</td>
<td>0.10</td>
<td>0.09</td>
<td>-0.02</td>
<td>0.45</td>
<td>0.18</td>
<td>-0.12</td>
<td>1.00</td>
</tr>
</tbody>
</table>

* Since process innovations are usually not sold on the market, in our questionnaire we only included this question for product innovations.

The results of our regression analysis are presented in Table 3.12. This table shows a reasonable fit (McFadden’s pseudo $R^2$ at 0.310). Based on these results, we can make a number of interesting observations. First, as is to be expected based on the findings from the literature presented in Section 3.3, public financial support and innovativeness display a positive statistically significant relationship to the degree of formal protection of both product innovations and process innovations.

Second, the level of innovation investments and firm location in an urban area show a negative statistically significant relationship to the degree of formal protection of both product innovations and process innovations. In other words: firms with higher innovation investments and firms that are urban-based both show lower degrees of formal protection than do firms with lower innovation investments and firms that are rural-based.

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31 For models with categorical dependent variables it is not possible to calculate a single $R^2$. Therefore, a number of approximations called ‘pseudo’ $R^2$ have been developed. Generally, McFadden or Cox and Snell are published.

32 Because of these rather unexpected results for the level of innovation investments and urban locations, we decided to re-evaluate our protection model by running the same analyses with a dependent variable only stating registered formal protection or not. However, we still found the level of innovation investments and urban locations significantly negatively related to the degree of registered formal protection.
Third, the lifespan of the innovation, the size of the firm, and the educational level of the entrepreneur are not statistically significantly related to the degree of formal protection of both product innovations and process innovations. Market scope is also not related to the degree of formal protection of the product innovations, but was not tested in relation to process innovations because process innovations are usually not sold on the market.

Fourth, the experience of the decision maker shows a positive statistically significant relationship to the degree of formal protection of product innovations. However, the experience of the decision maker does not have any statistically significant relationship with the degree of formal protection of process innovations. The degree of collaboration reveals a positive statistically significant relationship to the degree of formal protection of product innovations, but the effect could not be identified for process innovations because of a lack of variance, as an extremely large number of firms collaborated.

Fifth, the newness of process innovations displays a positive statistically significant relationship to the degree of formal protection. However, there is no statistically significant relationship between the newness of product innovations and their degree of formal protection.

Table 3.12 Influences on the protection of product and process innovations

<table>
<thead>
<tr>
<th></th>
<th>Product Innovations</th>
<th>Process Innovations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient</td>
<td>Std. error</td>
</tr>
<tr>
<td>Investment</td>
<td>−0.833***</td>
<td>0.320</td>
</tr>
<tr>
<td>Support</td>
<td>1.836**</td>
<td>0.320</td>
</tr>
<tr>
<td>Collaboration</td>
<td>2.185</td>
<td>1.249</td>
</tr>
<tr>
<td>Market</td>
<td>−0.328</td>
<td>0.381</td>
</tr>
<tr>
<td>Newness</td>
<td>−0.077</td>
<td>0.225</td>
</tr>
<tr>
<td>Innovativeness</td>
<td>0.697*</td>
<td>0.400</td>
</tr>
<tr>
<td>Lifespan</td>
<td>0.312</td>
<td>0.511</td>
</tr>
<tr>
<td>lnSize</td>
<td>0.334</td>
<td>0.250</td>
</tr>
<tr>
<td>Urban</td>
<td>−1.677***</td>
<td>0.599</td>
</tr>
<tr>
<td>Education</td>
<td>0.885</td>
<td>0.561</td>
</tr>
<tr>
<td>Experience</td>
<td>0.654*</td>
<td>0.296</td>
</tr>
<tr>
<td>Product Innovation Dummy</td>
<td>−1.885 (Std. error 2.907)</td>
<td></td>
</tr>
<tr>
<td>Number of observations</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>McFadden’s Pseudo $R^2$</td>
<td></td>
<td>0.310</td>
</tr>
</tbody>
</table>

Notes: * Significant at the 10% level; ** Significant at the 5% level; *** Significant at the 1% level.
In order to test for potential problems of multicollinearity, we calculated the variance inflation factors (VIF). In line with our earlier discussion based on the bilateral correlations, we found no evidence of multicollinearity problems since the highest VIF value was only 1.76.

a Owing to the large number of firms that collaborated, this variable was omitted.
b Not included in the questionnaire, since process innovations are usually not sold on the market.
3.6 Discussion

In this chapter we have explored the relationship between the innovation, the firm, and the decision maker, on the one hand, and the degree of formal protection of both product innovations and process innovations in the Dutch printing industry, on the other. Although our results are based on SMEs in the Dutch printing industry, we find many of the results from the literature on both SMEs and large firms confirmed. Besides these results, we also find a few unexpected (potentially sector-specific) results, which will be discussed in this section.

First, a statistically significant but negative relationship is found between the level of innovation investments, on the one hand, and the degree of formal protection of both product innovations and process innovations, on the other. These results are counterintuitive, because (on the basis of the literature) it was expected that the entrepreneurs would choose to protect their higher investments with more formal protection, in order to cover the risks of copying. However, this turned out to be not the case. Since we made no distinction between kinds of investment in the innovation (e.g. buying an innovation, or investing in research), one explanation could be that the higher innovation investments are actually spent on innovations that are (partly) adopted instead of developed by the firm itself. As a consequence, protection would not be relevant in most cases (sometimes even not possible), since any protection would be taken care of by the original innovator itself. This may also explain the high level of collaboration observed in the sample.

Second, although the literature hinted in the other direction, firms in urban locations appear to protect both product innovations and process innovations less formally than firms in rural locations do. A possible printing industry-specific explanation could be that the more production-like printing houses introduce more product or process innovations than the more service-like printing shops, but that they are also more often located in rural areas. This would possibly also imply that the rural-based respondents are larger in terms of their number of employees. However, we find no indication of this when looking at size differences between urban and rural firms, and since our survey did not make a distinction between printing houses and printing shops, this explanation remains speculative.

Furthermore, the expected lifespan of the innovation is not found to be related to the degree of formal protection of the innovation. This is probably because of the lack in variation
of this variable (only few innovations have a longer expected lifespan than 6 years). A similar lack of variation may also explain the absence of a statistically significant relationship between the degree of formality of the protection of product innovations and the market scope. We also found no statistically significant relationship between the educational level of the decision maker and the degree of formal protection of the innovation. Apparently, the educational level does not matter in this context; higher educated decision makers do not protect their innovations more formally than lower educated decision makers do.

Even though this is generally considered an important determinant of protective actions, firm size also shows no statistically significant relationship to the degree of formality of the protection. Interestingly, the results discussed in Section 4.6 also showed that firm size is not related to registered designs and registered copyrights.

The experience of the decision maker and the degree of collaboration with stakeholders showed a positive statistically significant relationship to the degree of formality of protection of product innovations (which was more or less to be expected), but does not show a statistically significant relationship to the formal degree of the protection of process innovations. The difference between product and process is key here. Product innovations are generally sold, which makes them more public, and therefore they can be copied relatively easily. Process innovations, on the other hand, generally stay within the firm, which makes protection less necessary.

Finally, there is no statistically significant relationship between the newness of product innovations and the degree of formality of protection. This is contrary to the statistically significant positive relationship between the newness of process innovations and their degree of formal protection. However, more research is needed to determine why this only occurs for process innovations.
3.7 Conclusions

In this chapter, we focused on the protective actions of SMEs in the Dutch printing industry from three perspectives: the innovation; the firm; and the decision maker within the firm. These explanations were given separately for product innovations and process innovations.

On the basis of our literature study, we operationalised these three perspectives into the following 12 explanatory variables: the level of innovation investments; public financial support; collaboration with stakeholders; the geographical market; the newness of the innovation; the innovativeness of the innovation; the lifespan of the innovation; firm size; previous use of protective actions of the firm; location of the firm; educational level of the entrepreneur; and, finally, experience with protective actions of the entrepreneur. Previous use of protective actions of the firm and experience with protective actions of the entrepreneur appear to indicate exactly the same, and therefore were taken together in the variable experience. Four levels of protective actions were used: no protection; informal protection; non-registered formal protection; and registered formal protection.

Although the included firms are relatively large compared to the average firm in this sector, and also have a much higher degree of collaboration than average for this sector, our results confirm a number of our expectations based on the literature and our research in the Zwolle Chamber of Commerce region as discussed in Chapter 2. In accordance with the literature and/or our own expectations, we find the degree of formal protection of product innovations to show a positive statistically significant relationship to the following four explanatory variables: innovativeness; public financial support; collaboration; and experience of the entrepreneur. Also in accordance with the literature, we find the degree of formal protection of process innovations to display a positive statistically significant relationship to public financial support; newness of the innovation; and innovativeness of the innovation.

Contrary to our expectations, we find the degree of formality of the protection of both product innovations and process innovations of SMEs in the Dutch printing industry to reveal a negative statistically significant relationship to the level of innovation investments and to urban locations. The first of these unexpected results (concerning the level of innovation investments) seems to be caused by many firms in this sector actually investing in the adoption of (expensive) innovations, instead of actually innovating themselves. This would lower the need for protection, as any protection would generally be taken care of by the
innovator itself. The second of our unexpected results, the degree of formality of the protection being related to a rural location, may be caused by the more production-like printing houses introducing more product and process innovations than the generally more urban-based service-like printing shops. Finally, also unexpected, firm size (in employees) turns out not to be statistically significantly related to the degree of formality of the protection of both product and process innovations of SMEs in the Dutch printing industry. Although this is contrary to the literature, we find more indications of firm size being less important for some varieties of registered formal protection in Section 4.6.
## Appendix 3.A Survey questions

### Part 1: The respondent

1. What is your position?
   - Owner/manager
   - Head of the R&D department/Head product development
   - Other

2. Gender
   - Male
   - Female

3. What is your highest completed education?
   - Primary education
   - Secondary education
   - Bachelor’s / Master’s degree

4. Which of the following protective actions do you personally have prior experience with?
   - Patents
   - Registered designs
   - Trademarks
   - Confidentiality clauses
   - Registered copyrights
   - Licensing
   - Developing high-trust relationships with customers, suppliers, and employees
   - Technological copy protections
   - Keeping things quiet
   - Maintaining lead-time advantages

5. How do you rate the effectiveness (Does it work?) of these actions?
   - Effective
   - Ineffective
   - Don’t know
   - ++
   - +
   - ±
   - -
   - --
   - 
   - 
   - 
   - 
   - 
   - 
   - 
   - 
   - 
   - 
   - 
   - 
   - 
   - 
   - 

6. To what degree do you have a say in the selection of a protective action?
   - I have much influence
   - I have a little influence
   - I have no influence at all

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33 This is an English translation of the original interactive online Dutch survey, which is available upon request.  
○ only one answer possible; □ multiple answers possible.
Part 2: The firm

7. How many employees (full time equivalent, including employed owners and family members) did your company have in 2008?

8. Is your company autonomous regarding the selection of protective actions?
   - Not autonomous
   - Partially autonomous
   - Completely autonomous

9. What is your main sector of operation (SBI code)?

10. What is the zip code of your main place of business?

11. In which geographical market do you aim to sell your products?
   - Local
   - National
   - International

12. With which of the following protective actions does your company have prior experience?
   - Patents
   - Registered designs
   - Trademarks
   - Confidentiality clauses
   - Registered copyrights
   - Licensing
   - Developing high-trust relationships with customers, suppliers, and employees
   - Technological copy protections
   - Keeping things quiet
   - Maintaining lead time advantages

13. Did your company innovate during the last 5 years (introduced one or more products, processes, or services that were new to the company)?
   - Yes (please continue with question 15)
   - No

14. Why not?

Thank you for participating!

Part 3: The innovation(s)

15. These innovations were
   - New or improved products
     (please answer questions 16 up to and including 27)
   - New or improved processes
     (please answer questions 28 up to and including 37)
   - New or improved services
     (No further questions for improved services)
## Part 3.1: A product innovation

The following questions concern a recent product innovation. If your company has introduced more than one product innovation during the last 5 years, we ask you to pick the most representative for your company and fill out the questions for that innovation.

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>16. How representative is this product innovation for your company?</td>
<td>Highly representative, Moderately representative, Hardly representative, Not representative</td>
</tr>
<tr>
<td>17. This product innovation was</td>
<td>New to our company, New to the region, New to the country, New to the world</td>
</tr>
<tr>
<td>18. How radical (innovative) was this product innovation?</td>
<td>Highly radical, Moderately radical, Hardly radical, Not radical</td>
</tr>
<tr>
<td>19. If applicable, with whom did you collaborate during the innovation process?</td>
<td>Customer(s), Supplier(s), Colleague(s) in another region, Colleague(s) in the same region, Sector association, Public knowledge institutions, Chamber of Commerce, Public institution(s) to promote innovation, Other</td>
</tr>
<tr>
<td>20. Who are the intended customers of the product innovation?</td>
<td>Other businesses (Business to business), Consumers (Business to consumer), Other</td>
</tr>
<tr>
<td>21. How long do you expect to profit from this product innovation (sell, use, or profit in another way, starting from the introduction of the innovation)?</td>
<td>Less than 18 months, Between 18 months and 6 years, Between 6 and 20 years, More than 20 years</td>
</tr>
<tr>
<td>22. How much did you invest in this product innovation (including labour, materials, education, etc.)?</td>
<td>Less than €50,000, Between €50,000 and €100,000, Between €100,000 and €500,000, More than €500,000, Unknown</td>
</tr>
<tr>
<td>23. Did your company receive a form of public financial funding for this product innovation?</td>
<td>Yes, No</td>
</tr>
</tbody>
</table>
24. What is the current or future market scope of the product innovation?

- Local
- Regional
- National
- International

25. How easy or hard is it for a competitor to copy your product innovation?

- Really easy
- Easy
- Not easy, not hard
- Hard
- Really hard

26. How did your company protect this product innovation, or how will your company protect it in the near future?

- Patents
- Registered designs
- Trademarks
- Confidentiality clauses
- Registered copyrights
- Licensing
- Developing high-trust relationships with customers, suppliers, and employees
- Technological copy protections
- Keeping things quiet
- Maintaining lead-time advantages

27. Please provide for the protective actions not selected above, the main reason for not using them for this product innovation.

- a. Patents
- b. Registered designs
- c. Trademarks
- d. Confidentiality clauses
- e. Registered copyrights
- f. Licensing
- g. Developing high-trust relationships with customers, suppliers, and employees
- h. Technological copy protections
- i. Keeping things quiet
- j. Maintaining lead-time advantages

<table>
<thead>
<tr>
<th>Reason for Not Using</th>
<th>Not considered</th>
<th>Low protective value</th>
<th>Low protective value</th>
<th>Too time-consuming</th>
<th>Too expensive</th>
<th>Do not know how</th>
<th>Legally not possible</th>
<th>Not relevant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patents</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Registered designs</td>
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<td>○</td>
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<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Trademarks</td>
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<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Confidentiality clauses</td>
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<td>○</td>
<td>○</td>
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<tr>
<td>Registered copyrights</td>
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<td>○</td>
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<td>○</td>
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<tr>
<td>Licensing</td>
<td>○</td>
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<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Developing high-trust relationships with customers, suppliers, and employees</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Technological copy protections</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Keeping things quiet</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Maintaining lead-time advantages</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Part 3.2: A process innovation

The following questions concern a recent process innovation. If your company has introduced more than one process innovation during the last 5 years, we ask you to pick the most representative for your company and fill out the questions for that innovation.

<table>
<thead>
<tr>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>28. How representative is this process innovation for your company?</td>
<td>Highly representative</td>
</tr>
<tr>
<td></td>
<td>Moderately representative</td>
</tr>
<tr>
<td></td>
<td>Hardly representative</td>
</tr>
<tr>
<td></td>
<td>Not representative</td>
</tr>
<tr>
<td>29. This process innovation was</td>
<td>New to our company</td>
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<tr>
<td></td>
<td>New to the region</td>
</tr>
<tr>
<td></td>
<td>New to the country</td>
</tr>
<tr>
<td></td>
<td>New to the world</td>
</tr>
<tr>
<td>30. How radical (innovative) was this process innovation?</td>
<td>Highly radical</td>
</tr>
<tr>
<td></td>
<td>Moderately radical</td>
</tr>
<tr>
<td></td>
<td>Hardly radical</td>
</tr>
<tr>
<td></td>
<td>Not radical</td>
</tr>
<tr>
<td>31. If applicable, with whom did you collaborate during the innovation process?</td>
<td>Customer(s)</td>
</tr>
<tr>
<td></td>
<td>Supplier(s)</td>
</tr>
<tr>
<td></td>
<td>Colleague(s) in another region</td>
</tr>
<tr>
<td></td>
<td>Colleague(s) in the same region</td>
</tr>
<tr>
<td></td>
<td>Sector association</td>
</tr>
<tr>
<td></td>
<td>Public knowledge institutions</td>
</tr>
<tr>
<td></td>
<td>Chamber of Commerce</td>
</tr>
<tr>
<td></td>
<td>Public institution(s) to promote innovation</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td>32. How long do you expect to profit from this process innovation (sell, use, or profit in another way, starting from the introduction of the innovation)?</td>
<td>Less than 18 months</td>
</tr>
<tr>
<td></td>
<td>Between 18 months and 6 years</td>
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<tr>
<td></td>
<td>Between 6 and 20 years</td>
</tr>
<tr>
<td></td>
<td>More than 20 years</td>
</tr>
<tr>
<td>33. How much did you invest in this process innovation (including labour, materials, education, etc.)?</td>
<td>Less than €50,000</td>
</tr>
<tr>
<td></td>
<td>Between €50,000 and €100,000</td>
</tr>
<tr>
<td></td>
<td>Between €100,000 and €500,000</td>
</tr>
<tr>
<td></td>
<td>More than €500,000</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
</tr>
<tr>
<td>34. Did your company receive a form of public financial funding for this process innovation?</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>35. How easy or hard is it for a competitor to copy your process innovation?</td>
<td>Really easy</td>
</tr>
<tr>
<td></td>
<td>Easy</td>
</tr>
<tr>
<td></td>
<td>Not easy, not hard</td>
</tr>
<tr>
<td></td>
<td>Hard</td>
</tr>
<tr>
<td></td>
<td>Really hard</td>
</tr>
</tbody>
</table>
36. How did your company protect this process innovation, or how will your company protect it in the near future?

- Patents
- Registered designs
- Trademarks
- Confidentiality clauses
- Registered copyrights
- Licensing
- Developing high-trust relationships with customers, suppliers, and employees
- Technological copy protections
- Keeping things quiet
- Maintaining lead-time advantages

37. Please provide for the protective actions not selected above, the main reason for not using them for this process innovation.

- Not considered
- Low protective value
- Too expensive
- Too time-consuming
- Do not know how
- Legally not possible
- Not relevant

<table>
<thead>
<tr>
<th>Action</th>
<th>Not considered</th>
<th>Low protective value</th>
<th>Too expensive</th>
<th>Too time-consuming</th>
<th>Do not know how</th>
<th>Legally not possible</th>
<th>Not relevant</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Patents</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
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<tr>
<td>b. Registered designs</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
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<td>❌</td>
<td>❌</td>
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<tr>
<td>c. Trademarks</td>
<td>❌</td>
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<td>❌</td>
<td>❌</td>
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<tr>
<td>d. Confidentiality clauses</td>
<td>❌</td>
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<td>❌</td>
<td>❌</td>
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<tr>
<td>e. Registered copyrights</td>
<td>❌</td>
<td>❌</td>
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<td>❌</td>
<td>❌</td>
<td>❌</td>
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<tr>
<td>f. Licensing</td>
<td>❌</td>
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</tr>
<tr>
<td>g. Developing high-trust relationships with customers, suppliers, and employees</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
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<tr>
<td>h. Technological copy protections</td>
<td>❌</td>
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<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
</tr>
<tr>
<td>i. Keeping things quiet</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
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</tr>
<tr>
<td>j. Maintaining lead-time advantages</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
<td>❌</td>
</tr>
</tbody>
</table>
4 Determinants of patents, registered designs, and registered copyrights

4.1 Introduction

The protection of innovations has been the subject of publications by the European Patent Office (1994), Kitching and Blackburn (1998), Brouwer and Kleinknecht (1999), Masurel (2002, 2005), Suthersanen et al. (2007) and many others. Most of these publications focus on patents, and neglect other registered formal alternatives such as registered copyrights and registered designs. Furthermore, the publications that do consider these alternatives (e.g. Amara et al., 2008; Cohen et al., 2000; Levin et al., 1987) generally treat them as equal alternatives. They neglect to note that registering a copyright offers less protection and is much cheaper than applying for a patent or registering a design (see Section 4.2). In this chapter, the data of the Dutch 2006 Community Innovation Survey (CIS) are used to test: (a) whether registered copyrights and patents/registered designs have an ordinal setting; and (b) whether the known determinants of the application for patents also apply on registered designs and registered copyrights. First, in Sections 4.2 and 4.3, existing theories are considered, followed by the formulation of our hypotheses in Section 4.4. Section 4.5 deals with the fieldwork and the descriptive statistics of the variables. Section 4.6 presents the results of the regressions. The discussion of the results follows in Section 4.7, and, finally, Section 4.8 provides the conclusions of our research.

4.2 Innovation and its protection

Any firm that has invested in innovation generally wants to prevent a competitor from copying this innovation. This can be achieved by (a mixture of) protective actions, varying

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34 This chapter is based on Mol and Masurel (2012), but has been partly rewritten to increase consistency throughout this thesis, and to add a number of clarifications.

35 Parts of the issues addressed in this section have already been discussed in more detail in Section 1.2.3.
from all kinds of informal protective actions to the registered formal protective actions like patents, registered designs and registered copyrights (see Section 1.2). Patents are probably the best-known form of registered formal protection. Patents are used to claim a 20-year period of monopoly on an invention that is new, innovative and industrially applicable. As explained in Section 1.2.3, registered designs have many similarities with patents regarding legal status, procedures, etc. The difference is that patents protect the technology behind an invention, whereas registered designs are used to claim a 25-year monopoly (at least in the EU) on visual aspects. Patents and registered designs are relatively expensive forms of protection (see Section 1.2.3). After a patent or registered design has been granted, its main goal is to claim a temporary monopoly. Registered copyrights can be used to protect the same (aspects of) innovations as patents and registered designs, as well as all kinds of innovations that are excluded from patents (like mathematical formulas, books, and paintings). Registered copyrights are a much cheaper form of protection (see Section 1.2.3). However, registered copyrights hardly prevent any competitor from copying the innovation (just a minor modification would prevent the ‘copy’ from violating the registered copyright involved).

4.3 Influences on the protection of innovation

Factors that relate to whether or not a firm decides to use a certain kind of protection can be found by looking at the extensive literature on innovation protection. This literature mainly focuses on patents, and predominantly neglects registered designs and registered copyrights. However, due to sometimes ambiguous naming in US research (in the US a patent can be both a design patent and a utility patent), these results on patents sometimes also include registered designs.

A frequently mentioned variable related to applying for a patent is the size of the firm. Amara et al. (2008), Arundel and Kabla (1998), Baldwin et al. (2001), and the European Patent Office (1994) discovered a positive relationship between the size of the firm, on the one hand, and the probability of applying for a patent to protect an innovation, on the other. Larger firms more often protect their innovations with patents than smaller firms do. The relationship between firm size in terms of number of employees and other protective actions remains under-investigated. However, Amara et al. (2008) did find a positive relationship

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36 The issues addressed in this section have already been discussed in more detail in Sections 1.3 and 1.4.
between the firm size in employees of Canadian knowledge-intensive business services (KIBS) and registered designs and trademarks, but not between firm size and any of the other included protective actions (registered copyrights, confidentiality agreements, secrecy, complexity of designs, lead-time advantages).

Scholars also agree that the probability of applying for a patent to protect an innovation increases with the level of R&D investments (e.g. Amara et al., 2008; Brouwer and Kleinknecht, 1999; European Patent Office, 1994). However, this relation between R&D and the probability of a firm applying for a patent was not confirmed by Arundel and Kabla (1998) for innovations by Europe’s largest manufacturing firms. Furthermore, regarding the effect of the level of R&D investments on the registration of designs and the registration of copyrights, Amara et al. (2008) did not find the level of R&D investments of Canadian KIBS to be related to registered designs and registered copyrights.

There also seems to be a relationship between the type of innovation and its protection. Product innovations are more often protected by patents than process innovations (Arundel and Kabla, 1998; Cohen et al., 2000; Levin et al., 1987). According Cohen et al. (2000), this ‘...is unsurprising because process innovations are less subject to public scrutiny and thus can be kept secret more readily’ (p. 10). Again, the effect of the type of innovation on the use of other registered formal protective actions remains unclear.

According to Brouwer and Kleinknecht (1999) and Arundel and Kabla (1998), the percentage of patent applications is also determined by the sector in which the firm operates. Brouwer and Kleinknecht (1999), as well as Arundel and Kabla (1998), found ‘chemicals and pharmaceuticals’, ‘mechanical engineering’, ‘office and computing equipment’, ‘electrical equipment’, and ‘precision instruments’ most patent-intensive for product innovations and ‘chemicals and pharmaceuticals’, and ‘rubber and plastics’ to be most patent-intensive for process innovations. Again, the relationship between the sector and other forms of registered formal protective actions remains unclear.

Another factor related to the protective behaviour of firms is whether they collaborated during the innovation process. Nowadays, many firms are in the process of adopting a kind of open innovation principle (Chesbrough, 2003). In open innovation, firms do not only rely on their own expertise and knowledge, but also include external parties in the innovation process. Because firms committed to open innovation have to share some of their
intellectual property, this might also have an impact on their protective behaviour. Based on Chesbrough et al. (2006), and also the results by Brouwer and Kleinknecht (1999), we expect a positive relationship between collaboration and the probability of a firm protecting an innovation with a patent or other registered formal protective action. However, according to Paasi et al. (2010), the joint application for a patent is not a common practice; instead, confidentiality clauses (not measured in the 2006 Dutch CIS) are typically used in open innovation processes.

As well as these more or less proven factors, a number of new factors related to the probability of a firm applying for one or more patents (and possibly other forms of registered formal protective behaviour) can be identified. These factors stem from earlier (explorative) research (see Chapter 2 and Appendix 2.A), and from several expert interviews. First, we find indications that there is a positive relationship between the scope of the geographical market and the formality of the protection. Compared with firms that sell their innovations on a national or international market, firms that sell their innovation only on a regional market are probably less likely to pay for national or international protection by means of a form of registered formal protection.

Secondly, we also find indications that firms that have received a form of public financial support are more inclined to apply for patents. A possible explanation for this is that firms which apply for funding are more aware that they are innovating, or that they have to show some form of transparency in order to obtain supportive funding. However, public financial support can also be an indication of innovation quality, since the best innovations may also be the ones that meet the criteria for public financial support, and these best innovations are generally also the ones that receive the most formal form of protection.

### 4.4 Hypotheses

In the previous sections we introduced three forms of registered formal protection for innovations: patents, registered designs, and registered copyrights. We argued that, although the aspects of the innovation that are protected differ (technology versus design), patents and registered designs provide a comparable degree of protection. We also argued that registered copyrights can be used to protect the same aspects of the innovation that patents and registered designs do, but offer much less protection. We identified seven factors that may
determine the decision to use (application for or registration of) one or more of these protective actions: firm size; level of R&D investments; whether or not the innovation can be considered a product innovation; the sector in which the firm operates; collaboration with external parties; market scope; and public financial support. Based on these factors, we formulated the following seven hypotheses:

\( H1: \) The size of the firm is positively related to the degree of protection.

\( H2: \) The level of R&D investments is positively related to the degree of protection.

\( H3: \) Product innovations are positively related to the degree of protection.

\( H4: \) Operating in a patent-intensive sector is positively related to the degree of protection.

\( H5: \) Collaboration with other organisations is positively related to the degree of protection.

\( H6: \) Operating on an international and/or national market is positively related to the degree of protection.

\( H7: \) Public financial support is positively related to the degree of protection.

4.5 Fieldwork

Our data comes from the Dutch 2006 Community Innovation Survey (CIS), currently the most recent available version of a European harmonised survey on the subject of innovation. Although the CIS aims to be representative regarding innovation in the included countries, according to Tether (2001) some critical remarks can be made regarding: (1) interpretive differences of the survey questions between respondents; (2) the definition of innovation (also including innovations that are only new to the firm and therefore could be considered an adoption instead of an innovation); (3) the survey’s focus on technological product and process innovations instead of also including other types of innovations such as service innovations and market innovations. The Dutch 2006 CIS questionnaire was sent by Statistics Netherlands (CBS)\(^{37}\) to all the 1,596 Dutch firms with more than 250 employees and to a random selection of 12,618 (21.6 per cent) of the 58,489 Dutch firms that employ between 10 and 250 people. Firms were obliged by Dutch law to fill in the survey, but not every firm complied. This resulted in a response from 1,060 firms with more than 250 employees (a 66.1

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\(^{37}\) Statistics Netherlands is a semi-governmental institution that gathers statistical information about the Netherlands.
per cent response rate) and 8,882 firms that employ between 11 and 250 people (a 70.1 per cent response rate).

Almost one-third of these firms (3,341, or 33.6 per cent) can be labelled as innovative, according to the CIS definition. That is, they introduced a new product or process between 2004 and 2006, are still in the innovation process, or have discontinued the innovation process. As we were only interested in innovative firms, the rest of the respondents were omitted from our data set. It should be noted, however, that the CIS questionnaire did not focus on a specific innovation. Instead, the respondents were asked if their firm had introduced any new products or services during the period 2004–2006. In addition, the respondents were asked whether the firm had applied for a patent\textsuperscript{38} or had registered a design and/or registered a copyright in the same period. As a consequence, a direct link between the innovation activities and the registered formal protection is likely, but not guaranteed.

We first had to deal with the issue of the use of multiple forms of protection.\textsuperscript{39} 212 firms combined multiple forms of registered formal protection (see Figure 4.1). Of these firms, 45 firms combine all three forms of protection (patents, registered designs, and registered copyrights). 34 firms combine one or more patents with one or more registered copyrights (without registered designs), and 8 firms combine one or more registered designs with one or more registered copyrights (without patents). Finally, 125 firms combine one or more patents with one or more registered designs (without registered copyrights).

\textsuperscript{38} Owing to long application procedures for patents (see Section 1.2.3), the CIS only measures whether a patent is applied for and not, as it does for the other protective actions, whether the patent actually is granted.

\textsuperscript{39} It was not an option to deal with all combinations of protection forms separately, because owing to the low number of respondents who used some combinations, this would have led to groups that would have been too small to comply with Statistics Netherlands privacy regulations.
Since patents and registered designs show many similarities regarding procedures, costs and degree of protection, we coded them together (2), followed by registered copyrights (1) and no protection (0). Firms that combined multiple forms of protection are coded with the level that provides the most protection (e.g. a firm that registered a copyright and applied for a patent is coded in the ‘patent/registered design’ group).

Table 4.1 shows that the overwhelming majority of the firms (78.7 per cent) did not use patents, registered designs, or registered copyrights. Only 2.9 per cent relied solely on registered copyrights, and 18.4 per cent applied for a patent and/or registered a design (sometimes combined with registering a copyright). This high percentage of our respondents who chose not to use any kind of registered formal protection confirms the findings by the European Patent Office (1994), Brouwer and Kleinknecht (1999), Kitching and Blackburn (1998), and Cohen et al. (2000).
Table 4.1 Frequency of registered formal protection

<table>
<thead>
<tr>
<th>Form of registered formal protection</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0) No registered formal protection</td>
<td>2,629</td>
<td>78.7</td>
</tr>
<tr>
<td>(1) Registered copyright</td>
<td>97</td>
<td>2.9</td>
</tr>
<tr>
<td>(2) Patent/Registered design</td>
<td>615</td>
<td>18.4</td>
</tr>
<tr>
<td>Total</td>
<td>3,341</td>
<td>100</td>
</tr>
</tbody>
</table>

The average number of employees per firm is 280.6 (standard deviation 1171.3). The average R&D expenditure is 2,059,290 euros with large differences between firms (standard deviation 22,213,513 euros). The R&D variable consists of: the total of the intramural (in-house) R&D; the acquisition of extramural R&D; the acquisition of machinery, equipment and software; and the acquisition of other external knowledge (according to the CIS definition).

Regarding the type of innovations introduced by the respondents (see Figure 4.2), we find that many of the responding firms introduced multiple innovations or introduced innovations that would, for example, be considered both a product and process innovation: 50.0 per cent (1,669) of the firms introduced one or more product innovations; 35.4 per cent (1183) of the firms introduced one or more service innovations; 67.3 per cent of the firms (2250) introduced one or more process innovations; and 5.3 per cent of the firms (178) were still in the innovation process, or had abandoned the innovation.

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40 The number of innovations was not measured by the Dutch 2006 Community Innovation Survey.
The number of respondents did not permit us to include the sector variable at the two-digit SBI level, because of the privacy regulations of Statistics Netherlands. As a consequence, we decided to replace it with a dummy which stated whether or not the sector was, according to Brouwer and Kleinknecht (1999) and Arundel and Kabla (1998), patent-intensive or not. While the relationship between operating in a patent-intensive sector and the application for patents is obvious, its effect on the use of registered designs and registered copyrights remains under-investigated. 17.2 per cent of our respondents operate in what is called a patent-intensive sector (‘chemicals and pharmaceuticals’; ‘mechanical engineering’; ‘office and computing equipment’; ‘electrical equipment’; ‘precision instruments’; or ‘rubber and plastics’).

The dummy stating whether or not a firm collaborated with other firms or parties during the innovation process shows that 45.2 per cent of the innovative firms collaborated...
with external parties during the innovation process. Furthermore, we find that 23.8 per cent of the respondents received a form of public financial support.

We also included a market dummy variable, which indicates whether or not a firm sells on an international and/or national market. In our data set, 12.4 per cent of the respondents deliver solely to the local and/or regional market, while 87.2 per cent (also) sell to the international and/or national market (0.4 per cent missing).

### 4.6 Regression results

Given the situation that registered designs and patents \((a)\) are more or less legally comparable forms of protection, and \((b)\) offer a much stronger (and more expensive) protection than registered copyrights, a multivariate ordered logit model (equation 4.1) was constructed. This model was designed to determine the effect of firm size \(\ln(\text{Size})\),\(^{41}\) level of R&D-investments \(\ln(\text{R&D})\),\(^{42}\) type of innovation \((\text{Product})\), patent-intensive sector \((\text{PSector})\), market scope \((\text{Market})\), collaboration with other organisations \((\text{Collaboration})\), and public financial support \((\text{Support})\), on the degree of protection \((0\ \text{no protection};\ 1\ \text{registered copyright};\ 2\ \text{patent/registered design})\):\(^{43}\)

\[
Y_i^* = \alpha_i + \beta_1 \ln(\text{Size}_i) + \beta_2 \ln(\text{R&D}_i) + \beta_3 \text{Product}_i + \beta_4 \text{PSector}_i + \beta_5 \text{Market}_i + \beta_6 \text{Collaboration}_i + \beta_7 \text{Support}_i + \varepsilon_i
\]  

\[(4.1)\]

First, we checked for multicollinearity issues by looking at the correlations between the independent variables, but found no indications of strong multicollinearity. Second, as an ordered logit model needs the effects of the independent variables to be homogenous for all

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\(^{41}\) Since an increase of one employee or 1,000 euros in R&D-investments has much more impact on a small firm than on a large firm, we compensated for this by taking the natural logarithm of the number of employees and the level of R&D-investments.

\(^{42}\) 673 firms (both SMEs and large firms) responded that they had not invested in R&D. Because many firms (especially SMEs) do not explicitly keep track of their R&D investments (e.g. Kleinknecht et al., 2002) and taking the (natural) log of zeros would result in omitting these respondents, zeros have been increased by 0.5. However, because increasing zeroes (especially this many) may introduce some bias in the results, we also conducted the same analyses without increasing the zeros. The results of these analyses (available upon request) do show some differences regarding the size of the coefficients, but not regarding their statistical significance.

\(^{43}\) Ordinal regression models, such as ordered probit and logit models, assume the ordinal dependent variable \(Y\) to be generated by an unobserved continuous variable \(Y^*\). The values of \(Y\) (no protection; registered copyright; patent and/or registered design) depend on whether or not \(Y^*\) has crossed a certain threshold value (Greene, 2003).
Determinants of patents, registered designs and registered copyrights

logits (proportional odds assumption), generally a parallel lines test is conducted to confirm this. However, the null hypothesis of parallelism was rejected. Changing the link function (to negative log-log, complementary log-log, probit, or cauchit), as suggested by Nurosis (2008), and/or omitting the least relevant variables, showed no improvements regarding the lack of homogeneity of the effects of the independent variables. Therefore, we abandoned our ordinal approach, and switched to a multinomial logit model.

As we abandoned our ordinal approach, we also decided to separate the 41 firms that registered a design (without also applying for a patent) from the firms that applied for a patent. This resulted in the following dependent variable: (0) no protection \((n=2,629)\); (1) registered copyright \((n=97)\); (2) registered design \((n=41)\); (3) patent \((n=574)\).

The results of our multinomial logit model in Table 4.2 show large differences between the three kinds of registered formal protection. All the included variables have a positive statistically significant relationship to having applied for a patent. Only whether the innovation is a product innovation, and whether the firm collaborated during the innovation process are found to display a positive statistically significant relationship to the registration of designs. Finally, only the level of R&D investments is found to reveal a positive statistically significant relationship to the registration of copyrights, and operating in a patent-intensive sector shows a negative statistically significant relationship to the registration of copyrights.

Regarding our hypotheses, we can confirm that firm size, operating in a patent-intensive sector, the market scope, and public financial support are positively related to the application for patents, but not to the registration of copyrights and designs. We can also confirm the positive relationship between the level of R&D investments and the application for patents and the registration of copyrights, but not between the level of R&D investments and the registration of designs. Finally, we can confirm that introducing a product innovation instead of a service or process innovation, and collaborating during the innovation process, are positively related to the application for patents and the registration of designs, but not to the registration of copyrights.

An important implication of these results is that, although patents and registered designs have many similarities in costs, procedures, and legal power, firm size and the level of R&D investments show a statistically significant positive relationship to patents, but not to
registered designs. Apparently, whatever is holding small firms back from applying for a patent is not there for registered designs.

Table 4.2 Parameter estimates of the multinomial logit regression

<table>
<thead>
<tr>
<th>Protection</th>
<th>Coefficient</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnSize</td>
<td>0.227**</td>
<td>0.043</td>
</tr>
<tr>
<td>lnR&amp;D</td>
<td>0.140**</td>
<td>0.024</td>
</tr>
<tr>
<td>Product innovation</td>
<td>1.520**</td>
<td>0.130</td>
</tr>
<tr>
<td>Patent-intensive sector</td>
<td>0.423**</td>
<td>0.121</td>
</tr>
<tr>
<td>(Inter)national Market</td>
<td>1.030**</td>
<td>0.288</td>
</tr>
<tr>
<td>Collaboration</td>
<td>0.404**</td>
<td>0.111</td>
</tr>
<tr>
<td>Support</td>
<td>0.789**</td>
<td>0.114</td>
</tr>
<tr>
<td>Registered design</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnSize</td>
<td>0.084</td>
<td>0.124</td>
</tr>
<tr>
<td>lnR&amp;D</td>
<td>0.018</td>
<td>0.067</td>
</tr>
<tr>
<td>Product innovation</td>
<td>0.940**</td>
<td>0.361</td>
</tr>
<tr>
<td>Patent-intensive sector</td>
<td>−0.214</td>
<td>0.417</td>
</tr>
<tr>
<td>(Inter)national Market</td>
<td>1.583</td>
<td>1.022</td>
</tr>
<tr>
<td>Collaboration</td>
<td>1.144**</td>
<td>0.370</td>
</tr>
<tr>
<td>Support</td>
<td>0.586</td>
<td>0.359</td>
</tr>
<tr>
<td>Registered copyright</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnSize</td>
<td>0.046</td>
<td>0.082</td>
</tr>
<tr>
<td>lnR&amp;D</td>
<td>0.129**</td>
<td>0.045</td>
</tr>
<tr>
<td>Product innovation</td>
<td>0.302</td>
<td>0.216</td>
</tr>
<tr>
<td>Patent-intensive sector</td>
<td>−1.333*</td>
<td>0.435</td>
</tr>
<tr>
<td>(Inter)national Market</td>
<td>1.247</td>
<td>0.519</td>
</tr>
<tr>
<td>Collaboration</td>
<td>0.294</td>
<td>0.219</td>
</tr>
<tr>
<td>Support</td>
<td>0.412**</td>
<td>0.244</td>
</tr>
<tr>
<td>Number of observations</td>
<td>3,328</td>
<td></td>
</tr>
<tr>
<td>McFadden’s $R^2$</td>
<td>0.174</td>
<td></td>
</tr>
</tbody>
</table>

Notes: The reference category is ‘no protection’; * significant at the 5% level; ** significant at the 1% level.

Limitations and recommendations

Our results are subject to several limitations. First of all, since the CIS simply asked whether or not a firm had innovated, and whether or not a firm had applied for or registered a specific kind of protection, we have no information whether these firms developed one or more innovations, and which innovation the protection was meant for. Second, we also have no information whether or not the R&D investments were invested in these specific innovations. Third, our results on registered designs and registered copyrights are based on a relatively low number of firms that did not combine them with patents. Fourth, we only included a ‘patent-intensive sector’ dummy, and did not take more detailed differences between sectors into account. Finally, we only included the Dutch CIS data set. Further research using a more extensive data set is needed to address these issues.
4.7 Discussion

It can be argued that registered formal protection of innovations has an ordinal setting: patents and registered designs offer more protection than registered copyrights do. However, we are unable to confirm this ordinal setting, as our results failed the proportional odds assumption. As an alternative approach, we used a multinomial logit model to determine whether or not the known determinants of the application for patents also relate to the registration of designs and the registration of copyrights.

Our results show the expected statistically significant relationship between our explanatory variables and the application for patents, which is not surprising since our hypotheses were derived from the literature on (predominantly) patents. However, we find only a few of the statistically significant relationships on patents confirmed for registered copyrights or registered designs, and none confirmed for all three protective actions.

Registered designs are not statistically significantly related to the size of the firm and the level of R&D investments, even though on the basis of the results of Amara et al. (2008) on Canadian KIBS, we did expect a positive statistically significant relationship. In retrospect, this absence of a positive statistically significant relationship is not that surprising, as designing the shape of a product may be relatively inexpensive (compared with the investments in technology). Therefore, the decision to register a design may not be that dependent on firm size and R&D budgets. We expect that the difference between our results and the results by Amara et al. (2008) comes from the fact that the latter source only includes KIBS, that exist on the basis of knowledge and therefore in general have a strong need for protection.

Regarding the lack of a statistically significant relationship between the market scope and registered designs we expect the following: as designing a product is relatively inexpensive, the decision to register a design may not be dependent on the market scope. Registered designs are also not statistically significantly related to whether or not a firm operates in a patent-intensive sector. This is also not that surprising, as the main characteristic of a patent-intensive sector seems to be a focus on technology, and this does not necessarily go hand-in-hand with a focus on design. Finally, registered designs are also not statistically significantly related to whether a firm received a form of public funding. We expect this to be
caused by many public funding initiatives that focus on the promotion of technology (which can be protected by patents) and not on the promotion of design.

Registered copyrights also show few statistically significant relationships to the included variables. In general, we expect this to be because registering a copyright is relatively cheap, and is therefore not that dependent on our explanatory variables. However, we do find a positive statistically significant relationship between registered copyrights and the level of R&D investments. We also find that registering a copyright is statistically significantly related to sectors that are not patent-intensive. This makes sense, as we would expect innovations (that meet patent application criteria) in patent-intensive sectors to be protected by a patent.

### 4.8 Conclusions

Only a small part of the innovative firms (21.3 per cent) from the Dutch 2006 CIS chose to apply for a patent, register a design or register a copyright, leaving most innovations unprotected, or protected by either informal or non-registered formal means. 2.9 per cent of the innovative firms registered a copyright, while 18.4 per cent of the innovative firms applied for a patent or registered a design (sometimes combined with registered copyrights).

Although approaching our protection variable as ordinal seemed very promising, the ordinal nature of our protection variable could not be confirmed. After switching to a multinomial logit model, we found that only a few of the variables that are statistically significantly related to the application for patents are also statistically significantly related to registered designs and/or registered copyrights. Although all of our seven explanatory variables show a positive statistically significant relationship with patent application, none of the explanatory variables is also statistically significantly related to both other forms of protection. Registered designs only show a positive statistically significant relationship to whether the innovation was a product innovation, and whether a firm collaborated during the innovation process. Registered copyrights only shows a positive statistically significant relationship to the amount of R&D investments and a negative statistically significant relationship to operating in a patent-intensive sector.

Therefore, future research should focus on the reasons why registered designs and registered copyrights hardly have any statistically significant relationship with the variables
that explain the use of patents. In particular the fact that patents are positively related to firm size and the level of R&D investments whereas the (in many ways comparable) registered designs are not, could be valuable for future initiatives to promote patents among SMEs. Furthermore, attention should be paid to finding alternative variables that may explain the use of registered designs and registered copyrights. Finally, the decision of firms to combine several forms of formal and/or informal protective actions merits more scholarly attention.
5 Registered formal protection and firm performance

5.1 Introduction

The major driving force of economic development is technological change (Solow, 1957), which generally stems from innovation and inventive activities (e.g. Romer, 1994; Schumpeter, 1947). According to Schumpeter (1947), innovation is not only a major driving force for economic development, but also key to both the survival and growth of firms. Innovative firms are, according to Nelson and Winter (1982), constantly seeking for a (temporary) advantage over their competitors. One of the legal instruments to extend this advantage (by preventing competitors from imitating the innovation) could be applying for a patent, or registering another kind of registered formal protection (i.e. registered designs, trademarks, or registered copyrights). However, as stated in Chapter 1, the fact that only a small percentage of the innovations are protected by registered formal protection raises the question whether protecting an innovation by means of a patent, registered design, trademark, or registered copyright has any effect on the performance of the firm (see Section 1.2.3 for more information on patents, registered designs, trademarks, and registered copyrights). The literature (see Section 5.2) shows that firms that use patents or other kinds of registered formal protection generally have a higher chance of survival, and tend to grow faster. However, most of the growth effects that are found (see Table 5.1 for an overview) are based on research on the effects of protection (mostly patents) on the market value of large publicly traded firms (quoted on the stock exchange), and therefore may not apply to 99.99 per cent of all firms in the Netherlands. Additionally, according to Griffiths et al. (2005), scholars who focus on market value incorrectly assume the stock market to work efficiently. The few scholars that have also included non-publicly traded firms (and, as a consequence, focus on other aspects of firm growth, as the market value of non-publicly traded firms is not available)
found mixed results. They also tend to address the heterogeneity in firm growth between sectors only by including a sector variable, and do not attempt to determine the effect of protective actions for a specific sector (for example, by including an interaction effect between the protective actions and sectors). Furthermore, most of these results are derived from using patents or other kinds of registered formal protection as a proxy for innovation, and thereby compare firms that use registered formal protection with firms that do not, and ignore whether a firm actually innovated at all. This makes it unclear whether the firm growth or survival is related to the innovation itself, or to the protection of the innovation.

This chapter focuses on the relationship between the use of registered formal protection to protect an innovation, on the one hand, and the survival and growth (measured by the number of employees, the level of sales and labour productivity) of innovative firms in the Netherlands, on the other. This is done by comparing innovative firms that have applied for a patent, registered a design, registered a trademark, or registered a copyright with innovative firms that did not. It contributes to the body of literature by: (i) not only focusing on large publicly traded firms but also including small and medium-sized enterprises; (ii) comparing only innovative firms; (iii) including not only patents but also registered designs, trademarks, and registered copyrights; and (iv) examining the effects of protective actions per sector. Section 5.2 gives an overview of the literature on the effects of registered formal protection on firm survival and growth. Section 5.3 provides the descriptive statistics, followed by the results of our regression analyses in Section 5.4. Section 5.5 discusses the results, after which our conclusions are presented in Section 5.6.

5.2 Firm performance

In order to establish the relationship between registered formal protection and firm performance (for an overview of ways to measure firm performance, see Murphy et al., 1996), first we need to determine whether registered formal protection is related to firm survival. Second, it is important to see whether the use of registered formal protection results in firm growth (e.g. in terms of profit, sales, employment, labour productivity, and market value).

Both firm survival and growth are the result of a complex and dynamic process that is determined by many more aspects than just innovation (for an overview see Wiklund et al., 2009) and the subsequent decision whether or not to protect this innovation (see, among
others, Drucker, 2001). However, this thesis is about protection, and therefore only aims to determine the effects of the use of registered formal protection on firm survival and growth. In order to do so, we start this section with an overview of what is known about the effects of registered formal protection on both firm survival and growth, after which we discuss different ways to measure firm growth. This is followed by an overview of the differences between sectors regarding firm characteristics, innovation processes, means of protection, etc.

5.2.1 Registered formal protection and firm survival
When we look at whether or not protective firms have a higher survival rate, we find many studies (e.g. Audretsch, 1991; Cefis and Marsili, 2005, 2006) which conclude that, although differing by, for example, country, sector, type of firms, and included variables, both firm size and innovation are positively related to firm survival. However, the relationship between registered formal protection and survival is unclear. The scholars who included registered formal protective actions (Helmers and Rogers, 2010; Jensen et al., 2008; Wagner and Cockburn, 2010) found patents and trademarks (registered designs and registered copyrights were not included) to be positively related to firm survival. However, these scholars used these protective actions as a proxy for innovation, and therefore their results do not provide a clear answer whether or not this positive relationship is caused by the innovation, the registered formal protection, or both.

5.2.2 Registered formal protection and firm growth
The studies that included the relationship between the use of protective actions and firm growth (for an overview, see Table 5.1) tend to focus mainly on the relationship between registered formal protection (generally patents) and changes in the market value of large firms, and thereby largely ignores small and medium-sized enterprises. Although the results differ to some extent, the majority of the results summarised in Table 5.1 showed patents to be related to an increase in market value.
### Table 5.1: Studies that included the relationship between registered formal protection and the growth of firms

<table>
<thead>
<tr>
<th>Author(s)/Year</th>
<th>Protection Variables</th>
<th>Primary Method(s) of Analysis</th>
<th>Total No. of Observations</th>
<th>No. of Firms</th>
<th>Time Period</th>
<th>Included Sector(s)</th>
<th>Sector Variables</th>
<th>Firm Selection</th>
<th>Country</th>
<th>Employment</th>
<th>Sales</th>
<th>Productivity</th>
<th>Market Value</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arts et al. (2010)</td>
<td>patents</td>
<td>3-stages least squares with fixed effect</td>
<td>4,002</td>
<td>272</td>
<td>'86-'04</td>
<td>multiple</td>
<td>sector dummies</td>
<td>more than 10 million USD in R&amp;D investments</td>
<td>USA</td>
<td>CAN</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bloom and Van Reenen (2002)</td>
<td>patents</td>
<td>Event study</td>
<td>20</td>
<td>3 days</td>
<td>biotech</td>
<td>-</td>
<td>-</td>
<td>20 largest biotech</td>
<td>USA</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bosworth and Rogers (2001)</td>
<td>patents</td>
<td>fixed effect</td>
<td>2,000</td>
<td>200</td>
<td>'68-'96</td>
<td>multiple</td>
<td>sector dummies</td>
<td>publicly traded</td>
<td>UK</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Comanor and Scheer (1969)</td>
<td>patents</td>
<td>correlation</td>
<td>57</td>
<td>'55-'60</td>
<td>pharmaceutical</td>
<td>-</td>
<td>-</td>
<td>unrelated</td>
<td>USA</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ernst (2001)</td>
<td>patents</td>
<td>fixed effect</td>
<td>433</td>
<td>50</td>
<td>'84-'92</td>
<td>mechanical engineering</td>
<td>-</td>
<td>-</td>
<td>DEU</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Geroski (1995)</td>
<td>patents</td>
<td>fixed effect, generalised least squares</td>
<td>440</td>
<td>'72-'82</td>
<td>manufacturing</td>
<td>various sector variables</td>
<td>publicly traded</td>
<td>UK</td>
<td>unrelated</td>
<td>unrelated</td>
<td>unrelated</td>
<td>unrelated</td>
<td>unrelated</td>
<td>rate of return</td>
</tr>
<tr>
<td>Geroski et al. (1997)</td>
<td>patents</td>
<td>fixed effect, random effect</td>
<td>1,897</td>
<td>271</td>
<td>'76-'82</td>
<td>multiple</td>
<td>various sector variables</td>
<td>publicly traded</td>
<td>UK</td>
<td>unrelated</td>
<td>unrelated</td>
<td>unrelated</td>
<td>unrelated</td>
<td></td>
</tr>
<tr>
<td>Greenhalgh and Rogers (2006)</td>
<td>patents</td>
<td>EU patents trademarks</td>
<td>fixed effect, first difference</td>
<td>3,227</td>
<td>532</td>
<td>'89-'02</td>
<td>production</td>
<td>Pavitt sectors</td>
<td>publicly traded</td>
<td>UK</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Greenhalgh and Rogers (2007)</td>
<td>patents</td>
<td>EU patents trademarks</td>
<td>generalised method of movements, fixed effect</td>
<td>6,421</td>
<td>1,600</td>
<td>'96-'00</td>
<td>manufacturing and services</td>
<td>publicly traded</td>
<td>UK</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Griffiths et al. (2005)</td>
<td>patents</td>
<td>trademarks designs</td>
<td>fixed effect</td>
<td>11,929</td>
<td>1,922</td>
<td>'89-'02</td>
<td>multiple</td>
<td>more than 50 million in turnover</td>
<td>AUS</td>
<td>+</td>
<td>profit</td>
<td>+</td>
<td>profit</td>
<td>+</td>
</tr>
<tr>
<td>Griffiths (1981)</td>
<td>patents</td>
<td>fixed effect</td>
<td>1,091</td>
<td>157</td>
<td>'68-'74</td>
<td>multiple</td>
<td>sector dummies</td>
<td>publicly traded</td>
<td>USA</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Griffiths et al. (1991)</td>
<td>patents</td>
<td>fixed effect</td>
<td>2,377</td>
<td>340</td>
<td>'73-'80</td>
<td>multiple</td>
<td>sector dummies</td>
<td>publicly traded</td>
<td>USA</td>
<td>+</td>
<td>unrelated</td>
<td>(pharmaceutical sector +)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hall et al. (2005)</td>
<td>patents</td>
<td>fixed effect</td>
<td>12,118</td>
<td>1,982</td>
<td>'79-'88</td>
<td>manufacturing</td>
<td>sector dummies</td>
<td>publicly traded</td>
<td>USA</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Narin et al. (1987)</td>
<td>patents</td>
<td>correlation</td>
<td>17</td>
<td>'75-'82</td>
<td>pharmaceutical</td>
<td>-</td>
<td>-</td>
<td>top 35 in world pharmaceutical sales</td>
<td>USA</td>
<td>-</td>
<td>unrelated</td>
<td>financial performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Niefert (2005)</td>
<td>patents</td>
<td>fixed effect, first difference</td>
<td>6,820</td>
<td>1,387</td>
<td>'90-'93</td>
<td>multiple</td>
<td>sector dummies</td>
<td>start-ups</td>
<td>DEU</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Riab-Bekkou (2003)</td>
<td>trademarks</td>
<td>ordinary least squares</td>
<td>81</td>
<td>'92-'96</td>
<td>multiple</td>
<td>Forbes most international 100</td>
<td>USA</td>
<td>-</td>
<td>+</td>
<td>value added</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Sandner and Block (2011)</td>
<td>patents</td>
<td>trademarks</td>
<td>non-linear least squares</td>
<td>6,757</td>
<td>1,126</td>
<td>'96-'02</td>
<td>multiple</td>
<td>sector dummies</td>
<td>publicly traded</td>
<td>Multiple</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>profit</td>
</tr>
<tr>
<td>Scherer (1985)</td>
<td>patents</td>
<td>ordinary least squares</td>
<td>365</td>
<td>'55-'60</td>
<td>industrial</td>
<td>sector dummies</td>
<td>Fortune 500</td>
<td>USA</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Toivainen et al. (2002)</td>
<td>patents</td>
<td>fixed effect</td>
<td>1,541</td>
<td>877</td>
<td>'89-'95</td>
<td>multiple</td>
<td>sector dummies</td>
<td>publicly traded</td>
<td>UK</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Only a few of the studies summarised in Table 5.1 included other registered formal protective actions,\(^{44}\) such as registered designs and trademarks (i.e. Bosworth and Rogers, 2001; Greenhalgh and Rogers, 2006, 2007; Griffiths et al., 2005; Sandner and Block, 2011). Although their results are not entirely consistent, trademarks were predominantly found to be related to an increase in market value, whereas registered designs (only included once) were not.

Greenhalgh and Rogers (2006) also included differences between sectors, and found the number of European patents divided by the value of tangible assets to be related to an increase in market value of firms in the science-based and specialised suppliers sectors. For patents only valid in the UK, Greenhalgh and Rogers (2006) also found the patent-assets ratio (the number of patents divided by the value of tangible assets in millions of pounds) to be related to a decrease in the market value of firms in the supplier-dominated sector. However, this was not confirmed for European patents (also valid in the UK). Finally, they found the trademarks-assets ratio to be related to an increase in the market value of firms in five out of six Pavitt-Tidd-sectors (see Section 5.2.4), the only exceptions being related to a decrease in the information-intensive sector and no relationship in the full sample.

When we look at the level of sales (generally referred to as just ‘sales’), employment, or productivity, we find more mixed results: the relationship between patents and changes in sales (the other protective actions were not included) varies from negative (Artz et al., 2010) to unrelated (Geroski, 1995; Geroski et al., 1997) to positive (Bloom and Van Reenen, 2002; Comanor and Scherer, 1969; Ernst, 1995; Scherer, 1965); a relationship between patents and an increase in the number of employees was found by Niefert (2005); the relationship between patents and productivity varies from unrelated (Geroski, 1995) to positive (Bloom and Van Reenen, 2002; Greenhalgh and Rogers, 2007). Registered designs were also found to be related to an increase in productivity by Greenhalgh and Rogers (2007). Finally, patents, registered designs, and trademarks were found to be related to an increase in the profit of large firms (Griffiths et al., 2005).

Although most of the research summarised in Table 5.1 differed in statistical method, number of firms, time frame, sector, variables included, and, to a lesser extent, country (mostly the US and the UK), the scholars summarised in Table 5.1 generally tended to use

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\(^{44}\) For more details on the differences between patents, registered designs, trademarks and registered copyrights: see Section 1.2.3.
registered formal protection (sometimes combined with R&D investments) as a proxy for innovation. Although this may be viable for the purpose these scholars had, it does not provide a clear answer to the question: What is the effect of the registered formal protection, and what part of the firm growth comes from the innovation? The few scholars who also included whether or not a firm innovated (or the number of innovations introduced), found registered formal protection to be unrelated to productivity (Geroski, 1995), and the relationship between registered formal protection and sales to be negative (Artz et al., 2010), or also unrelated (Geroski, 1995; Geroski et al., 1997). However, these scholars focused on the relationship between patents and changes in firm performance (measured by sales, productivity, market value, and/or return on assets) of only a limited number of large publicly traded firms. Furthermore, the above-named scholars also paid limited attention to potential differences in the effects of patents between sectors.

5.2.3 Measuring firm growth

Firm growth can be defined in many different ways. Looking at the literature summarised in Table 5.1, market value is the most favoured. However, as stated before, market value has the disadvantage that data is generally only available for publicly traded firms, which leaves out a substantial part of the firms (mostly small and medium-sized). Furthermore, using market value also has the disadvantage that it incorrectly assumes stock markets to work efficiently (Griffiths et al., 2005).

As a consequence, we decided to look at ways to measure firm growth that are more suitable for SMEs. According to a meta-study on growth studies of SMEs by Shepherd and Wiklund (2009) (see Table 5.2), sales are the most common means to measure firm growth. However, the disadvantage of using sales is that sales are an output entity, and yield no insight into the resources that were used to obtain these sales, or how efficiently these resources were used.

Employment growth is another common means to measure firm growth (Shepherd and Wiklund, 2009). However, employment growth is the result of an increase in competitiveness, which in turn is the result of an increase in productivity (Glaeser et al., 1992). Therefore, we not only included sales and employment records, but also focused on how input and output relate to each other throughout the years, by including labour productivity. On a further distance, in Table 5.2, the indicators profit and equity/assets are also sometimes used to
measure firm growth. As we were only able to acquire these data for a small number of firms, we decided not to include these indicators in our analyses.

Table 5.2 Growth studies' use of indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Number of studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
<td>61</td>
</tr>
<tr>
<td>Employees</td>
<td>13</td>
</tr>
<tr>
<td>Profit</td>
<td>9</td>
</tr>
<tr>
<td>Equity/assets</td>
<td>6</td>
</tr>
<tr>
<td>Other</td>
<td>15</td>
</tr>
</tbody>
</table>


5.2.4 Distinction of sectors

When looking at firm survival and growth, differences between sectors should also be taken into account: even though firms tend to show large heterogeneity, some homogeneity in firm growth patterns can be found within sectors (e.g. Bernard and Jones, 1996; Nickell, 1996; Syverson, 2011; Wiklund et al., 2009). A much-used sectoral taxonomy was made by Pavitt (1984), who distinguished four different manufacturing sectors, based on sources of technology, the type of customers, and the means of appropriating benefits (the term used by Pavitt 1984 to describe how firms in this sector generally protect their innovations). Summarising Pavitt (1984), these sectors can be described as follows.

First, firms in the science-based sector generally obtain their technology from their own R&D or from public knowledge institutions. These high-tech firms generally service customers who are both price- and performance sensitive. Appropriation in this sector is based on knowledge of R&D, patents, and process secrecy. Typical industries in this sector are electronics and chemicals.

The second high-tech sector, the specialised suppliers sector, consists of relatively small firms that aim their products at a highly specialised but mostly small market. A typical example would be the manufacturing of machinery. These firms generally conduct their own R&D, but benefit greatly from the experience of advanced users. The strategic focus is mostly on performance rather than on price. Typical appropriation in this sector consists of patents and knowledge of both design and users.
The third sector is the scale-intensive sector. Firms in this sector are generally big mass-production firms (like the production of steel or glass) that conduct their own R&D, and are looking for price-cutting innovations. Due to the high costs of possible failures, most innovations are only incremental. The appropriation of innovations is generally done by patents, secrecy, and specialised know-how.

The fourth sector, the supplier-dominated sector, consists of low-tech firms that hardly conduct any innovative activity on their own. Most of the innovations come directly from their suppliers. Appropriation is done by means like trademarks, marketing, and advertisement. Examples of firms in the supplier-dominated sector are agricultural firms and traditional manufacturing firms.

This taxonomy was later extended by Tidd et al. (1997) with an ‘information intensive’ sector and a ‘traditional services’ sector to also include service-based firms. However, since we only have data for a relatively small number of firms ($n<100$) from the information intensive sector, we decided to use a Pavitt-based classification from Bogliacino and Pianta (2010), who included service-based firms in the original four Pavitt-sectors (see Table 5.3).
Table 5.3 Classification of sectors, based on Pavitt-Bogliacino-Pianta

<table>
<thead>
<tr>
<th>Sector</th>
<th>Industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science-based</td>
<td>Chemicals&lt;br&gt;Office machinery&lt;br&gt;Manufacture of radio, television and communication equipment and apparatus&lt;br&gt;Manufacture of medical, precision and optical instruments, watches and clocks&lt;br&gt;Communications&lt;br&gt;Computer and related activities&lt;br&gt;Research and development</td>
</tr>
<tr>
<td>Specialised suppliers</td>
<td>Mechanical engineering&lt;br&gt;Manufacture of electrical machinery and apparatus n.e.c.&lt;br&gt;Manufacture of other transport equipment&lt;br&gt;Real estate activities&lt;br&gt;Renting of machinery and equipment&lt;br&gt;Other business activities</td>
</tr>
<tr>
<td>Scale-intensive</td>
<td>Pulp, paper and paper products&lt;br&gt;Printing and publishing&lt;br&gt;Mineral oil refining, coke and nuclear fuel&lt;br&gt;Rubber and plastics&lt;br&gt;Non-metallic mineral products&lt;br&gt;Basic metals&lt;br&gt;Motor vehicles&lt;br&gt;Financial intermediation, except insurance and pension funding&lt;br&gt;Insurance and pension funding, except compulsory social security&lt;br&gt;Activities auxiliary to financial intermediation&lt;br&gt;Construction&lt;br&gt;Electricity, gas and water supply</td>
</tr>
<tr>
<td>Supplier-dominated</td>
<td>Food, drink and tobacco&lt;br&gt;Textiles&lt;br&gt;Clothing&lt;br&gt;Wood and products of wood and cork&lt;br&gt;Fabricated metal products&lt;br&gt;Furniture, miscellaneous manufacturing; recycling&lt;br&gt;Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel&lt;br&gt;Wholesale trade and commission trade, except of motor vehicles and motorcycles&lt;br&gt;Retail trade, except of motor vehicles and motorcycles; repair of personal and household goods&lt;br&gt;Hotels and catering&lt;br&gt;Inland transport&lt;br&gt;Water transport&lt;br&gt;Air transport&lt;br&gt;Supporting and auxiliary transport activities; activities of travel agencies&lt;br&gt;Mining of coal and lignite; extraction of peat&lt;br&gt;Agriculture, hunting and related service activities&lt;br&gt;Sewage and refuse disposal, sanitation and similar activities&lt;br&gt;Other services activities</td>
</tr>
</tbody>
</table>


Note: a ‘Construction’, ‘Electricity, gas and water supply’, ‘Mining’, ‘Agriculture’, ‘Sewage and refuse disposal’, and ‘Other services activities’ were added based on other Pavitt-based classifications (Abreu et al., 2008; Kristensen, 1999; Miozzo and Soete, 2001; Pavitt, 1984; Tidd et al., 1997).
5.2.5 The effect of registered formal protection on firm survival and growth

When we combine all the findings from Section 5.2 so far, we can formulate several hypotheses. First of all, although registered designs and registered copyrights were not included in the results summarised in Section 5.2.1, firms that use registered formal protection showed a larger survival rate than firms that did not.

Second, both patents and registered designs were found to be predominantly related to firm growth in employment, sales, and productivity. We specifically include registered designs here, on account of the sometimes ambiguous naming in US research (in the US a patent can also be a design patent, see Section 1.2.3). As many of the relationships between registered formal protection, on the one hand, and firm growth in employment, sales, and productivity, on the other, were found in high-tech sectors (like pharmaceuticals or mechanical engineering), this effect seems to be strongest in the (high-tech) science-based sector and the specialised suppliers sector. This stronger effect in the science-based and specialised suppliers sector has also been more or less confirmed by Greenhalgh and Rogers (2006), who found similar results between the number of patents per asset (the number of patents divided by the value of tangible assets in millions of pounds) and growth in market value.

Third, trademarks were found to be predominantly related to an increase in market value, profit, and productivity. We found no research on the relationship between trademarks and sales, nor between trademarks and the number of employees, but, on the basis of the rest of the results in Table 5.1, we expect this to be positive as well. When we look at the differences between sectors, Greenhalgh and Rogers (2006) found the number of trademarks per asset to be significantly related to an increase in the market value of firms in five out of six Pavitt-Tidd-sectors (the extension made by Tidd et al. (1997), see Section 5.2.4), the exception being the information-intensive sector. However, since we use a slightly different Pavitt-based classification in which the information-intensive sector is not included separately, we expect trademarks to be related to firm growth in terms of number of employees, productivity, and sales in all our four Pavitt-Bogliacino-Pianta-sectors.

Fourth, registered copyrights, although they are initially aimed at another kind of invention, can sometimes be seen as a less expensive and less protective alternative for a patent or a registered design. Due to their low costs and ease of obtaining (see Section 1.2.3),
we expect them to be mostly used in the (low-tech) supplier-dominated sector. However, since their protective force is rather limited, we do not expect registered copyrights to be related to firm growth (for an overview of the expected effects summarised above, see Table 5.4).

Table 5.4 Hypotheses regarding the relationship between registered formal protection and firm growth in number of employees, sales, and productivity

<table>
<thead>
<tr>
<th></th>
<th>Full Sample</th>
<th>Science-based suppliers</th>
<th>Spec. suppliers</th>
<th>Scale-intensive</th>
<th>Supplier-dominated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patent &amp; Registered design</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Trademark</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Registered copyright</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Notes: 0 no statistically significant relationship; + positive statistically significant relationship with relatively small coefficients; ++ positive statistically significant relationship with relatively large coefficients.

5.3 Data and descriptive statistics

To test our hypotheses, we combined data from several data sets from Statistics Netherlands. First of all, we used the Dutch 2006 Community Innovation Survey (CIS), a European harmonised survey on the subject of innovation (including registered formal protection). The Dutch 2006 CIS was sent to all firms that employed over 250 people, and to a random sample of over 20 per cent of the firms that employ between 10 and 250 people. This resulted in a response of 1,060 firms with more than 250 employees (a 66.1 per cent response rate) and 8,882 firms with between 11 and 250 employees (a 70.1 per cent response rate).

Because we are interested in the effect of registered formal protection on the performance of innovative firms, we selected the 3,163 firms that declared that they had introduced new products, services, or processes between 2004 and 2006, and can therefore be considered innovative. However, we are still at risk of measuring firm or innovation quality instead of the effect of the registered formal protection, since probably the most successful firms and the best innovations are the ones that are protected. These firms would probably also display higher growth without any protection, and therefore any positive coefficients do not necessarily have to be the result of the protective actions.

45 Contrary to Chapter 4, we only included the firms that had actually introduced one or more innovations, omitting 178 firms that are still in the innovation process, or had discontinued the innovation process.
The employment records for the years 2006, 2007, 2008, and 2009 were obtained by matching the data of these innovative firms with the Business Register, a data set containing employment, sector, and entry and exit data of all firms in the Netherlands. This gave us employment and/or discontinuation data on all 3,163 innovative firms.

To obtain sales records for the years 2006, 2007, and 2008, we also matched these 3,163 innovative firms with the Production Statistics data sets. The Production Statistics data sets are based on several sector-specific surveys that are sent annually to all firms that employ over 50 people and to a random sample of firms employing between 10 and 50 people. The total response for these specific years was between 56,000 and 57,000 firms (an around 76 per cent response rate). From these data, we were able to obtain sales records for 2,219 of our 3,163 innovative firms in 2006, 2,027 firms in 2007, and 1,941 firms in 2008.

5.3.1 Registered formal protection

Of the 3,163 firms that can be considered innovative, 996 firms used one or more forms of registered formal protection: 553 applied for a patent; 205 registered a design; 614 registered a trademark; and 179 registered a copyright. 39.1 per cent of these protective firms combined two or more forms of registered formal protection. Although we find large differences between firms, on average we find these protective firms to be larger in employment and sales than the non-protective firms (see Table 5.5).

Table 5.5 Average number of employees and sales in 2006 according to type of protection

<table>
<thead>
<tr>
<th>Number of firms</th>
<th>Number of employees</th>
<th>Sales (x €1,000,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patent</td>
<td>553</td>
<td>322.5</td>
</tr>
<tr>
<td>Registered design</td>
<td>205</td>
<td>441.7</td>
</tr>
<tr>
<td>Trademark</td>
<td>614</td>
<td>336.1</td>
</tr>
<tr>
<td>Registered copyright</td>
<td>179</td>
<td>421.0</td>
</tr>
<tr>
<td>No registered formal protection</td>
<td>2,167</td>
<td>179.2</td>
</tr>
</tbody>
</table>

46 Statistics Netherlands introduced a new method for identifying firms in the Production Statistics in 2009 (and in the Business Register in 2010): firms that are part of a holding are now registered under the identification number of the holding, instead of being registered under their own identification number. Because over two-thirds of the respondents of the 2006 CIS were part of a holding (and we generally had no innovation data for the rest of the holding), we were unable to obtain reliable sales records from 2009 onwards, and employment records from 2010 onwards.
The use of patents, registered designs, trademarks, and registered copyrights shows large differences between the four Pavitt-Bogliacino-Pianta sectors (see Table 5.6). This is not surprising, since one of the distinctive factors between the Pavitt-Bogliacino-Pianta sectors is the means of appropriation. As a consequence, we would indeed expect a tendency towards patents in the science-based and specialised suppliers sectors. Based on Pavitt (1984) we would also expect the percentage of firms that did not apply for registered formal protection to be the lowest in the supplier-dominated and scale-intensive sectors. However, the high percentage of trademarks (26.6 per cent) in the science-based sector does not fit the typical appropriation regime in this sector (see Section 5.2.4).

<table>
<thead>
<tr>
<th></th>
<th>Full Sample</th>
<th>Science-based</th>
<th>Spec. suppliers</th>
<th>Scale-intensive</th>
<th>Supplier-dominated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patent</td>
<td>17.4</td>
<td>18.9</td>
<td>20.2</td>
<td>18.1</td>
<td>15.1</td>
</tr>
<tr>
<td>Registered design</td>
<td>6.5</td>
<td>4.9</td>
<td>7.8</td>
<td>6.6</td>
<td>6.1</td>
</tr>
<tr>
<td>Trademark</td>
<td>19.4</td>
<td>26.6</td>
<td>14.3</td>
<td>18.1</td>
<td>20.9</td>
</tr>
<tr>
<td>Registered copyright</td>
<td>5.7</td>
<td>6.6</td>
<td>5.6</td>
<td>7.1</td>
<td>4.7</td>
</tr>
<tr>
<td>No registered formal protection</td>
<td>68.5</td>
<td>59.3</td>
<td>69.0</td>
<td>70.4</td>
<td>70.0</td>
</tr>
<tr>
<td>Total number of firms</td>
<td>3,163</td>
<td>391</td>
<td>784</td>
<td>649</td>
<td>1,339</td>
</tr>
</tbody>
</table>

Notes: Due to long application procedures, the CIS measures whether the respondents applied for a patent but not whether it was granted. Details about the patent application procedures can be found in Section 1.2.3; Multiple forms of registered formal protection are possible.

5.3.2 Survival rate

Looking at the survival rate, we find that 531 of these 3,163 firms did not survive until January 2010. A large number of these firms were discontinued in 2007 (41.2 per cent), a little over a quarter of these 531 firms were discontinued in 2008 (26.4 per cent), and, finally, almost one-third (32.4 per cent) were discontinued in 2009 (or by 1 January, 2010). This slight increase in 2009 may have been caused by the economic crisis that started in the course of 2008.

Looking at the differences in survival (Figure 5.1), we find that firms that applied for one or more patents, registered one or more designs, and registered one or more trademarks have a higher survival rate than the firms that did not use registered formal protection, or used registered copyrights. This confirms the findings from the literature that protective actions are
positively related to firm survival,⁴⁷ although the non-surviving firms probably also include successful innovators that have been taken over.

*Figure 5.1 Survival rate according to type of protection*

When we look at the differences in survival per sector (see Table 5.7), we find that firms that applied for a patent have a higher survival rate than the non-protective firms in all sectors (although with large differences between sectors). Firms that registered a design, trademark, or copyright also have a higher survival rate than firms that did not use registered formal protection, except for registered copyrights in the specialised suppliers sector and for registered designs, trademarks, and registered copyrights in the scale-intensive sector. In these particular cases the survival rate is lower than that of firms that did not use registered formal protection.

⁴⁷ Because the firms that protected their innovations are also, on average, the larger ones in terms of employment and sales (Table 5.5), we checked our results shown in Figures 5.1, 5.2, 5.3, and 5.4 for a size effect by also including the non-protective firms that employ over 100 people. However, size effects do not explain the differences between protective and non-protective firms that were found.
Table 5.7 Survival rate of protective and non-protective firms per sector by January 2010 (in percentages)

<table>
<thead>
<tr>
<th></th>
<th>Full Sample</th>
<th>Science-based suppliers</th>
<th>Spec. intensive</th>
<th>Supplier-dominated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patent</td>
<td>86.6</td>
<td>85.1</td>
<td>87.3</td>
<td>84.7</td>
</tr>
<tr>
<td>Registered design</td>
<td>84.9</td>
<td>84.2</td>
<td>86.9</td>
<td>79.1</td>
</tr>
<tr>
<td>Trademark</td>
<td>83.6</td>
<td>87.5</td>
<td>78.6</td>
<td>77.1</td>
</tr>
<tr>
<td>Registered copyright</td>
<td>82.1</td>
<td>88.5</td>
<td>75.0</td>
<td>80.3</td>
</tr>
<tr>
<td>No registered formal protection</td>
<td>82.6</td>
<td>83.2</td>
<td>77.4</td>
<td>83.2</td>
</tr>
</tbody>
</table>

5.3.3 Firm growth patterns

In order to gain more insight into how the growth of protective firms relates to that of the non-protective firms, we visualised the average number of employees, sales, and labour productivity of the protective firms against the non-protective firms (see Figures 5.2, 5.3, and 5.4).

First of all, as stated before, we find the protective firms to have, on average, more employees than the non-protective firms (see Figure 5.2). Furthermore, when we look at the growth rate of the number of employees, we find that firms that use registered formal protection (applied for a patent, registered a design, registered a trademark, or registered a copyright) do not, on average, show higher growth rates than the non-protective firms. On the contrary, we even find a steep decrease in the number of employees between 2006 and 2007 for the firms that registered a design or registered a copyright, and a smaller decrease for the firms that applied for a patent or registered a trademark.

Finally, although 2009 was heavily influenced by the economic crisis, we do not see this reflected in the average number of employees of the protective and the non-protective firms compared with the previous years. However, this is not really a surprise, since firms are generally reluctant to cut down in their number of employees (labour hoarding), ‘...as they hope that demand will pick up later and do not want to pay the cost of re-hiring the laid-off workers’ (Pessoa and Van Reenen, 2014, p. 444). These results also seem to correspond with the total employment of the Netherlands which showed only a mild decrease in 2009 (see Van den Berge et al., 2014).
When we look at the average sales\textsuperscript{48} of the non-protective firms compared with those of the protective firms (Figure 5.3), we again find the protective firms to be larger. While the average non-protective firms showed some growth between 2006 and 2007, this is not confirmed for the protective firms. On the contrary, the average sales of firms that applied for a patent or registered a trademark remained rather stable, whereas the firms that registered a design or registered a copyright show a decrease in sales between 2006 and 2007. Between 2007 and 2008 only those firms that had registered a copyright showed an increase in average sales, while the average sales of the rest of the firms remained rather stable.

\textsuperscript{48} Sales in 2006 consumer prices. Since our initial results were largely influenced by outliers, we omitted the sales and productivity data for 65 outliers in labour productivity (sales per employee) that exceeded the standard deviation by more than five times.
The average labour productivity, measured by sales per employee (Figure 5.4), shows the labour productivity of the protective firms to be much closer to the non-protective firms compared with the differences found between protective and non-protective firms regarding employees and sales. This makes sense, since any firm with an above-average labour productivity will keep on attracting more employees, as long as the marginal benefits are larger than the marginal costs (e.g. Varian, 2009). This would eventually lead to a firm that is larger in terms of number of employees and sales, but not in terms of labour productivity (Glaeser et al., 1992).

However, we do find some differences when looking at the growth patterns. First, contrary to the increase in productivity that we find for all other firms between 2006 and 2007, the average productivity of firms that registered a design remains stable between 2006 and 2007. Second, we find the average productivity of firms that applied for a patent, registered a trademark, or registered a copyright lacked the decrease in productivity between 2007 and 2008 that we do find for non-protective firms and firms that registered a design.
In general, we can conclude that firms that applied for a patent, registered a design, or registered a trademark have a higher survival rate than the non-protective firms. However, in the scale-intensive sector this is only the case for firms that applied for a patent; the firms that used another kind of registered formal protection have a lower survival rate than the non-protective firms. Firms that registered a copyright have a higher survival rate in the science-based and the supplier-dominated sector, but not in the specialised suppliers and the scale-intensive sector. Second, the protective firms are larger in terms of number of employees and sales, but this difference is much smaller in labour productivity. Third, although we find that the average protective firms showed different growth patterns in number of employees, sales, and labour productivity than the non-protective firms, in general, we do not find that the average protective firm displayed more growth regarding the number of employees and sales. However, we find that firms which applied for a patent, registered a trademark, or registered a copyright lack the decrease in productivity between 2007 and 2008 that we do find for non-protective firms and firms that registered a design.
5.4 Registered formal protection and firm growth

In this section we introduce a number of regression models to determine whether or not the use of registered formal protection is related to the growth of innovative firms measured by the number of employees, sales and labour productivity (see Table 5.8 for the definition of variables). We included a fixed effect to account for any unobserved heterogeneity between firms (see Models 5.1 and 5.2). For the number of employees, we looked at the relationship between registered formal protection between 2004 and 2006 and the growth in number of employees in 2007, 2008, and 2009 (compared with 2006). For labour productivity and sales, we only looked at the growth in 2007 and 2008, owing to the unavailability of comparable data for 2009 (see Footnote 46). Because the effect of protection is likely to differ among sectors owing to differences in sources of technology, type of customers, and typical means of appropriation (see Section 5.2.4), we ran every model twice, once without any interaction between the protection dummies and sector dummies (named ‘total’, see Model 5.1) and once including the interaction effects between the protection dummies and the sector dummies (see Model 5.2). Because we aim to explain the effect of protection on firm growth (and not firm growth as a whole), and because we have a relatively high number of included dummy variables, we did not include any other explanatory variables in our main analyses (only a fixed effect).

The method above differs from the existing literature by combining the following aspects. First of all, since we want to obtain more insight into the effects of the protective behaviour itself, we only included firms that have innovated (see the beginning of Section 5.3). Second, we also included small and medium-sized enterprises. Third, we did not only include sector dummies to account for differences between sectors, but also included the effect of the protective actions per sector. Fourth, we did not focus on a firm’s entire innovative history by including the total portfolio of protective actions (or something similar), but by dummies stating whether or not the firm had applied for a patent, registered a design, registered a trademark, and/or registered a copyright between 2004 and 2006. Finally, owing to data unavailability, we limited our time frame to the years 2006–2008 or 2006–2009, depending on what aspect of firm growth we were looking at. However, although the time it

49 We included a number of well-known innovation variables in our robustness tests (see the end of this Chapter), but we found no indication that would suggest the need to revise our model.
takes for the effect of the protection to be the strongest would probably differ from sector to sector, according to the findings of Ernst (2001) for the German manufacturing sector and Scherer (1965) for the US 500 largest industrial corporations, the effects of patents on firm growth are the strongest around 2–3 years after the introduction of the innovation. We assume this effect to be similar for the other protective actions.

<p>| Table 5.8 Definition of included variables |</p>
<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Measurement Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>ln(Empl&lt;sub&gt;i&lt;/sub&gt;)</td>
<td>Dependent variable, natural log&lt;sup&gt;a&lt;/sup&gt; of the number of employees of firm &lt;i&gt;i&lt;/i&gt; in year &lt;i&gt;t&lt;/i&gt; (2006–2009).</td>
<td>Continuous</td>
</tr>
<tr>
<td>ln(Sales&lt;sub&gt;i&lt;/sub&gt;)</td>
<td>Dependent variable, natural log&lt;sup&gt;a&lt;/sup&gt; of the sales (€1000) of firm &lt;i&gt;i&lt;/i&gt; in year &lt;i&gt;t&lt;/i&gt; (2006–2008).</td>
<td>Continuous</td>
</tr>
<tr>
<td>ln(Prod&lt;sub&gt;i&lt;/sub&gt;)</td>
<td>Dependent variable, natural log of the sales (€1000) per employee of firm &lt;i&gt;i&lt;/i&gt; in year &lt;i&gt;t&lt;/i&gt; (2006–2008).</td>
<td>Continuous</td>
</tr>
<tr>
<td>Year&lt;sub&gt;t&lt;/sub&gt;</td>
<td>Year dummies stating whether the year of measurement &lt;i&gt;t&lt;/i&gt; of the dependent variable is 2009, 2008, 2007 or 2006.</td>
<td>1 Year … 0 Not year …</td>
</tr>
<tr>
<td>Sector&lt;sub&gt;s&lt;/sub&gt;</td>
<td>Sector dummies stating the sector &lt;i&gt;s&lt;/i&gt; in which firm &lt;i&gt;i&lt;/i&gt; operates.</td>
<td>1 Science-based 2 Specialised suppliers 3 Scale-intensive 4 Supplier-dominated</td>
</tr>
<tr>
<td>Pat&lt;sub&gt;i&lt;/sub&gt;</td>
<td>Dummy stating whether or not firm &lt;i&gt;i&lt;/i&gt; applied for a patent between 2004 and 2006.</td>
<td>1 Patent 0 No patent</td>
</tr>
<tr>
<td>Dsg&lt;sub&gt;i&lt;/sub&gt;</td>
<td>Dummy stating whether or not firm &lt;i&gt;i&lt;/i&gt; registered a design between 2004 and 2006.</td>
<td>1 Registered design 0 No registered design</td>
</tr>
<tr>
<td>Tm&lt;sub&gt;i&lt;/sub&gt;</td>
<td>Dummy stating whether or not firm &lt;i&gt;i&lt;/i&gt; registered a trademark between 2004 and 2006.</td>
<td>1 Trademark 0 No trademark</td>
</tr>
<tr>
<td>Cp&lt;sub&gt;i&lt;/sub&gt;</td>
<td>Dummy stating whether or not firm &lt;i&gt;i&lt;/i&gt; registered a copyright between 2004 and 2006.</td>
<td>1 Registered copyright 0 No registered copyright</td>
</tr>
<tr>
<td>α&lt;sub&gt;i&lt;/sub&gt;</td>
<td>Firm &lt;i&gt;i&lt;/i&gt; specific intercept.</td>
<td></td>
</tr>
<tr>
<td>µ&lt;sub&gt;it&lt;/sub&gt;</td>
<td>Error term for firm &lt;i&gt;i&lt;/i&gt; in year &lt;i&gt;t&lt;/i&gt;.</td>
<td></td>
</tr>
</tbody>
</table>

Note: <sup>a</sup> Since taking the natural log would result in losing the firms with no employees or no sales, all zeros (56) have been increased by half the lowest measured value.

The ‘total’ fixed effect model on employees without sector interaction:<sup>50</sup>

\[
\ln(Enpl_{it}) = \alpha_{i} + \sum_{t=07}^{09} \beta_{1,t} Pat_{i} Year_{t} + \sum_{t=07}^{09} \beta_{2,t} Dsg_{i} Year_{t} + \sum_{t=07}^{09} \beta_{3,t} Tm_{i} Year_{t} + \sum_{t=07}^{09} \beta_{4,t} Cp_{i} Year_{t} + \sum_{t=07}^{09} \gamma_{1,s} Year_{t} Sector_{si} + \mu_{it} \tag{5.1}
\]

<sup>50</sup> Models for sales and labour productivity are equal to Model 5.1 and 5.2, with the exception that they do not include 2009 data (see the beginning of Section 5.4).
The fixed effect model on employees with sector interaction:

\[ \ln(Empl_{it}) = \alpha_i + \sum_{t=07}^{09} \sum_{s=1}^{4} \beta_{1,ts} Pat_i Year_t Sector_s + \sum_{t=07}^{09} \sum_{s=1}^{4} \beta_{2,ts} Dsg_i Year_t Sector_s + \sum_{t=07}^{09} \sum_{s=1}^{4} \beta_{3,ts} Tm_i Year_t Sector_s + \sum_{t=07}^{09} \sum_{s=1}^{4} \beta_{4,ts} Cp_i Year_t Sector_s + \sum_{t=07}^{09} \sum_{s=1}^{4} \gamma_{1,ts} Year_t Sector_{si} + \mu_{it} \] (5.2)

In Tables 5.9, 5.10, and 5.11 we report the results both with and without sector interaction. We also included Chow tests\(^{51}\) to determine whether the protection has any effect on firm growth that would not show up in our individual coefficients, by comparing the coefficients of a specific kind of protection for the included years not only with the reference year (2006), but also with each other. Any statistically significant effect would imply that using that specific kind of protection had an effect on firm growth measured by the number of employees, sales, or labour productivity.

First of all, all our models show a relatively low fit as we only included protection variables (and a fixed effect). However, we aim to explain the effect of protection on firm performance here (and not firm growth as such). Regarding the number of employees (Table 5.9), in our total model we find, contrary to our expectations based on the literature, no statistically significant relationship between the protective actions, on the one hand, and the changes in the number of employees, on the other. In our model that included a sector interaction effect, we do find some statistically significant effects. We find patents to be statistically significant related to a relatively large increase of the number of employees in the scale-intensive sector (10.0 per cent) in 2007. However, this effect seems only temporary, as the coefficients become much smaller and lose statistical significance in 2008 and 2009. After a statistically insignificant effect in 2007, we also find a statistically significant effect between patents and the growth in number of employees in the supplier-dominated sector in

\(^{51}\) Chow tests are generally used to determine whether the effects among different groups are heterogeneous, by testing whether the coefficients in two linear regressions on different data sets are equal. In this particular case, we use Chow tests to determine whether there is any growth effect over the years (determined by coefficients that are not equal according to the Chow test) by not only comparing all years with the reference category, but also with each other (e.g. \(\beta_{1,2009} \neq \beta_{1,2008} \neq \beta_{1,2007} = 0\)).
2008 (11.1 per cent) and in 2009 (8.4 per cent). This is contrary to the literature, since we would expect the effects to be the strongest in the science-based sector and the specialised suppliers sector. Registered designs are statistically significantly related to a large increase in the number of employees in the specialised suppliers sector in 2008 (16.9 per cent) and 2009 (17.8 per cent). Based on our Chow tests, we also find registered designs to be related to changes in the number of employees in the supplier-dominated sector. Looking at the coefficients, it seems that after an initial statistically insignificant 6.1 per cent decrease in the number of employees in 2007, firms in the supplier-dominated sector that registered a design started growing in terms of number of employees in 2008, and finally in 2009 ended up growing 3.2 per cent more than the non-protective firms. We do not find trademarks and, as we expected, registered copyrights to be statistically significantly related to changes in the number of employees.

Table 5.9 Relationship between the use of registered formal protection and the number of employees in 2007, 2008, and 2009

<table>
<thead>
<tr>
<th>Dependent = ln(Employeesit)</th>
<th>Total</th>
<th>Science-based</th>
<th>Specialised suppliers</th>
<th>Scale-intensive</th>
<th>Supplier-dominated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>0.033 (0.03)</td>
<td>0.001 (0.04)</td>
<td>-0.063 (0.07)</td>
<td>0.100* (0.04)</td>
<td>0.072 (0.05)</td>
</tr>
<tr>
<td>2008</td>
<td>0.032 (0.03)</td>
<td>-0.071 (0.07)</td>
<td>-0.032 (0.07)</td>
<td>0.036 (0.07)</td>
<td>0.111* (0.05)</td>
</tr>
<tr>
<td>2009</td>
<td>0.032 (0.03)</td>
<td>-0.021 (0.07)</td>
<td>-0.006 (0.07)</td>
<td>0.010 (0.07)</td>
<td>0.084* (0.04)</td>
</tr>
<tr>
<td>Chow</td>
<td>-0.002 (0.07)</td>
<td>0.023 (0.09)</td>
<td>0.069 (0.08)</td>
<td>0.008 (0.18)</td>
<td>-0.061 (0.15)</td>
</tr>
<tr>
<td>Registered design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>0.057 (0.07)</td>
<td>0.104 (0.13)</td>
<td>0.169* (0.07)</td>
<td>0.059 (0.19)</td>
<td>-0.047 (0.14)</td>
</tr>
<tr>
<td>2008</td>
<td>0.065 (0.06)</td>
<td>-0.009 (0.13)</td>
<td>0.178* (0.07)</td>
<td>-0.011 (0.19)</td>
<td>0.032 (0.10)</td>
</tr>
<tr>
<td>2009</td>
<td>-0.009 (0.13)</td>
<td>-0.009 (0.13)</td>
<td>0.187 (0.07)</td>
<td>-0.011 (0.19)</td>
<td>0.032 (0.10)</td>
</tr>
<tr>
<td>Chow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trademark</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>-0.060 (0.05)</td>
<td>-0.007 (0.04)</td>
<td>-0.086 (0.07)</td>
<td>0.074 (0.06)</td>
<td>0.019 (0.04)</td>
</tr>
<tr>
<td>2008</td>
<td>-0.031 (0.03)</td>
<td>0.022 (0.06)</td>
<td>-0.139 (0.08)</td>
<td>0.009 (0.09)</td>
<td>0.022 (0.04)</td>
</tr>
<tr>
<td>2009</td>
<td>-0.030 (0.03)</td>
<td>0.002 (0.06)</td>
<td>-0.125 (0.09)</td>
<td>0.030 (0.09)</td>
<td>0.025 (0.04)</td>
</tr>
<tr>
<td>Registered copyright</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>-0.064 (0.05)</td>
<td>-0.243 (0.17)</td>
<td>-0.022 (0.11)</td>
<td>-0.104 (0.10)</td>
<td>0.003 (0.06)</td>
</tr>
<tr>
<td>2008</td>
<td>-0.059 (0.05)</td>
<td>-0.244 (0.17)</td>
<td>-0.003 (0.09)</td>
<td>-0.092 (0.11)</td>
<td>-0.005 (0.06)</td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sector*yeardummies</td>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R² Within</td>
<td>0.01</td>
<td>0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of firms</td>
<td>3,163</td>
<td>12,052</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: * significant at the 5% level; ** significant at the 1% level; reference year is 2006; standard errors are in parentheses.
To illustrate these results from Table 5.9, let us define two identical (in 2006) hypothetical firms X and Y that, for ease of comparison, both operated in the supplier-dominated sector; employed 100 people at the end of 2006; and had an annual sales of 100,000,000 euros. Both firms innovated between 2004 and 2006, and without any protective actions both firms would show an, also hypothetical, annual 1 per cent growth in employees and sales, while the labour productivity would remain the same. The only difference between firm X and firm Y is that firm X decided to protect its innovation by applying for a patent somewhere between 2004 and 2006, while firm Y did not.

Based on the above scenario, we know that, at the end of 2007, firm Y would employ 101 employees (100 + 1 per cent), and, based on Table 5.9, firm X would employ 108 (101 + 7.2 per cent) employees, with a 95 per cent confidence interval between 97 and 119 employees (see Figure 5.5). Because the 101 employees of firm Y are within the 95 per cent confidence interval of firm X, there is no statistically significant difference between firm X and firm Y. In 2008, firm X would employ 113 (102 + 11.1 per cent) employees (confidence interval: 103–123), which is statistically significantly more than the 102 employees (101 + 1 per cent) of firm Y. In 2009, firm X would employ 112 (103 + 8.4 per cent) employees (confidence interval: 104–120). This is again statistically significantly more than the 103 employees of firm Y in 2009.

*Figure 5.5 Development of the number of employees of hypothetical firm X that applied for a patent and firm Y that did not apply for a patent*
Our results on sales (Table 5.10) also show only a few statistically significant results, although we again find relatively large coefficients. In our total model, we only find a statistically significant relationship between registered copyrights and a decrease in sales in 2007 (5.1 per cent). This is unexpected, since registered copyrights are the only protective action that we expected not to be related to changes in sales in any way. The lack of statistically significant results for patents (and other protective actions) confirms the findings by Geroski (1995) and Geroski et al. (1997), who found patents not to be related to changes in sales (of publicly traded firms).

When we look at our sector interaction model, we again hardly find any statistically significant relationships, whereas the few statistically significant relationships that are found show a negative coefficient. We find patents to be related to a decrease (14.0 per cent) in sales in the science-based sector in 2008. Although we expected a positive relationship, this does confirm the findings by Artz et al. (2010), who found a negative effect of patents on the sales of large publicly traded firms. Registered designs do not show any statistically significant relationship to sales at all. This is again not according to the literature, since we expected them to be related to sales growth in all four sectors. Also contrary to our expectations, trademarks are statistically significantly related to a decrease in sales (12.6 per cent) in the scale-intensive sector in 2007, but when in 2008 the coefficient increases to 12.9 per cent it loses statistical significance. Our Chow tests show, as well as the decrease in sales in the scale-intensive sector already discussed above, also a statistically significant relationship between trademarks and sales in the science-based sector. Looking at the coefficients, it seems that, after an initial statistically insignificant increase (4.8 per cent) in sales in 2007, in 2008 firms that registered a trademark show a relatively large decrease in sales ending up with (2.2 per cent) less sales than the other firms. Finally, as expected, we do not find an effect for registered copyrights in our sector interaction model.
When we take another look at our hypothetical firms X and Y, we find no statistically significant differences for both years (see Figure 5.6). Firm Y would have sales at 101 million euros in 2007, and firm X would have sales at 103 million euros (confidence interval: 99–107). In 2008 firm Y would have sales at €102 million, and firm X would have sales worth 104 million euros (confidence interval: 98–110).

### Table 5.10 Relationship between the use of registered formal protection and sales in 2007 and 2008

<table>
<thead>
<tr>
<th>Dependent = (\ln(\text{Sales}_{it}))</th>
<th>Total</th>
<th>Science-based</th>
<th>Specialised suppliers</th>
<th>Scale-intensive</th>
<th>Supplier-dominated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>0.010 (0.03)</td>
<td>−0.076 (0.05)</td>
<td>0.075 (0.07)</td>
<td>0.001 (0.06)</td>
<td>0.016 (0.02)</td>
</tr>
<tr>
<td>2008</td>
<td>0.011 (0.06)</td>
<td>−0.140* (0.07)</td>
<td>0.125 (0.10)</td>
<td>0.259 (0.23)</td>
<td>0.016 (0.03)</td>
</tr>
<tr>
<td><strong>Chow</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Registered design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>−0.004 (0.03)</td>
<td>−0.005 (0.14)</td>
<td>0.011 (0.06)</td>
<td>−0.032 (0.05)</td>
<td>−0.033 (0.03)</td>
</tr>
<tr>
<td>2008</td>
<td>−0.119 (0.12)</td>
<td>0.027 (0.18)</td>
<td>0.032 (0.20)</td>
<td>−0.532 (0.44)</td>
<td>−0.048 (0.04)</td>
</tr>
<tr>
<td><strong>Chow</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trademark</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>−0.016 (0.02)</td>
<td>0.048 (0.05)</td>
<td>0.003 (0.04)</td>
<td>−0.126* (0.04)</td>
<td>0.003 (0.02)</td>
</tr>
<tr>
<td>2008</td>
<td>−0.002 (0.04)</td>
<td>−0.022 (0.07)</td>
<td>0.155 (0.17)</td>
<td>−0.129 (0.08)</td>
<td>0.002 (0.02)</td>
</tr>
<tr>
<td><strong>Chow</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Registered copyright</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2007</td>
<td>−0.051* (0.03)</td>
<td>−0.126 (0.1)</td>
<td>−0.023 (0.04)</td>
<td>−0.037 (0.06)</td>
<td>−0.040 (0.04)</td>
</tr>
<tr>
<td>2008</td>
<td>−0.217 (0.14)</td>
<td>−0.120 (0.12)</td>
<td>−0.395 (0.44)</td>
<td>−0.408 (0.37)</td>
<td>−0.041 (0.05)</td>
</tr>
<tr>
<td><strong>Chow</strong></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Sector*yeardummies</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R² Within</td>
<td>0.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of firms</td>
<td>3,163</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of observations</td>
<td>6,187</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Notes: * significant at the 5% level; ** significant at the 1% level; the reference year is 2006; standard errors are in parentheses.
When we look at Table 5.11, we find registered formal protection not to be related to changes in labour productivity in our total model. This confirms the findings by Geroski (1995) on the relationship between patents and the labour productivity of publicly traded firms. We do find a number of effects in our sector interaction model. In contrast with the literature summarised in Table 5.1, registered designs are found to be statistically significantly related to a decrease (14.8 per cent) in labour productivity in the supplier-dominated sector in 2008. Trademarks are found to be statistically significantly related to a decrease (12.2 per cent) in labour productivity in the scale-intensive sector in 2007, but in 2008 this effect is much smaller and loses statistical significance. Both effects are also confirmed by our Chow tests.
Looking at our hypothetical firms, firm X that applied for a patent and firm Y that did not, we find that both firm X and firm Y do not show any statistically significant difference in labour productivity (see Figure 5.7). Firm Y would have a labour productivity of 1,000 (x 1,000) euros in 2006, 2007 and 2008, and firm X would have a labour productivity of 971 (x 1,000) euros (confidence interval: 963–979) in 2007 and 985 (x 1,000) euros in 2008 (confidence interval: 979–991).

### Table 5.11 Relationship between the use of registered formal protection and labour productivity in 2007 and 2008

<table>
<thead>
<tr>
<th>Dependent = \ln(\text{Productivity}_{it})</th>
<th>Total</th>
<th>Science-based</th>
<th>Specialised suppliers</th>
<th>Scale-intensive</th>
<th>Supplier-dominated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patent</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2007</td>
<td>0.006 (0.03)</td>
<td>0.134 (0.09)</td>
<td>−0.063 (0.05)</td>
<td>0.067 (0.12)</td>
<td>−0.029 (0.04)</td>
</tr>
<tr>
<td>2008</td>
<td>0.011 (0.04)</td>
<td>0.040 (0.11)</td>
<td>0.067 (0.12)</td>
<td>0.025 (0.03)</td>
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</tr>
<tr>
<td>Chow</td>
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<td></td>
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<tr>
<td>Registered design</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2007</td>
<td>−0.022 (0.04)</td>
<td>0.016 (0.09)</td>
<td>−0.019 (0.06)</td>
<td>−0.070 (0.07)</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>−0.147 (0.08)</td>
<td>0.100 (0.2)</td>
<td>−0.292 (0.22)</td>
<td>−0.148** (0.05)</td>
<td></td>
</tr>
<tr>
<td>Chow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trademark</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>−0.030 (0.02)</td>
<td>0.008 (0.06)</td>
<td>−0.122 (0.05)</td>
<td>0.015 (0.03)</td>
<td></td>
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<tr>
<td>2008</td>
<td>0.008 (0.04)</td>
<td>0.200 (0.17)</td>
<td>−0.080 (0.07)</td>
<td>0.007 (0.03)</td>
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<tr>
<td>Chow</td>
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<tr>
<td>Registered copyright</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>0.035 (0.04)</td>
<td>0.005 (0.07)</td>
<td>−0.014 (0.06)</td>
<td>0.110 (0.09)</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>−0.116 (0.11)</td>
<td>−0.499 (0.43)</td>
<td>−0.179 (0.18)</td>
<td>0.093 (0.07)</td>
<td></td>
</tr>
<tr>
<td>Chow</td>
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<td></td>
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<tr>
<td>Sector*yeardummies</td>
<td>Yes</td>
<td></td>
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<tr>
<td>R² Within</td>
<td>0.03</td>
<td></td>
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<tr>
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<td>3,163</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of observations</td>
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<tr>
<td></td>
<td>6,176</td>
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</tbody>
</table>

Notes: * significant at the 5% level; ** significant at the 1% level; reference year is 2006; standard errors are in parentheses.
Robustness

To determine why our results differ from most of the findings from the literature, as well as to check the robustness of the results, we ran three other sets of analyses. First, we included some well-known innovation-specific variables (the level of R&D investments; collaboration with other organisations; and whether or not the innovation was a product innovation) in our models. The results showed a statistically significant effect of the level of R&D investments, and whether the innovation was a product innovation on the growth in sales and labour productivity. However, the effects of the registered formal protection variables remained comparable to our earlier findings in terms of both sign and statistical significance in all our analyses.

Second, we also included the non-innovative firms from the 2006 CIS data set. Although we found a statistically significant relationship between having applied for a patent and the growth in number of employees in 2008 and 2009 for our total model (equation 5.1), the results for our model with sector interaction (equation 5.2) showed comparable results to the model without the non-innovative firms. Furthermore, the results on sales and labour productivity (both total and with sector interaction) were also comparable in terms of sign and statistical significance.
Third, since many of the results from the literature came from (large) publicly traded firms, we tried to only include publicly traded firms. However, because of the privacy regulations of Statistics Netherlands, we were unable to do so. As an alternative, we limited our data set with innovative firms to include only large firms (more than 250 employees). Although, compared with our original analyses, more differences occurred here regarding the size of coefficients and the statistical significance of specific coefficients, the results still showed a similar lack of statistically significant relationships.

Looking back, we can conclude that although the coefficients are relatively large, registered formal protection is hardly statistically significantly related to firm growth in employment, sales, and labour productivity. This is basically a confirmation and extension of the findings by Geroski (1995) and Geroski et al. (1997).

**Limitations and recommendations**

Our results are subject to a number of limitations. First of all, regarding patents we only had data on the application for patents and not on whether the patent was granted. Second, although we did only include the innovative firms, some endogeneity problems may have occurred because probably the best innovations and/or best performing firms are the ones that are protected, and without any protection these firms would probably also display more growth. Third, our results do not offer an explanation why the few effects that are found appear in that specific sector, in that specific year. Fourth, since the CIS simply asks whether or not a firm introduced new products, new processes, or both, and whether or not they applied for a patent or registered a design, registered a trademark, or registered a copyright, we do not know whether these effects come from one or more innovations. Fifth, our model does not take any prior innovative or protective behaviour into account, and therefore the growth of the firms could be influenced by earlier actions. Sixth, we only included Dutch firms. Finally, we looked at a relatively short time-period. Further research using a more extensive data set is needed to address these issues.

**5.5 Discussion**

Although we find that the firms which applied for a patent, registered a design, or registered a trademark have a higher survival rate than the firms which did not use a form of registered
formal protection, we are unable to confirm this for firms which registered a copyright. Looking at the differences across sectors, we find that this higher chance of survival for firms that applied for a patent, registered a design or registered a trademark is confirmed in all sectors, with the exception of the scale-intensive sector. In this sector, only firms that applied for a patent show a survival rate that is higher than the survival rate of the non-protective firms, while firms that registered a trademark, design, or copyright show a survival rate that is lower than the survival rate of the non-protective firms. The latter could be caused by the very nature of the scale-intensive sector, since firms in this sector are mainly looking for price-cutting innovations, and protecting the name or appearance of a product may not be that important for this kind of innovations.

With our ‘total’ firm growth model, we find an effect only for registered copyrights on sales in 2007. However, since this relationship is negative (implying a decrease in sales), this could just as well be caused by the firms putting many of their resources into the transition to the new product(s) or process(es), instead of using these resources for realising sales. This would make sense, since a firm that decides to invest in a form of registered formal protection would probably also be willing to put great effort into making it a success, sometimes at the cost of short-term sales. However, this does not answer the question why this effect only emerges for registered copyrights and not for the other protective actions.

Looking at firm growth in our models that include a sector interaction effect, we find a similar lack of statistically significant results. Contrary to the literature, we only find having applied for a patent to be related to the growth in the number of employees (but not to the growth in sales and labour productivity) in the supplier-dominated (in 2008 and 2009) and scale-intensive sector (in 2007), and not, as we expected, in the science-based and specialised suppliers sector. We do find having applied for a patent to be related to a decrease in sales for firms in the science-based sector in 2008. In both cases (the relationship to the number of employees, as well as the relationship to sales), we presume this to be caused by the transition to one or more new product(s) or process(es). While firms in the supplier-dominated and scale-intensive sector seem to hire additional employees for this transition, this may be harder for firms in the more specialised science-based sector, as specialised employees are harder to find. Therefore, they may have to reallocate existing employees for this transition, resulting in a (temporary) decrease in sales.
Registered designs are found to be related to growth in the number of employees of firms in the specialised suppliers sector (in 2008 and 2009) and after an initial decrease in 2007, also to the number of employees of firms in the supplier-dominated sector. Because we find registering a design not to be related to sales in any sector, and related to a decrease in labour productivity for firms in the supplier-dominated sector in 2008, we presume this relation to growth (in the number of employees) to be again caused by extra employees hired for the transition process.

Trademarks are related only to a decrease in both sales and labour productivity of firms in the scale-intensive sector in 2007, and after an initial increase in 2007 also to a decrease in sales in the science-based sector. We again presume this decrease in sales (and in the scale-intensive sector also in labour productivity) to be related to the transition to a new product or process.

The lack of statistically significant results in general may be caused by several factors. First of all, the lack of statistically significant results may be caused by the unpredictable nature of growth rates (Geroski et al., 1997). Second, the lack of statistically significant results could also be caused by the fact that most of the literature is somewhat dated. Recently, the speed of innovation has increased (Florida, 2002) and it could be that the patenting and other protective systems are unable to match this speed. Furthermore, nowadays patents and other protective actions seem mainly to have a strategic purpose, and may be ‘...only distantly related to a firm’s innovation efforts’ (Artz et al., 2010, p. 736).

The few times we do find registered formal protection to be statistically significantly related to firm growth, it is related only to an increase in the number of employees, and to a decrease in sales or labour productivity. This strengthens our above-mentioned presumptions that the few effects that are found are due to firms putting more effort into the transition to a new product or process than the firms that do not protect their innovation. However, to confirm this hypothesis, more research is required on the long-term effects of registered formal protection on firm growth.

To conclude this discussion with a critical note, although most of our results lack statistical significance, this does not necessarily mean that applying for patents, registering designs, registering trademarks, or registering copyrights has no effect on firm growth at all. On the contrary, since many of our coefficients are rather large, and, based on Figure 5.4, we
do find indications of at least an effect regarding the labour productivity of firms that applied for a patent, registered a trademark, or registered a copyright, there could still be some economic significance in our coefficients (see, Ziliak and McCloskey, 2008).

5.6 Conclusions

Based on the findings from the literature we expected a positive effect of patents, registered designs, and trademarks on both the survival and growth of firms (measured by sales, employees, and labour productivity). Furthermore, we expected the effects of patents and registered designs to be strongest in the science-based and specialised suppliers sectors and the effects of trademarks to be roughly equal among sectors.

First of all, looking at the survival rate, we find (in line with the findings in the literature) that innovative firms which applied for a patent, registered a design, or registered a trademark have a higher chance of survival compared with non-protective firms. Firms that registered a copyright do not show a higher chance of survival compared with the non-protective firms. When we also include the sector in which a firm operates, we find this higher survival rate for firms that applied for a patent, registered a design, or registered a trademark confirmed in all sectors, with the exception of the scale-intensive sector. In this sector only those firms that have applied for a patent show a higher survival rate than the non-protective firms. However, the above-mentioned higher survival rate for protective firms could also be caused by the characteristics of the firm or innovation instead of the protective actions, since registered formal protection is probably used by the best-performing firms and/or for the best innovations, and even without any protection these firms might also display more survival.

Second, on the basis of the majority of the findings in the literature, we would expect the application for patents, registration of designs, and registration of trademarks to be related to firm growth. However, in line with earlier findings by Geroski (1995), Geroski et al. (1997), Griliches et al. (1991), and Bosworth and Rogers (2001), this is not confirmed by our results. Possible explanations why our results differ from the mainstream could be: the unpredictable nature of growth rates (Geroski et al., 1997); the increasing speed of innovation (Florida, 2002) and the inability of protective systems to match this speed; because nowadays patents and other protective actions seem mainly to have a strategic purpose, and may be
‘...only distantly related to a firm’s innovation efforts’ (Artz et al., 2010, p. 736); or simply our results being particular for the Netherlands.

Summarising, our results show that firms which use registered formal protection generally do have a better chance of survival. However, it turns out that, contrary to most of the findings from the literature, the use of registered formal protection does not show a statistically significant effect on the growth of those firms.
6 Conclusions

6.1 Summary of results

Innovation comes from ideas, which are sometimes the result of years of research. However, ideas are non-rivalrous (Romer, 1990); that is, by using an idea one does not exclude someone else from using the same idea. This non-rivalrous nature of ideas makes it possible for any competitor to copy the idea without having to make the same amount of investments, and this competitor would therefore be able to sell the innovation at a lower price than the original inventor. This phenomenon, generally known as the ‘free-rider problem’ (Olson, 1965), would result in a lack of incentive for any firm or individual to invest in inventive activity, and eventually would lead to a lack of technological progress.

A way to overcome this problem is by creating a temporary monopoly, just long enough for the inventor to reclaim his fixed costs, but also short enough to prevent it from limiting future technological progress. This eventually led to our current intellectual property system that provides innovative firms with the possibility to gain a temporary monopoly on an innovation by applying for a patent, registering a design, registering a trademark, or registering a copyright. However, as the literature suggests, many innovative firms, especially small and medium-sized firms (SMEs), decide not to use one of those registered formal protective actions. Instead, SMEs choose to protect their innovations by other, less formal means, or decide not to protect at all.

In order to gain more insight into how and why firms protect their innovations, this thesis has focused on the following three research questions:

(i) How do firms protect their innovations?
(ii) Which factors determine the choice of a specific form of protective action?
(iii) Is the use of a specific form of registered formal protection related to firm performance?
Chapter 2 presented an analysis of the patent data (obtained from the Netherlands Patent Office) of all of the around 26,000 firms in the north-east of the Netherlands (Zwolle Chamber of Commerce area). On the basis of the patent data, we concluded that, in line with the findings from the literature in the field of innovation and innovation protection, 99.5 per cent of the SMEs in this region did not own patents. We also found that these SMEs owned relatively more 6-year patents than large firms did. This is not surprising, since the (currently abolished) 6-year patent was specifically tailored for SMEs, by being cheaper and more short-term-oriented. Furthermore, the few SMEs in the Zwolle Chamber of Commerce region that owned one or more patents did not let them expire as often as larger firms did. It seems that SMEs that own a patent, maybe due to their high dependence on a single innovation (Nooteboom, 1994), value these patents more than larger firms do.

Chapter 2 also included the results of 20 explorative interviews with owner-managers of SMEs from the same region on their choice of protective actions, and their motives for doing so. Following Kitching and Blackburn (1998), we distinguished four groups of protective actions with an increasing level of formality (see Section 1.2 for details): ‘no protection’; ‘informal protection’ (e.g. maintaining lead-time advantages, investing in a relationship based on trust); ‘non-registered formal protection’ (e.g. confidentiality clauses, licensing); and ‘registered formal protection’ (i.e. patents, registered designs, trademarks, and registered copyrights).

Although our results may be biased by selecting our respondents from the network of Windesheim University of Applied Sciences, on the basis of a limited number of 20 interviews, we confirmed that the respondents prefer the less formal protective actions (i.e. confidentiality clauses, licensing, investing in maintaining lead-time advantages, investing in relationships based on trust) over the more expensive registered formal forms of protection (i.e. patents, registered designs, trademarks, registered copyrights). We also found indications that the degree of formality of the protection is positively related to the age of the firm; to the amount of R&D investments of the firm; and to whether the innovation was a product innovation (as opposed to process, market, or service innovations). Contrary to the literature, we found no indication that the degree of formalisation of the protection was related to the number of employees of the firm or to the educational level of the entrepreneur. However, this lack of statistically significant results for size and educational level seems to be caused by
Conclusions

the low variance in size and the selection of owner-managers from the network of Windesheim University of Applied Sciences.

Although we originally aimed to include more industries (see Section 1.6), due to the low number of respondents from other industries Chapter 3 focused specifically on the protection of innovations by SMEs in the Dutch printing industry. This rather traditional sector is of special interest, because of its large number of SMEs. Furthermore, starting in the 1930s, there have been three main drivers of innovation in the printing industry, which resulted in a sector that seems continuously challenged to reinvent itself. First, the sector has transformed from a blue-collar craftsman industry to a more computerised industry, which has led to increased outputs, and to a decrease in the demand for skilled blue collar workers. Second, owing to the (inevitable) use of ink, chemicals, and other toxics in the sector, a great deal of attention has been paid to health issues among employees and to environmental effects. This has resulted in various governmental regulations and sector-initiated certificates, all aimed to make the sector more sustainable. Third, more recently, the advent of home printing and e-reading has resulted in more changes in the sector. According to Smallbone et al. (2000), the introduction of new technologies and closer ties between customers and printers have fundamentally altered the structure of the industry. This has resulted in new products and services ‘...and the creation of new markets for on-demand, short-run, colour printing, as well as database creation and management’ (Smallbone et al., 2000, p. 299).

We sent a survey to 1,337 firms in this sector with questions about the firm, the owner-manager, and a recent product and/or process innovation. Based on the results of 79 SMEs (out of a total of 93 responses) that had introduced a product innovation, a process innovation, or both, we found large differences in the determinants of the degree of formality of the protection of product and process innovations. Generally, process innovations are protected less formally than product innovations. This outcome of our research is not very surprising, since ‘Process innovations are less subject to public scrutiny and thus can be kept secret more readily’ (Cohen et al., 2000, p. 10). This difference between product and process innovations does not only reflect on the degree of formality of the protection of product and process innovations, but also reflects on the different factors that are related to the degree of formality of the protection.
Looking at the determinants of the degree of formality of protection of product innovations, we found this degree to be positively related to: whether the firm received a form of public financial support for the innovation; whether the firm collaborated (with competitors, customers, suppliers, public knowledge institutions, Chamber of Commerce, or sector association) during the innovation process; the level of innovativeness of the innovation; and whether the firm/entrepreneur had experience with the different protective actions. Surprisingly, we found the degree of formalisation of protection of product innovations to be negatively related to the level of innovation investments of the firm and to the firm being located in an urban area (as opposed to a rural area). The negative effect of the level of innovation investments on the degree of formality of the protection could be caused by many of the innovations in the Dutch printing industry being adopted (e.g. by buying a new printing press) instead of being invented by the firm itself. Adopting an innovation instead of inventing it would make protection useless, and in some cases even impossible, since it would probably already be covered by the inventing firm itself. The negative effect of being located in an urban area on the degree of formality of the protection is also rather surprising at first sight. However, this negative effect might be related to the fact that service-oriented firms (e.g. copy shops) in the Dutch printing industry are more often located in urban areas, while the more innovative mass-production printing houses are more often located in low-populated industrial areas.

The degree of formality of the protection of process innovations was found to be positively related to: whether the firm had received a form of public financial support for the innovation; the newness of the innovation (new to the firm; new to the region; new to the country; new to the world); and the innovativeness of the innovation. Again, similar to product innovations, the degree of formalisation of the protection of process innovation was found to be negatively related to the firm’s level of innovation investments, and to the firm being located in an urban area.

These studies on the protective behaviour of SMEs in the north-east of the Netherlands and the Dutch printing industry from Chapter 2 and 3, combined with the findings from the literature (mostly on the patents of large firms), gave us insight into the variables that are related to the protective behaviour of both SMEs and large firms. We took these explorative results from Chapters 2 and 3 and tested them in Chapter 4, using the much larger data set of
the Dutch 2006 Community Innovation Survey (CIS), on three different kinds of registered formal protection (i.e. patents, registered designs, and registered copyrights).

Looking at the results of Chapter 4, first of all, we confirmed earlier findings that many of the innovative firms do not apply for a patent, register a design, or register a copyright. Furthermore, we found the application for patents, registration of designs, and registration of copyrights to be related to different firm and innovation variables (since we had no control over the survey questions, we were unable to include any entrepreneurial variables). First, whether the firm applied for a patent was found to be positively related to all included firm and innovation variables: the size of the firm in terms of number of employees; the level of R&D investments of the firm; whether the innovation is a product innovation (and not a process innovation or service innovation); whether the firm operates in a patent-intensive sector; the geographical market scope of the firm; whether the firm collaborated (with competitors, customers, suppliers, public knowledge institutions, Chamber of Commerce, or sector association) during the innovation process; and whether the firm received a form of public financial support for the innovation. Registering a design was only found to be positively related to whether the innovation was a product innovation, and whether the firm collaborated during the innovation process. Finally, registering a copyright was found to be positively related to the level of R&D investments of the firm, and negatively to the firm operating in a patent-intensive sector.

Chapter 5 focused on the relationship between the use of registered formal protection and firm survival, and between registered formal protection and firm growth (measured by changes in the number of employees, the amount of sales, and the level of labour productivity). This was done by comparing innovative firms that decided to apply for a patent, register a design, register a trademark, or register a copyright with innovative firms that did not, using the data from the Dutch 2006 CIS data set combined with employment records and survival records from the Dutch General Business Register (Algemene Bedrijven Register) for the years 2006 up to and including 2009, and sales records from the Dutch Production Statistics (Productie Statistiek) for the years 2006 up to and including 2008. Since both our own results from Chapter 4 and the results from the literature showed large differences in the protective behaviour between sectors, we accounted for heterogeneity between sectors by dividing the group of CIS respondents into four different sectors (supplier-dominated; scale-
intensive; specialised suppliers; science-based), based on a classification by Pavitt (1984) which was extended by Bogliacino and Pianta (2010).

Looking at the results of Chapter 5, first of all, we found the application for patents, registration of designs, and registration of trademarks to be positively related to firm survival in all sectors, except the scale-intensive sector. However, this higher survival rate could be caused by the best innovations and/or the best-performing firms being protected in the most formal manner, and even without any protection, these firms would probably also display a higher survival rate. These kinds of endogeneity problems make it difficult to determine whether the higher survival rate comes from the firm, the innovation, the protection, or a combination of these factors. In the scale-intensive sector we only found application for a patent to be positively related to firm survival. This may be because firms operating in this sector are mainly searching for innovations that reduce production costs, which would make protecting the name or appearance of a product just not that important for them. More striking is that we hardly found any statistically significant relationship between the use of registered formal protection, on the one hand, and firm growth measured by firm employment, sales, and labour productivity, on the other. Possible explanations could be the unpredictable nature of growth rates (Geroski et al., 1997), the increased speed of modern innovation (Florida, 2002), the changing role of protection (Artz et al., 2010); or these results being particular for the Netherlands.

6.2 Conclusions

By combining the results of all the research covered in the empirical chapters of this thesis, we can now answer our three Research questions and discuss our contribution to the existing literature in this field of research.

(i) How do firms protect their innovations?

First, based on Kitching and Blackburn (1998), we have made a distinction between four groups of protective actions with an increasing level of formality: ‘no protection’; ‘informal protection’ (e.g. maintaining lead-time advantages, investing in a relationship based on trust); ‘non-registered formal protection’ (e.g. confidentiality clauses,
licensing); and ‘registered formal protection’ (i.e. patents, registered designs, trademarks, and registered copyrights). From Chapters 2, 3 and 4, we can confirm the findings from the literature that many of the innovative firms in the Netherlands do not apply for a patent, register a design, register a trademark, or register a copyright, but instead protect their innovation in a less formal way, or not at all. Furthermore, firms that decide to apply for a patent, register a design or register a copyright, mainly apply for a patent, and not so often register a design or register a copyright.

Since the majority of the results from the literature come from large firms, and not so much from SMEs (see Sections 1.3 and 1.4), we also explicitly focused on the protective behaviour of Dutch SMEs. First, we found many SMEs in the north-east of the Netherlands (see Chapter 2) do not apply for patents. The few SMEs in the north-east of the Netherlands that owned one or more patents, owned relatively more 6-year patents than larger firms did. This is not surprising, since the 6-year patent was specifically tailored for SMEs, by being cheaper and more short-term oriented. We also found that SMEs in the north-east of the Netherlands that owned a patent (both 6-year and 20-year) did not let them expire as often as larger firms did. Apparently, SMEs that do decide to patent value their patents more than larger firms do.

(ii) Which factors determine the choice of a specific form of protective action?

In Chapter 4 we confirmed the firm and innovation aspects that are generally considered to be related to the application for patents. Whether or not a firm decided to apply for a patent was found to be related to: the size of the firm (in terms of the number of employees); the level of R&D investments by the firm; whether the innovation was a product innovation; whether the firm operates in a patent-intensive sector; the geographical market scope of the firm; whether or not during the innovation process a firm collaborated (with competitors, customers, suppliers, public knowledge institutions, Chamber of Commerce, or sector association); and whether the firm received a form of public financial support.

Although our number of respondents who registered a design without also having applied for a patent was limited in Chapter 4, the decision to register a design was found to be positively related to whether the innovation was a product innovation (and not a process
innovation or any other kind of innovation), and whether the firm collaborated with other parties during the innovation process. Surprisingly, we did not find a statistically significant relationship between the size of the firms, measured in terms of number of employees, and the registering of a design.

Our number of respondents who registered a copyright (without also having applied for a patent or registered a design) presented in Chapter 4 was also limited. However, we did find the registration of copyrights to be positively related to the level of R&D investments of the firm, and negatively related to the firm operating in a patent-intensive sector.

Regarding the factors that are related to the protective behaviour of SMEs, in Chapter 2 we found that a number of the results from the literature on patents and large firms also apply to the degree of formalisation of the protective actions by the SMEs selected from the network of Windesheim University of Applied Sciences. These results concern: the age of the firm; the level of R&D investments by the firm; and whether the innovation was a product innovation. Contrary to the findings from the literature on patents, we did not find the size of the firm in terms of number of employees to be related to the degree of formality of the protection.

In Chapter 3, specifically on the protective behaviour of SMEs in the Dutch printing industry, we found the degree of formality of the protection of both product and process innovations to be positively related to: whether the firm received a form of public financial support; the innovativeness of the innovation; and a rural location; and negatively related to innovation investments.

The protection of product innovations (but not process innovations) by SMEs in the Dutch printing industry was also found to be positively related to collaboration (with competitors, customers, suppliers, public knowledge institutions, Chamber of Commerce, or sector association) during the innovation process, and earlier protective behaviour of the small or medium-sized firm (or the entrepreneur). The protection of process innovations of SMEs in the Dutch printing industry was, contrary to product innovations, also positively related to the newness of the innovation.
(iii) Is the use of a specific form of registered formal protection related to firm performance?

With regard to Research question (iii) we can conclude that, with the exception of the scale-intensive sector, the application for a patent, registration of a design, or registration of a trademark is positively related to firm survival. In the scale-intensive sector only having applied for a patent is positively related to firm survival.

Furthermore, in contrast to the findings in most of the literature, we hardly found any statistically significant relationship between registered formal protection and the growth of firms measured by firm employment, sales, and labour productivity. This may be caused by: the unpredictable nature of growth rates (Geroski et al., 1997); the increasing speed of innovation (Florida, 2002), and the inability of patenting and other protective systems to match this speed; the fact that, nowadays, patents and other protective actions seem to have mainly a strategic purpose, and may be ‘…only distantly related to a firm’s innovation efforts’ (Artz et al., 2010, p. 736); or these results being particular for the Netherlands.

6.3 Implications

Although our results presented in this thesis are subject to the above-mentioned limitations regarding included sectors, country, regions, and selection of respondents, some important implications for at least the Netherlands can be derived concerning the factors that determine the decision to opt for a specific kind of protection and the relationship between registered formal protection and firm performance.

The most important implication of these results comes from the fact that, contrary to the findings from the literature, we hardly found any statistically significant relationship between registered formal protection and firm growth. However, in the few cases we did find a statistically significant relationship between registered formal protection and firm growth, the coefficients were relatively large and in majority positive on the number of employees and negative on sales and labour productivity. Because patents, registered designs, trademarks and registered copyrights are meant to give an inventor a temporary advantage (as an incentive to keep investing in R&D), this general lack of a statistically significant relationship could (after more research) emphasise the need for improvements of the current protective system. On the basis of the work of Florida (2002), one could even hypothesise that owing to the increased
speed of innovation (possibly with the exception of a few specific sectors in which the investments are high and innovations are easy to imitate), we might need some kind of short term version of the current protection system more tailored to modern kinds of innovation, or that maybe there is no need for registered formal protection at all.

A second important implication comes from the fact that, although the probability of the application for a patent is related to firm size, this was not confirmed for registered designs. This is rather unexpected, since patents and registered designs have, other than the differences of what they protect (technology vs. shape), many similarities in costs, procedures and degree of protection. Apparently, whatever is holding SMEs back from applying for a patent is not there for registered designs, which could (after more research) be valuable information for initiatives that aim to promote patents among SMEs.

### 6.4 Further research

Although this dissertation has shed more light on the protective behaviour of firms, it has also raised a number of new questions. First of all, although we found many firm, innovation, and entrepreneurial characteristics that are related to the decision to have a certain kind of protection, or to the degree of formality involved, our results also show many differences between the aspects that are related to the application for patents, the registration of designs, and the registration of copyrights. In particular, the fact that firm size is related to the application for patents, but not to the registration of designs and the registration of copyrights, was unexpected. However, since our data set contained a rather small number of firms that only registered a design or a copyright, more research on this matter would be valuable.

Second, our results from the Dutch printing industry included many results that may be limited to this sector. More specifically, lower firm innovation investments in the Dutch printing industry are related to a more formal way of protecting. Is this specific for the Dutch printing industry, or do these results also emerge in other industries? This would call for more research on both the Dutch printing industry, as well as on other industries.

Third, this dissertation researched the effectiveness of registered formal protective actions. This was done by comparing innovative firms that applied for a patent, registered a design, registered a trademark, or registered a copyright with other innovative firms. This dissertation did not include the effectiveness of the (less formal) non-registered or informal
Conclusions

protective actions, and therefore gives no insight into the interesting question which protective actions are the most effective for a specific type of firm and innovation. A more detailed instrument to measure the (combination of) actions used to protect innovations and their effects on firm performance could be developed, after which more research, similar to that undertaken in Chapter 5, including alternatives for registered formal protective actions, would be of value.

Finally, we found hardly any statistically significant relationship between the use of patents, registered designs, trademarks, or registered copyrights and the growth of firms. However, this could be caused by the relatively unrefined way we measured both the protective actions (by means of a dummy stating whether a firm used a specific kind of protection) and firm growth (by the increase in the number of employees, sales, and labour productivity). Furthermore, these results do not answer the question why these registered formal protective actions do not have a stronger impact on the growth of firms. More research regarding the effect of protective actions in two areas of interest would prove valuable. First, why do our patenting and other intellectual property systems not seem to contribute to firm performance? Second, how could the current intellectual property systems be improved to better serve non-publicly traded firms, specifically SMEs?
Samenvatting

(Summary in Dutch)

Een bedrijf dat bereid is om te investeren in innovatie, zal er in de regel ook zeker van willen zijn dat het profiteert van deze innovatie zonder dat een concurrent de innovatie kopieert. Dit heeft uiteindelijk geleid tot het huidige systeem ter bescherming van intellectuele eigendommen. Dit beschermingsysteem biedt een bedrijf de mogelijkheid om een tijdelijk monopolie op een innovatie te verkrijgen door middel van het aanvragen van een patent, geregistreerd ontwerp, merk, of geregistreerd auteursrecht.\textsuperscript{52} Uit de literatuur blijkt echter dat veel innovatieve bedrijven, met name MKB-ondernemingen (bedrijven met minder dan 250 werknemers), geen gebruik maken van deze formeel geregistreerde beschermingsvormen. In plaats hiervan kiezen ze ervoor om hun innovaties door minder formele beschermingsvormen (zoals bijvoorbeeld met behulp van vertrouwelijkheidsverklaringen of het opbouwen van een vertrouwensband) te beschermen, of bescherming ze hun innovaties helemaal niet.

Deze dissertatie richt zich op het verschaffen van nieuwe inzichten in het beschermingsgedrag van zowel MKB-ondernemingen als grote bedrijven door antwoord te geven op de volgende 3 hoofdvragen:

(i) Hoe beschermen bedrijven hun innovaties?
(ii) Welke factoren beïnvloeden de keuze voor een specifieke vorm van bescherming?
(iii) Is het hanteren van een specifieke formele beschermingsvorm gerelateerd aan bedrijfsprestaties?

Aangezien de bevindingen in de literatuur met name zijn gebaseerd op het patenteergedrag van grote bedrijven en niet zozeer op dat van MKB-ondernemingen, zijn we in Hoofdstuk 2 begonnen met een analyse van de patentgegevens (verkregen van het Nederlandse

\textsuperscript{52} Voor uitleg over aanvraagprocedures en kosten zie de website van de Rijksdienst voor Ondernemend Nederland (www.rvo.nl)

(i) Hoe beschermen bedrijven hun innovaties?

Allereerst zijn er op basis van Kitching en Blackburn (1998) vier verschillende groepen van bescherming met een oplopende mate van formaliteit onderscheiden: ‘geen bescherming’, ‘informele bescherming’ (bijvoorbeeld investeren in het behouden van de lead-time voordelen of investeren in een vertrouwensband), ‘formele niet registreerbare bescherming’ (bijvoorbeeld vertrouwelijkheidsverklaringen en licenties) en ‘formele registreerbare bescherming’ (patenten, geregistreerde ontwerpen, merken en geregistreerde auteursrechten). De resultaten uit hoofdstuk 4 bevestigen de resultaten uit de literatuur, namelijk dat veel innovatieve bedrijven geen patent, geregistreerd ontwerp, merk of geregistreerd auteursrecht aanvragen. In plaats hiervan kiezen ze ervoor hun innovatie op een minder formele manier te
beschermen of zelfs helemaal niet. Ook ontdekten we dat patenten en merken veel meer gebruikt worden dan geregistreerde ontwerpen en geregistreerde auteursrechten.

Specifiek met betrekking tot MKB-ondernemingen, blijkt uit de empirische resultaten wederom dat veel MKB-ondernemingen uit de omgeving van Zwolle (zie Hoofdstuk 2) geen patent, geregistreerd ontwerp, merk of geregistreerd auteursrecht aanvragen. Vooral patenten (zowel Nederlandse als Europese) blijken onder MKB-ondernemingen nog minder populair te zijn dan bij grote bedrijven. De weinige MKB-ondernemingen die wel een patent bezitten, bezitten relatief vaker het (inmiddels afgeschaafde) 6-jarige Nederlandse patent dan grote bedrijven. Dit is op zich niet verrassend, aangezien het Nederlandse 6-jarige patent specifiek gericht was op MKB-ondernemingen, door goedkoper te zijn en een kortere looptijd te bieden. We hebben ook aangetoond dat MKB-ondernemingen uit de omgeving van Zwolle die een patent bezitten dit minder vaak laten verlopen dan grote bedrijven. MKB-ondernemingen die een patent aanvragen lijken, mede door hun grote afhankelijkheid van een enkele innovatie, hieraan meer waarde te hechten.

Vooral de informele beschermingsvormen zijn het meest gebruikt door onze respondenten uit het MKB, hoewel deze resultaten enigszins beïnvloed zijn doordat de respondenten uit de grafische industrie of het netwerk van hogeschool Windesheim kwamen.

(ii) Welke factoren beïnvloeden deze beslissing?

Met betrekking tot de bedrijfs-, beslissers- en innovatiekenmerken die van invloed zijn op de beslissing om een patent aan te vragen, hebben we de resultaten uit de literatuur bevestigd dat het aanvragen van een patent gerelateerd is aan de grootte van het bedrijf uitgedrukt in het aantal werknemers, de hoogte van de R&D-investeringen door het bedrijf, of de innovatie een productinnovatie betrof (in plaats van een proces- of dienstinnovatie), of het bedrijf in een patent-intensieve sector opereert, de grootte van de geografische markt die het bedrijf bedient, of het bedrijf heeft samengewerkt tijdens het innovatieproces (met concurrenten, leveranciers, klanten, kennisinstellingen, brancheorganisatie, en/of de Kamer van Koophandel), en of het bedrijf wel of niet een vorm van subsidie heeft ontvangen voor het innovatieproces.

Hoewel het aantal bedrijven dat een geregistreerd ontwerp aanvroeg (zonder ook een patent aan te vragen) redelijk beperkt was, bleek het aanvragen van een geregistreerd ontwerp
gerelateerd aan de volgende factoren: of de innovatie een productinnovatie betrof, en of er tijdens het innovatieproces is samengewerkt (met concurrenten, leveranciers, klanten, kennisinstellingen, brancheorganisaties, en/of de kamer van Koophandel). Verrassenderwijs vonden we geen statistisch significante relatie tussen de omvang van het bedrijf uitgedrukt in het aantal werknemers en het aanvragen van een geregistreerd ontwerp. Dit gebrek aan statistisch significant verband is enigszins contra-intuïtief, aangezien we verwachtten dat dezelfde terughoudendheid die we vonden met betrekking tot het patenteergedrag van MKB-ondernemingen ook van toepassing zou zijn op het aanvragen van andere formele geregistreerde beschermingsvormen.

Met betrekking tot het beperkte aantal bedrijven dat alleen een auteursrecht registreerde (zonder patent of geregistreerd ontwerp) ontdekten we dat het registreren van een auteursrecht gerelateerd is aan de hoogte van de R&D-investerings door het bedrijf en negatief aan of het bedrijf opereert in een patent-intensieve sector (in plaats van een andere sector). Blijkbaar hebben bedrijven die opereren in een patent-intensieve sector nauwelijks behoefte aan geregistreerde auteursrechten en bedrijven in niet patent-intensive sectoren juist wel.

Met betrekking tot de factoren die gerelateerd zijn aan de mate van formalisatie van de bescherming door MKB-ondernemingen uit het netwerk van hogeschool Windesheim konden we de volgende uit de literatuur bekende factoren bevestigen: de hoogte van de R&D-investerings door het bedrijf, of het een productinnovatie betrof (in plaats van een proces-, markt- of dienstinnovatie) en de leeftijd van het bedrijf. In tegenstelling tot de literatuur vonden we echter geen verband tussen de mate van formalisatie van de bescherming en de grootte van het bedrijf gemeten in werknemers.

Specifiek met betrekking tot het beschermingsgedrag van MKB-ondernemingen in de grafische industrie toonden we aan dat de mate van formaliteit van de bescherming van zowel product- als procesinnovaties positief gerelateerd was aan: verstrekte subsidies ten behoeve van de innovatie, de mate van innovativiteit van de innovatie, en een rurale locatie van het bedrijf. De mate van formaliteit van de bescherming van zowel product- als procesinnovaties was negatief gerelateerd aan de hoogte van de innovatie-investerings door het bedrijf. Dit laatste zou kunnen komen doordat veel innovaties in de Nederlandse grafische industrie geadopteerde bestaande innovaties zijn (bijvoorbeeld een gekochte nieuwe drukpers) in plaats
van door het bedrijf zelf ontwikkeld. Het adopteren van een innovatie maakt bescherming veelal overbodig, aangezien dit waarschijnlijk al door het uitvindinge bedrijf zelf is gedaan.

De bescherming van productinnovaties (maar niet de bescherming van procesinnovaties) door MKB-ondermningen in de Nederlandse grafische industrie bleek ook nog gerelateerd aan het eerdere beschermingsgedrag van de onderneming (of de ondernemer), en samenwerking gedurende het innovatieproces (met concurrenten, leveranciers, klanten, kennisinstellingen, brancheorganisaties en/of de kamer van Koophandel). De bescherming van procesinnovaties bleek, in tegenstelling tot productinnovaties, ook nog beïnvloed door de mate van nieuwheid van de innovatie (nieuw voor het bedrijf, regio, land, of wereld).

(iii) Is het toepassen van formele bescherming gerelateerd aan bedrijfssprestaties?

Met betrekking tot de bedrijfssprestaties hebben we zowel gekkeken naar de kans van een bedrijf om voort te bestaan, alsmede de groei in het aantal werknemers, de omzet, en de arbeidsproductiviteit. Allereerst hebben bedrijven die een patent, geregistreerd ontwerp of merk hebben aangevraagd, met uitzondering van de bedrijven in de schaal-intensieve sector (zie Sectie 5.2.4), een grotere kans om na vier jaar nog te bestaan. In de schaal-intensieve sector gold dit alleen voor bedrijven die een patent hadden aangevraagd. Verder vonden we, in tegenstelling tot de meeste literatuur, zo goed als geen relaties tussen het aanvragen van formele geregistreerde bescherming en de groei van een onderneming in het aantal werknemers, de omzet en de arbeidsproductiviteit.

Implicaties

Deze dissertatie heeft allereerst laten zien dat het aanvragen van patenten, geregistreerde ontwerpen, merken, en geregistreerde auteursrechten nauwelijks effect heeft op de bedrijfssprestaties. Dit benadrukt de mate waarin het huidige systeem ter bescherming van het intellectuele eigendom niet meer lijkt aan te sluiten bij hedendaagse innovaties en roept op tot onderzoek naar de achterliggende oorzaak en de effectiviteit van alternatieve beschermingsvormen. Eventueel zou dit kunnen leiden tot aanpassingen van dit beschermingssysteem.
Tevens blijkt het aanvragen van een geregistreerd ontwerp, in tegenstelling tot een patent, niet alleen weggelegd voor grote ondernemingen. Dit is nogal verassend, aangezien patenten en geregistreerde ontwerpen, anders dan wat ze beschermen (technologie versus vorm), veel overeenkomsten hebben in kosten, procedures, en mate van bescherming. Blijkbaar is datgene wat MKB-ondernemingen tegenhoudt om een patent aan te vragen niet van toepassing op het aanvragen van geregistreerde ontwerpen. Deze kennis kan, na vervolgonderzoek naar de oorzaken waarom deze vergelijkbare beschermingsvormen als verschillend worden ervaren, gebruikt worden bij toekomstig innovatiebeleid gericht op het promoten van patenten onder MKB-ondernemingen.
References


Cover illustration: sketch of flying machine by Leonardo da Vinci