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Policy principles for the creation and success of corporate and academic spin-offs[☆]

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ABSTRACT

Following a design science approach, this paper develops a framework of policy design principles for fostering technology entrepreneurship in a region. These principles are grounded in research findings and describe the factors and causal mechanisms that explain the founding and success rates of both corporate and academic spin-offs. We differentiate between principles that serve the *creation* of spin-offs versus those focusing on their subsequent *chances of success*. We provide an in-depth empirical application of this framework to spin-off policy in the regions of Eindhoven and Leuven. This application of the framework serves to assess the extent to which standing spin-off policy in both regions is (1) up-to-date, (2) comprehensive as well as (3) sufficiently robust against 'policy fashions'. Several directions for redesigning spin-off policy follow from this assessment.

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1. Introduction

Technology entrepreneurship implies the creation of new companies that exploit opportunities provided by technological innovation. Fostering technology entrepreneurship has become a major topic for (regional) public policy makers, as a means to release currently unexploited opportunities hidden in individuals, shelved technologies and resource combinations. Researchers in the field of technology entrepreneurship have conducted detailed studies of, for example, the factors fostering (successful) technology-based university spin-offs (Rothaermel et al., 2007; Shane, 2004), corporate spin-off creation (e.g., Tübke, 2005; Zahra et al., 2007), spin-off creation from research institutions (e.g., Clarysse et al., 2005; Hindle and Yencken, 2004; Lockett et al., 2005), and the role of science parks and incubators (e.g., Bergek and Norrman, 2008; Lofsten and Lindelof, 2005; Phan et al., 2005). As such, the literature on corporate and university spin-offs has been growing in dispersed directions, making it difficult to formulate unequivocal policy recommendations. Furthermore, previous attempts to develop practice-oriented design recommendations from 'thick' case descriptions (e.g., Debackere, 2000;

Lockett et al., 2005; Rasmussen, 2008; Roberts and Malone, 1996) provide a partial view of spin-off policy or have refrained from specifying the contextuality of policy recommendations (O'Gorman, 2003).

At the same time, policy fashions rather than empirical evidence or well-established theory tend to influence the policies adopted by policy makers (Bower, 2003; Mowery et al., 2004). In other words, there is a major risk that policy misses out on key scholarly insights and lacks a solid basis from which adequate policy programs and measures can be developed for stimulating technology entrepreneurship in corporate and university settings.

In this respect, we adopt a design science method to develop design principles grounded in the body of research evidence and targeted at informing policy makers. This approach connects the existing or emerging body of scientific knowledge to the pragmatic, action-oriented knowledge of practitioners. It codifies design knowledge in principles grounded in both practice and theory; these principles can be continually improved by obtaining feedback from implementation and experimentation (Romme, 2003; Romme and Endenburg, 2006). The resulting principles serve to develop new policies or improve existing policies, by applying academic knowledge that tends to be dispersed and difficult to access by policymakers (Van Aken, 2004; cf. Rasmussen, 2008).

Based on this design science approach, the aim of this paper is to develop a policy framework that serves to assess whether standing spin-off policy (1) reflects recent academic insights, (2) is comprehensive and (3) is sufficiently robust against 'policy fashions'. The principles implied by this framework can motivate and inform the (re)design of policies regarding technology-based

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entrepreneurship in a region. To test the validity of this claim, we apply our framework by assessing and comparing standing policy in two high-tech regions, namely Eindhoven (the Netherlands) and Leuven (Belgium).

In this respect, this paper makes two key contributions. First, we offer policy makers in the area of technology entrepreneurship an integrated framework for assessing their current policy in a grounded and coherent way, allowing for systematic comparisons with other regions. Such a framework is not available in the current literature, which may be one of the reasons why policy misses out on key academic findings. Second, this study informs (technological innovation and entrepreneurship) research by demonstrating how one can develop empirically and theoretically valid policy principles that address (major) voids in standing policy practices. In this way, our study informs scholars about how they can enhance the practical value of their findings and inform policy makers in a more grounded way.

The paper proceeds as follows. First, in Section 2, we introduce the research method of science for design in relation to fostering technology entrepreneurship in regional settings. Subsequently, in Section 3, design principles are developed by drawing on previous research. In Section 4, we assess spin-off policy in the Eindhoven and Leuven regions. Finally, we discuss the main findings and draw a number of conclusions in Section 5.

2. Method: science for design

The science for design approach, developed by organization researchers, links the scientific knowledge base to the pragmatic and creative work of practitioners (e.g., Romme, 2003; Van Aken, 2004). According to Romme and Endenburg (2006), the worlds of academia and practice can be linked by propositions – so-called design principles – that are grounded in state-of-the-art research. These normative principles connect the descriptive nature of scientific research and the action-oriented nature of policy-making practices, as they serve to define the deeper intentions and ‘generative mechanisms’ behind particular public policies (Denyer et al., 2008). With help of these design principles, particular policies can be developed (Romme and Endenburg, 2006). In this study, we derive policy design principles from a synthesis of a variety of literatures.

The conceptual basis for this qualitative synthesis is constituted by the model developed by Bekkers et al. (2006). This model is based on the notion that different institutional layers of a national system of innovation form the selection environment for spin-offs (Nelson, 2001; Groenewegen and van der Steen, 2006). This model is useful for the purpose of our qualitative research synthesis, for two reasons.

First, the model distinguishes between the creation of a spin-off and its subsequent chances of success, once established. This is in line with recent calls in the literature not to conflate foundation rates and success rates, and to keep the process of spin-off creation analytically separate from its subsequent success or failure (e.g., Djokovic and Souitaris, 2008; Hackett and Dilts, 2004).

Second, the model demonstrates how different institutional layers of a national system of innovation have a differential effect on the creation of spin-offs viz-à-viz their success chances (Nelson, 2001; Groenewegen and van der Steen, 2006). In particular, it shows that higher institutional levels provide the conditions that affect the establishment of spin-offs, whereas the low(er) levels form the conditions that mostly affect their success chances once established (Bekkers et al., 2006). Given the largely person-centric view that dominates the entrepreneurship literature, the factors affecting the creation and growth of spin-offs

have to some extent been ignored—although they seem to be particularly relevant for policy. Developing an understanding of the role of these different institutional layers requires an inquiry into a different literature, such as on the role of sectoral characteristics (O’Gorman, 2003), technology (Marsili, 2001; Shane, 2001), regional institutions (Audretsch and Stephan, 1996; Saxenian, 1996), and the role of incumbent firms (Shane and Venkataraman, 2003). Here, the model presented by Bekkers et al. (2006) provides a coherent framework to understand and combine the role of such antecedent conditions for spin-off creation and success. An overview of the model is provided in Fig. 1.

Following this model, we have systematically collected literature along the different institutional layers, based on four steps.

As a first step, we determined the relevant bodies of literature for this study. We selected the field of economics of innovation to consider the role of sectoral characteristics and technology development patterns, forming the second layer. The literature on strategy and management as well as entrepreneurial activities of universities and/or PROs was selected to explore the role of the parent company or PRO/university (as the third layer). In addition, we selected literature on regional policy and regional innovation systems with regard to the fourth layer of the model. We have not included literature on the first layer, as the role of national law and policy falls beyond the scope of our study.

As a second step, we identified key articles from two sources: the ABI/Inform database and a gross list of references assembled from publications that provide reviews of the field and/or synthesize relevant theoretical perspectives. Here, we followed four guidelines. First, the article needed to be related to the creation and/or success chances of spin-offs and needed to belong to one of the core fields of literature that we considered. Second, the article was published in a journal with a high impact factor (beyond 1.5) or in a specific topic-oriented journal such as *Technovation* or *Journal of Technology Transfer*. Third, from this set of selected articles, we have chosen those articles that carried the highest number of citations. Fourth, we ensured to also include articles from key authors as identified in review articles and textbooks, such as Di Gregorio and Shane (2003), Dosi (Dosi et al., 1988), Gans and Stern (2003), Levinthal and March (1993), and Teece (1986). Table 1 provides an overview of the selection of literatures and examples of key publications.

As a third step, from this literature selection we coded the main factors fostering or discouraging the creation and/or success chances of spin-offs (Denyer et al., 2008). We specifically searched for ‘generative mechanisms’ that explain the factors and causal mechanisms for spin-off creation and its success (cf. Denyer et al., 2008; Van Aken, 2004).

As a fourth step, we clustered these findings and combined them into instructive policy principles. In this way, the resulting principles are linked to general theories that explain the key mechanisms underlying the creation and/or success chances of spin-offs (Denyer et al., 2008). Table 1 presents an overview of the different bodies of literature, with examples of core publications and some of their key insights.

3. Design principles to foster technology entrepreneurship

In this section we discuss the conditions enhancing or inhibiting the foundation and success chances of spin-offs along the three institutional layers in Fig. 1 (i.e., the second, third and fourth layer). In Section 3.1 we discuss how institutions at the sectoral and parent company level imply founding conditions for the creation of corporate spin-offs. In Section 3.2 we focus on

The four institutional layers that affect spin-off foundation and success rates (adapted from Bekkers et al., 2006).

Fig. 1. The four institutional layers that affect spin-off foundation and success rates (adapted from Bekkers et al., 2006). (a) In case of a corporate spin-off and (b) in case of a spin-off from a university or PRO (public research organization).

technology development patterns and the role of the PRO or university as founding conditions for the creation of academic spin-offs. Section 3.3 discusses the role of regional policy which largely affects success chances of spin-offs, once they have been founded.

3.1. Corporate spin-offs

In this section we discuss the conditions enhancing or inhibiting the foundation of corporate spin-offs along two lines. First, the role of sectoral factors is discussed. Subsequently, we discuss the role of the parent company.

3.1.1. Sectoral factors

Sectors differ in the extent to which they may provide fertile ground for establishing spin-off companies. In general, sectors with high technological opportunity conditions and a variety of technological approaches will be more conducive to the creation of corporate spin-offs (Breschi and Malerba, 1997; Shane, 2001). Under such conditions, incumbents will be able to pursue only a limited number of technological opportunities, given scarce resources and specialized capabilities. As a result, ample technological opportunities tend to remain unexploited, which in turn provides fertile ground for new entrants as well as for corporate spin-offs (Breschi and Malerba, 1997; Marsili, 2001). These conditions are typically found in sectors with immature technologies such as software, microelectronics, biotechnology, and multimedia. In industries with more mature technologies, technological opportunities will be far more limited, reducing the possibilities for new firm formation and corporate spin-offs (Shane, 2001).

Table 1

Fields and literature included in review.

Literature	Model layer	Examples of key publications	Key insights
<i>Economics of innovation</i>	Second	Breschi and Malerba (1997), Dosi et al. (1988), Teece (1986)	Sectors differ in the degree of technological opportunities. Dominant designs can hinder new venturing. IP regime affects spin-off creation. Characteristics of the technology influence chances for spin-offs.
<i>Strategy and management</i>	Third	Chesbrough and Tucci (2005), Levinthal and March (1993), Nooteboom (2000)	Vested interests of established firms can prevent exploitation of path-breaking technologies.
<i>Entrepreneurship (spin-offs)</i>	Third	Di Gregorio and Shane (2003), Roberts and Malone (1996), Zucker et al. (1998)	Important factors are formed by: scientific quality, entrepreneurial climate, and the degree of embeddedness of the spin-off.
<i>Regional policy and innovation systems</i>	Fourth	Asheim and Coenen (2005), Gans and Stern (2003), Saxenian (1996), Audretsch and Stephan (1996)	There are important differences between establishing a novel value chain and leveraging an existing value chain, depending on external conditions. Interaction between companies and co-location of companies and PROs are important.

In addition to these technology related issues, the sectoral IP regime also affects the creation of corporate spin-offs. A sectoral IP regime refers to the extent to which inventions can be patented and these patents can be effectively defended against infringement (Shane, 2001). In case of a strong IP regime, a corporate venture can patent its technology and license it to prospective incumbents (Dushnitsky and Lenox, 2005). An example is the biotechnology industry in which small biotech firms often patent and license their technology to incumbent pharma firms. So, if the 'right' technological opportunity conditions are present, as discussed above, a strong IP regime will enhance the creation of corporate spin-offs. In case of a weak IP regime, a corporate venture may still be an option, although protecting its inventions from imitation becomes more difficult. In that case, more viable ways to appropriate economic rents include engaging in early collaboration with powerful partners or not disclosing the invention (Dushnitsky and Lenox, 2005).

3.1.2. Parent company: vested interests of incumbent firms

Incumbent firms with proven success in existing technologies and markets often exert strong firm-internal pressures to conform to established ways of doing, which may lead them to ignore disruptive developments (Christensen, 1997; Nooteboom, 2000; Wallin and Lindholm Dahlstrand, 2006). These pressures are social, economic and cognitive in nature. Social pressures follow from existing interfirm relationships that prevent incumbents to enter into new relationships and developments, because of vested interests in the current cooperation and the risk of negative reputation effects. An economic argument is that firms tend to have large sunk costs in existing technologies through investments in R&D, production equipment, training of people, and so on. Moreover, investing in existing technology generates earlier and more certain returns—compared to investments in new, unproven technology (Gilsing and Nooteboom, 2006; Levinthal and March, 1993). In addition, from a cognitive perspective, incumbents may not recognize the opportunity of radical novelty, because it falls outside their absorptive capacity (Cohen and Levinthal, 1990). These firm-internal barriers can be profound and mutually reinforcing. As a consequence, the only option that remains for employees with a strong belief in the value of the new technology is simply to leave.

Taken together, these three pressures also explain why an internal corporate venture often encounters problems when it proves to be successful. In this respect, it may be perceived as a threat to the established business of the parent company, because it can not only disrupt current technologies and ways of operating but also compete for scarce corporate resources (Chesbrough and Tucci, 2005; Von Hippel, 1977). As a consequence, incumbent firms only invest in corporate ventures if these build upon current technologies and businesses, but much less in spin-offs that are unrelated to their current technologies and established ways of operating (Hellman, 1996; Siegel et al., 1988).

In sum, when new technologies are complementary to ongoing innovation activities and build on existing operations, internal corporate venturing is an effective instrument for strategic corporate renewal (Keil, 2002). However, if a new technology is substituting current technology and breaks with established ways of operating, spinning off such ventures is more favorable (Chesbrough and Tucci, 2005; Siegel et al., 1988). In that case, regional policy should enable these corporate spin-offs to start and flourish in an environment that is independent from the parent company so that they can engage in constructive and frequent interaction with others. Here, regional clusters, science parks and incubators tend to provide the facilities and resources

that enable these ventures to start (Bergek and Norrman, 2008; Etzkowitz and Klofsten, 2005; Grimaldi and Grandi, 2005).

3.1.3. Policy design principles

Overall, these research findings can be synthesized in a number of design principles for policy directed at the creation of new corporate spin-offs:

1. Target business sectors that provide a fertile ground for new entrants as well as spin-offs. These sectors are characterized by
 - a. high technological opportunities;
 - b. a broad variety of technological approaches; and
 - c. a strong IP regime.
 (If these business sectors are absent or underrepresented in the region, it is better not to waste any resources on corporate spin-off policy.)
2. Develop and provide business development facilities for ventures spun off from corporations in order to provide some degree of protection from firm-internal pressures inhibiting or demotivating the development of radical innovations—particularly ventures that are *unrelated* to the established technologies and business routines of the corporation.

3.2. Spin-offs from universities and public research organizations (PROs)

In this section we discuss the founding conditions for academic spin-offs. First, the characteristics of the technology are discussed, and subsequently the role of the university or public research organization (PRO).

3.2.1. Characteristics of the technology

A key overall factor determining whether an academic spin-off will and can be created is the nature and type of technology the spin-off draws on. In this respect, Shane (2002, 2004) makes an important distinction between technology that is especially conducive to the creation of spin-offs versus technology that is more suitable for licensing. Academic spin-offs are especially effective in exploiting general purpose, early-stage technological inventions that have the potential for (major) transitions in the market place as well as in production processes (Shane, 2004). In this respect, the literature on the economics of innovation shows that the potential for such disruptive transitions is not spread equally across technological fields (Breschi and Malerba, 1997). The conditions in *science-based* technological fields are more beneficial for spin-offs than in *development-based* technological fields (Asheim and Coenen, 2005; Marsili, 2001). We discuss these conditions, outlined in Table 2, here in more detail.

Technologies conducive to creating spin-offs are radical in nature, draw to a large degree on tacit knowledge, are in an early stage of development, serve a general purpose, are likely to

Table 2

Characteristics of technology that are more conducive to spin-offs versus those more conducive to licensing to established firms (adapted from Shane, 2004).

Spin-off firm	Licensing to established firm
Radical	Incremental
Tacit and codified knowledge	Codified knowledge
Early stage	Late stage
General purpose	Specific purpose
Significant customer value	Moderate customer value
Major technical advance	Minor technical advance
Strong IP protection	Weak IP protection
Science-based technological field	Development-based technological field

produce significant customer value, involve major technical advances, and are protected by strong IP (Shane, 2002, 2004). These technologies are *science-based*, characterized by a strong dependency on knowledge as developed by universities and public research organizations (Coriat and Weinstein, 2004; Pavitt, 1984). The search and development process is primarily based on tacit knowledge, although the outcomes of the search process can be codified in patents or publications. Especially for these codified outcomes, protection of a strong IP regime is needed against undesirable spillovers and imitation. For this science-based knowledge, academic spin-offs form an excellent vehicle to exploit radical, early-stage technologies. Spin-offs have the capacity to exploit the codified outcomes by combining it with the tacit knowledge of the inventors (as founders or as highly involved employees or consultants) required for the further development of the new technology. The relation between the university or research organization and the spin-off firm is a reciprocal one: the spin-off draws on the tacit knowledge of scholars as well as on lab and other facilities to further develop the early-stage technology, whereas the PRO or university draws on spin-offs to develop its technological inventions into disruptive commercial applications.

The technology licensed to established firms is typically more incremental in nature, draws largely on codified knowledge, is in a more mature stage of development, serves a specific purpose, is likely to produce moderate rather than significant customer value, involves minor technical advances, and involves a weak IP regime (Shane, 2004). This type of technology is embedded in *development-based* technological fields, characterized by a systemic knowledge base. This implies that no single firm can dispose over all the knowledge it needs. In development-based technological fields, the potential for (incremental) innovations especially emerges at the interfaces of different disciplines and technologies, which together make up the systemic knowledge base (Asheim and Gertler, 2005; Teece, 1986). The firms that exploit this technology have the capability to integrate such related technologies, a capability that cannot be taken off the shelf. The relation between PROs and the established firms they license technology to is largely one-directional, with codified knowledge going from science to industry (Marsili, 2001). Whereas PROs focus on monodisciplinary research, the involved firms focus on the integration and application of this monodisciplinary knowledge from academia. The tacitness of this integration process makes it difficult to use IP rights. In sum, in development-based fields with weak IP protection, such as electro-mechanical devices and cars, academic spin-offs seem to be more unlikely (Dushnitsky and Lenox, 2005). Because a solid IP base is lacking, alternative mechanisms such as close cooperation between established firms and university researchers may form better alternatives (Shane, 2004). Here, mechanisms such as co-location, mobility of researchers and informal regional networks are more effective, which can be enhanced by creating effective science parks or facilitating cluster networks (Etzkowitz and Klofsten, 2005; Friedman and Silberman, 2003; Vedovello, 1997).

3.2.2. The role of the university or PRO

Critical for the development of state-of-the-art technology is human capital. In this respect, research has found that 'star scientists' from high(er) quality academic institutions create spin-offs in larger numbers and capture more rents from them when compared with low(er) quality institutions (Di Gregorio and Shane, 2003; Van Looy et al., 2004; Zucker et al., 1998). Thus, high-quality research by research organizations tends to encourage the creation of spin-off companies (cf. Wright et al., 2008).

An important factor is the presence of an 'entrepreneurial climate' at the incumbent university. University environments that do not encourage entrepreneurship tend to strongly inhibit spin-off activity (O'Shea et al., 2004). In this respect, Shane (2004) argues that the decision to start a spin-off is to a large extent socially conditioned: previous efforts by pioneering entrepreneurial faculty members to start a company make other academics believe that it is an acceptable and desirable activity. A clear example is the entrepreneurial culture at MIT (Roberts and Malone, 1996).

Regarding the role of incubators, the literature reports mixed findings. Di Gregorio and Shane (2003) observed no impact of the support by a university-based incubator. However, others have found a positive impact of the support activities provided by the incubator or the technology transfer office and the expertise of the coaching staff (Lockett and Wright, 2005; Meyer, 2003; Powers and McDougall, 2005). This points at the importance of the layout of the actual support processes for spin-off creation and success (Rasmussen et al., 2006).

In this respect, universities and PROs can play an important role in helping to develop the (regional) networks of spin-off firms (Etzkowitz and Klofsten, 2005). In general, networks around spin-offs have four potential benefits: augmenting the opportunity identification process, providing access to loci of resources, enhancing timing advantages, and constituting a source of trust (Djokovic and Souitaris, 2008). Because of these benefits, establishment of a network is closely related to the success of the start-up (Hackett and Dilts, 2004). However, too much embeddedness of the spin-off company in the university environment and its network can have detrimental effects, because the spin-off may remain too much oriented on the academic world (Bekkers et al., 2006). Therefore, it is important that the support infrastructure operates in a decentralized manner (cf. Debackere and Veugelers, 2005; Vohora et al., 2004) and the region provides support and cooperation structures that go beyond those offered by universities, such as science parks and dense high-tech clusters (Audretsch and Stephan, 1996; Friedman and Silberman, 2003; Vedovello, 1997).

3.2.3. Policy design principles

Overall, these research findings can be synthesized in a number of design principles for policy directed at the creation of new academic spin-offs:

1. Create technology transfer policies at universities and PROs tailored to the characteristics of the technological field:
 - a. if the new technology is embedded in a more development-based technological field, then transfer mechanisms such as co-location, mobility of researchers and informal regional networks are more effective;
 - b. if the new technology is embedded in a more science-based technological field, then spin-offs are more effective.
2. Stimulate universities and PROs to attract and/or retain eminent scholars and build leading Ph.D. programs as well as build a socially supportive entrepreneurial climate.
3. Stimulate universities and PROs to gradually loosen and disconnect their ties with a particular spin-off firm, to motivate the spin-off to develop a strong market orientation and obtain access to new contacts and information.

3.3. Regional policy

Once established, the main challenge for both types of spin-offs is successful *commercialization*. So, our focus shifts from founding conditions towards *success* conditions: what factors

contribute to the (commercial) success of spin-offs, once established? Here, we distinguish between two different strategies that is establishing a novel value chain (Section 3.3.1) and leveraging an existing value chain (Section 3.3.2).

3.3.1. Establishing a novel value chain and competing against incumbents

A key factor is the strategic trade-off between establishing a novel value chain and competing against incumbent firms versus leveraging an existing value chain and collaborating with incumbents (Gans and Stern, 2003). Two critical factors determine which of the two types of strategy is more effective: the nature of the appropriability conditions and the distribution of ownership and control over specialized complementary assets (Teece, 1986).

A strategy of establishing a novel value chain and competing head-on against incumbent firms is viable only in case of tight appropriability conditions and when there is no need for specialized downstream complementary assets (Gans and Stern, 2003; Teece, 1986; Tripsas, 1997). Tight appropriability conditions are attractive for a spin-off because it improves its strategic position vis-à-vis incumbents that will form potential competitors when establishing a novel value chain. Such tight appropriability conditions are formed by a strong sectoral IP regime, which enables spin-offs to successfully protect their intellectual property. In a weaker sectoral IP regime, appropriability can still be tight when a spin-off's invention is very difficult to imitate. This is the case for radical inventions based on tacit knowledge, where competitors may have great difficulties understanding and copying it (Nooteboom, 2000).

The ability for a spin-off to establish a novel value chain increases if downstream complementary assets, required to commercialize the invention, are *not specialized* and can be acquired in the open market (Rothaermel, 2001; Teece, 1986; Tripsas, 1997). In that case, the incumbent firm is not needed to provide an existing value chain as spin-offs can develop a new one instead. The potential gains and revenues from such a strategy can be enormous (Christensen and Bower, 1996). However, high investments and risks are involved and, in addition, the new technology may suffer from lack of 'legitimacy' (Aldrich and Fiol, 1994). This may form a barrier for further developing and upscaling the technology.

There are a number of policy implications to be drawn here. A serious risk is that policy makers 'listen' only to established players with vested interests in existing technologies (Gilsing and Nooteboom, 2006). When listening only to these players, policy creates a risk of further reinforcing the pressures that tend to drive out the exploration and development of radically new technology. However, here regional (innovation) policy can make a difference by encouraging an open dialogue about emerging technologies. Government agents can play a role in structuring the interorganizational environment of emerging new technologies in a way that encourages the development of trust between firms. One of the mechanisms to create such a trust-enhancing and dialogue-rich environment is by co-locating spin-offs, established firms and universities in regional clusters and science parks—with clear regulations guiding the interactions (Etzkowitz and Klofsten, 2005; Saxenian, 1996).

3.3.2. Leveraging an existing value chain and collaborating with incumbents

An alternative strategy is formed by leveraging an existing value chain, an option that is more viable and common for spin-offs (Gans and Stern, 2003; Parhankangas and Arenius, 2003; Tripsas, 1997). This leveraging strategy is especially viable in the case of specialized downstream complementary assets (Gans and

Stern, 2003; Teece, 1986; Tripsas, 1997). In this respect, the tightness of appropriability affects the form of collaboration. In short, 'the less tight, the less hands-off'. Thus, in case of tight appropriability the spin-off's intellectual property is formally licensed to one or more buyers, whereas in case of moderate or low appropriability the spin-off engages in strategic technology alliances or gets acquired.

An important advantage of leveraging an existing value chain is the lower level of required investments. However, those firms that control key complementary assets are also the ones that form the most likely imitators (Gans and Stern, 2003). Put simply, when trading ideas, the willingness of potential buyers to pay depends on their knowledge of the idea, yet knowledge of the idea implies that potential buyers need not pay in order to exploit it.

In case of strong appropriability (such as strong IP protection), the risk of disclosure is generally limited. Moreover, disclosure does not detract from the spin-off's ability to profit from its invention. In this case, collaboration with one or more incumbent firms allows the spin-off to avoid high sunk investments in complementary assets. At the same time, established firms avoid investments to catch up and the incumbent can still steer the development of the new technology (Gans and Stern, 2003). In this way, both parties win (cf. Wallin and Lindholm Dahlstrand, 2006). However, for some technologies and sectors appropriability conditions are less tight, as intellectual property is weakly protected, leaving spin-offs vulnerable to the risk that their inventions are expropriated (Breschi and Malerba, 1997; Tripsas, 1997). Here, the spin-off should approach a large number of potential partners. This serves to credibly threaten to pursue the novel idea with a third party, in the context of bilateral negotiations with a particular established firm (Anton and Yao, 1995; Gans and Stern, 2003).

There are a number of policy implications to be drawn here. To initiate and enhance strategic collaboration between spin-offs and incumbents, policy makers can ensure an efficient functioning of this 'market for technology' by enabling transparency (cf. Johnson, 2008). On the *supply side*, this implies that all technology-based spin-offs are identified and challenged to expose their ideas to potential buyers of their inventions. This may bring corporate spin-offs into contact with other companies than their parent company, thus enabling an 'escape' from firm-internal pressures at the parent company that inhibit the development of new technology. In addition, it may enable academic spin-offs to loosen their connection with the university, to become more market oriented, and to obtain access to new contacts and information.

Providing transparency on the *demand side* entails identifying all relevant technology-based incumbent firms and making this information public. Such a strategy will provide spin-offs with information about their market and collaboration potential. This addresses an important bottleneck as most spin-offs face great difficulties finding sufficient 'prospects' for their technology and ideas (Gans and Stern, 2003). In addition, this enhances a spin-off's ability to threaten with pervasive disclosure to increase its bargaining power (Anton and Yao, 1995). Furthermore, transparency enables the incumbent firm to maintain a clear overview of relevant spin-off activity as well as to build a reputation as a reliable partner for spin-offs. This way, they can safeguard access to promising new technologies, which can make the difference between 'finishing first' versus dropping out altogether (Chesbrough, 2003; Katila and Mang, 2003).

Furthermore, to enable the strategic collaboration between spin-offs and incumbents, policy makers could stimulate co-location of these organizations. In a science park setting, for example, spin-offs can more easily make use of expensive facilities of companies (Etzkowitz and Klofsten, 2005) and

Table 3

Policy principles resulting from the literature review.

Principles directed at the <i>creation</i> of corporate and university spin-offs	<p>In any given region, policy with regard to spin-offs from established (small as well as large) firms should:</p> <ol style="list-style-type: none"> 1. Target business sectors that provide a fertile ground for new entrants as well as spin-offs; these sectors are characterized by <ol style="list-style-type: none"> a. high technological opportunities; b. a broad variety of technological approaches; and c. a strong IP regime. (If these business sectors are absent or underrepresented in the region, it is better not to waste any time and resources on corporate spin-off policy.) 2. Develop and provide business development facilities for ventures spun off from corporations in order to provide some degree of protection from firm-internal pressures inhibiting or demotivating the development of radical innovations—particularly ventures that are <i>unrelated</i> to the established technologies and business routines of the corporation. <p>In any given region, policy with regard to spin-offs from universities or PROs should:</p> <ol style="list-style-type: none"> 3. Create technology transfer policies at universities and PROs tailored to the characteristics of the technological field: <ol style="list-style-type: none"> a. if the new technology is embedded in a more development-based technological field, then transfer mechanisms such as co-location, mobility of researchers and informal regional networks are more effective; b. if the new technology is embedded in a more science-based technological field, then spin-offs are more effective. 4. Stimulate universities and PROs to attract and/or retain eminent scholars and build leading PhD programs as well as build a socially supportive entrepreneurial climate. 5. Stimulate universities and PROs to gradually loosen and disconnect their ties with a particular spin-off firm, to motivate the spin-off to develop a strong market orientation and obtain access to new contacts and information.
Principles directed at the <i>success</i> of corporate and university spin-offs	<ol style="list-style-type: none"> 6. With regard to spin-offs with radically new (emerging) technologies that may threaten the position of incumbent firms, regional policy should: <ol style="list-style-type: none"> a. provide a certain degree of protection to these ventures by offering incubation facilities and funding; b. facilitate the ongoing flow and exchange of ideas and knowledge by encouraging a transparent and open dialogue about the significance of emerging technologies; c. facilitate the development of trust between firms to reduce

Table 3. (continued)

<p>coordination costs and support initiatives towards experimentation with emerging technologies.</p> <ol style="list-style-type: none"> 7. With regard to spin-offs with new technology that extend existing technologies and market strategies by incumbent firms, public policy should provide (conditions that enhance) transparency of both the supply and demand side of the market for technology. 8. Public policy should provide means for spin-offs—such as well-regulated science parks—to operate independently from parent companies, so they can engage in frequent interaction with others.
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intermediary organizations and clear regulations can settle conflicting goals and reduce cognitive barriers (Johnson, 2008). Such an infrastructure is also helpful to increase the success chances of university spin-offs, because close proximity between the sources of the knowledge and its commercialization are important success conditions (Audretsch and Stephan, 1996; Friedman and Silberman, 2003; Saxenian, 1996; Vedovello, 1997).

3.3.3. Policy design principles

Overall, these research findings can be synthesized in a number of design principles for policy directed at increasing the success chances of newly formed spin-offs.

1. With regard to spin-offs with radically new (emerging) technologies that may threaten the position of incumbent firms, public policy should:
 - a. provide a certain degree of protection to these ventures by offering incubation facilities and funding;
 - b. facilitate the ongoing flow and exchange of ideas and knowledge by encouraging a transparent and open dialogue about the significance of emerging technologies;
 - c. facilitate the development of trust between firms to reduce coordination costs and support initiatives towards experimentation with emerging technologies.
2. With regard to spin-offs with new technology that extend existing technologies and market strategies by incumbent firms, public policy should provide (conditions that enhance) transparency of both the supply and demand side of the market for technology.
3. Public policy should provide means for spin-offs – such as well-regulated science parks – to operate independently from parent companies, so they can engage in frequent interaction with others.

Table 3 summarizes the policy (design) principles inferred and synthesized from the literature.

4. Assessment of spin-off policy in the Eindhoven and Leuven region

In this section we discuss and compare spin-off policy of the Eindhoven and Leuven regions based on the policy principles derived from the literature. Section 4.1 provides a brief overview

of both regions and explicates our methods of data collection. In Section 4.2 we compare the two regions and we assess policy in each region in terms of its degree of fit with the policy principles.

4.1. Eindhoven and Leuven: brief overview and methods of data collection

In order to test our framework and demonstrate the usefulness of the policy principles developed earlier in this paper, we selected two high-tech regions: the Eindhoven region (Netherlands) and the Leuven region (Belgium). There are two different reasons for selecting these two regions. First, the two regions exhibit complementary profiles, which provide an interesting basis for comparison. The Eindhoven region is considered as one of the strongest high-tech regions in Europe (Hollanders, 2006) whereas the Leuven region has a particular strong reputation for its large number of (successful) academic spin-offs and its effective policy in this respect (Debackere and Veugelers, 2005; Polt, 2001). As such, a comparison between both regions can be highly informative. Furthermore, because of the complementary profiles, assessing these two regions provides a representative test of the policy framework. Second, in both regions various public and private policy measures have been developed to enhance spin-off activity, whereas these policies are to a considerable extent codified in various studies and reports (cf. Clarysse et al., 2005; Van Burg et al., 2008; Van Looy et al., 2004). In this way, we can build on these documents and triangulate among them in order to enhance the quality of our assessment of standing policy.

4.1.1. Brief overview of both regions

The Eindhoven region in the South of the Netherlands is shaped by the dominance of Philips, founded in 1891. The presence of Philips, and later many technology-based companies around it, has laid the foundation for a strong high-tech region. In the 1950s, another pillar of innovation and entrepreneurship came into being when Eindhoven University of Technology was founded. Over the years, a major policy focus has been to facilitate cooperation within industry as well as between industry, government and this university. Furthermore, over the last decades of the 20th century, entrepreneurship and corporate and university spin-offs have gained more attention from regional policy makers. This has become visible, among others, by means of establishing a formal technology transfer office at the university, the development of a large high-tech campus in 2000 and the creation of the Philips incubator in 2002. The regional parties involved in spin-off support and entrepreneurship policy together constitute a dense network, with regular meetings and many (informal) events.

The Leuven region, in the North of Belgium, is a region that has heavily stimulated entrepreneurship and spin-off creation, for more than 30 years. The main drivers of knowledge generation and resulting spin-off creation are the Katholieke Universiteit Leuven and the research centre for microelectronics IMEC. Besides that, a number of important multinational companies contribute to the high-tech character of the region, such as NXP, Huntsman, Intel and Alcatel. In the 1970s, the university founded a liaison office that has been successful in creating academic spin-offs, with a special focus on investments and growth. Within the region, there is close cooperation between the different parties, formed by government, industry and the university.

Table 4 provides a concise summary of the programs and policies in both regions, especially regarding financing and coaching, which are currently in place for the creation and/or success chances of spin-offs. Table 4 highlights important differences such as, for example, the fact that Eindhoven has fewer seed funding possibilities than the Leuven region. The self-

Table 4

Summary of the evaluation of financing and coaching programs.

	Financing		Coaching		
	Leuven	Eindhoven		Leuven	Eindhoven
Pre-seed	6	3	Financial coaching	2	3
Seed	6	1	Research and development	6	3
Start-up	6	2	Market development and sales	6	2
Early stage	6	5	Production/operation	5	5
Expansion	4	5	Management and organization	5	2
Pre-IPO	4	5			

Table 5

Data collection.

Case	Articles and reports	Interviews
Eindhoven region	Self-assessment (2006)	Managing director of university technology transfer office and incubator
	Report of inventory of programs targeted at spin-offs and needs of the spin-offs (2008)	Director strategy of regional innovation support organization
	9 relevant policy reports	Coordinator startups for regional development organization
	Van Burg et al. (2008)	
Leuven region	Self-assessment (2006)	Managing director of university technology transfer office and incubator
	Report of inventory of programs targeted at spin-offs and needs of the spin-offs (2008)	Entrepreneurship and innovation professor
	5 relevant policy documents	
	Clarysse et al. (2005), Debackere (2000), Debackere and Veugelers (2005), Van Looy et al., (2004), Kirwan et al. (2006)	

assessments report the details of this difference: Eindhoven has five seed initiatives, most of which are formed by limited funds that become rapidly exhausted or still are in an initial phase. In contrast, Leuven has 18 seed initiatives, many with a rather successful track-record and disposing over large(r) funds.

4.1.2. Methods of data collection

We collected data in three steps, see also Table 5. First, we collected existing reports and academic publications regarding high-tech support in these two regions. Second, a number of policy makers as well as practitioners in Leuven and Eindhoven have filled out a self-assessment of their programs and policies. This self-assessment tool has been developed and described in previous research (Kirwan et al., 2006; Lecocq et al., 2008). Third, seven semi-structured interviews with policy makers in these regions have been conducted. These interviews served to validate the self-assessment results and to acquire additional in-depth information on specific policy objectives and programs. After completing the data collection, we 'confronted' our observation on standing policy practices with the policy principles derived from our literature review (cf. Van Burg et al., 2008). Outcomes of this comparison were discussed with four regional policy makers to ensure the reliability and validity of our interpretations and recommendations.

4.2. Assessing policy in Eindhoven and Leuven

In this section we assess and compare standing policy in both Eindhoven as Leuven based on its fit with the policy principles articulated in Table 3.

4.2.1. Eindhoven region

In the Eindhoven region we observe an emphasis on increasing the number of spin-offs established, by stimulating both corporate and university spin-offs in the early and middle stages of the start-up process. With regard to this emphasis on enhancing spin-off creation, standing policy appears to reflect most of the relevant key policy principles listed in Table 3. As the policy makers reported, there is a general awareness that spin-offs have the best fit with sectors that are characterized by ample technological opportunities as well as (legal) possibilities for IP protection. In addition, various recent incubation initiatives such as Techno-partner and Incubator 3+ offer start-ups some degree of autonomy in the early phases of the spin-off process. As the director of the university technology transfer and incubator reported, it has meanwhile become common practice to make an explicit trade-off between alternative modes of technology transfer as well as to 'push' start-ups to rapidly develop a strong market orientation.

As far as policy principles with regard to success are concerned, there are some programs in place that stimulate and facilitate interaction and collaboration between established firms and start-ups in their early phase such as, for example, the formalized network program 'Incubator 3+' we mentioned earlier. However, these programs are only to a limited extent in line with our literature-based policy principles 6b, 6c and 8, which stress the need for developing trust, reducing coordination costs and supporting experimentation. In addition, the Eindhoven region also lacks any policies that would be in line with principles 6a and 7 in Table 3.

This focus on stimulating the number of established spin-offs raises a concern. Earlier research demonstrated that founding conditions operate rather autonomously from regional factors (Stuart and Sorenson, 2003). The latter especially have an impact on the degree of success. In this respect, the framework developed in this paper (see also Fig. 1) suggests that national policy and laws as well as sectoral characteristics form the major forces that drive spin-offs' founding rates. In other words, it seems that policy in the Eindhoven region is especially trying to reach for aims (i.e., boosting the number of start-ups) that are beyond its immediate influence, whereas it allocates fewer resources into domains that it can influence more directly. An example is, among others, the finding that in the Eindhoven region there is limited attention for coaching on market development and organizational development in comparison with coaching on finance, R&D, production and operations (see Table 4). These latter activities are relatively more important for getting started, whereas the two former activities are more important for becoming successful. Also, the various programs under the label of 'awareness creation' have as their aim to increase the number of start-ups rather than coaching start-ups, which tends to be more critical to boosting success chances.

Furthermore, the policy principles 6b and 6c, which are particularly conducive for the development of more disruptive innovations (Gans and Stern, 2003), also remain largely unaddressed. Instead, the current body of policy in the Eindhoven region carries a strong focus on stimulating spin-offs to enhance and extend existing technologies, market strategies or (research) infrastructures of incumbent firms. This requires the creation and maintenance of durable relationships with incumbents, however,

at the expense of a spin-off's autonomy and necessary exposure to others (cf. principle 8).

Overall, this body of policy motivates spin-offs to (rapidly) find application areas in existing markets where incumbents hold dominant positions. This suggests that an (implicit) choice has been made for leveraging existing value chains and collaborative ties with incumbents as the most viable strategy for spin-offs. Although this choice as such can be a sensible one, it ignores the alternative option: establishing a novel value chain and competing against incumbents. As the policy makers in the Eindhoven region report, spin-offs are especially weighed and assessed in terms of the degree of fit with existing businesses and technologies. This explains the strong focus on directly marketable applications and collaboration with innovative firms with excellent reputations. As a result, the clear policy message conveyed to (potential) spin-offs is that they should seek immediate complementarities with incumbents, which essentially implies to not engage in the pursuit of a stand-alone strategy.

4.2.2. Leuven region

In comparison with Eindhoven, policy in the Leuven area is somewhat more developed. This difference may be attributable to the fact that policy within the Leuven region has a comparatively longer history, dating back to the 1970s. Taken together, the set of policy initiatives seems to be rather comprehensive, in terms of both breadth and depth. Regarding its breadth, the total program (from pre-seed to pre-IPO) reveals a wide range of measures and programs regarding spin-off funding, spin-off coaching and awareness creation. Regarding its depth, there is a wide variety of measures and programs per phase (see Table 4). In this way, policy in Leuven seems to strike a careful balance between policy principles aimed at establishing spin-offs (1–5) and those aimed at increasing success chances (6–8). For example, as far as establishing spin-offs is concerned, there are ample initiatives for funding in each of the start-up phases but also various programs to raise awareness among potential entrepreneurs. In view of boosting success chances, there is (among others) a strong emphasis on coaching in each of the venturing phases that mostly affect success, such as market and organizational development (principle 6).

Compared to the Eindhoven region, the Leuven region has a relatively strong emphasis on spin-offs' success potential. The success potential is assessed in terms of its future prospects for a successful IPO, with a stand-alone strategy being the preferred option over collaboration with incumbents (cf. principle 6). The managing director of the incubator reported that, due to this focus on (stand-alone) success, the Leuven policy mix stresses a rapid 'confrontation' of ideas and products with the market and tries to raise the interest of investors as early as possible. In addition, policy in the Leuven regions emphasizes the importance of protecting intellectual property as much as possible. Furthermore, (highly) experienced entrepreneurs are encouraged to participate, in a balanced mix with young entrepreneurs, already in the very early phases of spin-off activity. In most cases, external management expertise comes on board almost immediately, rather than having the original inventor become CEO or become a member of the management team. Moreover, one explicitly considers the need for an exit option for investors, in case they are about to invest. Not only an IPO but also a 'trade sale', such as selling the spin-off to an established firm, can serve as an optional exit strategy. Nevertheless, this focus on 'immediate market success' carries a certain danger of rewarding risk averse behavior by spin-offs that may not be conducive to the creation of more radical, path-breaking innovations.

A final concern that applies to both regions pertains to current *national* policy (of Dutch and Belgian governments) that tends to overemphasize the role and benefits of spin-offs. In this respect, a spin-off is a means to an end, and should not become an end in itself. In both regions, this awareness seems to be sufficiently present as in each particular case an explicit trade-off is made between licensing, strategic collaboration with others, and spin-offs. Nevertheless, both regions are facing a growing pressure from national policy makers who are expecting more and more spin-offs, which apparently leaves little room for choosing the most effective technology transfer mechanisms for each particular case.

4.2.3. Suggestions for redesign

Based on our assessment of policy in both regions, we conclude that the policy approaches differ in two important ways. In Eindhoven, policy focuses on increasing the number of spin-offs and emphasizes collaboration with established players. In contrast, Leuven puts more emphasis on increasing the success chances of spin-offs and stimulating the pursuit of a stand-alone strategy. Despite these key differences, however, we see that both policy programs carry a similar kind of risk over time. The (unintended) consequence of both programs is that spin-offs with more incremental innovations are more likely to be stimulated than the ones with more radical innovations. In Leuven, this follows from the strong emphasis on rapid market success through a stand-alone strategy, which increases the chance that spin-offs with more radical technology will be considered as very risky and unattractive. In Eindhoven, this follows from the emphasis on collaboration with established players who have economic interests and expertise in current technologies.

In this respect, an important suggestion that follows from the literature review is that both strategy options – collaboration with incumbents and a stand-alone strategy – should be explicitly considered. As discussed in Section 3.3, the question is not so much ‘which strategy option is the better one’, but ‘which strategy option is the better one under which conditions’. Such an analysis is required upfront, in order to be able to decide which strategy to pursue. In this way, spin-offs would not be ‘pushed’ into one specific strategy mode that may be suboptimal or even counter-productive to their commercialization success. Furthermore, this would also stimulate incumbent firms to look beyond their established fields of expertise, enhancing their performance on the longer term (Gans and Stern, 2003). In this respect, regional policy is advised to value incremental and radical innovations equally and to implement programs that reflect this dual emphasis. Here, policy makers in Leuven and Eindhoven should especially focus on principles 6b, 6c and 7:

- encourage and facilitate an open dialogue about the significance of emerging technologies to ensure an ongoing flow of knowledge
- facilitate the development of trust between firms, to reduce coordination costs and support initiatives towards experimentation with emerging technologies
- stimulate the development of a transparent market for technology.

5. Discussion and conclusions

Our framework of policy principles served to assess to what extent standing spin-off policy is in line with (recent) insights arising from the academic literature. In this respect, we have been able to determine whether standing policy is (1) up-to-date, (2) comprehensive as well as (3) sufficiently robust against ‘policy fashions’. Following these three criteria, we draw the following

conclusions. First, the two policy programs differ in the degree to which they are in line with most of the policy principles derived from the literature. The Eindhoven region has a major focus on the creation of spin-offs but apparently less so on their success chances, whereas Leuven’s approach appears to be more balanced. Second, in comparison with Eindhoven, policy in Leuven is more comprehensive given the depth and scope of its policy mix. Third, both programs suffer to some extent from national policy that overemphasizes spin-offs, at the expense of an explicit choice among alternative mechanisms for technology transfer.

The framework of Bekkers et al. (2006) has provided a coherent framework for understanding the combined role of various antecedent conditions for spin-off creation and success. More specifically, its distinction between establishing spin-offs vis-à-vis success chances has proven to be particularly useful as this effectively discriminates between the two regions regarding their major policy emphasis. Nevertheless, the framework by Bekkers et al. (2006) also has an important shortcoming. It basically adopts an input-output view of spin-off policy by differentiating between its input side (number of spin-offs) and its output side (number of *successful* spin-offs), and how different institutional levels affect each side of the process. However, it ignores what goes on inside regional policy and technology transfer processes themselves, putting a limit on a more in-depth understanding of spin-off policies and practices. To open up this black box, we distinguished between collaboration with established players and the pursuit of a stand-alone strategy. Based on this distinction, it has become clear that both regional programs, despite some key differences, carry an (unintended) risk over time of especially stimulating incrementalism at the expense of more path-breaking technological change. These important findings carry a number of implications for both practice and theory.

As far as policy practice in general is concerned, one can observe in both regions a similar ‘appetite’ for measuring spin-offs in terms of numbers. Policy makers tend to have a preference for ‘tangible’ inputs and outputs (Mowery et al., 2004). Although a focus on numbers as such may serve legitimate goals of transparent reporting and accountability, it also creates a potentially false impression of ‘control’. Whereas the numbers can still look ‘right’, our study shows that policy runs the risk of sacrificing more radical innovations in favor of seemingly ‘safer’ incremental innovations. Instead, we suggest that policy goes beyond such a quantification approach and accepts the intricacies that come with a trade-off between the two different strategies. This implies that policy makers resist the temptation to mainly listen to established players with vested interests in existing technologies. Typically, such firms operate in existing industries that have widespread legitimacy for a long period of time already, and dispose over ‘deep pockets’ to hire lobbyists that can favorably influence new legislation or policy (Aldrich and Fiol, 1994). When listening ‘too well’ to these players, policy creates a risk of reinforcing the very same pressures that tend to kill the development of radical innovations and economic renewal, as discussed in Section 3.1.2. Instead, policy makers should also engage in a dialogue with the new players formed by corporate and academic spin-offs, preferably at a very early stage. In this way, policy contributes to ensuring a healthy mix between preserving regional strengths in established fields of expertise and the creative destruction by some start-ups that challenge these established fields. Such a healthy mix is likely to secure future competitiveness and sustainable economic growth on the long term.

The implication for theory development is as follows. The use of our conceptual framework suggests that new and more comprehensive insights especially emerge from the joint consideration of different institutional layers (cf. Denyer et al., 2008).

This implies that an in-depth and more comprehensive understanding of corporate and academic spin-offs especially requires multidisciplinary research that combines two or more of the different fields of literature that we considered. Bridging the literature on sectoral technological dynamics, on corporate renewal or on the role of PROs as well as on spin-offs will contribute to a more in-depth understanding of the role of contextual conditions and how they may affect spin-off creation and success chances. This role of contextual conditions has been largely overlooked in the literature until now, given its largely person-centric view that still dominates. Future research also needs to engage in further testing and extending the framework developed in this paper. These future tests may involve additional work with policy makers in the Eindhoven and Leuven regions, but should also incorporate other regions. Tests in other regions will also serve to increase the generalizability of the policy principles implied by the framework.

In sum, our framework of policy principles makes two key contributions. First, it informs (spin-off) researchers as to how they can significantly enhance the practical value of their research findings. Second, the framework supports policy makers in developing spin-off policies that are grounded in research findings, thus increasing the likelihood of more as well as more successful spin-offs in the future. The framework proposed in this paper applies especially to regions with a certain critical mass in high-tech industrial and public research activity. More broadly, our study demonstrates how a synthesis of current scientific knowledge can contribute to policy evaluation and redesign. In this respect, the design science method employed in this study may be applicable to other policy questions and contexts as well.

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