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Institutional change and resource endowments to science-based entrepreneurial firms

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Abstract

This paper considers the question of whether the resource endowments of science-based entrepreneurial firms are influenced by the way technology transfer is organised at the parent organisation. We studied one public research organisation in detail (IMEC, Belgium), by questioning all managers involved in technology transfer and the founders of all science-based entrepreneurial firms set up between 1986 and 2002. This research identifies three generations of companies at IMEC, mirroring the organisational changes in technology transfer policies and displaying distinct resource characteristics. Establishing an incubator structure for spin-offs seems to be a learning process during which little decision making can be exerted over senior management's social network in the financial and business community for securing the financial, technological and human resources for the science-based entrepreneurial firms.

Keywords: Science-based entrepreneurial firms; Public Research Institute; Technology transfer

1. Introduction

How do institutional practices change? Researchers from different perspectives on organisations have directly or indirectly addressed this aspect of organisational reality. The primary objective of this paper is to investigate changes in institutional practices regarding technology transfer policies that potentially affect the emergence and resource endowments of new science-based entrepreneurial firms (SBEFs).

Although different authors have proposed stage models providing insight into the dynamically interrelated activities connected to spinning off ventures (Vohora et al., 2004; Clarysse and Moray, 2004), few have looked into the specifics of internal strategies enacted by the research institute and how these influence the commercialisation of research results by setting up ventures (Markman et al., 2003; see for example, Clarysse et al., 2005). Through an historical process analysis, this study extensively documents the organisational level institutional changes regarding the spin-off policies of one research institute, the Inter University Micro Electronics Centre (IMEC),

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since its inception in 1984 up to 2003. Although these changes need to be partly understood in their broader environmental context, our objective is specifically to investigate the link between these internal organisational changes and the resources endowed to the SBEFs.

Selecting IMEC as single case is appropriate for different reasons. First, tackling the question of interest requires a detailed intra organisational understanding of the processes involved. As the unit of analysis is at the interplay of the Public Research Organisation (PRO) and the SBEFs and extensive data collection is needed at both levels, this research is ideally tackled in the context of one PRO. Second, studying a centre of excellence is particularly useful because several researchers have argued that the successful commercialisation of technology and the emergence of new firms very often happens in close co-operation with organisations where top science is being performed (e.g. Zucker et al., 1998). Third, the fact that IMEC focuses on one technology domain enhances the unit homogeneity in the case design, which is important to draw valid conclusions. Finally, other researchers have successfully used single sites studies to increase understanding about particular issues related to technology transfer and spinning out ventures (e.g. Shane and Stuart, 2002, studying MIT spin-offs and Jacob et al., 2003, studying Chalmers University of Technology), allowing other researchers and policy makers to discern the applicability of the findings to their own contexts.

To anchor the scope of our investigation, we frame questions from three perspectives, each representing subsequent steps in addressing the problem of interest: How is the process of spinning off ventures organised within a public research institute? How did this process change over time? Do the nature and the origin of resources going to the SBEFs change in line with evolutions in technology transfer policies at the parent institute? As historical analysis has been used successfully in the study of institutions and institutional change (Cusumano and Selby, 1995; Leblebici et al., 1991; Sini and David, 2003), we used interviews and secondary data sources to reconstruct the life history of the institute's commercialisation trajectory.

The remainder of the paper unfolds along the following lines. First, we discuss the context of SBEFs from PROs in Europe and point to the importance of studying the interplay between the micro-institutional environment and the ventures that emerged from the PRO. Second, we discuss the research design and methodology of the study. Third, we present the data and findings. We position IMEC in the Flemish landscape of public research organisations, we describe in detail how the spin-off process evolved and how it is organised in IMEC (2003–2004) and argue that three generations of science-based entrepreneurial ventures can be distinguished according to different eras in the management of technology transfer. Finally, some conclusions and implications are discussed.

2. Context: science-based entrepreneurial firms from European PROs

Since the mid-1990s, European public research organisations have been increasingly involved in commercialising their research results and spinning off new ventures (OECD, 1998). More specifically, generating new companies has been viewed as an alternative to licensing and contract research. However, one caveat in many studies on SBEFs has been the lack of a clear definition. In practice, SBEFs often denote all the ventures that are "listed" as having emerged from PROs. However, these listings often include firms with different types of links with university or the research institute at time of setting up the firm. Roberts (1991, 103–107) described the large variety in the high technology entrepreneurial firms that emerged from MIT. He rated the importance of technology transferred to the new firm, representing the degree of dependence on source technologies: direct, partial and vague[1]. The first two categories represent the (IP based) "spin-offs", whereas the category 'vague' represents the "start-ups", as conceptualised by AUTM. Start-ups are characterised by the fact that no formal transfer of technology took place at the onset of business activities.

We can indentify two major reasons why the formation of new companies from the science base of PROs –

[1] Since Roberts (1991) studied high technology entrepreneurship generically, he also included a category "none" to capture the firms that were set-up apart from knowledge acquired during a research process in the context of the university (e.g. MIT graduates that started a car repair shop).

start-ups and spin-offs alike – has become much more central to the mission of European PROs. First, the creation of new enterprises is increasingly being used as a performance indicator for evaluating public investment in PROs. Second, the bubble in the stock markets at the end of the 1990s and, related, a number of extremely successful trade sales has attracted the attention of the management of these public research organisations. Professional organisations such as ASTP[2] have repeatedly presented best practice examples of spin-offs as significant sources of income for public research organisations.

In this context, universities and public research institutes started to develop internal systems to support this. These systems comprise activities such as the management of contract research, the protection of intellectual property, the negotiation of licenses and the support of independent companies. The development of procedures and systems to support and stimulate the creation of companies is in line with the contemporary notion of science-based entrepreneurship, which is shifting from serendipitous and individual to being perceived as social and organised (Jacob et al., 2003). At the same time, the development of such procedures evokes the question of imprinting, dealt with in institutional theory. New firms founded to exploit intellectual property emerging from science are typically embedded in a parent organisation, bringing about its own culture, rules and procedures. In this perspective, institutional theorists argue that emerging firms build internal consistencies that are in alignment with their institutional context (Dacin, 1997). Intuitively, isomorphic forces might even be especially present in new ventures, which typically have a limited resource base: science-based entrepreneurial firms may incorporate legitimating structural elements from the host organisation in order to attract the necessary resources.

Researchers have taken steps to study the organisational institutional context in which technology transfer activities take place. For instance, Bercovitz et al. (2000) looked at the effect of institutional structures and policies on patenting and licensing behaviour. Di Gregorio and Shane (2002) related the institutional determinants with the spin out rate of (public) research organisations. These institutional determinants include characteristics relating to reward systems, entrepreneurial/academic culture, IP policies and the overall organisational structure of the research organisation.

In this paper, we extend previous research by looking at how institutional changes influence the resource endowments of ventures that are set up to exploit research results. Since the value chain of spinning off science-based entrepreneurial firms encompasses different parties – scientists, technology transfer personnel, senior administrators and the founders of the companies – we employ a dual case study methodology (Leonard-Barton, 1990), combining historical and prospective case analysis, based on 40 face-to-face interviews, 20 standardised questionnaires, archival searches and a database with evolutionary financial data about the companies.

3. Research design

Data collection is performed at different levels and using a mix of techniques, avoiding common method bias. We collected regional data on spin out activity, data about technology transfer policies and data about the science-based entrepreneurial ventures that emerged from the institute since 1991. These data collection efforts resulted in a combination of quantitative and qualitative data, allowing triangulation (Jick, 1979).

3.1. Research site

IMEC is a non-profit independent research centre in the field of microelectronics, nanotechnology, enabling design methods and technologies for ICT systems.[3] The center was founded in 1984 as part of a comprehensive program in the field of microelectronics to strengthen the microelectronics industry in Flanders (Belgium). In its pursuit of becoming an internationally recognised centre of excellence in microelectronics, the institute has been participating in a multitude of collaborative efforts, including European R&D programs, European Networks and collaboration

[2] ASTP: Association of European science and technology transfer professionals. See http://www.astp.net.

[3] www.imec.be.

Table 1
Overview of data collection at IMEC

	Face-to-face interviews ($N = 40$)	Standardized survey ($N = 20$)	Secondary sources
PRO IMEC management	9	UNICO/NUBS TTO survey	Press releases, year reports, IMEC website
Science-based entrepreneurial firms (20 since 1991)	Total: 31	Total: 20	Longitudinal database of financial data of 23 companies
Two spin-offs set up in 1996	8	Standardized survey	Press releases, year reports, company website
One spin-off set up in 2002	6	Standardized survey	Press releases, company website
17 other SBEF	17	Brief phone survey and standardized survey	Press releases, company websites, year reports

with leading-edge companies and R&D organisations in Flanders and internationally. In 1991, a business model was introduced to manage R&D partnerships: IMEC's Industrial Affiliation Program (IIAP). This model of joint R&D partnerships is based on shared costs and risks while expertise, talent and IP are brought together. Over the years, IMEC has increasingly developed its technology transfer policy, including rules and procedures for establishing SBEFs. Up to 2002, IMEC has set up 23 ventures, of which 20 since 1991.

3.2. Data collection and methods

We collected data on the rate of establishment of SBEF from other PROs in the region.[4] We found this was crucial since this study is in its pure form "one case". Although in "single" case studies analytical generalisation is of primary importance – instead of statistical generalisation – these regional data allow contextualising the findings. Second, we interviewed all senior managers involved in technology transfer policies at IMEC. A key issue in these interviews was to gain insight in the magnitude of technology transfer activities, how the spin out trajectory is positioned in the broader research commercialisation strategy and how this evolved over time. Third, we interviewed representatives of the SBEFs that emerged from the institute, focusing on the start-ups history and resource acquiqition. Fourth, we performed more detailed process studies of three spin-offs, to better understand the dynamics of venture formation and development as it is embedded in this particular research organisation. One venture was studied prospectively over a period of 20 months; two ventures were studied retrospectively. Finally, we surveyed all the SBEFs using a structured, standardised instrument to get a detailed view on the resources. Table 1 summarises the different data sources and the respective methods.

[4] We updated data collected by Clarysse et al. (2003) in a study on Spin outs in Flanders. We add to this effort by complementing the list of academic starters, distinguishing between academic start-ups and academic spin-outs and complementing the data on the capital these companies attracted at time of start up.

4. Data and findings

This section presents the data and the main findings of the study. First, we briefly position IMEC in relation to other PROs in Flanders. Second, we hone in on how IMEC's spin out trajectory is structured and how it evolved over time. Third, we compare the IMEC starters with other science-based entrepreneurial firms and high tech start-ups in Flanders, in terms of start capital, founding team and technology development at time of founding. Fourth, we argue that three generations of IMEC ventures can be distinguished, mirroring the way organisational technology transfer policies evolved. Finally, given the increased focus on establishing science-based entrepreneurial firms since the mid-1990s, we reflect upon the companies' financial return and employment: do they meet the expectations?

4.1. Science-based entrepreneurial firms in Flanders

The budget for science, technology and innovation in Flanders amounts to €1322 million in 2003, 57% of

Table 2
Characteristics of research–industry technology transfer in Flemish Public Research Organisations

	Age of TTO (years)	Research expenditure, K€	No. of TTO employees (new ventures)	External legal fees for IP protection, K€	Invention disclosures	No. of academic ventures 1991–2002
	Data for 2002					Spin-offs/start-ups
Research Institutes						
IMEC	9	136707	42 (12)	1600	103	12/11
VIB	7	52000	10 (1)			3/0
VITO	8	45000	19 (0)	180	0	0/1
Universities						
KUL	32	183000	23 (3,5)		9	21/17
UGent	4	75902	3 (1)	400	25	2/12
VUB	5	48000	5,5 (2,5)	120	25	9/0
UA	4	44400	4 (3)	51	19	1/2
LUC	4	18700	1 (0,4)	2,5	0	3/2
KUB	0	816	0	0	0	0/0

which is geared towards R&D activities (compared to 49% in 1996). The Flemish PROs – the universities and research institutes – rely significantly on government financing for their activities either directly through subsidies or contract research. Moreover, since the mid-1990s there is increasing emphasis on technology transfer activities. This trend was formalised in a number of university decrees that put the return and services to society equally high on the agenda of universities as education and research.[5] Moreover, since 1998 the PRO legally owns the IP generated from research[6] and government started subsidising the interface services. In this context, PROs set up seed capital funds to facilitate investments in science-based entrepreneurial firms and interface services worked towards professionalising their activities. In Flanders, there are nine Public Research Organisations: three research institutes and six universities. Siegel et al. (2003), identified a number of input indicators related to university–industry technology transfer, internal to the research organisation: invention disclosures (a proxy for the set of available technologies), labour employed by the Technology Transfer Office (TTO), and the legal fees incurred to protect the university's IP. Table 2 gives an overview of these input indicators for all the Flemish PROs. In total, 93 science-based entrepreneurial firms emerged from Flemish universities and research institutes from 1991 to 2002.

The Katholieke Universiteit Leuven (KUL) and IMEC are the largest research organisations in terms of research expenditure, the size of the technology transfer office and the science-based entrepreneurial firms generated from their knowledge base. Together, they account for 54% of the science-based entrepreneurial firms generated in Flanders between 1991 and 2002. Not surprisingly, these two institutions set the professionalisation trend among the interface services in Flanders.

Different authors have suggested that PROs differ significantly in relative productivity in transferring technology to industry and that studying the organisational practices in PROs management of IP would be a useful complement analysis of numeric variation amongst institutes (Siegel et al., 2003; Di Gregorio and Shane, 2003). The next section elaborates in detail on the technology transfer practices related to spinning out new ventures in IMEC.

4.2. The spin-off process at IMEC: a centrally led technology push model

This section specifically sheds light on the spin-off process in IMEC and how it evolved over time. What is the decision making process and which phases does a potential project go through before it is actually spun off? Different activities of a spin-off management

[5] Decree of February, 22, 1995 (B.S. 19 juli 1995).

[6] University decree of August, 29, 1998, art 103 (B.S. 29 augustus 1998); Cfr. Bayh-Dole Act in the US in 1980.

process have been identified by Degroof (2002) and elaborated by Clarysse et al. (2005). Following these authors' conceptualisation, we discuss: (a) How IMEC has set up structures to enable the identification of technological opportunities. (b) How IMEC bridges the time between the identification of the opportunity and the start of the incubation phase. (c) The specifics of the incubation phase: which activities is IMEC actually engaged in? (d) The internal strategies towards IP assessment and transfer to the spin-off. (e) How IMEC finances the projects in incubation and the firms subsequently established.

4.2.1. Opportunity recognition

The recognition of entrepreneurial opportunities has been identified as one of the central features in the study of entrepreneurship (Shane and Venkataraman, 2000). How are these identified at IMEC? Since the mid-1990s there is increasing awareness at IMEC that knowing the pool of technological opportunities is a first step in the commercialisation process. Most recently, IMEC has been discussing opportunities to establish an Idea Board that has a *technological orientation*: what are the hot topics that are at most 3 years away from the application phase? Which industry standards are likely to be implemented? This Board wants to enable the proactive identification of new, potential intellectual property and ideas from a technological point of view.

The *commercial orientation* of opportunity recognition for technology transfer and spinning off ventures seems to have a much longer history. Since business development in Flanders began as a formal structure and separate entity (1991), this division has undergone major changes and shifts in responsibilities. In the early years (1992–1993), the heads of IMEC's business development division (two persons), managed the commercialisation of research. The most important shift happened in 1996–1997, when a separate "Incubation" cell was established. This cell moved a couple of times in the organisation structure of IMEC, showing that IMEC went through an important learning phase in the second half of the 1990s as to where to position these "venturing activities".

Senior management of the different departments is still very much involved today in the "Sales Board". This structure takes the form of a communication platform that brings together the heads of department from the Scientific Divisions, the Incubation and Industrialisation (I&I) Division and the Business Development Department. These Sales Boards are specific for each scientific division and meet every 8 weeks to discuss overall business development opportunities: technological developments that can be structured in contract research through IMEC's Industrial Affiliation Programme with industrial partners, licensing agreements or opportunities for establishing SBEFs. Compared to the Idea Board, this platform has a *commercial orientation*. An idea is considered appropriate for a spin-off if the application phase is less than 2–3 years away and if IMEC can freely use the IP associated to the idea. Most of the time, this is an iterative process. If the Sales Board deems an idea or project feasible for spin-off creation, the project is administratively transferred to the division Incubation and Industrialisation.

4.2.2. From first market analysis to incubation

This phase during the spin out process has gained momentum ever since an "Incubation" division was set up (1996–1997). Since then, the department has professionalised its activities from an organisational and methodological perspective. The Incubation and Industrialisation Division comprises a team of eight of which three are directly engaged in evaluating and supporting specific spin-off projects. Each of these eight business developers have a Ph.D. in engineering/sciences and are assigned to a project based on their acquaintance with the project's technology. A project leader performs a preliminary market analysis and a first evaluation of the intellectual property position. This evaluation phase takes 4–6 months and happens in collaboration with the inventors/researchers that are interested in commercialising the technology through a spin-off. If it is decided that an idea cannot be structured in a spin-off (yet), the idea is sent back to the Sales Board with specific feedback. If the results of the market analyses are positive, the project manager writes an Incubation Plan, again in close collaboration with the researchers(s)/inventor(s). Interestingly, during this stage the role of the researcher–entrepreneur remains limited. The market analysis seems to be a largely technical and methodological process. At this point the Vice President (VP) of I&I will have a meeting with the patent office (structured in the department Business Development Division) to evaluate the use of Intellectual Property components by other companies, including the extent of exclusivity.

4.2.3. Incubation and business plan development

Once a project enters the incubation phase, the researchers involved get separate offices on the IMEC Campus in order to start their first (commercial) activities. Depending on the particular case, an 'Incubation Company' is set up. Sometimes it may be important that the "incubated" project is set up as an independent company to attract subsidies for technology development and to gain legitimacy towards potential partners and/or clients. For the spin-offs established since 1999, this is always the case and also reflects an increasing structuring and visibility of the incubation process within IMEC.

The spin-off project gets both operational and strategic support. The Enterprise Cell within the Financial Department (three full time equivalents) supports the project from a "corporate" perspective: juridical/IP matters, accounting and fiscal issues. Although during this stage there is not a Board of Directors, the researchers–entrepreneurs are coached in the development of the company's business model and commercial strategy by a Steering Committee. This Committee meets monthly and consists of the VP and the Project Leader of I&I, the VP of the Financial Department, the VP of Business Development and (one of) the inventors/researchers–entrepreneurs.

The incubation phase usually takes 12–18 months[7] and should result in venture capital investment in the "Incubation Company". It is also at this time that the intellectual property is formally transferred to the spin-off and that the incubation costs are discounted. The Enterprise Cell follows up the company after external capitalisation and provides feedback to the VP of the Financial Department.

4.2.4. Transfer of intellectual property

One of the most important shifts IMEC went through since the mid-1990s is an increasing focus on positioning itself as an international player through programme driven partnerships (IMEC's Industrial Affiliation Programme). The specific IPR policy of IMEC was a central facilitating factor in the internationalisation process. Moreover, it has led to an increase in intellectual property (background information) with new commercialisation routes in Flanders.

In the context of spin-off companies, the valuation of the IP traditionally happened at the start of the incubation phase through a licensing agreement. Since 1999–2000, IMEC stopped its non-exclusive and exclusive "licensing for royalties" strategy towards spin-offs and decided to move to a model based on the exchange of IPR for equity. The context for this change is that since the mid-1990s IMEC increasingly wanted to manage the spin out process in an integrated way, instead of only focusing of the management of IP. With the change in approach to commercialising IPR, the institutional incentive for exploiting the research has changed. In the first model, the incentive was 'income generation' through royalties from licensing. The second model implies that IMEC spins off an existing research activity (and the corresponding revenues) and that the financial return is much more dependent on the success or failure of the new firm. Concurrently though, in a model based on IP for equity, venture capitalists require a maximum input of IP in return for their investment. This imposes a risk on IMEC of losing a complete research stream. Additionally, given the economic downturn started in 2000–2001, VC's are not willing to assign high values to IP from the start, since most of the IP's potential remains to be proven. This introduces a conflict since it also essential that the full IP is brought into the company from the beginning in order to have freedom to operate. Therefore, IMEC has adopted a strategy in which the valuation of the IP happens in different phases.[8]

It is a huge challenge for IMEC to address two broad goals: establishing SBEFs AND maintaining momentum in its leading research streams, without jeopardising both parties. In its attempt to keep a critical mass of know how and technology within IMEC, the research institute has developed an "Intellectual Property Fingerprint Model". The model implies that the partner gets a unique "fingerprint" of IP from

[7] There is one particular company that, at the time of writing, entered the 24th month of incubation. Venture capitalists could not (yet) be convinced and IMEC decided the invest €1 million in the company themselves.

[8] For example, in a first stage, a lower boundary is defined based on the historical costs incurred to develop and maintain the IP (e.g. 750,000€). In the subsequent stages, the increase in IP valuation is connected to specific milestones until the 'full value' that has been negotiated between the parties has been reached (e.g. 1 500,000€). The valuation of IP is performed within IMEC and the scientific division is compensated for the value of the IP at time of establishment of the spin out.

IMEC, including exclusive and non-exclusive components. The necessity and mix of each of the components is evaluated on a case-by-case basis. IMEC wants to apply this model to their spin-off companies. The "unique fingerprint" would be developed during the incubation phase. At the beginning, the spin-off would receive non-exclusive licenses for all technologies they potentially need throughout incubation. After the incubation phase, ideally when a first injection of external capital takes place (ventures capital, business angel or corporate money), exclusive licensing agreements would be negotiated for these technologies specific for the spin-off and for the developments, improvements made during this stage. However, venture capitalists require exclusivity, which often means stopping the research activities in this particular domain.

4.2.5. Funding process

The financial environment has changed significantly since the early 1990s and IMEC has attempted to follow the trends proactively. Since in Europe the venture capital industry and financial markets financing technologies in the (pre)-seed stage were rather immature in the early 1990s, the "funding gap" (see Cressy, 2002; Lockett et al., 2002) was a major challenge facing science-based entrepreneurial firms. Thus, in order to deal with financial constraints, some European PROs increasingly set up seed capital funds to address the funding needs of projects they evaluated as promising technologies in their portfolio of contract research. In addition, this attention to the issue of finance was shared by governmental institutions through the provision of alternative sources of risk capital, i.e. governments creating their own (pre)-seed funds.

In the early years, the main financial partners for the science-based entrepreneurial firms were large, corporate firms. In addition, IMEC and the universities from the associated labs brought in a part of the capital. During the mid-1990s venture capital in Europe had become a more legitimate source of funding for start-ups in 1997 IT Partners was established, an "IMEC friendly" venture capital fund which would target the semiconductor industry. IMEC wanted to consider only those projects requiring capital in the range of €750,000–1,000,000. The idea behind the establishment of IT Partners was to meet the need for funding for the potential IMEC spin-off projects and to manage more professionally IMEC's portfolio of participations. ITP only invests 25–30% of the required capital and requires the ventures to attract complementary (VC) money.

In 2000, IMEC decided to launch an Incubation Fund because of the increasing difficulty in securing venture capital for early-stage, high potential projects that have not yet made a working prototype or drafted a long-term business plan. IMEC's Incubation Fund was established in October 2001 with €5 million[9] to stimulate new possible spin-off initiatives by providing the necessary (pre)-seed capital to prepare prototype products and early market introductions during the incubation period. The problem of the IMEC Incubation Fund seems to be a *contradiction in terms*: the Fund wants to meet the need for capital in early stage technology but it also seems to be a bottleneck for the young companies. A first explanation for this is that the fund was confronted with much larger proposals than initially targeted: invest maximum 20% of the Fund in a project and up to 60% of the required capital.[10] Moreover, due to the small size of IMEC's Incubation Fund, they could not secure (part of) the follow up financing for the incubated projects. Finding a lead investor for follow up financing is practically impossible in the current financial and economic climate in Belgium, especially when the existing shareholder does not (cannot) co-invest. Finally, IMEC's IP policy is such that IP is only brought in at the time of external capitalisation, which makes negotiations with potential venture capitalists even harder. The Fund's shareholders decided to shift the investment focus of the fund to early stage investment, i.e. at the moment that IMEC brings in its IP and other venture capitalists (VCs) step in.[11] IMEC is actively planning to set up a seed Fund (€40–60 million).

4.3. Resource endowments to IMEC ventures

IMEC spun off its first venture in 1986 and up to 2002, 23 companies were established. Table 3 provides

[9] De financial partners are KBC Investco, Fortis Private Equity N.V., Software Holding & Finance N.V. and V.E.M. Chaudfontaine CVBA.

[10] This is because IT Partners formally has the right to invest up to 40% of the capital (postmoney, after which IP is brought in and VC's stepped in).

[11] In total, the Fund invested about €1.2 million in two projects.

Table 3
Science-based entrepreneurial firms from IMEC (established between 1986 and 2003)

Start-ups	Spin-offs
Cobrain (1987) (Trade sale, Matrix, 4Q 2003)	C-Cam Technologies (1996) (B, 2Q 1999)
LCI SmartPen (1992) (B, 2Q 2002)	Coware (1996)
Soltech (1989)	Frontier Design (1997) (Trade sale: Adelante Technologies, 4Q 2002)
JSR Electronics (1989)	Oligosense (1998)
Easics (1991) (Trade sale: TransWitch, 4Q 2000)	Q-star test (1999)
Destin (1992) (B, 2Q 2001)	Fillfactory (1999)
Alphabit (1992) (Trade sale: HP, 1997)	Septentrio (2000)
Acunia/Smartmove (1996) (B, 4Q 2003)	Xenics (2000)
Target Compiler Technologies (1996)	Photovoltech (2001)
Sirius communications (1996) (Trade sale: Agilent Technologies, 4Q 2001)	Vivactis (2002)
Ansem (1998, with KUL)	Loranet (2002) (B, 3Q 2003)
3E (1999)	

B: Bankrupt.

an overview of the population of companies that originated from IMEC up to 2002.[12]

Table 4 gives an overview of some characteristics of these companies in terms of financial resources (capital after 12–18 months), the human resources (number of founders and employees) and the technology resources (the maturity of the technology at time of founding). Resource based scholars have traditionally pointed to these three types of resources as significant assets. We compare the SBEF that emerged from IMEC to other Flemish SBEF (Moray, 2004) and other high tech start-ups (Heirman and Clarysse, 2004) set up from 1991 up to 2002.

The average SBEF from IMEC established since 1991 raises almost €2 million of capital within 12–18 months after founding. If we take the three firms into account established before 1991, the average capital is €1.6 million. This is significantly higher than the other science-based entrepreneurial ventures and high tech start-ups established in the same region and time period. Only seven IMEC ventures attracted venture capital at founding or within the 12–18 months after founding; four of those were incorporated in 1999 or later. A group of IMEC starters received the majority of their founding capital from large corporate firms ($N=9$). The other companies were financed either by IMEC (or IMEC's Incubation Fund since 2001) and individual, private investors ($N=7$).

The SBEFs from IMEC display unique resource characteristics compared to other science-based entrepreneurial ventures and high tech start-ups established in the same region and period. Although the specific technology focus of IMEC could partly explain the high capital levels, we observe large differences within the group of SBEF that emerged from IMEC. To what extent do organisational changes in technology transfer policies explain for this heterogeneity in starting resources?

4.4. The interconnectedness of institutional context and resource endowments

4.4.1. Three generations of science-based entrepreneurial firms at IMEC

Following the evolution within IMEC regarding the transfer of IP and the investment policy, we distinguish "three generations" of science-based entrepreneurial firms at IMEC. The first generation of starters runs up to 1995. The second generation of companies are those firms established in the period 1996–1998. From 1999 onwards, a third generation emerges.

We looked at the financial, technological and human resources at time of founding. For the financial resources, we both look at the founding capital and the capital the ventures were able to attract within the first 12–18 months. This is important, since legal

[12] In 2003, four other spin-offs were in incubation phase at IMEC: Magwel, Andel Systems NV, PowerEscape Inc. and Gemidis.

Table 4
Resource endowments to IMEC ventures at time of founding compared to other science-based entrepreneurial firms and high tech start-ups in Flanders[c]

Characteristics	Measures	SBEFs from IMEC		Other SBEFs[a]		Other high tech start-ups[b]	
		Data	*N*	Data	*N*	Data	*N*
Capital after 12–18 months (K€)[*]	Mean	1957.2	20	688.5	57	234.1	120
	Median	671.8		198.3		61.5	
	S.D.	2585.8		1362.4		713	
	Min–max	75–9940		3–6000		0.1–5000	
Number of founders[d,*]	Mean	3	19	2.6	56	1.8	120
	Median	3		3		1.5	
	Min–Max	0–11		1–7		0–6	
Number of employees at time of founding	Mean	5	19	3.3	55	4	121
	Median	3.5		3		2	
	S.D.	6		3		10	
	Min–Max	0–25		0–16		0–101	
Maturity of technology (0–3)[e]	Median	1	20	1	55	0	121
	Min–Max	0–3		0–3		0–3	

[a] Moray (2004), IN: Clarysse (2004).
[b] HITO Database, Steunpunt Ondernemingen, Ondernemerschap en Innovatie.
[*] Differences between groups significant at $p < 0.01$ (Kruskall–Wallis test).
[c] For the other high tech start-ups, we use the definition of 'research based start-ups' as conceptualised and sampled by Heirman and Clarysse (2004).
[d] Founders are the persons who have a hands-on function in the company AND/OR who have equity at time of formal incorporation.
[e] Measured on 0–3 scale: idea phase (0), alpha prototype: proof of concept; the technological idea works in a lab environment (1), beta prototype: prototype that works in a real life environment (2) and market ready product (3).

founding is in some cases only a vehicle to raise credibility and only requires a legal minimum capital to be injected. For the technological resources, we discern whether or not technology was transferred formally (start-up versus spin out) and the maturity of the technology, adopting Roberts' scale (1991) from basic research (1) becoming increasingly developmental (8) until alpha prototype (9)[13]. Although on average IMEC ventures are set up with an alpha prototype ready, we wanted to be able to measure the maturity in more detail before technology development reached that stage. We also add some detail in evaluating the human resources. At least two issues are of crucial importance in terms of establishing a critical mass of human resources in a high tech firm: the researchers developing the technology and professional management. Clearly, researchers acquainted with the technology are important intangible assets since the legitimacy of the technology often resides in its intellectual carrier(s), but they often need to be complemented with professional business developers. Therefore, we also looked at the extent IMEC researchers were involved in the science-based entrepreneurial firm and the number of external managers attracted in the venture within 12 months after founding. Table 5 provides an overview of the resources at time of founding of the three generations of science-based entrepreneurial firms.

4.4.1.1. First generation: 1986–1995. For all the companies established up to 1995, IMEC only brought in a limited amount of cash. The main source of external capital, were incumbent firms. Especially interesting is that these firms' capital levels did not raise significantly after 18 months. Moreover, IMEC did not have much experience in setting up companies and it was

[13] We decided to use another measurement scale as compared to the one used in Table 4, to gain more insight in the diversity in technological maturity among the SBEFs from IMEC. Since half of the firms start activities without an alpha prototype, we believe it was interesting to understand the relative positioning of these companies in technological maturity (1–8; 9 represents an alpha prototype). This level of detail in maturity of technology was not available for the other data sets with which we compared the IMEC ventures.

Table 5
Resource endowments of three generations of IMEC ventures at time of founding

	1987–1995 ($N = 7$)	1996–1998 ($N = 8$)	1999–2002 ($N = 8$)
Financials (mean, K€)			
Founding capital	457	293	1621
Capital after 12–18 months*	594	1163	3026
Technology (median)			
Maturity	9	7	5
Involvement inventor	3	5	5
People (median)			
Number of founders	3	4	4
Mean experience founders (years)	17.5	35.8	41
FTE employees	2	3	4.5
Number of external management	0	0	0
Number of IMEC researchers in company	1.5	1.5	4

* Difference between groups significant at $p < 0.05$ (Kruskall–Wallis test).

difficult to evaluate the concrete capital needs. As a result, some of these firms – all start-ups – were largely undercapitalised. Most of the companies set up during this era were based on a clear need from a corporate firm. As a result, most of these firms had a working alpha prototype ready at the time they started their business activities (nine represents an alpha prototype). Few IMEC researchers joined the start-up (on average 1.5 full time equivalents).

From the seven start-ups established up to 1992 (from 1993 up to 1995 no science-based entrepreneurial firms were set up), only one is still in operation as an independent entity today (Soltech). Four companies have been acquired (UCB Electronics, Matrix/Cobrain, Alphabit en Easics) and two went bankrupt (LCI SmartPen en Destin). Easics was set up in 1992, acquired by TransWitch in 2001 and operates as an R&D subsidiary.

4.4.1.2. Second generation: 1996–1998. During the early 1990s, IMEC went through some major changes in the organisation of its business development activities. The introduction of IMEC's Industrial Affiliation Programme was a prominent change. This professionalisation trend in industrial liaisons affected the way IMEC set up new ventures: during this era IMEC increasingly grows attentive for bringing in IP in the firms. We observe a careful shift to the transfer of IP through licensing agreements, but IMEC does not engage in this effort in a systematic way. Of the eight firms established from 1996 to 1998, three are spin-offs (i.e. IP-based) and also received some start capital from IMEC (Oligosense, C-Cam Technologies en Coware NV). IMEC brought in only cash in the five other firms at the start of their activities. In most cases though, license agreements were negotiated during the lifetime of the start-up.

We observe a significant increase of the capital that the second-generation IMEC starters can attract during the first 12–18 months. On average the firm started operations with €293,000, whereas after 12–18 months the capital level increases up to more than €1 million. The fact that this generation of firms can attract additional capital can be explained by the overall shift from industrial capital providers to seed capital funds, business angels and venture capitalists as main sources of capital for the first round of external financing. Apparently, these firms needed to 'survive' the first 18 months with low levels of capital and prove the workability of an alpha prototype in order to convince investors to bring in the required capital. Although IT Partners was set up during this period, the Venture Capital Fund did not invest in any "second generation spin-off" at time of start-up.[14]

The founders setting up these ventures seem to have more cumulative sector and business experience than their colleagues from the first generation starters have (36 years compared to 17 years). In addition, the inventor or principal investigator that triggered the initial

[14] ITP did invest in 2 third generation IMEC ventures at time of start up: Fillfactory and Septentrio.

research is in most cases part of the core management team (CEO or CTO) (score = 5).

4.4.1.3. Third generation: 1999–2002. The third generation starters are characterised by the fact that all but one are spin-offs, whereas during the first era only start-ups were established and the second generation showed a balanced mix of start-ups and spin-offs. Additionally, these firms seem to start business activities with a less mature technology (score 5, compared to 7 and 9 in the two previous generations). This evolution clearly reflects the increasing technology push model adopted by IMEC. We can expect that the IMEC spin-offs will be formally incorporated in an earlier phase through internal capitalisation (via the IMEC Holding managing the bulk of participations since 2000—or via the new seed fund). This should enable the spin-offs to get easier access to EU/ESA and project financing from the Flemish government. From 1999, the IP policy of IMEC gets up to speed: IP is brought into the spin-off for equity. Also, the incubation costs/investments from are discounted at the time an external capitalisation takes place.

IMEC researchers that were involved in the research project are more prone to join the company, instead of remaining an employee at IMEC. The mean start capital increases significantly during this period. Fillfactory started the trend, followed by Septentrio and Xenics, which have closed different successful capital rounds to date. IMEC stopped bringing in cash into the companies. Between 1999 and 2003, IMEC did not invest cash in its spin-offs at time of founding.[15] However, with the crash of the technology stock markets during the first half of the year 2000, potential IMEC spin-off projects increasingly experienced difficulty to attract capital. As aforementioned, it was in this context that the IMEC Incubation Fund was established and two companies received capital from this fund. Since the mid-1990s, IMEC wanted to focus on technology platform companies that are riskier than other technology companies and that have higher capital needs.

In conclusion, the resource endowments of the SBEFs seem to co-evolve with the way IMEC transfers knowledge or technology. This is particularly reflected in the amount of starting capital and the maturity of the technology. The younger the firm, the higher the capital levels and the less mature the technology seems to be at time of founding.

Since IMEC devotes substantial attention to developing their incubation activities to foster the development of new firms, we also shed some light on how much financial value these firms represent and how much persons they employ (January, 1, 2004).

4.5. Valuation and employment

Although we do not posit a causal relationship between the resources endowed to the firms and their subsequent financial value and employment figures, we look at the figures per “generation” described in the previous section. Looking at these figures is especially interesting for policy makers, as they include setting up science-based firms as evaluation criterium for continuing subsidising technology transfer activities. Implicitly it is expected that these companies contribute to regional development and growth, through attracting (foreign) capital and securing employment (Table 6).

4.5.1. Multiples and internal rate of return

An important indicator to measure the valuation of a company is the “fair market value”: the estimated valuation of a company based on the guidelines of the European Venture Capital Association (EVCA).[16] We used the fair market value to calculate the financial value added over the years for each generation of IMEC ventures. More specifically, we calculated the average multiple for each generation of IMEC starters by dividing the total fair market value today for all companies in the group by the total cumulative capital invested in the companies.[17] Next to the estimated multiple, we also calculated the realised multiple, taking into account the value of the exits (trade sales and bankruptcies) realised during each era. Since multiples do not take into account the different time perspective over which investments are made, we also calculated the internal rate of return per year for each company and averaged it per generation of SBEF.

[15] During this period, IMEC did perform a number of follow up investments to defend its investment and get the young companies through the economic downturn.

[16] See EVCA Yearbook (2003).

[17] This is not necessarily the multiple realised by IMEC: this depends on the capital investment of IMEC and their equity position.

Table 6
Employment and multiples of the three generations science-based entrepreneurial firms at IMEC

	1987–1995 (*N* = 7)	1996–1998 (*N* = 8)	1999–2002 (*N* = 8)
Realised multiple (actual exits)	2.54	0.69	0
Estimated multiple, incl. TS	2.88	1.47	1.9
Estimated IRR (%)	11.10	8.75	42.97
Employment Q3 2003 (No. of FTE)	48	271	126
Total invested capital, Q3 2003, K€	9915.40	81,897.90	29,293.65

Data last updated January, 1, 2004.

In general, the SBEFs from IMEC set up between 1986 and 1995 generate almost three times their investment value. A multiple of 2.88 for the first generation SBEFs reflects an estimated gross return of 11.1% per year on seed and follow up investments.[18] This return seems to be higher than the average return realised with other seed investments (about 5%) (Murray and Mariott, 1998). However, for an early stage venture capitalist this is rather low. With an average gross return of 11%, the venture capitalist will be able to provide about 7% return to his investors, which is a risk neutral investment. Taking into account realised investments, and the five 'first generation' companies exited up till today generated an average multiple of 2.5. For the second and third generation, IMEC starters we mainly rely on the estimated valuation, since only two trade sales took place during this time. The estimated multiple based on the fair market value for the second generation (1996–1998) shows a multiple of 1.5.[19] The estimated internal rate of return is about 8.75%. Especially interesting here is that over a period of 5–8 years hardly a trade sale has been realised whereas venture capitalists have time horizons of 5–10 years. Obviously, the estimated multiple and IRR for the third generation of starters is indicative, since the IRR assumes that all investments are realised in 2003, which is not the case. That is why the latter is misleadingly high. More informative here is the estimated multiple, which is 1.9: somewhat higher than its equivalent for the second generation, but much lower than the expectation of a professional VC.

[18] Before dedcution of the costs incurred to set-up the companies, to incubate them and to participate in different boards of directors.

[19] Acunia closed the books in December 2003. The bankruptcy of Acunia was not taken into account (still valued at fair market value), since the curator is still negotiating for a potential acquisition of the firm.

4.5.2. Exits and employment

From the 23 science-based entrepreneurial firms that were set up, 3 went bankrupt and 5 were acquired. Form the active companies only five are operationally break-even. This seems to scare investors, especially given the current financial–economic conditions. Two companies established after 1999 were successful in closing new capital rounds in 2003, after they showed a plan to the investors to control the burn rate.

The active independent IMEC start-ups and spin-offs employ about 450 full time equivalents. In general, every investment of about €250,000 results in the creation of a full time job. If we assume that about 10% of this investment is done with public money (through the subsidy of the Flemish government to IMEC), then a job is created for every €25,000 public money invested.

5. Summary and conclusion

In this study, we offer an integrative perspective on how the venturing process is organised in a PRO, which is recognised as being a worldwide centre of excellence in the field of microelectronics. We show how the technology transfer policy adopted over time affects the resource endowments going to SBEFs. Spinning out ventures has clearly become an alternative way of commercialising technology in many public research organisations, including IMEC. However, setting up an organisation to implement a coaching model for SBEF is a complex issue, which needs strategic support by the top management and commitment of the board to invest resources in the long term.

In this paper, we have described in detail how IMEC learned to develop a structure in support of setting up new ventures. Both the strands of theory and research on organisational learning are potentially relevant to explain changing resource endowments of the SBEFs from an organisational/institutional perspective. First, the adaptive learning perspective views organisations as goal oriented systems that learn from experience by repeating apparently successful behaviours and discard unsuccessful ones. Second, the knowledge development perspective views organisations as interdependent entities with shared cognition and beliefs. Learning occurs as the latter are institutionalised and communicated. In this perspective, IMEC acts upon and learns from what policy makers communicate as being important (e.g. commercialising IP through setting up ventures).

The strategic choice to stimulate SBEF in general and, over time, spin-offs in particular had major implications. First, IMEC has been confronted with the need to finance these firms. The financing issue is often the first barrier that public research organisations want to remove because it is a visible problem not related to the organisation's core business. IMEC participated in the capital of a venture capital fund. Despite IMEC's presence in the board, the VC only invested in two IMEC spin-offs within 12–18 months after incorporation. IMEC learnt that the seed phase is not interesting for venture capital firms and tried to tackle this by setting up an Incubation Fund dedicated to invest in pre-seed and seed capital. The shareholders of the Incubation Fund were not VCs but a business angel and several financial institutes. However, IMEC found that the fund's expectations were not in line with those of IMEC. In fact, the fund's shareholders had similar expectations as the VCs about the exit potential of business plans and approached the plans in a similar way. Eventually, IMEC decided to finance the pre-seed and even the seed phase itself and only approach VCs in a later phase.

The paper also describes how IMEC changed its IPR management. Initially, IMEC did not transfer IP to the SBEF, but gave a (non)-exclusive license. However, IMEC learnt that in order to improve the value of the SBEF towards financial investors and potential buyers in a trade sale, a more complex IP strategy was needed. The organisation, therefore, developed and recently implemented a specific IP management model to guarantee enough freedom to operate and valuable proprietary technology for the spin-off in order to attract financial investors but without being forced to divest a full research stream within IMEC. The "IP fingerprint model" seems to be a promising solution but has not been applied yet to spin-offs and will have to prove its merit in the years to come.

Next to financial and technology resources, IMEC needed to manage the human resources. The first generation of SBEFs were created by entrepreneurially minded individuals. However, IMEC learnt that there might be many more and even better opportunities to be exploited if the initiative was not fully left to individuals who were persistent enough to start a company. First, some formal aspects of business plan support were developed such as making a financial plan, estimating roughly some market figures and assisting potential SBEFs in negotiating a deal. Gradually, IMEC has built a formal team of coaches within the organisation that are at the disposal of potential SBEFs during their incubation period. IMEC learnt that developing a business plan is not a back office exercise in number crunching but implies testing the different assumptions in the market place. This means that a supporting team is needed that provides the complementary skills to the founders. Finally, IMEC also initiated the recruitment of experienced external managers from its network to improve the potential of the SBEFs. However, this proved to be difficult and only in two cases such a manager could be attracted. Recently, IMEC attracted internal business developers to coach their projects in the incubation phase.

The main question we tackled is whether IMEC's technology transfer activities affect the resource endowments of the SBEFs that are created. This question is not only interesting from a practical point of view it is also inspired by theoretical considerations. In entrepreneurship research, the institutional context from which SBEFs emerge is often implicitly neglected by lumping together firms from diverse institutional parents, without controlling for these differences. Overall, SBEFs from IMEC start at a significantly larger scale than SBEFs from other public research organisations and other independent high tech start-ups. We have shown in the study that the extent to which IMEC has learnt from its past successes and failures has significantly impacted the starting configuration of its SBEFs. The differences are the largest for the financial resources (nearly €2 million for the third generation SBEFs versus €650K for the second generation versus €250K for the first generation SBEFs).

Since IMEC has undertaken many efforts to much better prepare its SBEFs to attract venture capital, it is not surprising that the SBEFs from IMEC start-up with a significantly larger capital base. It indicates the impact of the institutional choices made. However, these insitutional choices might go at the expense of small venture creation. Not all potential SBEF projects have the intrinsic capacity to attract VC money or to convince the investor community. However, some of these companies will have a sound economic basis for start-up.

We also find clear indication that SBEFs are started with a less mature technology than the other high tech start-ups. IMECs institutional changes are also clearly reflected in the maturity of the technology at which the different generations start, the involvement of the inventors in the SBEFs and the number of researchers recruited in the new venture. Whereas the first generation SBEF were started by researcher-entrepreneurs, who envisaged a nearby market opportunity, the third generation SBEFs are clearly the result of a strategic choice to commercialise a part of the technology through spin-offs instead of contract research or licensing. The spin-offs are based on a technology that is far from market ready and are only created if the technology seems to be too marginal as a basis for continuous contract research. Again, it illustrates the selection of a particular business model: the venture capital backed one. This means that value is created through building a technology portfolio, which is of interest to potential buyers. Contract research, which is the main source of revenues for IMEC is not possible, but packaging the technology in a company that creates value through an elaborated patenting strategy and testing some of the assumptions on the market is seen as an alternative.

Overall, we can conclude that the decisions taken at IMEC to change its venturing policies have an effect on the type of companies created. Companies have a business model that is clearly inspired on the venture capital backed model of growing a company and selling it at the right moment. In line with this, one would expect IMEC to create a lower number of companies. However, policy makers expect exactly the opposite. They relate the development and professionalisation of a technology transfer office to more SBEFs, which indicates that differences in starting resources are not taken into account.

Finally, we asked the question whether the expectation of policy makers in terms of financial value and employment are met. We calculated the multiple (and related IRR) realised by the SBEF from IMEC (first generation) and compared it to the multiples found in the venture capital literature. The IRR of 11.8% for the first generation of SBEF is double the IRR of 5.2% (Murray and Mariott, 1998) which was found to be an average for seed investments in high technology sectors. Still, this financial performance is below the expectations venture capitalists had during the mid- and late-1990s when they wanted to invest in high technology. In Belgium, these expectations were between 30 and 35% for seed investments, meaning that only few projects seemed attractive enough for investment (Manigart et al., 2002). The conclusion seems to be that the IMEC approach works and renders more gross profit than an average approach, but the organisational cost to realise this is very high and the average IRR is still much lower than the one that is expected by venture capitalists. Further, we observe that the science-based entrepreneurial ventures from IMEC create a total employment of about 450 full time equivalents. On the other hand, however, the total employment of a much less time consuming initiative such as the TOP programme at the university of Twente (The Netherlands) to stimulate science-based entrepreneurial firms was about 1200 people in 2001 (Van der Sijde et al., 2002). Total employment created by small start-ups might be higher than employment created by a few large spin-off companies.

6. Policy implications

Stimulating academic entrepreneurship has been high on the political agenda since the mid-1990s (e.g. OECD, 2003). In its shareholder agreement with the Flemish government, IMEC needs to set up one SBEF per year. Introducing such key performance indicators to encourage public research institutes and universities to take part in the entrepreneurial process has become increasingly popular among policy makers all over Europe. However, given the complexity of setting up such an entrepreneurial process, it seems questionable whether most PROs have the necessary resources and top management commitment to do so. Moreover, from a public policy perspective it remains even uncertain whether targeting one venture per year is a good idea. There are other models for stimulating academic entrepreneurship that seem to create much more employment and socio-economic return at a significant lower cost (see Clarysse et al., 2005). One of the key parameters that has to be taken into account is the diversity of start-up configurations and business models. Is the goal creating many small companies or a few large ones? And, from a regional development point of view: can the growth path of the large one(s) make up for the absence of the small ones that do not pass the tight selection criteria.

It is generally acknowledged that social networks play a significant role in the emergence of new firms (Aldrich, 2000, p. 81). IMEC senior management has built up an extensive network of contacts with people in the financial and business community. In this respect they can potentially act as brokers, facilitating the link with the founders-entrepreneurs of the science-based entrepreneurial firms. However, at the organisational level, the study shows that being a centre of excellence in a certain technological domain does not mean the rules of the financial community can be changed. We observe that IMEC had little or no impact on the decisions made by the VC in which the organisation participated as a shareholder.

Since VCs imitate each other's selection criteria, this usually means they will not invest in pre-seed deals. In fact, the IMEC case shows that the incubation period, the period in which the project is made investor ready in terms of IP, team and business model has to be financed by the research organisation itself. Very similar to the innovation funnel in a large company, most projects will die before they reach the VC community and not all projects presented to this community will be able to attract VC money.

This observation has major political consequences. In most European countries, policy makers choose to increase spin-off activity at universities and public research institutes by setting up "friendly VC funds" in which the government or university/research institute participates. These funds are very similar to the VC fund in which IMEC participated or, alternatively to the incubation fund that it has set up. In both cases the result was not as expected. In the first case, the fund itself was succesful but it hardly invested in any SBEF from IMEC. In the second case, investments were made but the expectations could not be met. After a couple of "friendly" investments, the incubation fund started to behave as a 'mini'-VC. Clearly, the key performance indicators of both funds were inspired by the VC community model requiring them to be selective. Projects in early phases (such as many SBEFs from research organisations) do not have a clear business model yet. Hence, it is extremely difficult to predict whether they will be able to generate the growth and visibility needed for a VC to invest. If a policy maker decides that public research organisations have to spin-off a fixed number of companies per year, it has also to make sure that either the research organisation can support this itself financially or it has to provide public money which will be a sunk cost in the first stages of the project.

If policy makers expect public research organisations and universities to stimulate start-ups, a simplistic view on these companies should be avoided. Spontaneous start-ups originate in the organisation's core business. But most PROs have no strong middle management with high potential business skills. Usually, they have a strong top management of professors or top managers (in research institutes), many bright researchers at junior level and a few as project leader at senior level. These are embedded in a culture where intellectual capacity is appreciated among peers, much more than business intelligence. A lack of entrepreneurial activity within the core of the organisation leads to a development of central support systems in the form of coaching, recruitment of external management and, inevitably, external capital sources. However, the chances to start-up a viable VC backed company are low and probably smaller opportunities will be overlooked. Thus, if the government wants to stimulate the recognition of business opportunities in public research organisations, there is a need for a well-balanced view of what entrepreneurship entails and it needs to be integrated in the organisation culture. More specifically, employees need to be recruited with a strong entrepreneurial orientation and commercial interests. Not surprisingly, this assumes a rather radical change in culture and structure.

In sum, our paper points to four major policy observations. First, if policy makers are interested in stimulating entrepreneurial ventures as a way to commercialise technology or stimulate regional development, a better understanding is needed about how different types and business models serve these objectives. Second, public research organisations that view these companies as an alternative to contract research or licensing learn how to optimize the process to create these companies. This process might be successful if several conditions are fulfilled such as a minimum critical mass of broad, innovative technologies, a deep pocket to protect and incubate these technologies and a sufficient amount of experience in both the VC and downstream buyer market. In contrast to IMEC, most universities fall short on one or more criteria. Thirdly, if the entrepreneurial route is chosen of spontaneous start-up acitivity, the model is highly dependent upon the entrepreneurial attitude of an organisation's middle management. Both the attitude and the middle management is often lacking in public research organisations. Seed capital and public support for a technology transfer office will not change this. Only a drastic change in structure and culture might help in the long run. Fourth, there seems to be an inverse relation between professionalising and centralising technology transfer activities and stimulating entrepreneurship. By increasing the top down control on the venture process, paradoxically most entrepreneurial individuals will be discouraged to continue their efforts to start a business.

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