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Valorisation of knowledge: preliminary results on valorisation paths and obstacles in bringing university knowledge to market

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Abstract

The current paper is concerned with exploring the outcomes of valorisation of technology focused research projects in the Netherlands. Drawing on an evaluation of 240 projects at universities in three cities and on in-depth knowledge of almost 50 projects, the paper explores to what extent technology inventions are brought to market and which factors hamper such development. An evaluation after 10 years indicates that a quarter of the projects could be brought to market and that in almost 30% of the projects research is still continuing. Looking back to factors hampering knowledge valorisation, it appears that shortage in the organizational situation at the university at that time is the most important factor. Problems in interaction with the business world are in second place The most important regional factor appears a shortage of financial incentives including easy access to (regional) venture capital. The implications of the results for policymaking and further research are discussed.

1. Setting the scene

Universities have a longstanding tradition as a knowledge creator, but not as a wealth creator. However, nowadays as wealth creators universities are often involved in contract-research commissioned by the business sector, in collaborative research projects (consortia) with business partners, and in the creation of spin-off firms aiming to use new knowledge owned by the university in a commercial setting. The rather new phenomenon of wealth creation started to grow in Europe in the early 1980s (Charles & Howells, 1992) and has now fully entered the research policy of modern universities as the 'third mission' often denoted as 'knowledge valorisation'. Consequently, university policy is nowadays full of tasks concerning invention disclosures, venturing, collaboration, patenting and licensing, etc. (Shane, 2004).

Knowledge valorisation is a process in which value is added to new knowledge in order to transform it into a new (improved) product, process or service in the market (PriceWaterhouseCooper, 2007). Conceived in this way, knowledge valorisation is a broader concept than innovation because the latter only refers to a successful introduction into the market. By contrast, knowledge valorisation also includes the often long lasting chain of processes that starts with first thoughts about market introduction and about the research/development steps needed to reach this goal. In this respect, knowledge valorisation refers to specific research projects and clearly defined products and/or processes. There is also a broader conceptualization of knowledge valorisation, namely as a complex and interactive process in which knowledge is made ready and available, and in which interaction between knowledge institutes and firms is crucial in all stages (Valorisation agenda, 2008). In this sense, valorisation is seen on a somewhat higher level of aggregation than individual projects.

Despite its current popularity in university policy and local/regional economic policy, much is still unknown about knowledge valorisation, e.g. to what extent knowledge is actually brought to market, how long this process takes, and which factors exert a hampering or stimulating influence on the speed of the process. It seems that the lack of insight and understanding is mainly caused by the comprehensiveness of the phenomenon of knowledge, and consequently of its valorisation. The many forms knowledge may take make it difficult to picture the flows of knowledge. Knowledge may be tacit, it may be codified in journals, patent descriptions, etc., it may be embodied in instruments, machinery and advanced equipment, and it may be embodied in academics and graduates starting a business. At the same time, knowledge valorisation may take many modes, like licensing of a patent to a firm, university-business collaboration to elaborate an invention to bring it to market, graduates working in research departments in the business sector, and spin-off firms engaged in developing an invention towards a marketable product or service.

Innovation studies in general tell us that market introduction depends on the nature of the invention (radical/incremental) including its cost level, the market (regulation, subsidies, market demand), as well as the strategies of the firms that are involved (Utterback, 1996; Christenson, 2003; Tidd et al., 2009). In terms of radical/incremental character, it seems that radical inventions requiring structural changes in infrastructures or even transitions (like the fuelling infrastructure in the case of electric cars and road equipment in the case of automated guided vehicles) face more obstructions than inventions that are incremental and fit into existing structures (Geels, 2004). Of course, the cost level plays a rule and the trade-off between newness/additional benefits of the invention and additional costs compared with existing products or processes. In addition, the way to market introduction may be full of obstacles in the case of heavy regulation, like in designing new drugs due to intensive testing and approval procedures. Conversely, inventions without such regulation and at the same time a strong subsidization by public money, may face an acceleration of their way to market. Such inventions may be dealing with cleaning the environment (like treatment of solid waste, polluted air and water). Of course, in connection with the previous factors, the strategies of the involved firms play an important role in bringing inventions to market. For example, firms may follow the path of first movers or follower (Lieberman and Montgomery, 1998). In addition, shifts in strategy may have an impact on attention for an invention. Firms may, for example, loose initial attention if they gain easy access to a competing innovation, following the strategy of merging or acquisition. Similarly, spin-off firms may become less focused on an invention if they move attention to consultancy, e.g. as a strategy of internal investment or merely of survival.

Also, spatial innovation studies have developed ideas on factors that hamper or stimulate market introduction of inventions. Among these are studies emphasizing agglomeration economies of large cities (Feldman, 1999; Capello, 2008), particularly knowledge spillovers, pools of specialized workers and other creative people (e.g. Florida 2002), and access to global traffic nodes (and global knowledge interaction); studies emphasizing a common regional culture, trust and social networks facilitating knowledge exchange (Keeble et al., 1999; Malmberg and Maskell, 1999), as well as more practical studies emphasizing the role of specific support infrastructure, including the supply of incubators, business accelerators and support packages for spin-off firms (Hannon and Chaplin, 2003; Hackett and Dilts, 2004; Soetanto and van Geenhuizen, 2007), and the establishment of science parks (van Geenhuizen and Soetanto, 2008).

So far, studies have analysed patents and patent citations (e.g. Jaffe et al., 2002) as well as spin-off firms (Pirnay and Surlemont, 2003; Lockett et al., 2003; Soetanto, 2009) as modes of knowledge valorisation, but other modes of valorisation that most probably are more significant (or at least more comprehensive) (d'Este and Patel, 2007) have remained outside the focus of analysis. The current paper deals with such a mode of knowledge valorisation, namely dedicated research projects at universities that are financed by public money to bring knowledge to market with involvement of potential users of the knowledge. The questions are as follows:

1. To what extent are research projects aimed at valorisation successful in bringing knowledge to market (or use in society)?
2. Which factors hamper a quick valorisation? To what extent are these factors related to the invention, the organizational context at universities, and to what extent are these related to regional conditions?
3. What could be new roles for local or regional authorities to enhance knowledge valorisation and to benefit more from it?

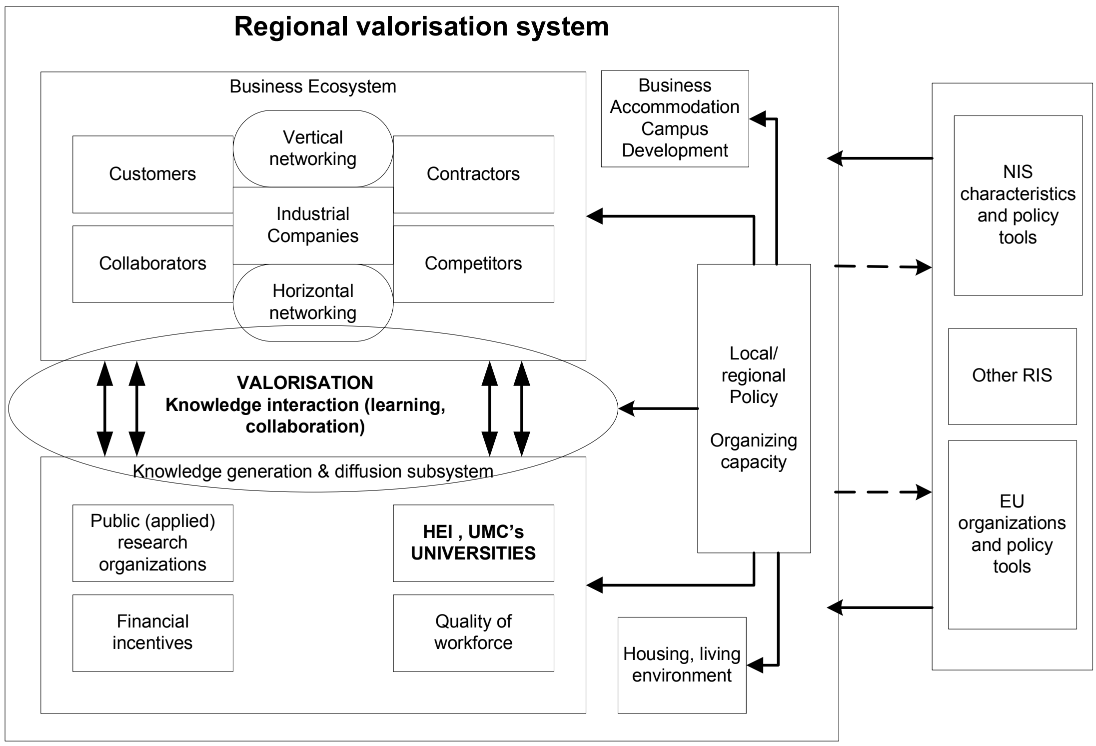
The paper has the following structure. Section 2 presents a conceptual model of knowledge valorization in a regional setting. This is followed by a discussion of the methodological characteristics of the study (section 3) and of the results in terms of market introduction and failure of research projects (section 4) and factors underlying failure (section 5). The type of factors identified forms the basis for a brief exploration of new roles of local/regional policy to enhance conditions for valorization and to improve benefits for the city/region (section 6). The paper closes with a reflection on the implications of the results, among others for policymaking and for further research. The study draws on data of 240 technology-focused research projects financed by Technology Foundation STW in the Netherlands, covering the cities of Amsterdam, Delft and Eindhoven, and on in-depth data from a selected sample of almost 50 of these research projects.

2. Regional valorisation system

A main condition for knowledge valorisation is *interaction* between university and the business sector (Figure 1). The term interaction is used in this context, not transfer, because increasingly university research is triggered by questions from the business sector, making the development process of an invention increasingly a two-way process instead of a one-directional linear process. In the interaction between researchers and firms, learning in bringing an invention to market may follow different models dependent on the types of technology involved. A distinction can be made between science-based learning including laws of nature (know-why), like in life sciences and nanotechnology, and problem-based learning with new applications (combinations) of existing knowledge (know how), like in medical instruments and automotive (Asheim et al., 2007).

From a regional perspective, Figure 1 pictures the ecosystem of firms in the region, including customers, contractors, competitors, and collaborators. If well-developed, this ecosystem provides supportive services, potentials for subcontracting, knowledge collaboration and collective learning, aside from access to knowledge sources in the country and abroad. These kinds of benefits have been indicated as cluster advantages in the literature (Porter, 1996; Bathelt et al., 2004). The size of this business ecosystem and the large players herein seems important, not only for developing economies of scale and scope but also for having a critical mass above which growth starts to develop as a self-propelling mechanism, and quite differently, also for reasons of image towards the outside world and attractiveness as a place of location. The figure also indicates importance of organisations of applied research (TNO in the Netherlands), of financial incentives and of the regional labour market. The latter not only refers to specialised academic knowledge workers but also skilled practical workers, like technicians and laboratory analysts. In an indirect way, the quality of living (housing) in the region is important. This holds for attracting and keeping knowledge workers in the region, in particular international top scientists from abroad. Partially this is a matter of improving the housing stock and spatial planning. Local spatial planning is also involved in supply of the business accommodation, land on industrial parks and development (restructuring) of university campuses and large firms' campuses.

What has increasingly attracted attention as an overall factor is what is named 'the organising capacity' of the municipality and regional authority (van den Berg et al., 2003). This quality characteristic of governing refers to the capacity of local/regional political actors to gain consensus and a sense of urgency on the direction of knowledge-based development in the city/region in the near future, and to gain sufficient commitment for policies that support this. More specific it refers to the capacity to connect university, public policy actors and the business sector, to gain benefits from their collaboration and activities in each other realms (Triple Helix) (e.g. Etzkowitz, 2008). The national innovation system needs also to be mentioned, as it influences for example how science and technology policy, particular public R&D spending, is organized, and how entrepreneurship and knowledge valorisation are valued in society (e.g. Edquist, 1997). Knowledge valorisation is also influenced by regulation of R&D and market access (testing rules, quality control, ISO standards, etc.) but this nowadays also partly originates from European Union regulation (Rathenau Instituut, 2009).



UMC's : university medical centres.

Figure 1 A simplified model of a regional valorisation system

3. Methodological aspects

The analysis of valorisation involves two steps. First, there is a broad scan of the outcome of 240 research projects financed by Technology Foundation STW (STW, various years) in terms of market introduction, continuation and failure, and secondly, there is an in-depth study of almost 50 projects representing market introduction and failure (or continuation with delay).

Technology Foundation STW (note 1) in its annual Utilization Reports provides for each project a short description and an evaluation of results at 5 or (if appropriate) 10 years after the start. This information, in some cases together with web-based information, enables to identify different outcomes of the projects. The label 'introduced to market' in the current paper indicates that the projects have led to a product, process or method that was brought to market through firms or to use in society, like in health care and environmental fields. This is a quite strict definition, adopted on purpose in order to identify the unambiguous 'success stories'. However, it does not mean that projects *not* labeled 'introduced to market' have been useless. On the contrary, they often have led to contracts with users, patent applications, have gained investment money and have led to a clear-cut product, process or method. The knowledge may still be used in other ways like sideways of the project and embodied in PhD graduates working in firms, but the projects have simply not reached the stage of market introduction or application in society. In line with this, failure is defined as 'not having reached this stage'. In a few cases this happens quite early with ceasing the project before the official end date or directly after the end, if no continuation can be foreseen, but in most cases it takes a longer time. Aside from these two results, there is a category of 'stagnation or development unknown' (only older projects) and a category 'continuation' of research.

In view of the long-lasting nature of knowledge valorisation, two different periods of project starts are selected in the current study, i.e. the years 1995 to 1997 and the years 2000 to 2002. A reason for taking two periods is the change in economic climate in the early 2000s which makes aggregating all years dangerous. It is plausible that in the early 2000s firms have been reluctant in engaging themselves with valorization. In addition, there is a different awareness of valorisation and requirements for success in the two periods: relatively low at the end of the 1990s but it has increased since then. Further, 2002 is selected as the most recent year of project starts because this is the year of the most up-to-date evaluation information available when the current study took off. (2008).

For the first period, STW provides evaluation information after 10 years, for the last period it provides evaluation information after 5 years. In addition, the number of projects in each period covers a sufficient amount for the three cities in this research as a first scan: Amsterdam, Delft and Eindhoven, i.e. a minimum of about 30 projects. This selection of cities means that both technical universities (Delft and Eindhoven) and general universities (University of Amsterdam and Free University) are included in the study.

The first step of the study is followed by an in-depth analysis of hampering factors in valorization processes, based on a selected sample of 48 projects representing market introduction and failure (delay), and covering the two periods and the two technical universities (Delft and Eindhoven) and two general universities (Amsterdam). To avoid manifold influences of different technologies and markets involved in valorization, the in-depth analysis covers a limited number of selected technology segments, i.e. biotechnology (medical and industrial), medical instruments (hardware/software), new materials (nanotechnology) and systems for sustainable energy, and automotive. The respondents in the in-depth interviews are the project leaders of the research. The in-depth interview is semi-structured with a mix of fixed and open answers. The subjects addressed are the timeline of the valorization, including major events, like application of a patent and start of collaboration with a firm, personal evaluation of the valorization so far, and major factors causing failure or delay. The current paper has a focus on the last part.

4. Valorisation results

This section deals with the outcomes of research projects started in the two periods. Overall, failure is faced by a minority of the projects, around 30%, but it tends to be somewhat stronger among the younger projects (34% versus 27%) (Table 1 and Table 2). On the other side, market introduction is also faced by a minority of the projects, i.e. 24% among the older projects and 12% (or 19%, if taken somewhat broader) among the younger ones. Aside from the downturn in the economy, the latter meagre results may also be caused by the short time-period of evaluation. Knowledge valorisation in technology areas takes more than five years before application can be reached, as evidenced by a high share of continued research (54%) for younger projects.

With regard to the different universities, TU Eindhoven is facing a relatively low failure rate for older projects, but also a relatively high share of stagnation or unknown development. It seems that Philips (with main research facilities in Eindhoven) and TNO (applied research facilities here) are major users in many projects. It is plausible that after some clear-cut development results, researchers (PhD) move from the university to these organisations for a job to elaborate the work, meaning that no next steps are visible in the context of the research projects and the share of introduction to market is relatively low (7%). However, the knowledge is certainly not lost in this situation. Among the younger projects, TU Eindhoven is facing a relatively high share of introduction to market, particularly if defined slightly broader, i.e. 16% and 25% respectively.

By contrast, TU Delft is facing a high share of introduction to market (33%) for older projects. This situation mainly rests on societal applications, and these fall back to a relatively low share among younger projects, i.e. 8% and (broader defined) 15%. The two general universities in Amsterdam are facing a somewhat high failure rate in both periods (34 and 43%) but perform on the average concerning introduction to market. It is plausible that researchers at these universities take more risks in adopting higher levels of newness in selected projects, a situation that would match with ideas in urban innovation theory. However, the two universities, in particular the bèta-complex, may also be less strongly oriented towards practical application compared with technical universities.

In conclusion, almost a quarter of the older projects (24%) could be brought to market according to the evaluation after 10 years and a slightly larger segment (28%) is facing a continuation of the research. This development suggests that valorisation of technical knowledge through dedicated projects is a long-lasting and vulnerable process, stumbled by many blocks. However, there is also some differentiation between the universities involved. TU Delft tends to be relatively successful in older projects; whereas TU Eindhoven tends to be relatively successful in younger projects.

Table 1 A scan of outcomes of projects taken off in 1995-1997 a)

	Amsterdam b)		**Delft**		**Eindhoven**		**Totals**	
Outcome	Abs.	%	Abs.	%	Abs.	%	Abs.	%
Failure after 5 or 10 years	13	34%	21	29%	4	15%	38	27%
Stagnation or development unknown after 10 years	7	18%	10	14%	12	43%	29	21%
Continuation after 10 years	11	28%	18	25%	10	36%	39	28%
Introduction to market/societal use	8	21%	24	33%	2	7%	34	24%
Totals	39	100%	73	100%	28	100%	140	100%

a) a few projects dealing with equipment are excluded.
b) University of Amsterdam and Free University aggregated.

Source: calculation by the author based on information from STW and website information.

Table 2 A scan of outcomes of projects taken off in 2000 - 2002

	Amsterdam a)		**Delft**		**Eindhoven**		**Totals**	
Outcome	Abs.	%	Abs.	%	Abs.	%	Abs.	%
Failure after 5 years	13	43%	12	30%	10	31%	35	34%
Continuation	13	43%	25	63%	17	53%	55	54%
Introduction to market/societal use *(according to a broader definition) b)*	4 *5*	13% *17%*	3 *6*	8% *15%*	5 *8*	16% *25%*	12 *19*	12% *19%*
Totals	30	100	40	100	32	100	1	

a) University of Amsterdam and Free University aggregated.
b) Including introduction to firms for last test/checks.
Source: calculation by the author based on information from STW and website information.

5. Obstacles in valorisation

The results in this section are derived from in-depth interviews with researchers involved in valorisation, both in introduction to market and failure. Again a distinction is made between older projects and younger projects (Table 3). The results for older projects are as follows:

- Broadly speaking, almost 60% of all factors affect the 'inner oval' of the projects directly (Figure 1), including the profile of the invention, the organizational context (university) and interaction with firms. By contrast, regional factors amount to 30% and national factors to around 10%.

- Shortages in the organisational situation at the university is the single most important hampering factor (31% of all factors). This concerns not only a lack of affinity of some researchers with valorisation, but also reorganisation of faculties leading to closing down or regrouping of specialized research groups, dealing with valorisation.

- Next is failure in interaction with firms (17%). This is concerned with a decreasing interest from firms over time, due to upcoming risks in market demand and high costs of taking the new product/process into production, aside from emerging competing technologies (solutions). Organisational change plays also a role, like bankruptcy of firms and merger and acquisition coming with new strategies. These developments tend to happen relatively often in medical life sciences and medical technology (instruments).

- A factor that also needs to be mentioned is the profile of the invention (10%). Inventions that have no outlook on mass production, seem too expensive for the extra's they bring (no breakthrough), or bear strong technology risks in next steps of the research suffer from lack of interest from firms and investors from the beginning.

- Among regional factors, it is a lack of particular financial incentives that hampers valorisation most (12% of all factors). This deals with both subsidies to attract firms from outside the region (abroad) and keeping spin-offs from the local university in the region (holds mainly for the region of Delft) and it deals with easy access to regional venture capital for spin-off firms provided by consortia of regional actors, like banks, universities, research institutes, and the province. The need for larger amounts of such venture capital is also a key issue (holds for all regions).

- Second are shortages in the labour market and business accommodation (7% each). Labour market shortages (specialists) occur in the regions of Delft and Maastricht, and deal with inventions that do not match with the current industrial structure of the region. Shortage in business accommodation holds for Delft and Amsterdam; the latter (shortage in room in incubators) is particularly true for spin-offs from Amsterdam Medical Centre.

Table 3 Factors hampering valorisation a)

Type of factors	**Projects 1995-97**		**Projects 2000-02**	
	Abs.	**%**	**Abs.**	**%**
Profile of invention	6	10%	0	
Organizational context (university)	18	31%	8	24%
Interaction with business world	10	17%	5	15%
Business ecosystem	2	3%	3	9%
Financial incentives	7	12%	4	12%
Labour market	4	7%	2	6%
Business accommodation	4	7%	3	9%
Remaining region	1	2%	2	6%
Regulation (e.g. prohibition of certain tests)	3	5%	1	3%
Culture/attitude (entrepreneurship, valorisation)	3	5%	4	12%
Remaining national system	1	2%	2	6%
Totals (number of factors)	59	100%	34	100%

a) Number of projects: 33 and 13 respectively.
Source: in-depth interviews by the author.

Comparing with the younger projects the following differences can be observed:

- Factors directly affecting the 'inner oval' have lost some importance (fallen back to almost 40%), particularly due to absence of inventions facing an unfavourable profile and less frequent problems in the organisational context at the university. It is plausible that these changes rest on an increased learning experience and awareness among researchers and university managers. At the same time, based on new awareness, new factors are forwarded, like lack of fertile ground for valorisation at academic hospitals (short-sighted planning, fragmentation of research), low urgency of valorisation at the university and lack of professional approach to valorisation at technology transfer offices (holds for all regions).

- With regard to regional factors, lack of financial incentives has remained as important as for older projects, but shortage in the business ecosystem has now increased in importance (9%). Also this phenomenon seems to relate to a new awareness, particularly the idea that the regional economy (and university) should exceed a certain size limit before growth starts to propel itself and the region becomes attractive for large firms from abroad (Eindhoven and Maastricht). In a similar vein, a lack of entrepreneurial spirit and drive for valorisation (12%) is now forwarded as a hampering factor in the broader context of the Dutch culture and value system.

The attention now briefly shifts to hampering factors affecting *spin-off firms* as a particular mode of valorisation. The in-depth study indicates that on average older projects produce almost one spin-off per project (0.9) whereas younger projects so far produce one spin-off out of three projects (0.3). However, averages are somewhat misleading in this context, due to a considerable differentiation between the projects. Thus, projects concerning a new process with multiple applications tend to yield larger numbers of spin-off firms compared to single product projects.

Problematic situations can be identified specifically for spin-off firms not cooperating with larger firms. The results of a study of 60 spin-off firms from TU Delft (van Geenhuizen and Soetanto, 2009) supplemented with insights from the in-depth interviews (medical life sciences and new materials) point clearly to two major bottlenecks in bringing university inventions to market by technology spin-offs:

- A shortage in knowledge and capabilities among researchers/entrepreneurs in marketing, concerning: 1) finding access (channels) to market, 2) negotiation with potential customers, and 3) assessment of market value of the invention.

- A shortage of financial capital in somewhat later stages, i.e. in which prototypes need to be tested and larger numbers of new products need to be manufactured for next steps of testing.

6. Local/regional authorities: new roles

There are no direct answers to the above set of hampering factors. Of course, universities themselves have an important task in improving the organizational situation inside the 'oval' (Figure 1). This mainly deals with increasing the affinity of researchers with valorisation, or compensating a shortage of affinity by appointment of additional (part-time) staff members with stong relations in the business world. In some universities (mainly technical) this is already common practice, at others not. One of the main solutions is that the *award structure* is changed: valorisation needs to be awarded in a manner similar to scientific publications; but this is a matter of the Ministry of Education, Culture and Science. Another point is that valorisation needs to focus on those areas that are in the centre of university research programs in flourishing research groups, not in small groups vulnerable to impacts from reorganisation.

This section deals with what municipalities/regional authorities could do to enhance valorisation and at the same time increase the benefits of valorisation for the city/region. The focus will be on relatively new roles, in addition to the more traditional roles in spatial planning, like providing room in incubators and business parks (science parks) and campus reconstruction. Two rather uncommon but necessary roles will be briefly examined, i.e. acting as a 'connector' and acting as an 'initiator'. Acting according to these roles is clearly related to what has been addressed in the conceptual part of the paper, i.e. the organising capacity of local/regional authorities and Triple Helix building.

The valorisation 'oval' (Figure 1) is concerned with management of research in valorisation (eventually in spin-off firms) and with management of relationships with the business sector. Local/regional authorities have no role to play in this management. However, there is also the design of *strategies* for short/medium term research and valorisation programs, particularly focusing on promising themes. Local/regional authorities have no direct influence here but may – in a cooperative effort – connect their interests with university interests in selecting relevant themes in a broader context of cluster formation and business development. The municipality/regional authority could act as a *connector* here. This role also involves bringing together other main players in selected valorisation processes in the region in order to enhance a stronger collaboration. A few municipalities/regional authorities are already quite experienced and successful in this role (like the region of Eindhoven); for most municipalities/regional authorities however, it is new and often a highly complicated task due to the involvement of more than one large city, a number of (different) universities and higher educational institutes, and a variety of regional valorisation themes.

The advantage of a better connection and alignment between municipality, university and regional businesses is a more efficient use of local/regional knowledge, including an improved chance to participate in national and EU regional funding of research. However, a warning is in place here. A too strong focus on the local/regional in collaborative learning policy contradicts the growing experience indicating that spatial proximity is just a facilitating condition for learning, not a necessary one (Boschma, 2005; Torré and Rallet, 2005). Thus, a local/regional policy in valorisation needs to balance the 'local/regional' with the 'national/global'.

Municipalities/regional authorities could also act more actively as an *initiator* of new financial incentives, particularly in responding to the need for easy access to venture capital in later stages of technology-based spin-offs. Note that experience is currently gained in the metropolitan area of Amsterdam with a consortium active in providing investment capital in the life sciences (the Life Science Fund Amsterdam). The actors involved are the large financial banks, the two universities and academic hospitals, related research institutes and the local and regional authority (Province). The benefits for the university will be that valorisation already quite far on the road to commercialisation gets an extra impulse with positive feed-back to research, and the benefits for the city/region will be that value-added and employment growth can take place in the metropolitan region, avoiding that the knowledge is sold abroad and benefits leave the region.

7. Conclusions, implications and future research

This paper has explored the outcomes of valorisation of technology projects at universities in the Netherlands. Drawing on an evaluation of 240 projects in three cities and on in-depth knowledge of almost 50 projects, the paper explored to what extent technology inventions are brought to market and which factors hamper such development. Projects were examined in two periods. It appeared that a quarter of the older projects could be brought to market within 10 years and a somewhat larger segment of the projects was facing a continuation of research. This situation suggests that valorisation of technical knowledge through dedicated projects is a long-lasting and vulnerable process, stumbled with many blocks. The share of younger projects brought to market is understandably smaller than among older projects, due to a shorter time available for valorisation. However, there is some differentiation between the universities involved, with the best results for TU Eindhoven. Note that with regard to projects in which market introduction could not be reached, valorisation efforts nevertheless have often led to clear-cut new products, processes or methods, patent applications and contracts with business actors.

With regard to hampering factors, the study revealed a dominance of problems in the organizational context of the universities involved, dealing with a lack of affinity of some researchers with valorisation, reorganisation of research sections and faculties, and in particular for younger projects, lack of urgency of valorisation and a lack of a professional approach to valorisation. Problems in interaction with the business world are in second place, mainly dealing with strategic shifts of firms and a reconsideration of risks taken with the invention. The most important regional factor appears to be a shortage of financial incentives including easy access to (regional) venture capital. The last factor holds in particular for technology-based spin-off firms, potentially affecting their chance of survival. A second danger for these firms is a shortage of market-related knowledge and capabilities.

The work in this paper on exploring the path to market introduction and related problems contains various limitations due to the use of information from one particular source of financing technology research. It could be that other programs in the Netherlands in which the business sector is stronger involved or involved in other ways, may produce a somewhat different picture. However, the in-depth interviews in the current study were structured in such a way that a broader picture could be reached than merely in relation to the particular financing source. This suggests that the most important obstacles to valorisation and particularly to spin-off firms have larger implications. However, this research had to narrow with regard to technologies and applications; i.e. medical and industrial life sciences and medical technology, material sciences (nanotechnology) and systems for renewable energy, and automotive. This means that fields like micro-electronics and information and communication technology, including multimedia and software design, have remained beyond the study. In addition, the study covered the Netherlands. However, given some similarities in the national value system and perceptions on entrepreneurship and risk-taking, the results may have implications for a larger area than only the Netherlands, like for Norway and Sweden, and partially also for Switzerland and Austria (GEM, 2007).

With regard to policy implications concerning the organisational context at universities, it can be safely stated that many conditions are currently being improved, because valorisation is facing a strong and more explicit attention at universities nowadays. For local/regional authorities, dealing with spatial conditions is not new, many are involved in incubation centres, science parks and campus development. What is new is the role of 'connector' of major actors in valorisation in the region and outside and of 'initiator' of supportive financial measures. The study so far has been descriptive and based upon a rather small number of in-depth studies of research projects. Next step of the research will include the elaboration of a causal model of knowledge valorisation and extension of the number of research projects, allowing for statistical testing of this model.

Notes

1. STW has been funding scientific research at Dutch universities and institutes since 1981. Its methods in organization of research bring together, immediately after start of the research projects, researchers and potential users of the results of these projects. The 'users' provide input and also financial or other contributions to the project. The consultations during the projects ensure that the research groups and users get as much as possible out of these contacts.

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