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Is the commercialisation of academic R&D really weak? - a critical assessment of a ‘dominant belief’ and associated policy responses*

Paper to be presented to The 2010 ERSA (The European Regional Science Association) Congress, Jönköping, August 19-23.

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1. Introduction

In the EU (1993) White Paper, it was argued that Europe's research and industrial base suffered from a comparatively limited capacity to convert scientific breakthroughs and technological achievements into commercial successes. The perception of a strong European science base which is not translated into economic growth was labelled the "European Paradox" in the EU Green Paper on Innovation (1995).¹ The Commission (1995, p.5) argued that

"European firms and governments must therefore redeploy their efforts, improve their capability to translate [research] into commercial successes".

Over time, the focus shifted to the commercialisation of *publicly* financed R&D.² Even though reports (e.g. EU, 2003) pointed to some positive trends in, for example, efforts to encourage the creation of university spin-offs, there is a strong belief that the EU is under-performing in the commercialisation of publicly funded science. Hence, the European Commission (2007, p.7) argued that:

"One important problem is how to make better use of publicly funded R&D. Compared to North America, the average university in Europe, generates far fewer inventions and patents."

The policy response to this problem is to strengthen the management of knowledge and intellectual property by European Universities (European Commission, 2007, p.7):

"This is largely due to a less systematic and professional management of knowledge and intellectual property by European universities."

However, in a critical paper, Dosi et al. (2006, p.1450) suggested that the European Paradox³ "...mostly appears just in the flourishing business of reporting to and by the European Commission itself rather than in the data." A thorough analysis of R&D, bibliometric, patent and industrial market share data led to the observation that (Dosi et al., 2006, p. 1461). "...the European picture shows worrying signs of weakness with respect to the generation of both scientific knowledge and technological innovation. However, no overall "European Paradox" with a leading science but weak "downstream" links can be observed" Dosi et al. (2006, p. 1460) further argued that ... "the presumed feeble links

¹ The idea was first developed in the preparatory work for the 1st edition of the European Report on S&T indicators (1994),

² Audretsch and Lehmann (2005) argued that a reason for this might be that while policy makers have no direct influence on large corporations, they can, more or less, influence universities as a promoter for entrepreneurship.

³ According to Dosi et al (2006) the European Paradox is quite similar to an earlier 'UK paradox' fashionable around thirty years ago.

between science and industry should be one of the most important aspects of the paradox conjecture. *Surprisingly, the evidence here is simply non-existing* (our italics)'. Hence, serious doubts were cast on the empirical foundation of an alleged paradox.

Scrutinising the interaction between universities and industry at the European, as opposed to the national level is, however, fraught with empirical difficulties as little cross-country comparative data exists. The phenomena in question are complex and may require detailed analyses of specific countries (EU 2003) using "local" knowledge and a multitude of national sources.

The Swedish case is, arguably, of particular value for a detailed analysis. For about two decades, a high R&D expenditure⁴ has been the starting point for a number of analysts claiming that there is a paradoxical relationship between R&D input and output in the form of e.g. new firm formation, share of "high tech" in manufacturing output/export and growth (e.g. Edquist and McKelvey, 1998; Braunerhjelm, 1998; Henrekson and Goldfarb, 2001; Henrekson and Rosenberg, 2001 and Andersson et al., 2002).⁵

This paradox initially focussed on the relation between high aggregate R&D intensity and a perceived weakness in the "high tech" industry. It was not until after the "European Paradox" was coined in 1995, that the Swedish policy debate began to focus on the narrower "academic paradox", i.e. how a perceived voluminous academic R&D is believed to be insufficiently commercialised in the form of new firms, patents, licenses and products.⁶

The purpose of this paper is to critically a) assess the validity of the belief in a poor commercialisation of academic R&D and b) discuss the currently proposed solutions, inspired by US Science Policy, to handle that alleged problem by focusing on the ownership of IPR. In addressing the first purpose, we limit ourselves empirically to the case of Sweden. This is done in sections 2 and 3. In section 2, we briefly outline the emergence of the belief. Section 3 contains a scrutiny of the empirical foundation of the literature that upholds that belief as well as empirical indications that cast serious doubt on it. The critical analysis of the usefulness of copying US science policy solutions in Europe is undertaken in section 4. Here we return to the EU level and draw upon literature in both the US and Europe. Section 5 contains our main conclusions.

⁴ With R&D investments of almost 4 percent of GDP, Sweden is one of the leading European countries in terms of research spending. It is also one of few countries that have managed to meet the Barcelona targets. In 2006 members of the European Union spent on average 2 per cent of GDP on research investments.

⁵ The concept of a 'Swedish Paradox' was coined as early as 1991 (Edquist and McKelvey, 1991) and according to Audretsch (2009), it was later adapted as the European Paradox. See also European Commission (2008).

⁶ Jacobsson and Rickne (2004) critically address the perception of a voluminous Swedish academic R&D.

2 The emergence of the belief in Sweden

In this section, we briefly describe the sequence through which the belief in a poor commercialisation of the results of academic R&D became dominant in Sweden.⁷

A focus on how to make academic R&D socially useful can be observed from, at least, the 1960s which is due to the Swedish model of having the Universities as the central research actor for society, as distinct from e.g. Germany where the Institute sector is very strong. Various enquiries and studies were, for instance, made in the 1980s on academic spin-offs (VINNOVA, 2003). These showed that there was a substantial spin-off activity; that these firms normally did not grow as expected but they contributed to growth through other means. The Royal Academy of Engineering Sciences coined these firms Research Based Knowledge firms and argued that

“...these are strongly specialised and their business idea is to through ‘productification’ transfer technology and knowledge from the science system. These...firms emerge and develop primarily in close collaboration with larger established firms. Through their specialisation, they can function as effective supplements to the large firms (VINNOVA 2003, p. 19).”⁸

Hence, over two decades ago, there was an appreciation that some of the impact of academic spin-offs on growth and employment can only be grasped by applying a system perspective.

At the end of the 1980s⁹ and in early 1990s, a parallel debate emerged on the relation between (high) R&D, (weak) knowledge intensive industries and (poor) aggregate growth (Ohlson and Vinell, 1987; Ohlson, 1991).¹⁰ Edquist and McKelvey (1991) popularised this argument by the notion of a Swedish Paradox. This path was pursued by others too, with some modifications in the arguments, forming a stream of papers on the presumed paradox between R&D intensity at the national level and an outcome indicator, be it growth or share of the “high tech” sector in production or exports (e.g. Braunerhjelm, 1998, Edquist and McKelvey, 1998).

This literature set the context for the discourse on how and to what extent academic science is made socially useful, leading to a perception of an “academic paradox”. Against the background of expectations of knowledge intensive areas, i.e. IT, biotechnology and material

⁷ We do this by analysing a diverse set of sources, including seven Government Science Policy Bills to the Parliament, books, academic papers, publications by interest organisations, debate articles in newspapers etc.

⁸ The original source is unfortunately not listed in VINNOVA (2003).

⁹ A report from the OECD (1987) showed the relationship between R&D as a share of GDP and the share of ‘high R&D intensity industries’ in manufacturing exports. Sweden was an outlier with high R&D intensity and low share of high tech exports.

technology, to have large growth effects¹¹ and a deep economic crisis in Sweden in early 1990's, a search was started for institutional and organisational changes that could increase the industrial impact of academic R&D. The 1992/93 Government Science Policy Bill clearly articulated that it had two priorities; designing strategic R&D programmes and strengthening the knowledge exchange between universities and industrial R&D work. It was argued that (Swedish Government, 1993, p. 29)

"...it is obvious that the knowledge flow between universities...and industry is insufficient. Deficiencies in the interaction means that available knowledge does not reach industrial applications to the extent that ought to be possible".

This theme runs through various later Bills too, although differently phrased. To remedy this problem would require "substantial improvements through a continued development of existing forms for interaction and the development of new forms" (Swedish Government, 1992/93, p. 10).

In the course of the subsequent decade, a number of science policy measures were taken, including expanding the PhD programmes¹², setting up Competence Centres and building infrastructure, e.g. through holding companies, to support commercialisation of research results in the form of patents and firms.¹³

An increased emphasis by the Government was put on *commercialisation* as from about 2000. Thus, "The results from research at Universities and University colleges in the form of inventions ought to be commercialised to a greater extent" (Swedish Government, 1999, p. 24) and "Research results ought to a greater extent lead to commercialisation" (Swedish Government, 2001, p.47).

¹⁰ These books gave a more complex view on the relationship between knowledge intensive industries and growth than the subsequent "Paradox" work. In particular, they emphasised a shortage of human capital (MSc and PhD) for these industries, in particular in engineering and natural science.

¹¹ "A large part of Sweden's structural renewal in the next ten to fifteen years must take place by growth in research and knowledge intensive industries" (Swedish Government Bill 1992/93:170, page 28).

¹² A major theme was the need to improve the absorptive capacity of industry, and its ability to conduct R&D, by employing more researchers. An expansion of MSc and PhD programmes in engineering and natural science was, therefore, advocated, and subsequently implemented.

¹³ Yet, the Government was also clear on both the time scale involved and the multidimensional nature of the usefulness of academic R&D. Thus, science, it was argued,

- cannot solve an economic crisis and unrealistic expectations on practical results from science will lead to disappointments and to wrong decisions (Swedish Government, 1992/93)
- creates a capacity to exploit knowledge generated abroad, enhancing the nation's absorptive capacity (Swedish Government, 1992/93 and 1998) and
- has an optional value in that it generates a readiness to respond to new opportunities and challenges (Swedish Government, 1992/93).

Hence, the Government Science Policy Bills revealed an appreciation of the multitude of ways in which science is made socially useful. Although increasing commercialisation through spin-offs is the objective of the holding companies, commercialisation (through spin-offs, patents, licences and products) was only one means by which academic R&D became socially useful.

Arguably, the focus on commercialisation was strengthened by work of a few academics; Henrekson and Rosenberg (2000, 2001), Goldfarb and Henrekson (2003) and the incorporation of key arguments in a government report (Andersson et al., 2002). A shared starting point for these studies was the larger “Swedish paradox”. As Andersson et al. (2002, p. 25) formulated it:

“Sweden belongs to those countries that invest most in the knowledge based economy but not those that profit most. On the contrary, Sweden has lost a great deal in terms of economic prosperity during the last decades, even if a certain recovery took place in the end of the 1990s. To remedy this “Swedish paradox” is of great importance for our ability to strengthen growth and welfare.”

These papers linked the “Paradox” to an insufficient contribution of the Universities to growth. An intermediate variable was the poor development of the ‘high tech’ sector, i.e. the starting point in the larger Paradox discourse that began at the end of the 1980’s. Henrekson and Rosenberg (2001, p. 210,211), thus, remarked that

“...the question naturally arises whether a contributing factor to the Swedish decline in terms of relative income is due to a failure in its university system to make the kinds of research contributions upon which advanced industrial economies have become increasingly dependent...in terms of sheer volume, the Swedish R&D effort is impressive by international standards. The publication rate in international scientific journals is likewise high. At the same time...Sweden does not seem to get full mileage out of its R&D efforts in terms of production and job creation in the high-tech, high value-added industries.”

Although it was clearly acknowledged that there is large number of ways whereby technology is transferred to industry,¹⁴ the focus is on commercialisation in the form of new business ventures, patents and licences (Goldfarb and Henrekson, 2003; Rosenberg and Hagén, 2003).

The papers all concluded that Sweden performed poorly in terms of commercialisation. For instance, when comparing Sweden and the US, Goldfarb and Henrekson (2003, p. 655) argued that:

“Although the general performance of technology transfer in Sweden is unknown, it is clear that the performance of its academic-based start-ups is weak...because of lack of data, we were only able to determine that Sweden has performed poorly in academic entrepreneurship.”

This message whereby a high R&D input is contrasted with a low output in terms of new firms was incorporated into an influential government report (Andersson et al., 2002). It was,

¹⁴ For instance, Rosenberg and Hagén (2003, p.13) refer to US studies in which it is claimed that recent university graduates are, frequently, the most effective of all diffusers of new science.

thus, argued that not only were there few academic spin-offs in Sweden but also that they did not grow (ibid, p.37, 38), suggesting that the potential for commercialisation was not realised (ibid, p. 48).

The report was written by members of the Innovation Policy Expert Group from the Ministry of Industry and Ministry of Education. The work of the group was conducted in close interaction with different stakeholders (e.g. industry, unions, policy makers, researchers etc) and the Heads of the two Ministries published a joint debate article in a leading newspaper based on the report. Arguably, this work influenced the 2004 Government Science Policy Bill (2004, p.140) which claimed that:

“The investments in research give, however, not enough benefit in the form of economic growth...there is an underutilised potential with respect to commercialisation of research results...the knowledge transfer to industry and commercialisation of research results has to increase.”

The same message was put forward by a range of individuals in different types of organisations in the subsequent years. A selection of these is found in Box 1.

Box 1: Selected repetitions of the “academic paradox” message

- Braunerhjelm et al. (2003, p.33-34) Sweden is the country in the world who invests the highest share of GDP in R&D [...] Despite of this, in comparison to other industrialized countries, Sweden is still specialized in low- and medium-tech production. Accordingly, the Swedish system of innovation lacks the ability to transform research into products and services; there is a missing link between industry and university. [...] This academic entrepreneurship is missing in the Swedish growth-process.
- Delmár et al. (2005, p. 79): “In Sweden, there is substantial knowledge creation in terms of large expenditure on R&D. However, it is well known that this knowledge is only marginally transformed into economic growth. In this report, we tap into one of the important reasons why this is the case...Sweden appears to be in a situation where there is an imbalance between knowledge creation and entrepreneurial activity with the latter being insufficient”
- Thomas Arctadius, Head of Business relations at Stockholm University (2006-02-03): “Sweden invests large sums (in an international comparison) in research and development but relatively few firms are created.”
- Private members bill 2006/07 from Finn Bengtsson and Andreas Norlén, Members of Swedish Parliament: Increased support for the commercialisation of academic R&D results: “Sweden has had evident problems in taking research results into new products and services in expanding firms. We are one of those countries that spend most on R&D but one of the poorest for creating new firms”.
- Sven-Thore Holm, CEO of Innovation Bridge South (2007-12-17): “The Swedish paradox...consists of Sweden being best in the world to allocate funds to R&D but does not reach the same position at all when it comes to generating research based products and firms.”
- Nils Karlsson, CEO of Ratio (IVA –Aktuellt, info@iva.se2009-03-31:”Sweden leads the league of research intensive countries. However, when it comes to ...commercialisation, Sweden does not play in the highest division....it is the lack of rapidly growing companies....that is Sweden’s Achilles’ heel, not top calls scientific results”.

Not surprisingly, the same message was repeated in the Government’s Science Policy Bill of 2008. It makes clear statements on three key empirical issues, taking a stance that may well

be seen as the ultimate reflection of a belief that emerged in the first years of the millennium:¹⁵

*“Research results have too rarely led to jobs, new products and growth in Sweden”
(Swedish Government, 2008, p. 19)*

“The Universities’ incentive to work with commercialisation and with research of relevance to industry has been relatively limited. Seen from an international perspective, there are relatively few products and firms that in reality have come directly out of an academic environment.”(Swedish Government, 2008, p. 122)

“The outflow of patents and licenses from research at Universities and University colleges is at a relatively low level given the extent of Swedish research...” (Swedish Government, 2008, p. 121)

3. A scrutiny of the empirical foundation of the belief

Clearly, a perceived poor commercialisation of academic R&D results is seen as a powerful explanatory factor behind the perceived “Swedish Paradox.” This belief is based on the perception that in an international perspective,

- there are few academic spin-offs and these firms remain small
- there is a paucity of patents and license agreement emanating from the academic sector
- the academic sector’s relevance to industry, for example its contribution to new products, is poor.

In what follows, we will a) discuss two broader methodological problems in the literature referred to above and b) critically assess the empirical foundations of the three detailed beliefs.

3.1 Two broader methodological problems

Tracing the impact of academic R&D on growth is fraught with methodological problems. In this scrutiny, we will point to two broader ones that plague the Swedish Paradox literature. A first is the absence of time lags in the analyses.¹⁶ These involve, at the simplest level, the lag between the initiation of R&D and the effects in terms of published papers. This lag only may be in the order of half a decade (Crespi and Geuna, 2008). Transforming academic results to commercial products takes additional years. Mansfield (1998, p. 673) reported that the lag from *recent* academic research results, that is results from academic research occurring within 15 years of the commercialisation of the innovation being considered, to commercial

¹⁵ Whilst it is very strong on the issue of commercialisation, it also recognises (i) the optional value of academic R&D (ibid, p.18); (ii) that “...a well functioning system for knowledge transfer between academia and industry is one of the foundations for the development of the large Swedish high technology firms” (ibid, p. 26) and (iii) that we have a comparable civilian R&D expenditure to Denmark and Germany (ibid, p. 35).

¹⁶ As also Dosi et al. (2006) point out, this is a well known property of technological knowledge.

introduction is on average 6 years. Yet another time lag (discussed more below) which is often much longer than half a decade, is the one between the formation of a spin-off and its eventual growth (Lindholm Dahlstrand, 2008). Further time lags are involved for these innovations and firms to diffuse/grow in such a way that a significant impact on economic growth can be traced.¹⁷ As is well known in the literature, the diffusion of a new technology is a process that often takes several decades (e.g. Grubler, 1996).

Yet, the literature referred to above does not consider time lags. Indeed, typically, the discussion starts with a reference to Sweden's poor performance in terms of growth since the 1970s. It then proceeds to reveal a strong R&D and publication performance and finish with pointing to this "paradoxical" situation. For instance, Henrekson and Rosenberg (2001) relate growth in GDP from 1970-1998; R&D inputs from 1981 to 1997 and publication data for 1995, i.e. no time lags are considered.¹⁸

A second methodological problem is the implicit assumption that academic R&D fully supports the 'high tech' sector. A very sizeable part of research at technical universities is within knowledge fields that support *low and medium technology* industries. A scrutiny of research at the second largest, Chalmers University of Technology, bears this out. About one third of the research is done in departments that are clearly not oriented towards generating technology for the 'high tech' sector. Moreover, in many of the other departments, 'low and medium tech' industries are *application areas*, together with 'high tech' industries. To give an example, in the Department of Chemistry and Biotechnology,¹⁹ "...the interface to industry is very broad, with collaboration covering everything from medicine and food to forest, transport and steel industries."²⁰ Hence, research that may, on the surface, be associated with 'high tech' (here biotechnology) are of relevance to many 'low and medium tech' industries. These industries have a 'multi-technological' base, as was discussed many years ago (Granstrand and Sjölander, 1989; Jacobsson and Oscarsson, 1995).²¹ Hence, relating *overall* academic R&D to GDP growth via commercialisation in the '*high tech*' sector is erroneous.

¹⁷ See, for instance, Rosenberg's excellent article in 1996.

¹⁸ Considering time lags would have meant relating R&D inputs in, say, the early 1980s, to benefits a number of years ahead, say a period beginning in the second half of the 1990s (although the length of the combined lags are unknown).

¹⁹ The home page of the Department, accessed November 3, 2009.

²⁰ Another example is the Dept for Computer and Information Technology where the..."collaboration partners in Swedish industry include amongst others Volvo, SAAB, Ericsson and Saab Space..." (home page accessed November 3, 2009).

²¹ Two (non-high tech) industries stand out as particularly important: the paper and pulp industry and the transport equipment industry. Indeed, Chalmers' total external research funding in 2007 directed towards the transport sector amounted to as much as SEK 213 million which constituted more than 20 per cent of total

Having pointed to two substantial methodological problems in the literature, we will proceed to scrutinize the empirical base of the three propositions stated in the beginning of this section. We will begin with the proposition that there are few academic spin-offs and that these remain small.

3.2 “There are few university spin-offs and these firms remain small”

The collection of data on new technology based firms is not a responsibility of any government body so the empirical studies of academic spin-offs referred to in the Swedish “academic paradox” literature are academic studies. We will specify the sources used in the paradox literature, scrutinise the data in those studies and add results from more recent work.

With reference to Utterback and Reitberger (1982) and Rickne and Jacobsson (1996, 1999), both Henrekson and Rosenberg (2001) and Goldfarb and Henrekson (2003) argue²² that there is empirical evidence of a low growth rate among Swedish new technology-based firms. They also suggested that existing studies of academic spin-offs (Olofsson and Wahlbin, 1993; Lindholm Dahlstrand 1997a, b) show that the direct employment generated by these firms is small. The same studies²³ were used by the influential report from the Innovation Policy Expert Group (Anderson et al., 2002) where it was argued that there are few academic spin-offs in Sweden and that these do not grow. Braunerhjelm et al. (2003) referred to the same studies²⁴ as well as to Henrekson (2002), Henrekson and Rosenberg (2000)²⁵ and Andersson et al. (2002). With reference only to Andersson et al. (2002), Delmar et al. (2003) make the same argument.

Hence, the empirical evidence on which this belief stands is contained in a few studies only. Table 1 summarises key features of the data. A number of observations can be made from scrutinising these studies.

Table 1 Key features of the studies on which the belief stands

Study	NTBF/	Number of	years	average	size/growth of the
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external funding (Dubois, 2009) and as many as 10 Departments mention the transport sector an application area in the Annual Report of Chalmers 2008.

²² Goldfarb and Henrekson (2003, p. 650) concluded that “we can establish that the entrepreneurship avenue is not working particularly well in Sweden. A careful reading of the research into small technology companies in Sweden reveals that none of them have become a large, significant presence in the Swedish economy (Utterback and Reitberger, 1982; Rickne and Jacobsson, 1996, 1999) and that this seems especially pronounced in the subset of these firms which are university spin-offs (Olofsson and Wahlbin, 1993; Lindholm Dahlstrand, 1997a, b).”

²³ Utterback and Reitberger (1982) was not referred to.

²⁴ The exception was Utterback and Reitberger (1982).

²⁵ This is a Swedish version of Henrekson and Rosenberg (2001). Henrekson (2002) is a Swedish version summarizing results from Henrekson and Rosenberg (2001) and from Goldfarb and Henrekson (2003).

	USO*	firms in the sample	covered	age of firms (years)	firms
Utterback and Reitberger 1982	NTBF	60	1965-75 (80)	10	49 employees sales 18 MSEK
Olofsson and Wahlbin, 1993	USO	569	- 1991	8-9	7 employees
Rickne and Jacobsson 1996	NTBF	53 (CPA)	1965-75 (80)	na	64**
Rickne and Jacobsson 1999	NTBF	1284	1975-1993	7-8	15.2 employees 5% >50 empl. 3 firms >200
Lindholm Dahlstrand, 1997a	NTBF	60 (CPA)	1965-75 (80)	21	sales 130 MSEK
Lindholm Dahlstrand 1997b	NTBF/ USO	60NTBFs + 193 USOs= 253	1965-1993	23/10	CPA: 160 empl Chalmers USOs 14 empl

Notes: NTFBs= new technology based firms, USO = university spin-offs, ** Employment in Sweden only
One firm had grown into a multinational firm with a turnover of SEK 10 billion in 1994

First, the empirical base is scattered. The oldest sample is one of sixty new technology based firms (Utterback and Reitberger, 1982) that mainly cover manufacturing firms started in 1965-74. This sample was followed until the mid 1990s (Lindholm-Dahlstrand 1997a, b).²⁶ There are also two estimates of larger populations. The first covers 569 university spin-offs started between 1974 and 1989 and still existing in 1991 (Olofsson and Wahlbin, 1993). The second expands the coverage to 1,284 new technology based firms, started in 1975-1993 and present in manufacturing and services in 1993 (Jacobsson and Rickne, 1999).²⁷ Hence, these latter two populations do not overlap with the Utterback and Reitberger study. This means that the data available on new firms is not longitudinal.

This is significant because it means that the data includes mainly firms that are very young and, as was noted above, there are long lead times between the formation and growth of firms, in particular university spin-offs. The average age of firms in Utterback and Reitberger (1982) was ten years and they employed on average 49 persons with a sales of MSEK 18. Eleven years later, sales had increased to MSEK 130 (Lindholm Dahlstrand 1997a) and at the average age of 23, the number of employees had increased to 160 (Lindholm Dahlstrand 1997b). In Rickne and Jacobsson's study (1999), firms had an average age of 7-8 years, employing about 15 persons²⁸ (5 per cent of the firms had over 50 employees). A few years later, Saemundsson (1999) found that at the average age of 11-12 years, 12 per cent had become medium-sized (i.e. over 50 employees) and 8 firms employed more than 250 persons. Thus, a

²⁶ Lindholm-Dahlstrand (1997b) adds a regional university spin-off population to the CPA study.

²⁷ There is a large overlap between these latter populations, see Jacobsson and Rickne (1999), footnote 31.

²⁸ These 15.5 employees corresponds quite well to the average of 14 employees of the ten years old Chalmers' university spin-offs in Lindholm Dahlstrand (1997b).

significant growth had taken place in both samples. Similarly, Lindholm Dahlstrand (2008) followed up²⁹ the university spin-offs in Rickne and Jacobsson (1999) and found that at the age of 15, the university spin-offs had reached an average size of 41 employees.

Thus, allowing for the young age of the firms, acknowledging that it normally takes a decade or so before firms start to grow, it is arguable that at the turn of the millennium, there was not any conclusive evidence for claiming that new Swedish technology-based firms and university spin-offs do not grow.

Second, the coverage is only Swedish firms so no international comparisons were made. The same limitation applies to Henrekson and Rosenberg (2001) and Goldfarb and Henrekson (2003). Whilst these include a discussion of both Sweden and the US, they do not contain data on US university spin-offs.³⁰ In the absence of internationally comparative data, it is not possible to conclude that the frequency and growth of university spin-offs is low compared to other countries.³¹ This is not a unique Swedish limitation as Arundel and Bordoy (2008, p. 5) point out:

“To date, there are very few... internationally comparable indicators...for evaluating the success of policies to promote the commercialisation of public science”.

This begs, of course, the question of which yardstick is used when it is alleged that spin-offs do not grow much, nor that they are few in an international comparison.³²

Third, none of the studies provide empirical data that allows any firm conclusions about the frequency of new technology-based firms or university spin-offs in Sweden. Utterback and Reitberger (1982) as well as Jacobsson and Rickne (1999) limited their studies by excluding a large number of very small new firms, while Olofsson and Wahlbin only included 12 of the Swedish Universities in their sample.

In contrast to the belief, acknowledging that there are large methodological problems involved in defining and measuring the number of university spin-offs, there appear to be a steady flow of such firms over the past decades. Wigren and Wahlbin (2008) reported that 2.5

²⁹ Using the Affärsdata database, which is based on figures collected in firms' Annual Reports.

³⁰ Goldfarb and Henrekson (p. 649) themselves conclude that “In contrast to the US, there is a lack of comprehensive data that tracks the transfer of intellectual property from universities to the private sector in Sweden”.

³¹ The same problem plagues later studies. For instance, we don't know if the 22 per cent of the individuals in the Swedish science and technology labour force who have been self-employed one year or more (Delmar et al., 2003) is high or low (which the authors claim).

³³ In rare study, Rickne (2000) found that in the field of biocompatible materials, Sweden had more spin-offs than the US.

³³ Compared to the general start-up frequency of the Swedish adult population, this is a high figure. If Swedish adult population was as active in company formation as Swedish university researchers, it would dramatically

per cent³³ of Swedish researchers started a firm in 2006 which corresponds to approximately 500 new firms started in a single year.³⁴ Out of these, 55 percent were based on the individual researchers' own research, i.e. corresponding to approximately 275 university spin-offs if we define such a firm as one in which an academic starts a firm where he or she exploits a discovery made in previous research.

This figure is about the same as in earlier periods. Lindholm Dahlstrand (2008) estimated that some 200 direct university spin-offs, i.e. a spin-off started by an academic research were started each year in the period 1975-1993. In addition, two categories of firms that involve spinning off *knowledge* from University research were identified. These are not normally included in Swedish studies of academic spin-offs which have a tendency to focus on researchers – rather than research – spun out of universities.

First, slightly over one hundred university spin-offs were estimated to have been started annually where the founder/entrepreneur was not the responsible university researcher, i.e. an “external entrepreneur.”³⁵ Taken together with the 200 direct spin-offs mentioned above, this corresponds to some additional 300 firms of a type that is likely to have been included in the Wigren and Wahlbin's (2008) sample, i.e. the figures are very close.

Second, there were also “indirect university spin-offs”, that is, firms established by previously employed university researchers but not until the founder had worked a period in industry. These firms were based on the founder's own earlier academic research results, but they are not likely to have been included by Wigren and Wahlbin (2008) as their method involved asking currently active researchers. Lindholm Dahlstrand (2008) estimated that some 400 indirect university spin-offs were started each year. Taken jointly, this suggests that some 700 new technology-based firms are started every year based on university research in Sweden.

Whether these figures (between 200 or 700) are high or low is impossible to say since, as noted above, there are no internationally comparative data available. The only ones available for the US are those provided by AUTM which reports some 400 to 500 university spin-offs

increase new firm formation. Indeed, Delmar et al. (2003) found a start-up frequency of over 20 per cent in their population of university graduates.

³⁴ There were some 10 000 responding researchers in the sample. On average the firm founders started 1.2 firms each. There were on average 4.3 founders in each firm, out of which 2.7 university employees. In the sample, this corresponds to $0.025 * 10\ 000 * 1.2 / 2.7 = 111$ new firms. An estimation on the national level includes a scaling up for the 45 200 researchers in Sweden that year, resulting in 500 new firms.

³⁵ Lindholm Dahlstrand (2008) identified three categories of firms that involve spinning off *knowledge* from University research. Two of these (indirect spin-offs and spin-offs started by external entrepreneurs) are not normally included in Swedish studies of academic spin-offs which have a tendency to focus on researchers – rather than research – spun out of universities.

each year, i.e. within the range of the figures above for Sweden.³⁶ This is, of course, an absurd comparison (US having about 30 times the Swedish population) and the only conclusion that can be drawn from it is that we don't know if the Swedish figures are high or low.

3.2 “There is a paucity of patents and license agreement emanating from the academic sector”

This belief is perhaps the most surprising as there is no relevant data collected by the Swedish Government. Collecting such data is, furthermore, very difficult in Sweden where the Universities do not own the patents. Instead, these are owned by the individual researchers or by firms. This means that specially designed studies have to be undertaken to find out the patenting activity by Swedish academics. We know of two recent publications.

In a survey of 10 000 university researchers (including PhD students), 1.8 per cent applied for a patent in 2006 (Wigren and Wahlbin , 2008, table 1).³⁷ This is equivalent to 115 patents and slightly over 500 patent applications if the results are scaled up to the entire population.^{38,39} Unfortunately, we do not know if the patents applications were sent to the Swedish Patent Office but the magnitude of this patenting activity can, nevertheless, be gauged by setting it in relation to the around 2,500 Swedish patent applications that year (with a Swedish applicant). Wigren and Wahlbin's figure corresponds to 4.6 per cent of these applications (and over 20 per cent if the up scaled figure is used).

The starting point of the second study was a dissatisfaction with the empirical foundation of recent policies with the purpose of stimulating patenting by Universities (Lissoni et al. 2009, p. 190):

“All these initiatives to stimulate patenting by universities and university staff...were based on scattered or no data at all. Most information on university patenting came either

³⁶ The AUTM studies report between 400 and 500 US university spin-offs annually (AUTM 1996 to 2009, Arundel and Bordoy, 2008). It should be noted that the AUTM reporting only includes data from less than 200 US Universities. These universities are however the most research intensive ones. In for example 2004, the 197 respondents accounted for 87% of federal and industry-financed research expenditures by American universities that offer science and engineering degrees (Arundel and Bordoy, 2008). In addition, there is likely a high number of US spin-offs created through *bypassing*, that is, without the university's (and the TTO's) knowledge (Markman et al., 2006, see also section 4 of this paper).

³⁷ 5.7 per cent had done so earlier.

³⁸ Wigren and Wahlbin (2008) found that 1.8% of the researchers in their study applied for patents in 2006. On average each individual applied for 1.4 patents, and there were on average 2.2 university researchers involved in each application. Thus, in the sample of 10 000 respondents this means $0.018 \times 10\,000 \times 2.2 = 115$ applications. With 45 200 researchers in Sweden this would correspond to 518 patent applications.

³⁹ In comparison, Wigren and Wahlbin (2008, appendix 7) found far fewer license agreements among their respondents. In 2006, there were only 41 license agreements, which corresponds to around a third of the number of patent applications (at least that year). We do however not know to what extent university spin-offs (where the researcher has left the university employment) tend to create license agreements based on earlier university research.

from surveys submitted to university liaison offices or from cursory looks at the identity of patent assignees”.

In order to develop a data base (drawing on EPO) that captures patenting activity by academic researchers, they included academics as not only assignees but also as inventors. In this manner, they were able to capture patents held by individual researchers as well as by firms collaborating with an academic researcher who is the inventor, but not the assignee. In Sweden, the share of academic patents, defined in that way, in total patents is, indeed, *at the same level* as in the US (6 per cent) but the difference is that most of these are *not* owned by the University but by firms collaborating with the Universities.⁴⁰ As Lissoni et al. (2009, p.203) argue:⁴¹

“Well over 60 percent of academic patent applications in France are owned by business companies, which also own almost 74 per cent of Italian academic patents and 82 per cent of Swedish ones; in contrast, business companies own only 24 per cent of US academic patents... The key piece of evidence...can be summarized as follows: universities in France, Italy and Sweden do not contribute much less than their US counterparts to their nations’ patenting activity; rather, they are less likely to reclaim the property of the patents they produce.”

In the Swedish case, the top companies owning *academic* patents, thus, include ABB, Ericsson, Pharmacia and UpJohn, Astra Zeneca, Telia, Siemens and Sandvik. These companies interact a great deal with Universities and obviously very often come out of that collaboration with the IPR. In the case of Royal Institute of Technology (KTH), for example, Rosenberg and Hagén (2003, p.36) argue that

“Ericsson had direct access to much of the research capability that resides in the technical universities. ...about two thirds of the patents that come out of the research at KTH became the property of private companies, in spite of the fact that these companies had contributed less than a fifth of KTH’s research budget”.

Hence, it would appear as if a substantial patenting activity is taking place but that it is ‘invisible’ without substantial efforts to build up a data base, either through survey or through detailed scrutiny of patent data bases. Yet, whereas this data is striking, there is nevertheless a strong question mark. As noted above, Universities constitute the central research actor for society, as distinct from e.g. Germany where the Institute sector is very strong. This means that in an international comparison which includes only Universities (and not institutes) we

⁴⁰ The period covered was about 1980-2000 and the number of academic patents in Sweden was about 1,200. This appears to be a small number which is somewhat puzzling.

⁴¹ Wigren and Wahlbin (2008, appendix 7) show that 54 per cent of the academics applying for a patent was made together with an external organisation which is consistent with the results of Lissoni et al. (2009).

would expect Sweden to come out strong. Such comparison would, therefore, need to include also institutes in order to properly gauge the performance of Sweden in this dimension.

3.3 “The academic sector’s relevance to industry, e.g. its contribution to new products, is poor”

As in the case of new firms, patents and licenses, there is a paucity of internationally comparable data on the academic sector’s contribution to new products. Studying this phenomenon is, furthermore, fraught with enormous difficulties as such a study would need to include the multitude of benefits (apart from patents) coming out of relationships in various Competence Centres and other university-industry networks. We will, however, point to two features in the Swedish innovation system which may suggest that these benefits are significant.

First, as discussed in section 2, the term Research Based Knowledge firm was coined already in the 1980s. The importance of these firms was subsequently underlined by Olofsson and Wahlbin (1993) who found that half of 569 academic spin-offs performed (technology) consulting at start up. Almost a third of the income in these firms was a result of selling R&D services, most often to other (large) companies. Indeed, a total of around 44 per cent of the technology traded inside Sweden originated in these university spin-offs.⁴² More recently, Lööf (2005) provided evidence that university researchers working as consultants to industry often are more important than the purchase of patents and licenses. These consultants are mostly found in university spin-off firms. Thus, the university spin-offs may have a significant, but *indirect* impact on industrial transformation in that their sale of technology generates an increased activity in the customer organization.

Second, it is well recognised that relationships are strong in Sweden between academia and larger firms. For instance the Swedish Government (2005, p. 11) stated that: “Sweden has a long tradition of collaboration between academia and industry.”⁴³ Goldfarb and Henrekson

⁴² The customers of the spin-offs were found to use this technology in their own R&D (over 30%), in their production (over 35%), and in their own products (approx 20%) (Olofsson and Wahlbin, 1993).

⁴³ In a survey conducted by RRV (The Swedish National Audit Office, 2001), 2 640 researchers answered a number of questions about their attitudes to and experience of commercialization of R&D results. One question was: “Do you have any experience of research collaboration with firms?” Among the applied scientists, 65 percent said that they had such experience; for professors working at a technical university, the figure was as high as 95 percent. The figure dropped, however, to 15 percent for younger natural scientists (PhD students) working in basic science. For medicine, the share of respondents reporting experience of research collaboration “...was relatively high, nearly at the level of the more applied” (VINNOVA, 2003, p. 34). Hence, for medicine and engineering, a considerable proportion of the researchers have experience of R&D collaboration with industry. This is also acknowledged in RRV (2001, p. 8): “...there is a dividing line between universities oriented towards technology and medicine and the others. The former have a longer tradition of collaboration with industry and have in general found it easier to shoulder the responsibility of the third mission”. RRV (2001,

(2003, p. 647) similarly argue that: “It is clear, however, that these contacts have been mainly with large-firms, and it has turned out that the large-firms have preferred that these contacts remain informal in nature”.

Informal relationships are, of course, very difficult to trace but are nevertheless part and parcel of academic R&D. The case of the new production process LignoBoost illustrates this, see Box 2. Researchers at Chalmers University of Technology provided ideas and knowledge that was subsequently patented by an Institute and which spun off a company for testing the process. The IPR as well as the firm were then acquired by a capital goods supplier.

Box 2 Ligno-boost

The **LignoBoost** Process is the result of successful co-operation between the Institute STFI Packforsk and Chalmers University of Technology. In a project co-ordinated by the Institute, Professor Theliander at Chalmers investigated why it was so difficult to obtain pure lignin with high dry content when extracting lignin from black liquor. New knowledge of the behaviour of lignin during displacement washing was developed. This led to the idea of a novel process solution which was gradually tested on the laboratory and pilot plant scale. Theliander’s work was supported by Professor Berntsson, who led the work on integrating the LignoBoost process into the Kraft pulp process. In the subsequent demonstration phase, STFI-Packforsk took the main responsibility and Chalmers assisted in technical matters. The idea of a novel process solution was given to STFI-Packforsk, which applied for patents. The demonstration was undertaken in 2007 by a company that was a spin-off from the Institute and which used a factory that the company had bought for that purpose. It was shown that the process concept worked. In June 2008, the spin-off company, including the IPR, was acquired by Metso Power, a capital goods supplier. A successful commercialisation process had come to an end, nine years after the first experimental test.

This is not a unique case. Studies of the role of academic research in the energy, pharmaceutical and telecommunication fields suggest that “... these academic fields were more or less inseparable from industry...for long periods of time.” (Hellström and Jacob, 2005).⁴⁴ A recent evaluation of the transport equipment R&D programme pointed to strengthened networks and impact of competitiveness of industry (VINNOVA 2009:2, p. 9):

“The policy has given substantial contributions to maintaining the competitive advantage of the Swedish transport equipment industry through strengthened research competence

table 3.3) also points to a – perhaps surprising – similarity between US researchers and Swedish researchers in their attitudes towards commercialization.

⁴⁴ This certainly still holds for the energy sector. In the government budget proposal (Swedish government, 2004, p. 79) one could read that: ” The activities in the [energy research] program have relatively strong links to industry ... more than 50% of the projects are lead by members of industry and more than 70% of the projects deal with applied research, development or demonstration”.

and absorptive capacity, strengthened collaboration with Universities and Institutes, strengthened internal competitive advantage for the car manufacturers within foreign owned corporations and important results that have been implemented in product development”

In sum, the proposition that the academic sector’s contribution to new products is poor stands on very weak grounds. On the contrary, there is evidence pointing in the opposite direction, although systematic studies are, again, not available.⁴⁵

4. A critical discussion of the EU policy response to the alleged problem of poor commercialisation

None of the three empirical statements can, thus, be substantiated by empirical evidence. Yet, in spite of the partly contradictory and shaky empirical evidence, there is a strong pressure to change the institutional framework so as to increase the perceived poor level of commercialisation. In 2003, Goldfarb and Henrekson suggested that the American university system is more effective in facilitating the commercialization than the Swedish system in which rights are awarded directly to the inventor. Since then, the OECD has repeatedly argued for a Swedish abandoning of the “Professor’s privilege” and the issue was brought up again in the latest Science Policy Bill (Swedish Government, 2008).

As was noted in the Introduction, since the adoption of the Bayh-Dole Act by the United States in 1980, a number of OECD governments have, indeed, already implemented policies that closely resemble it (Mowery and Sampat, 2005). The European Commission (2007, p.7) reported that “Several Member States have taken initiatives to promote and facilitate knowledge transfer (for instance new laws, IPR regimes, guidelines or model contracts) and many others are planning to intensify their efforts in this direction.” There is, thus, a distinct move away from professor’s privilege towards various systems of institutional ownership in order to facilitate the commercialisation of research results (EU, 2008).⁴⁶

There are two substantial problems with this institutional change. First, the Swedish case is not an exception in that there is a tension between the belief and empirical data. A recent attempt at finding internationally comparable indications of the commercialization of academic research is reported in Arundel and Bordoy (2008). They analyse six performance

⁴⁵ Wigren and Wahlbin (2008, appendix 7) report that 15.6 per cent of the respondents said that they participated in the development of a product or service in 2006. 75 per cent responded that they did so together with an external organisation.

⁴⁶ It is, however, important to note that before Bayh-Dole, the US Federal Government retained ownership of all patents granted using government funding. In Europe, it has instead been common that these ownership rights belonged to the university inventor.

indicators for several EU countries⁴⁷, Australia, Canada and the USA. Three of these refer to the *potential* for commercialization - invention disclosure, patent applications and patent granted- and three for *actual commercialisation* - licenses executed, start-ups and license revenue.

Whereas the United States is the leader on patents granted, Europe performs better in terms of number of licenses executed and number of start-ups. Contrary to the belief, the high rate of start-up formation in Europe suggests that European academics might not be less 'entrepreneurial' than their American counterparts. Not surprisingly, Arundel and Bordoy (2008, p.15) conclude that we "need to take a much more critical look at European assumptions about the causes of the "policy paradox"", other factors than a "failure of commercialization" should receive more attention. Hence, for our purposes, the diagnosis of the problem may well be incorrect also for these EU members.

Second, despite the apparent success of the Bay-Dole Act, it is not necessarily so that it has had a positive effect only on technology transfer and economic growth. Indeed, there is a growing literature in the US that critically addresses this institutional change. In what follows, we will identify central criticisms and discuss risks associated with European "copy-cat" behaviour with respect to institutional change in this field.

As is well known in the science policy literature, and as was argued above for the Swedish case, firms (in particular large ones) actively monitor academic developments and have a range of links with the scientific community in the form of *university-industry networks*. These may be formal, such as partnership in a Competence Centre, or informal personal networks. Through these networks, firms learn of promising academic knowledge developments via channels other than the technology transfer offices (Colywas et al., 2002). As was shown above in the Swedish case, firms also benefit disproportionately in terms of IP rights from projects with joint funding. Not surprisingly therefore, Dosi et al. (2006) point out that

"Interestingly, only very rarely has a critique of the Open Science System and the public funding of basic research come from corporate users"

US studies suggest that the transfer of IP rights to the University brought an increased administrative and bureaucratic behaviour that may interfere with the operation of other channels through which university inventions reach commercial application (Mowery et al

⁴⁷ Data was based on two earlier UK surveys and a survey of members in the ASTP (The Association of European Science and Technology Transfer Professionals) from 22 European countries.

2001, Litan et al., 2007). Indeed, a negative impact on University-Industry interaction is already seen in Denmark which recently abandoned the professor's privilege. As Helge Sander, Minister for Science, Technology and Innovation explains: "... a mid-term evaluation of the new proof of concept-scheme indicates that private investors have become more reluctant to invest in university inventions." In the Swedish case, where about 80% of the academic patents are already owned by industry (in spite of little funding input), a University ownership could well have a similar effect.⁴⁸

Enhancing *university revenues*, which was not a central argument for the policies articulated in Bayh-Dole, is now an important objective of universities in their patenting and licensing policies (Colyvas et al., 2002; Jensen and Thursby, 2001). According to Colyvas et al. (2002, p 68), however, "...there is no reason to believe... that policies that maximize a university's revenues are always aligned with those that maximize technology transfer." This may have implications for both type of technology that will be commercialised and the frequency of spin off firms.

As regards the former, revenue maximization may influence the type of technology that is being focussed on (Mowery et al., 2001, Markman et al. 2005, Litan et al. 2007):

"... the current reward structure and the centralization that accompanies it have turned TTOs into monopoly gatekeepers. Like any monopoly, this means that [...] TTO officers focus their limited time and resources on the technologies that appear to promise the biggest, fastest payback. Technologies that might have longer-term potential—or that might be highly useful for society as a whole, even if they return little or nothing in the way of licensing fees (...)—tend to pile up in the queue, get short shrift, or be overlooked entirely" (Litan et al. 2007, p. 8)

In terms of the latter, in a study of US TTOs, Markman et al. (2005,) argued that TTOs are typically found to be focused on short-term cash maximization and extremely risk-averse with respect to financial and legal risks. They revealed an overemphasis on royalty income and an under emphasis on entrepreneurship and concluded that "... these findings suggest that universities most interested in generating short term cash flows from their IP licensing strategies are least positioned to create long-term wealth through venture creation." (p.260). Siegel at al. (2004) complement this by adding that TTOs appear to do a better job of serving the needs of large firms than small, entrepreneurial companies. Thus, granting IP ownership to universities instead of university inventors (see footnote 46 above) may hamper entrepreneurial processes and university spin-offs.

⁴⁸ Several authors have argued that restrictions on use of knowledge associated with patents reduce the social returns to this public investment (Mowery et al., 2001, Shane, 2000).

This is, of course, serious, in particular as Litan et al. (2007) found that whilst spin-offs from universities are few in number, they are disproportionately high performing companies, and often (as in the Swedish case) serve as a mechanism to bridge the development gap between university technology and existing private sector products and services. Adding on to this, Phan and Siegel (2006)⁴⁹ suggest that increased *bypassing* activity is associated with more valuable discoveries and heightened entrepreneurial activities, highlighting the conundrum found in other studies that universities focused on entrepreneurial startups may do well to reduce restrictions over intellectual property and technology flows!

Only very few universities reap any significant financial returns from commercialization activities (see e.g. AUTM 2007, Litan and Mitchell 2009, 2010). For example Rogers et al (2000) argue that no matter if commercialization of university research is judged by the numbers of patents, licensing revenue or new companies formed, only very few universities show any success. Mostly, income flows from licensing are quite small as compared to the overall university budget; in most cases, they are unable to cover even the administrative costs of the ‘technology-transfer office’ in charge of them (Dosi et al. 2006, Litan and Mitchell 2009)! The Danish example demonstrates that the surplus may be low indeed.⁵⁰ The risk is, of course, that Universities may not allocate the required funding to fully exploit the IP rights (while at the same time blocking the exploitation in the form of spin-offs or through other means).

Several studies have also pointed out the importance of experience and learning among TTOs. In recent years, older and more experienced American universities have shown a growing enthusiasm for the more risky forms of entrepreneurial activity, namely, forming start-up companies (and taking equity) around a university-developed technology or licensing to small private firms rather than through the traditional commercialization route with large public companies⁵¹. For example Powers and McDougall (2005) found that as TTO offices gain experience, they are more willing to consider equity in start-up companies. Similarly, Bray and Lee (2000) found that universities that took equity had older TTOs, while the younger TTOs

⁴⁹ They refer to an unpublished study by Markman et al (2006).

⁵⁰ The Danish Agency for Science, Technology and Innovation (2009) reports that in Denmark the public institutions’ combined revenues from commercialisation more than doubled from just short of 38 million DKK in 2007 to approximately 83 million DKK in 2008. However, the costs were high too, for example paying for 54 full time equivalents employed at universities to assist in the commercialisation of university research.

⁵¹ This changing focus is mirrored in academic research where it is clear that much of the early literature looked at licensing revenues and licensing productivity, while an increasing number of later studies have focused on spin-outs or new firm formation, and joint ventures between researchers and large corporations in the form of sponsored research (Phan and Siegel, 2006; Power and McDougall, 2005)

focused primarily on licensing and royalty income. They concluded that as the TTO gained experience, its personnel were more willing to consider equity in start-ups.

In sum, this literature suggests that a European copy cat behavior may be counterproductive in that it involves risks in terms of obstructing the formation and effective operation of university-industry networks; reducing frequencies of entrepreneurial spin-offs, biasing the types of technologies focused on and costing the Universities sums that they may not be willing to spend. Awarding Universities the IP rights risks hampering rather than promoting technology transfer. Hence, it may not only be the diagnosis that is questionable, but also the medicine.

5. Conclusions and some implications for Policy

The purpose of this paper was to critically a) assess the validity of the belief in a poor commercialization of academic R&D and b) discuss the currently proposed solutions, inspired by US Science Policy, to handle that alleged problem by focusing on the ownership of IPR. In addressing the first purpose, Sweden was used as a case in which we drew upon our “local knowledge” and a multitude of national sources of data to assess the validity of the European wide belief in a poor commercialisation of academic R&D. We scrutinised the literature and available evidence and found a number of problems with this belief.

There are methodological problems involved, in particular an absence of considerations of time lags, as well as empirical problems. Altogether too strong conclusions have been drawn from incomplete and scattered data on the number and growth of spin-offs; internationally comparative data was not included leaving us with large question marks on the gauge used to say that Sweden performs poorly in terms of volume of university spin-offs and their growth; patent data gives picture of a Swedish strength and not a weakness and systematic studies are not available on the contribution of academic R&D to product development. Yet, strong university-industry networks exists which open up for knowledge transfer of a more informal type.

The limited data we have on firm formation and growth, patenting as well as an understanding of the role of Research Based Knowledge firms and university-industry networks, could equally well be used to argue that commercialisation is a more powerful mechanism of making science useful than what is commonly believed. Yet, the data is clearly not as solid as we would wish. Indeed, we would argue that in spite of the very certain statements made in the literature, including Government Science Policy Bills, it is difficult to avoid the conclusion that the empirical base for ascertaining how strong the

commercialisation of academic R&D in Sweden, in particular in an international perspective, is quite shaky. Recent work on other EU countries by Arundel and Bordoy (2008) suggest that the tension between belief and empirical data is not limited to Sweden.

There are equally strong doubts about the usefulness of the medicine prescribed to cure this, alleged, problem. We pointed to a set of risks associated with an European copy cat behaviour where the recipe is a change in the IP legislation. Drawing on largely US literature, we argued that a transfer of the property right from the researcher to the University risks reducing the functioning of university-industry networks and entrepreneurial activities, bias technical change and generating such high costs to the University that the technology transfer may not work well. It is a bit ironic to observe how experienced US universities now have started to encourage riskier forms of entrepreneurial activities, rather than the traditional licensing route with established companies. This change of attitude and behaviour seems to take place at the very same time as European policy makers and universities are trying to change in the very opposite direction.

Whilst we, thus, articulate strong doubts of the validity of the belief of a poor (Swedish) commercialisation and the usefulness of the proposed policy solution, the strongest conclusion is that the policy discourse draws on an empirical foundation which is very unsatisfactory. Indeed, in the Swedish case, we demonstrated that statements of an empirical nature were sometimes made where the data was missing, or quite contradictory to the statement made.

The overall conclusion is, therefore, that efforts have to be made to improve our empirical understanding and to avoid repetitions of the process whereby a belief becomes dominant without a matching empirical base. There are a number of issues here which we bring the reader's attention to.

First, policy needs to be based on documented evidence which is referred to by the Government. Unfortunately, in Sweden, Government Bills lack references to sources which mean that Members of Parliament and others concerned don't have easy access to this material.

Second, whilst many of the benefits that come out of academic research are difficult to quantify (Salter and Martin, 2001; Jacobsson and Perez-Vico, 2010) efforts have to be made to measure those that can be measured. Unfortunately, neither academic spin-offs nor academic patenting is documented by the Government, for instance by the Swedish Central Bureau of Statistics or by other units. With a better data, we do not, of course, exclude the possibility that the belief is correct, but it can also go the other way.

Third, as is well known in political science, policy making takes place in a context where *advocacy coalitions*, made up of a range of actors sharing a set of beliefs, compete in influencing policy in line with those beliefs (Smith, 2000). Science Policy is, of course, not an exception. It is, therefore, of vital importance that the civil servants engaged in preparing documentation and suggesting particular policies have the required competence, back-up and working conditions that allow them to critically assess proposals from various lobbyists, however these proposals are presented.

Finally, waiting for a real evidenced based policy should not stop us from trying to improve the social and economic value of academic research. In this task, it is, however, essential to include an assessment of the many benefits which are difficult to quantify. Here we need to go much beyond the current focus on spin-offs, patents and licenses and include more subtle, yet vital, benefits such as influencing the direction in which firms search for business opportunities (Jacobsson and Perez-Vico, 2010). These may be captured by a system approach; as Arnold (2004, p. 3) points out, "... a systems world needs system evaluations."

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