The different assessments of the Swedish Life Science Industry - what's behind the bright respectively the dark interpretation?

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> *"Swedish research within life science is of high quality, at the same time as companies engaged in this area represents a great share of Swedish export successes."* (Swedish Government Message, October 16th 2013) [3]

> *"Since the Millennium the Swedish pharmaceutical map has been redrawn. The Swedish pharmaceutical industry has been shrinking to an extend that is unprecedented in its history and worldwide."*
> (http://www.oresundsinstituttet.org) [4]

1. Introduction

The quotations above illustrate the inconsistent assessments of the economic situation of the Swedish life science industry, made in contemporary research and policy analysis. The assessment of this multifaceted industry; which besides the pharmaceutical area also includes the biotech equipment and medical technology areas, differs not only between contributors to the policy discourse and academic scholars, but also the academic field itself is divided.

One group of studies presents a rather optimistic view of the Swedish life science industry and its possibility to economize on research, policy and industrial investment. What the positive interpretations have in common is that they most often rely on approaches developed for

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analysis on a high level of abstraction, such as national innovation system, cluster or triple helix approaches. Moreover, they have to a large extent been utilised by policy makers as a point of departure for policy-oriented approaches. (For an overview, see Elzinga, 2004, Högselius 2010, Eklund, 2007, 2013, Waluszewski, 2011)

Another group of studies presents a more problematic view of the Swedish life science industry and its possibility to economize on research, policy and industrial investment. What these studies have in common is that they most often rely on approaches developed for empirical based, processes oriented studies, among others in the IMP setting. (Waluszewski, 2004, Shih, 2009, Linné, 2010, Ingemansson, 2011, Baraldi &Waluszewski, 2011).

However, what's perhaps most peculiar is that the different assessments of the Swedish life science industry are made on a rather similar understanding of the main changes in the Swedish life science industry over the last decades, including how these are related to changes in the global life science industry. This raises some important questions about the relation among the assessment of the renewal ability of an industry and underlying theoretical assumptions this is resting upon. Can the bright and the dark assessment of the Swedish life science industry and its ability to economize on innovation and industrial renewal be related to some specific theoretical presuppositions?

The aim of this paper is to present a brief overview of the different assessments that are made of the renewal ability of the Swedish life science industry and what analytical foundations these are built upon. In this paper, for practical reasons the Swedish life science industry is delimited to the pharmaceutical area and the closely related biotech equipment area, while the med tech area is not included.

The research question concerns a) the factors that are, explicitly or implicitly, assumed by the assessments to lie behind a specific industry's innovation and renewal ability, and b) the factors that are assumed to lie behind the possibility for actors to economize on these investments. An increased understanding of the relation among theoretical underpinnings and policy's framing of renewal opportunities and hindrances is not only important for policy, but also for business and the society at large.

The paper is organised as following. We will continue with taking a closer look of the bright and dark assessments including what observations they are resting upon. Then we will discuss the theoretical underpinnings of two major groups of studies..

1.1 A common interpretation of the restructuring of the Swedish and the global life science industry

Regardless if we turn to studies that gives a bright or a dark picture of the Swedish life science industry, the changes it has gone through over the last decades is characterised in a similar way – and as a global phenomenon. The acknowledged global changes can be summarised as following:

What especially the pharmaceutical part of the global life science industry has been facing since the 1990s; affecting also the biotech equipment area, is that along with increasing costs for the creation of new pharmaceuticals, a growing number of governments also advocates the use of *generics*, i.e. low cost copies of products which no longer are protected by patent proprietary. Or, as McKinsey (2011, p.1) characterised the situation that the life science industry is facing:

> *"Regulatory requirements—particularly the linkage among the benefits, risks, and cost of products—will increase, while the industry pipeline shows little sign of delivering sufficient innovation to compensate for such pressures. These factors suggest that the industry is heading toward a world where its profit margins will be substantially lower than they are today."*

In order to save the viability, "big pharma"[5], i.e. the large global pharmaceutical companies, have tried to expand in regions with economic growth and increased investments in health care, above all in Asia and South America. However, the three dominating measures undertaken in order to save the profit levels have been to, a) expand through mergers and acquisitions, b) outsource activities regarded as cost-driving; mainly research but also manufacturing, and c) handle renewal through in-licensing of potential innovations from the private as well as the public sector. (Mirowski, 2011, Sandström, 2012, Rickne et al 2012, Waluszewski et al, 2009)

[5] There is no clear definition of Big Pharma. One common way to define Big Pharma has been to rank the largest 20 companies by reported revenue. (Mirowski, 2011, p. 200) Another way, emerging in the wake of the last decades mergers and aquisitions, is to define it by reported reveneu <USD 5 billion. This definition makes the list of Big Pharma's somewhat shorter, or 16 companies in 2010. (McKinsey, 2011)

The outsourcing of cost-driving activities have given rise to the emergence of a new type of life science organisations; so called CRO's or "contract research organisations". These both private and public organisations have engaged in a wide variety of specialized activities within the life science industry; from pre-clinical and clinical trials, development of new biotech analytical equipment and method, over to drug delivery. (Mirowski, 2011, Sandström, 2012, McKinsey 2011)

As a result of the restructuring of the global life science industry, including mergers, acquisitions and the outsourcing and off shoring of research and other cost-driving activities, the number of big pharma has decreased over the two last decades, while the number of small, specialized private firms and public financed organisations has increased – and were the first differs significantly from the latter in terms of size and economic resources. (Mirowski, 2011, Sandström, 2012, McKinsey 2011)

1.2 The Swedish life science industry – when global change patterns affect the industry of a small nation

Also when it comes to the changes that have occurred in the Swedish life science industry over the last two decades, these are characterised in a similar way in studies that gives a bright respectively a darker interpretation of the industrial and economic consequences of these. The acknowledged changes of the Swedish life science industry can be summarised as following:

Before the mid 1990 the life science industry was dominated by two Swedish owned pharmaceutical companies; state owned Pharmacia (which also was the mother company of one of the world's largest biotech equipment companies, Pharmacia Biotech) and the private owned Astra. During the second half of the 1990s, both these companies was sold out, due to the 'economise through mergers and acquisition logic'. (Waluszewski, Håkansson, 2014, Nilsson, 2010)

Pharmacia merged with US based Upjohn and its industrial structure was immediately exposed to radical changes. The head quarter and all strategic functions was moved to the US, the biotech equipment and med tech parts of the company were sold out, and the activities Pharmacia-Ujohn kept in Sweden was mainly manufacturing. Even in terms of basic technology a radical shift was made, from Pharmacia's focus on biotech based drugs over to

Upjohn's focus on synthetic chemistry. Six years after the merger, Pharmacia-Upjohn was exposed to a new radical restructuring, when the company was bought by Pfizer. As a result, most of the remaining manufacturing activities in Sweden was sold out or closed down. The only remaining activity was the running of a production plant with about 500 employees. (Waluszewski, Håkansson 2014, Nilsson, 2010, Öresundsinstitutet, 2013)

After the changes in the Pharmacia sphere, Astra became the largest and dominating Swedish pharmaceutical company, representing about 80 percent of the Swedish export of pharmaceuticals. When Astra in the late 1990s was sold out to UK based Zeneca, its head quarter was moved to London, but besides that the first years of the millennium was characterised by business as usual in the Swedish part of Astra. However, in 2004 AstraZeneca started a process of reducing activities in Sweden, mainly in research. In 2010 the company's research activities in Lund was completely closed down and 900 employees engaged in research or research related activities lost their jobs. In 2012 the research activities in Södertälje, south of Stockholm, was closed down and 1350 employees engaged in research and research related activities lost their jobs. In total, the consequences of the changes of the Swedish pharmaceutical industry was that Sweden lost 9000 employees during the first decade of the millennium, or about 43 %. (Öresundsinstitutet, 2013, Waluszewski & Håkansson, 2014, Nilsson, 2010)

Along with the restructuring of the two dominating Swedish pharmaceutical companies, the total number of Swedish life science companies has increased. The main part of the new life science based firms are however 'micro companies', with less than10 employees. And among those only a few are engaged in drug delivery. For example, Oasmia, one of a handful companies engaged in this area which has passed the micro-stage, is basing its activities carried out by about 80 employees, on venture capital and on the expectations that it finally will find a substance possible to commercialize. One of the few pharmaceutical companies that have managed to emerge to an industrialised company with production and global sales is Orexo, which however has by-passed the risky work with developing new substances and instead based its activities on the creation of new combinations and applications of established substances. Orexo is since 2010 owned by Danish Novo A/S. (Sandström, 2012, Nilsson, 2010, *Svenska Dagbladet*, May 28, 2013)

If we take a look at the development within the related biotechnology area, which in Sweden in practise is biotechnological equipment and methods for analysing molecule interaction, also this part of the industry has been characterised by mergers and acquisitions. Compared to the pharmaceutical area, the Swedish biotech area has however got away better with the restructuring of the life science industry:

The dominating company in the Swedish biotech equipment area has its roots in the Pharmacia sphere. When the pharmaceutical part of Pharmacia was sold out to Upjohn, Pharmacia Biotech, already at that time one of the world's leading biotech equipment companies, was not included in the affair. This part of Pharmacia was instead sold to the British company Amersham Biosciences. The new owner continued to invest in the former Pharmacia Biotech industrial structure in Uppsala, to which also the head quarter of Amersham-Pharmacia Biotech was moved. When Amersham Pharmacia Biotech in 2004 was bought up by GE Healthcare, the Uppsala site once again became the heart of a new owners biotech equipment businesses. GE Healthcare did also buy back a Pharmacia Biotech spin-off in 2006, a company named Biacore, one of the few new biotech equipment companies that had survived the innovation journey and emerged in to an industrialised and profitable niche company in the molecule interaction field, with some hundred employees. (Waluszewski, Håkansson, 2014, Nilsson 2010)

GE Healthcare is; with R&D and industrial activities covering development and production of biotech equipment from laboratory and pilot over to large scale process equipment, and about 1600 employees, the dominating actor in the Swedish biotech industry. Besides GE Healthcare the Swedish biotech industry is populated by some dozens of start-ups engaged in the development of biotech analytical equipment and methods. Over the last two decades a handful of start-up companies has survived the innovation journey and are industrialised with global sales. Two of these are located to Uppsala and have strong historical links to Pharmacia Biotech. [6] (Waluszewski, Håkansson, 2014, Sandström, 2012, Ingemansson 2010)

[6] The two Uppsala based companies are Biotage, an American company which established its activities here in early 2000 through the buying of other Uppsala based companies; Pyrosequencing and Personal Chemistry, and the venture capital financed Gyros. Affibody is a Stockholm based company with links to KTH and KI, while Cellartis is located to Gothenburg. What these four biotech companies have in common is that they all are industrialised; i.e. they have commercialised product systems. Besides venture capital owned Gyros they are profitable – and have foreign owners.

The Swedish life science industry is in other words facing the similar situation as the global life science industry: By mergers and acquisitions in both the pharmaceutical and biotech equipment industry, of big pharma's outsourcing of 'cost-driving' activities to CRO's and relying on new pharmaceutical and biotech ventures for innovation and industrial renewal. Measured in numbers of companies, the Swedish life science industry is growing. Measured in terms of jobs, the Swedish life science industry is decreasing.

In what direction the industry will change is important: the life science industry still plays a significant role in the Swedish economy. In 2010 it represented about 9 % of the Swedish export and employed; if also sales companies are included, about 42 000 people. Besides that, the life science industry is an important counterpart to academic research in this field, and furthermore, it is the most important employer of PhD's working outside academia. About on fifth of the Swedish PhD's that continues their carrier in industry goes to the life science area. (Sandström 2012, Handelskammaren, Uppsala/Stockholm Uppsala Life 2010.)

From a political and policy perspective, a strong and expanding Swedish life science industry has been an explicit goal over the last three decades. (Axelsson & Laage- Hellman, 1986) For Sweden, which is characterised by its high cost level, but also, a high education standard and extensive investments in research, and furthermore, a long tradition in both research and industrial activities in the life science area, the latter is regarded as being of high strategic importance. The life science industry is known as being dependent on access to advanced research and technology, and its outcome is for high value added. Or as the role of the life science industry was expressed in the latest Swedish research and innovation bill:

> *"Life science research and businesses within pharmaceuticals, biotech and med tech are important future areas for Sweden" […] Companies within life science are developing products which most often has a very high value added. Such companies represent extensive export income to Sweden, large investments in research and development and many knowledge intensive jobs."* [7] (Prop. 2012/13:30, p. 80)

Hence, the assessment of the consequences of the past and contemporary changes of the Swedish life science industry, and how these are related to the global life science industry, is of significant importance for several reasons. It is the foundation on which policy measures

[7] Author's translation

are designed and implemented, with consequences for business, research and society at large. However, although the assessments made are based on a rather similar understanding of the main changes that the Swedish life science industry has gone through over the last decades, the differences are obvious when it comes to interpreting the consequences. Is the glass half-full or half-empty? Does the current state of life science in Sweden constitute an opportunity or a problem? In order to shed light over this question, in the next section we will take a closer look at the bright and dark assessments including what observations they are resting upon.

1.3 The restructuring of the global life science industry – increasing opportunities for the Swedish life science industry?

It is not only in policy initiated reports that a rather bright future of the Swedish life science industry is outlined. There are also a number of research reports; carried out with the restructuring in the Pharmacia- and Astra-spheres at hand, that outlines a rather positive view on the opportunities for the Swedish life science industry to expand and prosper. (See e.g. Teigland et al, 2004, Hallencreutz & Lundequist, 2006, Teigland & Lundequist, 2008, Sandström et al, 2011, Laage-Hellman et al 2012, Sandström, 2012)

One common denominator of these studies is that they draw attention to the possibilities that have occurred in the wake of changes that have characterised the Swedish and global life science industry over the last decades. The analysis has a common strike: they points at the possibilities to renew the life science industry in the wake of the selling out of Pharmacia and Astra, mainly through utilising the investments made in research and development capabilities. Given that Sweden can keep and utilise these resources; in terms of commercialisation of research, in the establishment and financing of new start-ups, for the renewal of established companies, or as means that can attract foreign life science companies to invest in Sweden, the life science industry is assigned significant possibilities to develop and prosper. (Sandström et al, 2011, Laage-Hellman, J., Rickne, A., Stenborg, E., 2012)

The perhaps most optimistic interpretations are made in policy related reports. The Swedish life science industry's access to "competence, prominent research, conditions for research financing", is seen as key resources for the ability to "reach out within innovations on the international market". (Sandström, 2012, p.12) Firstly, the competences that have been released through the restructuring is seen as possible to utilise in new as well as established life science companies, specialised on specific solutions related to the global life science

industry. Secondly, public financed research is seen as possible to utilise for industrial renewal, both through being a ground for the establishment of new start-ups and through being means that can attract foreign companies to establish research and development activities in Sweden. The latter aspect is expressed as following in the latest research and innovation bill:

> *"The government reports in this proposition a number of measures that will strengthen Sweden's position as a strong research nation within the life science area and as an attractive country for the international pharmaceutical, med-tech and biotech industry to place research and development units in."* (Prop. 2012/13:30, p. 81.)

The latter understanding is also reflected in the political commission to policy practitioners. The political reactions on Astra's latest close down of research activities in Sweden, where about 1350 researchers in the unit in Södertälje were dismissed, was to act in order to keep the research competence in Sweden. Through the establishment of a new national research institute; "Science for Life Laboratory", abbreviated "SciLifeLab", the ambition was to create a Swedish competence centre of significant importance for global life science companies. (Waluszewski & Håkansson, 2014) Along with the Swedish Innovation Agency Vinnova established a new agenda named "Sweden as international centre for life science", were Sweden's investment in research in the life science are was appointed as key resources for a continued positive development:

> *"Sweden has a good point of departure in terms of the large resources that through the two latest research and innovation bills have been invested above all in research within the life science area. These investments need to be managed in order to give result in terms of innovation and growth".*[8] (Vinnova, Dnr. 2012-01853)

1.4 The restructuring of the global life science industry – a threat for the Swedish life science industry?

There are however research reports that draws attention to some significant darker strikes of the changes in the global and the Swedish life science industry. One of the most acknowledged voice concerning these consequences of the restructuring of the global life

[8] Author's translation

science industry is Mirowski (2011). In short, Mirowski's main message is that big pharma's outsourcing and offshoring of activities related to research and development can be considered as these actors move of cost-driving activities over to public financed organisations and venture capital financed start-ups. (Mirowski, 2011, p. 199-208) Few of the CRO's that actually have managed to present a drug candidate or a biotech instrument that in beforehand seems to have a commercial potential, have had the economic ability to engage in the demanding industrialisation process. Instead, the trend is that promising projects are bought up by large, global life science companies, to be absorbed in their established industry structures. (Mirowski, 2011, sid 199-208, Pisano, 2006)

There is also a group of studies that underlines that the Swedish life science industry is no exception to this pattern. Regardless if the focus of the studies is the change in the industrial structure, in supplier-customer relationships or in the investor/owner structure, a common notion is the severe consequences that the selling out of two "complete" pharmaceutical firms; i.e. with structures adapted for development, production and use of the outcome, have had that for the Swedish life science setting. The direct consequences observed are reduction of research, development, production and marketing activities. The indirect consequences are reduced research collaborations with academia, changes in relation to suppliers and sub-suppliers, and above all, lack of large producing settings (global marketing and sales included) which new ventures can relate to. (Håkansson, Waluszewski, 2014, Öresundsinstitutet, 2013, Nilsson, 2010, Waluszewski, 2004)

A worrying observed trend is that the start-ups in the Swedish life science industry do not expand as expected; neither in terms of employments or investments. (Waxell, 2009, Nilsson, 2010) Other aspects brought forward is that although the amount of Swedish life science companies has increased since 2000, most of them are micro companies with less than 10 employees. Furthermore, only a few of the start-ups are engaged in the core activities of the life science industry's innovation process; the development of new drug candidates, but are instead engaged in carrying out different kinds of complementary activities. (Nilsson, 2010, Baraldi & Waluszewski, 2011, Baraldi, 2013 et al)

In similarity with what Mirowski (2011) underlines, the common observation is that the Swedish start-ups that actually have started a promising innovation journey suffers from difficulties to carry the costs in the long run. As a consequence, start-ups with promising

innovations tends to be bought up by established global pharmaceutical and biotech companies – not seldom located outside Sweden. (Waluszewski, Håkansson, 2014, Baraldi, 2013 et al, Strömsten & Waluszewski, 2013, Ingemansson, 2010)

The observed consequence is that both the industrial structure and the industrial competence have been depleted. (Öresundsinstitutet, 2013, Nilsson, 2010) During the first decade of the millennium 9000 employments was lost in the Swedish life science industry, or about 43 %. The consequences of only AstraZenecas' reduction in Sweden was expressed as following by Öresundsinstitutet:

> *"In Sweden AstraZeneca have reduced the employees form about 11 000 to 5 500, and closed down their research and development departments with about 950 persons in Lund and 1350 persons in Södertälje. The reduction is even larger if we compare with year 2003-2007 when AstraZeneca employed between 12 000 and 13 000 people in Sweden."* [9] (Öresundsinstitutet, 2013, p 3)

Even if the situation for the start-ups in the biotech area is seen as problematic, in this part of the Swedish life science industry there are also some positive strikes are observed. This is mainly seen in the fact that one of the world leading suppliers of biotech equipment for laboratory and large scale, Pharmacia Biotech, was not included in the Pharmacia and Upjohn affair. Instead, the biotech equipment business was sold out to the British company Amersham Bioscience. The latter continued to invest in Pharmacia Biotech's industrial structure in Uppsala, and so did also GE Healthcare, which bought the biotech business in 2004. With 1600 employees and head quarter in Uppsala, and activities covering development, production and global marketing of biotech equipment and methods for laboratory, pilot, and large scale, the Swedish life science industry is populated by one of the dominating global companies in this area. (Harrison, Waluszewski, 2009, Shih, 2009, Linné, 2011, Waluszewski, Håkansson, 2014) When one of the spin-offs from Pharmacia Biotech that after a decade of economic struggles with an innovative product system became profitable, it was bought up by GE Healthcare. In practise, this was the industrial environment it once emerged from and its activities could continue with Uppsala as geographic base. (Harisson, Waluszewski, 2009, Waluszewski, Håkansson, 2014)

[9] Author's translation

Still, what three of the four industrialised biotech start-ups with more than 30 employees have in common with GE Healthcare; Biotage in Uppsala, Affibody in Stockholm and Cellartis in Gothenburg, is that they have foreign owners, while the forth; Gyros is still financed by Swedish venture capital. The interpretation made is that the future location of these start-up companies' future industrial activities is seen as an open question. (Nilsson, 2010, Waluszewski, Håkansson, 2014)

Hence, besides stressing the fact that most start-ups and CRO's does never reach so far that they can survive on an industrialised innovation; regardless if the new concern a pharmaceutical substance or a biotech analytical device, another observation is made: The companies that have economic strength to industrialise innovation embryo's and to buy promising start-ups within the life science sphere are, with a few exceptions, located outside of Sweden.

1.5 A common empirical understanding – but two different assessments of the industrial consequences

To summarise, what both the studies that makes a bright respectively a dark assessment of the Swedish life science industry's ability to expand and prosper have in common is that the following observations are made:

- The pharmaceutical area of the life science industry is increasing in terms of number of companies and decreasing in terms of employees.

- The biotech equipment industry is dominated by a world leading foreign owned company and a handful of industrialised but also foreign owned companies.

The differences are, in short, following:

- The bright assessment of the Swedish life science industry's ability to expand and prosper is mainly based on the expectation that Sweden's heavy investment in research is a critical resources for the emergence of new and the attraction of established foreign firms to invest in Sweden.

- The dark assessment of the Swedish life science industry's ability to expand and prosper is mainly based on the observed changes in the industrial and the owner structure, and above all, in the weakened industrialisation capacity.

In the next section we will take a closer look at what theoretical underpinnings these different assessments are resting on.

2. What's under the surface of "systemic innovation thinking"?

At a first sight it seems as the different assessments of the Swedish life science industry are resting on a common theoretical ground: All of them depart from a systemic understanding of innovation and industrial renewal. For many innovation thinkers, the emergence of a systemic perspective during the last decades is the greatest breakthrough in their field (Mytelka & Smith 2002, Smits & Kuhlman 2004, Sharif 2006, Lundvall 2010, Soete et al 2010, Miettinen 2013). But what is the specific advantage of a system innovation thinking – and what aspects of it can shed light on how the assessment of a specific industry's ability to innovate, renew and prosper are made? If we should turn to an increasing body of anthology chapters and journal articles that claim to explain the emergence and content of systemic innovation thinking, the answer of what is specific with it could, somewhat caricatured, be as following:

In the mid-1980s a number of scholars realised that innovation is better viewed as taking place in a systemic context. This allowed innovation theory to break free from the straitjacket of neoclassical economics, whose deductive modelling was unsuitable to the messy real-world processes of technical change and industrial renewal. Social and institutional factors that had been exogenous to economists could now be seen as system components. The breakthrough also allowed a departure from the linear model; based on the idea that basic research influences applied research, which in turn influences innovation, clearing the field for more advanced interactive views. This type of systemic innovation thinking, with "National Innovation System" in the forefront, draw attention to the fact that innovation and industrial renewal does not take place in isolation but within a system – which could be affected. The "National Innovation System" concept was also very attractive to those who wanted to utilise innovation as a source of prosperity. For politicians and policy this became a role model for how society at least to some extent should be structured to facilitate innovation. With OECD as leading voice, "National Innovation System" and similar systemic models was spread

across the world in the 1990s and onwards. (Elzinga, 2004, Eklund, 2007, 2013, Högselius, 2011)

However, the explanation above gives a rather narrow picture of what systemic innovation thinking is and how it emerged. It is written from the perspective of "innovation studies", an emerging field coalescing around a common set of journals, conferences and classic works (Fagerberg & Vespagen 2009, Martin 2012). In this definition of innovation studies, which has been adopted by OECD and EU, adjacent and overlapping fields are either presented as obsolete and simplistic, such as neoclassical economic thinking on science and technology, or basically ignored. The latter fate has fallen both on Science and Technology Studies (STS) and on IMP studies, two different but related fields that have developed their own tradition of systemic thinking – without larger impact on innovation studies. (Eklund, 2007, 2013)

Hence, under the surface of a systemic innovation thinking a number of different approaches, with some significant differences can be outlined. While one type of systemic approaches; for example the IMP and STS traditions, underlines the importance of the established landscape; of the interaction among companies, organisations and individuals and the imprints this creates in terms of interdependencies among material and human resources, another; and in fact the dominating group of systemic approaches, have abstracted away these in favour of the interdependencies among the non-business and business settings on a group level. In the elegant systemic perspectives emanating from the OECD, the context exists only on a high level of abstraction.

2.1 The underpinnings of the bright assessments

It is also the latter type of systemic thinking that can be traced behind the bright assessments of the Swedish life science industry. In the most common systemic approaches; "National Innovation System" and "Triple Helix", the focus is directed to the relation among the state, the knowledge producing setting and the market, while the "Cluster" approach focuses on the knowledge spill-over among agglomerations of competing companies. Furthermore, although these approaches add a social dimension to the traditional market thinking, they are still compatible with the basic assumptions of the latter; i.e. of independent economic actors and of economically homogenous resources. The interdependencies are instead assumed to occur among different types of systems; among the knowledge producing setting, the state and the

market. Hence, these models can be depicted as "disentangled", since only macro-level interdependencies are taken into account. (Eklund, 2013, Waluszewski, 2011)[10]

It is also a group of approaches that, more or less in consonance with how these originally were presented in academia, have been adapted to fulfil the demands of policy analytical tools, to a large extend supported by transnational organisations as OECD and EU. Even if the original sources have varied, with National Innovation Systems in the forefront, the main policy contribution have been to adapt these from being tools utilised to analyse industrial and societal renewal in retrospect, to utilise these as recipes for how to stimulate a nations' innovation ability and growth. (Elzinga, 2004, Högselius 2010, Eklund, 2007, 2013, Waluszewski, 2011)

When applied on the life science area, following ingredients have been outlined as critical for the creation of a viable life science industry (Casper & Murray, 2004): The existence of a dynamic academic research environments, (Kenney, 1986), access to venture capital (Lerner, 1995) and a close spatial proximity among companies engaged in commercialisation of life science (Powell et al, 1996).

2.2 The underpinnings of the dark assessments

The attention to investments in place and the interactions that takes place in relation to them, a common denominator of the models utilised in most of the studies that gives a dark assessments of the Swedish life science industry, i.e. those based on IMP and STS related approaches. These approaches attention to the relation among the new and the existing has in turn a kinship with approaches developed by economists dealing with path dependence and increasing returns (David, 1985, Arthur, 1994) with development blocks (Dahmén, 1988), by history of technology (Hughes, 1987) and ANT theorists, (Latour, 1987 Callon, 19xx) The notion that interdependencies exist on both micro and macro levels means that the success of any new economic resource and the prosperity of any new firm is assumed to be dependent on the reaction from representatives of established technological, social and economic structures. In this perspective, innovation and industrial renewal are processes where anything new is

[10] This distinction between context-sensitive and abstract approaches very much parallels the distinction some scholars make between two types of social scientists, the first one historically and contextually sensitive, mostly based on empirical case studies, the other one decontextualized and variable-centred, aimed at abstract generalisation and emulation of the natural sciences. See Flyvbjerg 2001, Gaddis 2002.

judged by intricate patterns of established physical and social resources. (Håkansson et al, 2009, Marglin, 2008, Gudeman, 2001)

This way of approaching innovation and industrial renewal can be labelled "entangled", since it is not the quality of the new in itself, but what economic consequences it have on established technological, social and economic resources that is seen as decisive for the direction of the innovation process. The more the new is challenging investments in place, the larger investments needed in order to embed it into producing and using settings. (Olsen et al, 2013, Håkansson et al, 2009, Håkansson & Waluszewski, 2007)

In order to at least get a brief understanding of the potential economic benefits of something new, it is important to analyse: a) how resources are combined and activated across organisational borders in the settings were the new is going to be taken into large scale production and use, and b) what actors that can make what deals based in the embedding of the new. (Håkansson & Waluszewski, 2007, Olsen et al, 2013)

3 The assessment of innovation and industrial renewal – a question of imprints of disentangled or entangled analytical models

If we return to the question of the factors behind the different assessments of a) the Swedish life science industry's innovation and renewal ability, and b) different actors' possibility to economise on such processes, we argue that the answer is strongly coloured by the presuppositions embedded into the analytical tools.

If we make the assessment with a disentangled approach as point of departure, the ability to embed something new into a successful large scale production and use is assumed to be a result of:

- The new solutions relative performance
- The level of breakthrough – the more radical, the better chance to a high relative performance and successful innovation

The economic benefits of a successful innovation are assumed to be directed to:

- Those who invest in the innovation process; i.e. those who engage in the commercialisation of research results and in new or renewed firms in are implicitly assumed to be able to economise on these investments.
- The investments in research and innovation and the economic benefits of this engagement are explicitly assumed to take place the same legal borders.

If we make the assessment with an entangled approach as point of departure, the ability to embed something new into a successful large scale production and use is assumed to be a result of:

- What consequences the new has for investments in place in a producer and user setting; the more the new will increase the value of established resource constellations in the producer and user setting, the more likely that it will be transformed to a successful innovation.
- The level of breakthrough: the less the new challenge established resource constellations in the producer and user settings, the more likely that it will be transformed to a successful innovation.

The economic benefits of a successful innovation are assumed to be directed to:

- Those who represent the investments in place which can benefit most from embedding the new into a large scale production and use. This is not necessarily the same economic actors that engage in transforming research results to private properties.
- The places were those who represent investments in place which can benefit from are located. These are not necessarily located within the same legal borders as those engaged in the commercialization of research.

What assessment that is the most reliable; that the Swedish life science industry "*represents a great share of Swedish export successes"* (Swedish Government Message, October 16th 2013) or that the same industry *"has been shrinking to an extend that is unprecedented in its history and worldwide"* (http://www.oresundsinstituttet.org) is simply a question of what analytical approach, including what underpinnings it is resting on, we consider as most reliable. This paper has also shown that the term "systemic perspective" is very broad and encompassing, in fact covering both the approaches analyzed here. The need to be clear about what we mean

with a system, and with what our theoretical assumptions focus on and abstract away from, is an important implication of this study. Not only for research on innovation and industrial renewal, but also for policy, business – and last but not least – for researchers facing opportunities to engage in the commercialization of research.

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