Shaping a new industry – A market perspective

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Abstract

In contemporary policymaking there is a strong consensus that industries related to advanced knowledge and science are important for national competitiveness and economic growth. The underlying assumption is that the use of new knowledge, products and processes can strengthen industrial competitiveness and increase national wealth (OECD, 1996). Although the potential of innovation as a value-creator is eminent, the empirical evidence of the benefit of public management of industrial development and innovation is ambiguous (Shih, 2009). In this paper we will look closer into this issue by investigating a public effort to manage and create an industry. We aim to increase the understanding of the activities that make up the creation of an industry.

The empirical example used is the Taiwanese government's ambition to create a biotechnology industry which so far has been considered a disappointment in terms of industry income. However, since the government started to promote the sector the number of companies has grown rapidly. A large number of different actors have been involved in the emergence of the Taiwanese biotechnology industry. We draw upon earlier literature (see e.g. Helgesson et.al., 2004) which perceives markets and industries as shaped by a number of different actors, including policy, industry and academic. The views of these actors sometimes have a sound grounding in "reality" other times they are based on ideals and ideas from the model world (Håkansson & Waluszewski, 2002). Thus the creation of an industry is a part of a long chain of market activities encompassing a number of various conflicting as well as streamlined views. To understand of how these activities shape industries we will use a conceptual tool developed by Helgesson et.al., (2004) which analyzes market practices.

Introduction

In contemporary policymaking there is a strong consensus that industries related to advanced knowledge and science are important for national competitiveness and economic growth. The underlying assumption is that the use of new knowledge, products and processes can strengthen industrial competitiveness and increase national wealth (OECD, 1996). Although the potential of innovation as a value-creator is eminent, the empirical evidence of the benefit of public management of industrial development and innovation is ambiguous (Shih, 2009). In this paper we will look closer into this issue by investigating a public effort to manage and create an industry. We aim to increase the understanding of the activities that make up the creation of an industry.

The empirical example used is the Taiwanese government's ambition to create a biotechnology industry which so far has been considered a disappointment in terms of industry income. However, since the government started to promote the sector the number of companies has grown rapidly. A large number of different actors have been involved in the emergence of the Taiwanese biotechnology industry. We draw upon earlier literature (see e.g. Helgesson et.al., 2004) which perceives markets and industries as shaped by a number of different actors, including policy, industry and academic. The views of these actors sometimes have a sound grounding in "reality" other times they are based on ideals and ideas from the model world (Håkansson & Waluszewski, 2002). Thus the creation of an industry is a part of a long chain of market activities encompassing a number of various conflicting as well as streamlined views. To understand of how these activities shape industries we will use a conceptual tool which analyzes market practices.

A market practice perspective[1]

The model proposed by Helgesson et. al. (2005) distinguishes three broad subcategories of market practice: exchange practice, representational practice, and normative practice (see Figure 1 below).

Exchange practice refers to the continuous activities that purport to temporarily stabilise certain conditions (the parties to the exchange, the exchange object, the price, the terms of exchange) so that an economic or intra-organizational exchange becomes possible. This includes both highly idiosyncratic activities and more general ones that go into creating a specific economic exchange with an external counterpart or intra-organizational exchange within a firm. We include in these market practices, actions to change, coordinate and stabilize structures of different kinds, e.g. in order to reach certain policy objectives.

Representational practice refers to activities that contribute to depict markets, how they work, and how focal firms are positioned in the market context, and in our case representations related to various policy ambitions. Description and analysis of the potential market for new products or analysis of the profitability of different types of customers would be common types of representations in markets. One important part of representational practice is the conceptual and theoretical foundation for a specific description and analysis. The "network theory" concept is an important aspect of representational practice.

Normative practice refers to activities that contribute to establish objectives for how a market should be (re)shaped and work according to such norms and also for how specific actor(s) in the market define norms they consider to affect their over-all objectives. Some examples on the macro level are "market reforms", general rules of competition and on the

[1] A previous version of this section has been presented in a conference paper: Andersson, P and Mattsson, L-G (2007), "Construction of Temporality in Merger Processes", paper for *IMP Journal Seminar*, Trondheim, May 10-12 2007

micro-level, individual firms' over-all strategic objectives and economic control systems. An example is the development and communication of the objectives of certain policy ambitions.

The practices are linked to each other through chains of translations (Callon 1992). Thus, normative practice may produce rules and tools that become employed in exchange practice, as well as indicate measures and methods of measurement to be used in representational practice. Representational practice will produce both market descriptions that can be drawn upon in normative practice, and different types of results that feed back into on-going exchange practice. Exchange practice, finally, enters into representational practice through more or less systematic measurements and into normative practice through the interests it creates among actor(s).

We thus assume that industrial policy practices are part of, and interacts with other forms of market practices. Part of the "construction of new policies" concerns the complicated processes, where each individual actor more or less explicitly create e.g. representations, norms and exchange practices – in interactions – related to various industrial policy ambitions.

Figure 1. A market practice model

Case

A policy ambition to create a Taiwanese biotechnology industry

In the mid-1990s the Taiwanese government started to aggressively promote the biotechnology field. The importance of biotechnology had however already been acknowledged by Taiwanese policymakers in 1982 when it was identified by the government as one of the eight key technologies of the future. In 1984, a non-profit research institute, the Development Center for Biotechnology (DCB), was established. Commissioned by the government to promote the development of biotechnology in Taiwan, the DCB was modelled after Industrial Technology Research Institute (hereafter ITRI)[2]. Not long after, the first biotechnology company, Paoshen Pharmaceuticals involved in vaccine production was founded. A second biotechnology company was also established shortly thereafter (MOEA 2008a). According to Lee Chong Chou, the Director of the Biotechnology Office at STAG, these activities were the only commercial attempts in the biotechnology field:

> There were no real attempts of the government to really promote the biotechnology at the time. There were only two biotechnology companies prior to 1995 and the DCB did not have much success in help towards developing an industry. (Interview, Lee Chong Chou)

In the 1990s an increasing volume of expert opinions were voiced towards Taiwan needing a drastic change in industrial direction, as the electronic and semiconductor industries were becoming mature. An important message that was brought forward among policymakers was that in order to not fall behind the development of advanced countries, Taiwan needed to re-direct development to some more knowledge intensive sectors. The field which received most attention was biotechnology (Gwynne, 1991; Cyranoski, 2000; MOEA, 2003a). It would take until 1995 before some dedicated policy attempts to push the Taiwanese biotechnology industry forward were initiated. In that year the Taiwanese parliament approved a promotion plan for supporting the biotechnology industry, also known as *the first promotion plan for biotechnology*[3] (MOEA, 2003b). At the time the two biotechnology companies had already gone out of business, and the DCB had been heavily criticized for failing in its mission to establish a biotechnology industry (Interview, Chester Ho). One commentator explains the situation in the following words:

> In some cases, the government has had to reconsider its approach. The Development Center for Biotechnology, established in 1984 when Taiwan first started to make its biotechnology push, was almost universally discredited for failing to build homegrown business (Harris, 2002:p600).

Hence the view brought forward is that when the first promotion plan was accepted through a referendum in the Taiwanese parliament in 1995, there was basically no biotechnology industry in Taiwan. The biotechnology industry emerged in Taiwan after the mid 1990s through the government's extensive support and coordination. Since the first promotion plan for biotechnology, the Taiwanese government has devoted a considerable amount of resources into the life-sciences and biotechnology. Revisions of the promotion plan have been made on

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2 ITRI is a semi-governmental research institute founded in 1973 by the Taiwanese government. The mandate of ITRI is to lead the way in the industrial development.

[3] In the first promotion plan five major areas of attention were targeted: 1) Related Laws & Regulations; 2) R&D and Applications; 3) Technology Transfer & Commercialization; 4) Investment Promotion & Incubation; and 5) Biotech Service Industry & Industry Promotion.

a bi-annual basis, and to date the expansion of the biotechnology industry in Taiwan has continued to be an issue of direct government intervention. A quote from an online information provider on Taiwanese biotechnology, *Biotech East,* comments on the government's imperative role in planning biotechnology development as follows:

> The strategy and direction of Taiwan's biotechnology industry development is clear and focused. Industry, institutions and government bodies all follow developmental guidelines as set forth in the Promotion Plan for the Biotechnology Industry. This document, a road map defining national industry goals and clearly detailing the corresponding action steps required to get there, was first written and released by the Executive Yuan branch of the government in 1995, and has been revised biannually ever since (Biotech East, Internet).

The ambition to focus on developing knowledge-based industries in order to maintain economic competitiveness was further strengthened when in 2000 President Chen Shui Bian[4] proposed to transform Taiwan into a *Green Silicon Island.*[5] This provided additional fuel for the enlargement of the biotechnology sector. In August 2001, Chen also proclaimed biotechnology as the most important industry for Taiwan's future economic development (Wong, Internet). Consequently, in the *Six-year national development plan* of 2002 biotechnology was made one of the pillars of national development and a part of the *Two trillion twin star project.* The focus of this project was four specific industries, the Trillion industries: *semiconductors* and *digital display*; and the Twin stars: *biotechnology* and *digital content* (MOEA, 2006). Table .1 shows the specific economic goals for each industry set up by the Taiwanese government and the production value of the industries in 2006.

Table 1: Two Trillion Twin Star Industries - Status as of 2006 and goals for 2009

Industry	Year	Production value
Semiconductors	2006 2009	1.39 trillion NTD 256.1 billion NTD
Digital display	2006 2009	1.27 trillion NTD 1.6 trillion NTD
Biotechnology	2006 2009	177.5 billion NTD 256.1 billion NTD
Digital content	2006 2009	341.2 billion NTD 515 billion NTD

Source: (MOEA, 2007)

As reported by the MOEA, the high profile support of the biotechnology industry in Taiwan has resulted in an accelerated pace of development. In Table 2 below the results in terms of

[4] The Democratic Progressive Party's Chen Shui-Bian (in office 2000-2008) declared in his presidential inauguration speech that Taiwan should concentrate on knowledge based sectors in order to maintain economic competitiveness and sustainable development. The goal was to transform Taiwan into a "Green Silicon Island". (Chen Shui Bian, Internet).

[5] The Council for Economic Planning and Development of the Executive Yuan initiated the 'green silicon island' plan in February 2001. The plan is based on three major concepts: a knowledge-based economy, a sustainable environment, and a just society. The plan is implemented under seven principles: (1) increasing knowledge, (2) using resources effectively, (3) prioritizing environmental protection, (4) upholding justice, (5) promoting regional balance, (6) strengthening cooperation, and (7) expanding the economy. (Government Information Office (1), Internet)

number of companies and revenues among other measures for the biotechnology industry, which by the government's definition also includes pharmaceutical and medical device companies, are shown.

Table 2: The Taiwanese biotechnology industry (2005/2006)* * in Billions USD

Industry	**Biotechnology**	**Pharmaceuticals**	**Medical Devices**	**Total**
Revenue*	1.21/1.33	1.95/2.03	1.84/2.14	5.00/5.51
Number of companies	253/268	419/368	484/500	1156/1136
Size of work force	8090/8570	14995/12224	15000/16350	38085/37114
Domestic Sales/Exports	60:40/60:40	82:18/79:21	54:46/58:42	66:34/66:34

Source: (MOEA, 2008a)

As has been demonstrated through government statistics, Taiwanese biotechnology has grown considerably since the mid-1990s because of the extensive policy support. In the National Development Plan for 2008 (CEDP, 2006: p26) it was expressed that the Taiwanese government is continuing this support and undertaking "effective measures to eliminate the knowledge, technology, and digital gaps" that are currently present. In a report on the investments opportunities in the Taiwanese biotechnology industry, the following could also be read at on the website of *Invest in Taiwan*:

> Taiwan's concerted policy efforts to develop research, development and production capabilities in the biotech sector have paid off in creating a wealth of investment opportunities. Biotech research at Taiwan's top academic institutions is gaining international attention, while development capabilities, fostered through joint industry and government support, are turning these research achievements into commercially viable products (Invest in Taiwan (2), Internet).

However, albeit the impressive growth of biotechnology in Taiwan, the industry has had difficulty in living up to the high expectations set by policymakers and investors. Even though scientific publications have increased, the academic sector has grown and a producing structure of domestic research institutes and companies has been built up, there are still several complications. The producing structure is still weak and a using structure of Taiwanese biotechnology products has yet to be clearly crystallized. The disappointment over the Taiwanese biotechnology is discussed by Hsu et al. (2005: p281), which provide the following description:

> Although the Taiwanese Government has put in a great deal of effort, the progress of biotechnology industry has not been as good as predicted. The total industrial output of Taiwan's biotechnology industry was less than 600 million US dollars in 2000, and most of the output was traditional bio-product related, rather than modern biotechnology products.

A similar opinion, that the Taiwanese biotechnology industry has not been fairing that well commercially, has also been brought forward in Nature (Swirbanks & Cyranoski, 2000: p422):

> Just as with electronics, the Taiwanese government has tried to develop biotechnology over the past two decades. But the results so far stand in stark contrast to the booming

> electronics industry. One only needs to look at Hsinchu to see the tiny contribution biotechnology makes 0.1% of sales and so far there is no sign of a major upswing.

Due to the perceived weak financial results as well as the modest technological outcomes, at least when measured in terms of the number of "breakthrough innovations", the government's polices have been challenged (Interview, Hubert Hu). A critique expressed by the following commentator has been commonly heard in the debate:

> The strategies of the government have not created viable businesses. Most businesses just get government support and would not survive without. They do not have any good technologies or any products which can be sold outside of Taiwan (Interview, Pele Chong).

Another common criticism of the method to create an industry is voiced by the Director of the Biotechnology Program at STAG:

> To support the biotechnology industry science parks have also been established all over the island, and in order to facilitate the commercialization process of scientific advances research institutes serve as the bridge between academia and industry. The technology transfer model has however not been working very well, but we are trying to change that (Interview, Lee Chong Chou).

Above, some of the reasons why the Taiwanese biotechnology has been seen as a disappointment were touched upon. For example, from investors' perspective, revenues from biotechnology are considered to be very modest, especially compared to the revenue levels achieved in the electronics or semiconductor industries. Thus few private sector investors have been willing to invest in biotechnology, and foreign multinational companies have not been interested in establishing R&D or investing in Taiwanese biotechnology companies (Interview, Chen Chei Hsiang). Another perceived problem of the private sector investors was that the majority of Taiwanese biotechnology companies were involved in "low-tech" biotechnology. Furthermore, the Taiwanese biotechnology industry had not yet produced "breakthrough" innovations or products (Interview, Chester Ho). This was also acknowledged by Taiwanese policy, as written in a report that argued:

> Like those in other industrialized societies, Taiwan's knowledge-intensive industries are facing a number of bottlenecks which may retard their pace of development. These include insufficient infrastructure, lagging technological innovation, a shortage of investment capital and high-tech workers, and an inadequate legal and regulatory structure. Such bottlenecks are of serious concern, since they affect Taiwan's capacity for innovation and its ability to compete with other nations (CEPD, 2006: p8).

Policy strategies to develop a biotechnology industry

As noted, the Taiwanese government has played an active role in the emergence of a biotechnology industry in Taiwan. The government's major strategies in developing biotechnology have been targeted at promoting specific scientific fields as well as biotechnology business in general. These government efforts are described through the quote below in an article in *Taiwan Review*, published by the *Government Information Office:*

> Biotechnology is all the rage in Taiwan today, and runs through the industry from upstream basic research to downstream commercialization. In Taiwan, upstream actors such as Academia Sinica and university laboratories participate in various National Science and Technology Programs administered by the National Science Council.

> Midstream organizations are responsible for turning basic scientific research into usable technology and then into commercial commodities, or more succinctly, technology transfer. […] Public policymakers have also worked hard in recent years to rework the legal and regulatory infrastructures, tightening up some areas to bring Taiwan in line with international standards, such as in intellectual property protection, while beginning to relax other areas in order to promote more attractive investment and research environments. For its part, the government has attempted to facilitate innovative science and entrepreneurial bio-business in Taiwan. (Wong, Internet)

As the above quote reflects, Taiwanese policymakers are aiming at developing three levels, "upstream", "midstream" and "downstream". At the upstream section, universities and research institutes, i.e. organizations performing basic research are identified by policy as the major actors and are the subject of government guidance. The promotion of scientific areas considered by the government to have commercial potential has been given special attention (Campbell, 1997). At the midstream level, that is to say applied research, there are various government agencies identified as central and involved in the development of the Taiwanese biotechnology industry. These are intended to function as the intermediary step between basic research and industry. These research institutes are supposed to source, develop and absorb technologies from abroad and local universities. When these technologies have been developed they are to be transferred to the industry for commercialization. At the downstream level, company creation has been emphasized with start-up companies emerging from universities as well as the private sphere. A number of established companies have also been encouraged to diversify into biotechnology or to change their line of business given the generous government incentives (MOEA, 2008a; Interview, Julie Sun). Some of these incentives are described by Wong (Internet):

> The Ministry of Economic Affairs offers tax-relief benefits for new biotech businesses, offsetting start-up costs and the depreciation of capital investments over time. In order to promote technological innovation in the biotech field, the ministry provides incentives (both tax-based and subsidies) for new product R&D, particularly for small and medium-sized enterprises.

In addition to providing support and direction to upstream, midstream and downstream sectors, there are also efforts to create interaction and connections between them. For this purpose, the government is particularly active in providing incentives. Taiwanese policy has for example established a number of science parks, new research institutes with open-laboratory policies, and incubation centers to function as hubs for upstream, midstream and downstream collaboration. Collectively, the science parks and research institutes function as a general infrastructure, implementing government policies and supporting the Taiwanese biotechnology companies as well as research institutions (MOEA, 2003a; 2003b). Science parks are established all over the island to consolidate research, development, and commercial actors spatially. In each area, universities, research institutes and other research organizations are encouraged by the government to concentrate on specific areas in biotechnology.

Government plans

The government has employed a template, formally known as the *Technology Development Program*, when planning the development of new industries in the new millennium. For instance, the industrial policies fashioned by the *Ministry of Economic Affairs* (MOEA) are executed by a number of sub-departments, and the *Department of Industrial Technology* (DoIT) is one the executive branches. An important aim of the DoIT is to identify and promote new technological areas (Ministry of Economic Affairs, Internet). Through the

department's Technology Development Program (TDP) the major objectives have been to coordinate various sectors and create industrial innovation as exemplified in the quote below:

> The Technology Development Programs (TDP) have been a long-running initiative of the DoIT aimed at pooling the research resources from research institutes, the industry and academia to maximize their effectiveness. [This is done through three programmes] 1. Funding programs for Research Institutes support pioneering innovations, establish technological leadership and self-sufficiency, and realize industrial upgrades. 2. Funding programs for Private Sectors focus on assisting the private-sector with developing their own research capability to realize the objective of technology dispersion and industry upgrade. 3. Funding programs for Academia offer funding to research new innovative technologies and build up industrial technology innovation centers in order to promote the development of emerging high-technology industries. (Department of Industrial Technology (5), Internet)

In order to create industrial innovation Taiwanese policy identifies what technologies the industry needs and should concentrate on. Furthermore, it is decided by policy how the technologies are to be developed by research institutes, and also through which medium those technologies should be transferred and used by the industry. These policy guidelines are very similar to the ones the Taiwanese government implemented, and identified in retrospect, for the semiconductor industry. As is mentioned on the DoIT website, the origin of the government's *Technology Development Program* and the related strategies also go back to the 1970s when ITRI and the semiconductor industry were founded. In this model it is the research institutes that are the core of the industrial development system (Department of Industrial Technology (6), Internet). The program began formally in 1979, as the MOEA describes:

> MOEA began setting aside budgets to commission research institutions to take part in industrial technology research and development projects. The technology R&D work headed by the government has been oriented around advanced technologies, including applied research and development and the development of key technologies and components (Department of Industrial Technology (4), Internet).

In later years the Taiwanese government has also paid more attention to development organizations which perform basic research and a producing structure consisting of companies in the private sphere. (MOEA, 2005) This has resulted in technology development programs (TDP) specifically aimed for the academic and the industrial sectors (Department of Industrial Technology (3), Internet). For the Academic TDP some of the objectives have been to increase patents and include universities in the mission of industrial development.

> Over the past five years, the R&D Center of Excellence program has successfully promoted the formation of 54 thematic innovative and perspective industrial technology R&D centers from 21 universities, and 7 cooperative education alliances. This naturally attracts universities' attention to voluntarily consider the needs of industrial development and the industrial benefits of patent application and commercialization. To date, the achievements include: 1,445 patents filed, 327 patents granted, 265 cases of technological transfer (valued NTD 119.01 million), and 338 derivative assignments (valued approx. NTD 258.82 million) (Department of Industrial Technology (7), Internet).

At the down-stream level, the development program is described by the Taiwanese government as having the following focus:

> Industrial Technology Development Program was the first one to provide direct funding for enterprises to participate in industrial technology research. By the end of 2007, 424 projects had been carried out by 691 businesses, with nearly 15,000 researchers. Government grants was about NTD11.43 billion, and businesses investing facilitated to NTD 29.86 billon in return. On average, each NT dollar spent by the government through Industrial Technology Development Program resulted in 10.39 NT dollars of industrial output. […] Two types of innovation center programs were devised; with the first being the Multinational Innovative R&D Centers in Taiwan Program aims at attracting international R&D resources to Taiwan. The other was the Industrial Technology Innovation Center Program aims at establishing R&D centers that will help Taiwanese industries become technology R&D oriented. By December 2008 the two programs have helped establish 100 domestic enterprise R&D centers while also persuading 30 multinational enterprises to set up 39 R&D centers in Taiwan. These will carry out over 550 collaborative research projects in Taiwan and generate over NTD 37 billion in research spending (Department of Industrial Technology (8), Internet).

A new development discourse - From imitation to science based innovation

As has been described, industrial development in Taiwan is focused around three different governmental programs which guide industrial development, i.e. the technology development programs for research institutes, the academic sector, and industry. The first of these, which draws its inspiration from the semiconductor industry focuses on the research institutes, which acquire and source technologies from abroad and domestically to develop in-house and thereafter transfer to industry. The other two programs are aimed at local companies and universities respectively, to establish innovative technologies and domestic R&D capabilities.

Compared to earlier a large change in Taiwanese policymaking is the focus on innovation as the foundation of industrial development. In this context local universities and companies have received a more prominent role in the government plans to achieve this purpose. Moreover, in the knowledge-based economy, industrial innovation is supposed to start from basic and applied scientific research. The innovation strategy has been distinctively profound in Taiwanese industrial policy over the last decade. However, the public policies that emerged in the 1970s and 1980s aimed at developing a semiconductor industry were based on acquiring and adapting foreign technologies for the research institutes to create a local industry. In the 1990s, the industrial policy discourse had changed to favour a more innovation driven industrial development (Wong, 2002; Eriksson, 2005; Interview, Jack Chang). For instance as Huang Wen Hsiung, Vice Chairman National Science Council Executive Yuan commented in a speech in 2002:

> In keeping with the global trend towards technological and industrial development, the government will forge ahead with the implementation of the industrial development strategies discussed above. Taiwan will be transformed from a production based Taiwan to a knowledge based Taiwan (Huang Wen Hsiung, Internet).

The view which has prevailed in contemporary Taiwanese policymaking is that Taiwan needs to create its own technologies rather than to imitate, as was earlier done. This ambition is described by Wong (Internet):

> In the past, Taiwanese firms were able to adroitly borrow technology and, in turn, produce better quality goods faster and more cost-effectively. In post-industrial or post-manufacturing sectors such as biotech, businesses can no longer borrow technology, but must instead create technology.

A larger vision of this transition was described in the Taiwanese government's *Plan for National Development in the New Century* (2001-2004) where the attention was centered on developing knowledge-intensive fields to stimulate the economy:

> As the experience of the advanced industrial countries demonstrates, knowledge has become the driving force behind manufacturing excellence and economic dynamism. Investments in knowledge must be large enough to bring into play cross synergies and scale economies, and must focus not only on the development of new knowledge but also its productive application. […] The steady accumulation of knowledge and constant innovation in science and technology will boost manufacturing productivity, stabilize the economy, and speed Taiwan's emergence as a global operations center for new, traditional, and high-tech industries (CEDP, 2006: p15).

With this ambition, the main development strategies for industrial revival were in the *Plan for National Development in the New Century* to:

> Strengthen domestic research and development to reap the benefits of innovation and technological progress. At the same time, acquire cutting edge technology from the advanced industrial countries and, when appropriate, attempt to benefit from externalities associated with world-class research and development conducted in those countries. […] Upgrade the infrastructure and the legal and administrative framework relating to science, technological, medical care, and the environment, creating conditions conducive to the accumulation and dissemination of new knowledge. […] Develop a nationwide system for the promotion of technical knowledge and innovation (CEPD, 2006: pp17-18).

As understood, the revitalization of the economy is dependent on the ability to develop, produce and diffuse resources based on new knowledge to the industry. To achieve a sustainable development and economic growth the government has clearly stated that there is a need to:

> Establish a mechanism for the promotion of innovation, job creation, and the development of emerging industries. […] Strengthen industrial innovation and R&D, upgrade industrial technology, and accelerate the pace of industrial restructuring. (CEPD, 2006: p27)

In order to achieve these goals and economic development, the Taiwanese government promotes an innovation system where three different structures (development, production, and use) interact:

> There are over 150 universities and colleges in Taiwan providing the human resources needed for industrial development. In addition, several research institutes were established to develop technologies needed for industrial development. To further stimulate industrial development, the government also formulated various policies and initiatives to build an industrial innovation system. These include the Technology Development Programs, research organizations with collaboration among industry, universities and research institutes, R&D parks, tax exemptions, venture capital systems, and industry clusters. The establishment of such a collaboration system has stimulated rapid communication of knowledge among these sectors. This has become the main driving force behind local industrial development and, in turn, will be the advantage for international R&D investment in Taiwan (Department of Industrial Technology (1), Internet).

As has been demonstrated through government statistics, Taiwanese biotechnology has grown considerably since the mid-1990s because of the extensive policy support. In the National Development Plan for 2008 (CEDP, 2006: p26) it was expressed that the Taiwanese government is continuing this support and undertaking "effective measures to eliminate the knowledge, technology, and digital gaps" that are currently present. In a report on the investments opportunities in the Taiwanese biotechnology industry, the following could also be read at on the website of *Invest in Taiwan*:

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However, albeit the impressive growth of biotechnology in Taiwan, the industry has had difficulty in living up to the high expectations set by policymakers and investors. Even though scientific publications have increased, the academic sector has grown and a producing structure of domestic research institutes and companies has been built up, there are still several complications. The producing structure is still weak and a using structure of Taiwanese biotechnology products has yet to be clearly crystallized. The disappointment over the Taiwanese biotechnology is discussed by Hsu et al. (2005: p281), which provide the following description:

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A similar opinion, that the Taiwanese biotechnology industry has not been fairing that well commercially, has also been brought forward in Nature (Swirbanks & Cyranoski, 2000: p422):

> Just as with electronics, the Taiwanese government has tried to develop biotechnology over the past two decades. But the results so far stand in stark contrast to the booming electronics industry. One only needs to look at Hsinchu to see the tiny contribution biotechnology makes 0.1% of sales and so far there is no sign of a major upswing.

Due to the perceived weak financial results as well as the modest technological outcomes, at least when measured in terms of the number of "breakthrough innovations", the government's polices have been challenged (Interview, Hubert Hu). A critique expressed by the following commentator has been commonly heard in the debate:

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Above, some of the reasons why the Taiwanese biotechnology has been seen as a disappointment were touched upon. For example, from investors' perspective, revenues from biotechnology are considered to be very modest, especially compared to the revenue levels achieved in the electronics or semiconductor industries. Thus few private sector investors have been willing to invest in biotechnology, and foreign multinationals have not been interested in establishing R&D or investing in Taiwanese biotechnology companies (Interview, Chen Chei Hsiang). Another perceived problem of the private sector investors was that the majority of Taiwanese biotechnology companies were involved in "low-tech" biotechnology. Furthermore, the Taiwanese biotechnology industry had not yet produced "breakthrough" innovations or products (Interview, Chester Ho). This was also acknowledged by Taiwanese policy, as written in a report that argued:

> Like those in other industrialized societies, Taiwan's knowledge-intensive industries are facing a number of bottlenecks which may retard their pace of development. These include insufficient infrastructure, lagging technological innovation, a shortage of investment capital and high-tech workers, and an inadequate legal and regulatory structure. Such bottlenecks are of serious concern, since they affect Taiwan's capacity for innovation and its ability to compete with other nations (CEPD, 2006: p8).

The government's approach to solving these problems is to increase technological innovation. What is believed is that if new solutions and technologies can be developed they can also be transferred to the industrial setting through having a proper production structure. Use on the other hand is not clearly mentioned in government plans, but is treated as an exogenous factor.

Discussion

In this paper we have aimed to contribute to the understanding of how industries are shaped? How do different actors interact to form networks and connections that make, consolidate industries? The actors all show different degrees of action that falls within the frame for exchange practice, normative practice and representational practice. How different actors act during the development process has been connected to these three kinds of practices. The pattern how these practices have influenced each other are discussed below.

Norms and exchanges affect representations

The Taiwanese government has since the late 1980s been involved in creating a coherent image of how the Taiwanese semiconductor was created by Taiwanese policymakers. The successful commercial examples (exchange practices) had a great effect on the policy makers' way of creating pictures of the successful new semiconductor industry. Successful export figures etc. from the exchange practices were translated into fairly stable pictures of what constituted a successful industry. Furthermore, the norms for public policy that emerged as a result of this success resulted in fairly stable industry policies that later would spread to the activities to represent the new emerging biotechnology industry.

The image of how things should be done from the policy actors perspective is based both on earlier developments (such as the ones in the semiconductor industry) but also on an ideology based on innovation. The ambition to develop a knowledge economy and innovations is not particularly different from what other governments in the developed world have expressed. These ideas have been strongly promoted by the OECD for the past two decades. In this view, a shift to knowledge intensive sectors is considered as the next step in economic development. Consequently, advanced economies have been setting an agenda moving towards establishing industries related to these areas. In order for Taiwan to achieve this, Taiwanese policymakers have viewed the semiconductor industry as an inspiration concerning how policy can actively create further development, i.e. to take the next economic leap. How has this norm affected the emergence of an industry?

Exchanges and representations affect norms
The case has clearly shown that pictures and representations that successively were developed, depicting what constituted ”a successful new industry” became translated into a set of norms and ”rules” for the policy makers behaviour. It can be anticipated that in the case of the semiconductor industry, some of the successful commercial examples (successful exchange practices), also affected the policy makers normative practices.

Norms and representations affect exchanges
It can be anticipated that policy makers in Taiwan developed pictures – or representations – of what constituted a successful new industry. These representational practices resulted in various official descriptions and policy documents which successively resulted in stabilized norms for e.g. public research funding and investments. These normative and representational practices seemed to have at least an indirect effect on some exchange practices. For example, in certain periods of time, public investments, partly norm driven and based on some strong ideas, at least temporarily directed the biotech firms activities to invest in new regions and relationships. However, the case also shows that there is by far clear-cut relationships between the norms and representations and how they affect the companies' exchange practices. Companies in parts can choose what norms and representations to ”react on”, and some of their exchanges seemed to emerge *in spite of* the official norms and representations….

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