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Social Capital of a Knowledge-intense industry

A comparison of the biotech industry in Sweden, California and Japan

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Foreword

The transition from a manufacturing-industrial economy to a knowledge economy means a great challenge in a number of policy areas. Traditional production factors such as labor and capital do not seem to be enough in the new global competition. Human capital, social capital and new institutions are amongst the essential factors to promote growth in new, knowledge intense-industries.

This report studies one of the most knowledge-intense new industries, the biotech industry. The biotech industries of three of the world's most developed economies, Sweden, Japan and the U.S. are compared, and the policies for the industry's growth are discussed. The study focuses on the industry's social capital – i.e. the social networks and relations that companies, managers and employees are part of – and the role of this social capital for the industry's growth in the three countries.

The empirical studies of the biotech companies in the U.S. and Japan were made in collaboration with the Swedish Office of Science and Technology in Los Angeles and the Kyoto University.

Östersund, September 2005

Sture Öberg
Director-General

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English summary

This report compares the governmental policies for and the social capitals of one on the most knowledge-intense industries, the biotech industry, in Sweden, Japan (the Kansai region) and California. Based on the theories of innovation systems, knowledge clusters and triple helix, and their connections to the theory of social capital, the empirical analysis has been based on a questionnaire sent to biotech firms in the three areas studied.

Ever since the early breakthroughs of DNA research in the 70s, the United States has been the most prominent country in the world in the field of biotechnology. This holds both for academic research, industrial R&D and commercialization of the findings. Thus, in comparison with Sweden and Japan, public policies (and private initiatives) for growth of the biotech industry in United States in general and California in particular are by far the most developed. This holds not only for the amount of resources invested, but also for collaboration industry-academy-government.

In December 2002, the Japanese Prime Minister Junichiro Koizumi launched guidelines for a national biotechnology strategy containing 200 detailed action plans. The strategy covers the whole biotechnology sector. The outlined actions extend from more than doubling the biotech research budget over the following five years, to increasing the so far insufficient collaboration between universities and industry and between disciplines, from promoting start-ups, improving institutions for intellectual property and venture capital, to supporting cluster building and actions for the thorough permeation of public understanding. Koizumi's biotechnology strategy can be seen as an example of the Japanese type of large-scale, centralized, top-town policies. However, the content shows that the government is ready to try new methods and solutions. The conclusion must be that Japan has formulated one of the most ambitious and comprising biotechnology policies in the world. It remains to be seen at what pace it will be possible to implement the policies and achieve the expected results.

A number of actors have without much coordination been involved in the Swedish policies for strengthening the biotech sector. Commissioned by the Government, Vinnova has in May 2005 presented a proposal for a national biotech strategy. The proposal suggests an increase of the current yearly allowances on $22 millions to $145 millions. If the proposal is enacted by the Government, Vinnova will be able to play the coordinating role that probably is needed. The resource issues are highlighted by the Swedish biotech industry's organizations as well, which stress the shortage of seed capital and venture capital. Regarding research, it has been pointed out that the total public research funding of biotech and medicine research in the United States 2003 was more than eight times the per capita funding in Sweden.

With a few exceptions, the biotech industry consists of small firms with R&D as their main activity. Their smallness makes collaboration with other firms and research institutions a necessity. A large share of the biotech industry deals with products for human health, i.e. something which in general is considered a public good. Therefore, government has motives to interact with the industry, as financier of R&D and (where health care is to some extent a public sector responsibility) and as a demanding customer. Thus, the "golden triangle" of collaboration between companies, research institutions and government seems highly relevant for the success of the biotech industry. This means that the biotech industry has a need to develop a more complex social capital compared with most other industries.

The findings of the empirical study can be summarized in the following points.

With a very low staff turnover and very high valuation of internal knowledge exchange, the biotech companies of Kansai confirm the general picture of Japanese firms' focus on internalization. Relatively speaking, the Japanese biotech companies' strongest social capital seems to be the firm-internal social capital. The opposite seems to be the case for the Swedish companies, which scored lowest in this respect.

The external production-related social capitals of the Swedish and Californian firms have several similarities. Management of the companies of both regions values their employees' competence networks highly. A large share of the companies cooperate with external actors in R&D. The companies are marketing themselves towards potential partners, credit institutions and governmental agencies through publishing scientific articles to a similar extent. These activities are much more internalized in the Kansai companies, which in these respects seem to have a less developed external production-related form of social capital.

In other aspects of production-related social capital and also regarding environment-related social capital, the Swedish companies deviate from their Japanese and Californian counterparts. This holds both for the spatial extensions of their relations and the actors with whom they have relations. Concerning employees' competence nets and company recruitment, the Swedish firms seems to apply *local/regional* internalization that can be depicted as a spatial counterpart to the Japanese firms' corporate internalization. Another peculiarity of the Swedish firms is their limited contacts with government on different levels, reflected in the employees' competence nets and low share of companies receiving government support. Given that the Japanese companies, which also had a low share of receivers of support, are mainly older companies only partly dealing with biotech activities and only a few bioventures, to which government gives priority – it seems as though the Swedish biotech companies are the ones most isolated from and least supported by industrial policies.

The Swedish companies' local/regional internalization and screening off from government contacts could partly be explained by the company population, consisting of young, small, research-oriented firms that in their current stage mainly need contacts with some researchers at their local university and one or a few fellow firms. However, a supplementary explanation might be the traditional Swedish research policy, where universities are supposed to do "everything" and industrial research institutes hardly exist. In a research-intensive industry such as the biotech industry, industrial policies and innovation policies have to a certain extent been substituted by policies for university research. As a consequence, Swedish biotech firms have little to gain from contacts with government. The result is that the Swedish biotech clusters have many and dense links between firms and universities, but few and sparse links between these two actors and government. This situation is not in accordance with the theoretical ideal of a cluster and the corresponding theories of innovation systems and triple-helix cooperation.

The absence of a national strategy for the development of the Swedish biotech sector is also reflected in a lack of coordination between research and the commercialization of research. Beside the activities of mainly Vinnova, policies for biotech development are highly oriented towards university research. Of the three pillars forming an ideal innovation system, government seems to be the weakest pillar in Sweden.

If this explanation is correct, one of the three pillars of the Swedish biotech innovation system would be partly missing. The "missing pillar" of innovation policy is also discussed in Japan, but there it is the university that is considered as partly missing. For the biotech industry, this view is partly supported by the empirical results of the study. The employees

of the Kansai firms do indeed have stronger contacts with other companies and government than with universities and a relatively small share of the firms cooperate in R&D (with universities, research institutes or other firms). Apart from this, just like in other industries, the peculiarity of the Japanese biotech innovation system seems to be its national (and not regional or international) character.

A general impression of the Californian companies taking part in the study is their well developed social capital, both internally and externally as well as their spatial extension and their extension to different actors. The Californian firms score high in the measures of enterprise-internal social capital but have at the same time diversified external networks and relations. In spite of their location in three of the world's leading biotech regions (the Bay Area, Greater Los Angeles and San Diego), their networks are the most spatially extended. In contrast to the Swedish and Japanese firms, the Californian firms seems to have well-developed relations with both academy and government. Contrary to the conventional wisdom on American trade, a far higher share of Californian biotech firms received government support than the Swedish and Japanese.

From a policy perspective, the comparison of the biotech companies' social capitals in the three areas studied issues is a tentative conclusion that the American innovation policies in general and the Californian in particular are those most adapted to the theories of innovation systems, knowledge clusters and triple helix. It is beyond the scope of this study to say to what degree public policies has contributed to American and Californian biotech industries being the world leaders. However, if modern theories are at least partly right, these policies should have an impact.

Both Sweden and Japan are taking action to improve their systems of innovation. Sweden started a national agency for innovation systems of all industries in 2001. The Government bill on research policy proposed in March 2005 increased resources to Vinnova and the agency has proposed a national biotech strategy. Biotechnology is one of the prioritized research areas in the bill. Japan has launched a comprehensive biotech strategy and is "privatizing" the public universities into foundations, in order to increase the universities' incentives and opportunities to collaborate with private companies. The outcome of these actions remains to be seen.

Svensk sammanfattning

Denna rapport jämför den officiella politiken för och det sociala kapitalet i en av de mest kunskapsintensiva näringarna, bioteknikindustrin, i Sverige, Japan (Kansai-regionen) och Kalifornien. Med utgångspunkt i teorierna från innovationssystem, kunskapskluster och triple helix och deras kopplingar till teorin av socialt kapital, baseras den empiriska analysen på enkäter till bioteknikföretag i de tre studerade områdena.

Ända sedan den tidiga DNA-forskningens genombrott på 1970-talet har USA varit världsledande inom bioteknik. Detta gäller såväl akademisk forskning, FoU i företagen och kommersialisering av resultaten. I jämförelse med Sverige och Japan är således den offentliga politiken (och de privata initiativen) för bioteknikindustrins tillväxt mest utvecklad i USA i allmänhet och i Kalifornien i synnerhet. Detta gäller inte bara storleken på satsade resurser utan också för samarbetet näringsliv – akademi – offentlig sektor.

I december 2002 lanserade den japanske premiärministern Junichiro Koizumi riktlinjer för en nationell bioteknikstrategi innehållande 200 detaljerade verksamhetsplaner. Strategin omfattar hela biotekniksektorn. Planerna sträcker sig från mer än en fördubbling av bioteknikforskningsbudgeten under fem år, till förbättring av det otillräckliga samarbetet mellan universitet och företag och mellan ämnesdiscipliner; från stöd till nyföretagande, nya egendomsrättsregler och institutioner för ”kunskapsegendom” och riskkapital, till stöd till klusterbyggande och informationsåtgärder till allmänheten. Koizumis bioteknikstrategi kan ses som ännu ett exempel på den japanska typen av storskaliga, centraliserade top-down-åtgärder. Innehållet i strategin visar dock att regeringen är beredd att pröva nya metoder och lösningar. Slutsatsen blir att Japan har formulerat en av världens mest ambitiösa och omfattande biotektikstrategier i världen. Det återstår att se i vilken takt det kommer att vara möjligt att genomföra strategin och uppnå de förväntade resultaten.

Ett antal aktörer har utan större samordning varit inblandade i den svenska politiken för bioteknikindustrins tillväxt. På uppdrag av regeringen har ett förslag till nationell bioteknikstrategi lagts fram av Vinnova i maj 2005. Programmet föreslår en ökning av dagens anslag på 150 miljoner kronor per år till 1 miljard. Om programmet antas av regeringen kommer Vinnova att kunna spela den samordnande roll som sannolikt krävs. Resursfrågorna understryks också av de svenska bioteknikindustriorganisationerna som betonar bristen på såddkapital och riskkapital. När det gäller forskning påpekas det att de totala offentliga anslagen till bioteknik och medicinsk forskning per capita år 2003 var mer än åtta gånger högre i USA än i Sverige.

Bioteknikindustrin består med några få undantag av små företag med FoU som huvudsaklig verksamhet. Deras litenhet gör samarbete med andra företag och forskningsinstitutioner nödvändiga. En stor del av bioteknikindustrin arbetar med produkter för mänsklig hälsa, dvs. något som vanligen betraktas som en allmän (public) nyttighet. Av denna anledning har den offentliga sektorn anledningar att samverka med sektorn, som finansiär av FoU och (i de länder där hälsovården är mer eller mindre en offentlig uppgift) som krävande kund. Den ”gyllene triangel” av samarbete mellan företag, forskningsinstitutioner och offentlig sektor förefaller mycket viktig för bioteknikindustrins tillväxt. Det betyder att bioteknikindustrin behöver utveckla ett mer komplext socialt kapital jämfört med flertalet andra näringar.

Den empiriska studiens resultat kan sammanfattas i följande punkter:

Med en mycket låg personalomsättning och mycket hög värdering av internt kunskapsutbyte bekräftar bioteknikföretagen i Kansai den allmänna bilden av japanska företags fokus på internalisering. De japanska företagens starkaste sociala kapital ser relativt sett ut att vara det företagsinterna sociala kapitalet. Motsatsen tycks vara fallet för de svenska företagen, som hade de lägsta värdena i detta avseende.

Det externa produktionsrelaterade sociala kapitalet i de svenska och kaliforniska företagen hade flera likheter. I båda fallen värderade företagsledningarna de anställdas externa kompetensnät högt. En stor del av företagen samarbetar om FoU med externa aktörer. Företagen marknadsför sig gentemot potentiella partners, kreditinstitut och myndigheter genom publicering av artiklar i ungefär samma omfattning. I de japanska företagen är dessa verksamheter i mycket större utsträckning internaliserade, vilket tyder på ett mindre utvecklat externt produktionsrelaterat socialt kapital.

I andra avseenden avviker de svenska företagen från sina japanska och kaliforniska motsvarigheter. Det gäller både vilka andra aktörer man har relationer till och dessa relationers rumsliga utbredning. I fråga om de anställdas kompetensnät och företagens rekryteringar av nyanställda, kännetecknas de svenska företagen av en *lokal/regional* internalisering som kan beskrivas som en rumslig motsvarighet till den japanska industrins företagsinternalisering. En annan säregenhet hos de svenska företagen är deras begränsade kontakter med myndigheter och offentliga organ, något som avspeglas i de anställdas kompetensnät och den låga andelen företag som får någon form av offentligt stöd. Med tanke på att de japanska företagen, som också hade en låg andel stödmottagare, i huvudsak består av äldre företag som bara till viss del sysslar med bioteknik och ett mindre antal nya bioteknikföretag som står i centrum för regeringens satsningar, förefaller det som om de svenska bioteknikföretagen är de som är mest isolerade från och minst uppbackade av näringspolitiska åtgärder.

De svenska företagens lokala/regionala internalisering och avskärmning från myndighetskontakter kan delvis förklaras av företagsstrukturen, med många unga, små forskningsorienterade företag som i sin nuvarande utvecklingsfas främst behöver kontakter med någon eller några forskare vid det lokala universitetet och något eller några partnerföretag. En kompletterande orsak kan dock vara den svenska forskningspolitiken, enligt vilken universiteten förväntas göra ”allt” och där industriforskningsinstitut knappast existerar. I en forskningsintensiv industri som bioteknikindustrin har forskningspolitik kommit att ersätta den nödvändiga närings- och innovationspolitiken. Följden har blivit att svenska bioteknikföretag har lite att vinna på kontakter med myndigheter och andra offentliga sektorsorgan. Resultatet har blivit att de svenska bioteknikklustren har många och täta länkar mellan företag och universitet, men få och glesa länkar mellan dessa två aktörer och offentlig sektor. Utifrån teorierna om innovationssystem, kluster och triple helix-samarbete förefaller således inte den svenska situationen vara den allra bästa.

Avsaknaden av en nationell strategi för utveckling av den svenska bioteknikseksorn avspeglas också i bristen på koordinering mellan forskning och kommersialisering av forskningsresultat. Vid sidan av Vinnovas verksamhet är politiken för bioteknikens utveckling starkt knuten till universitetsforskningen. Av de tre pelare som enligt teorin formar det ideala innovationssystemet förefaller de offentliga sektorsorganen utgöra den svagaste pelaren i Sverige.

Om denna förklaring är riktig skulle en av de tre pelarna i det svenska biotekniska innovationssystemet delvis saknas. Innovationspolitikens ”felande länk” diskuteras också i Japan, men där är det universiteten som anses vara problemet. För bioteknikindustrins de ger den empiriska undersökningen ett visst stöd åt denna uppfattning. De anställda vid Kansai-regionens bioteknikföretag har starkare kontakter med andra företag och med myndigheter än med universiteten och en relativt liten andel av företagen samarbetar kring FoU (med vare sig universitet, forskningsinstitut eller andra företag). Liksom i andra branscher tycks en säregenhet hos den japanska bioteknikindustrin vara dess *nationella* (och inte regionala eller internationella) karaktär.

Ett allmänt intryck av de kaliforniska företag som deltog i studien var deras väl utvecklade sociala kapital, såväl internt och externt, som dess rumsliga utsträckning och dess utbredning mot olika aktörer. De kaliforniska företagen fick höga värden på sitt företagsinterna sociala kapital samtidigt som de hade en mångfald av externa nätverk och relationer. Trots deras lokalisering i tre av världens ledande bioteknikregioner (the Bay Area, Los Angeles-regionen och San Diego) hade de de mest rumsligt utsträckta nätverken. Till skillnad från de svenska och japanska företagen tycks de kaliforniska företagen ha välutvecklade relationer med såväl akademin som offentlig sektor. I motsats till den konventionella visdomen om amerikanskt näringsliv hade en betydligt större andel av de kaliforniska företagen mottagit offentligt stöd, jämfört med de svenska och japanska företagen.

Ur ett policyperspektiv mynnar jämförelsen av bioteknikföretagens sociala kapital i de tre studerade områdena ut i en preliminär slutsats att den amerikanska innovationspolitiken i allmänhet och den kaliforniska i synnerhet är den som är mest anpassad till teorierna om innovationssystem, kunskapskluster och triple helix. Det ligger utanför ramarna för denna studie att avgöra i vilken utsträckning det är politiska åtgärder som bidragit till att amerikansk och kalifornisk bioteknikindustri har blivit världsledande. Om de moderna teorierna åtminstone delvis är riktiga, borde dock de politiska åtgärderna ha haft effekter.

För Sveriges del kan de tre viktigaste policyslutsatserna således sammanfattas enligt följande:

Sverige har hittills saknat en nationell strategi för utveckling av bioteknikssektorn. Detta avspeglas i bristen på samordning av forskning och kommersialisering av forskningsresultat och – i jämförelse med våra konkurrentländer – små anslag till dessa verksamheter, räknat per capita.

Den offentliga sektorn tycks generellt ha en svag ställning i det svenska biotekniska innovationssystemet. Den av Vinnova föreslagna nationella strategin kan bidra till att förändra detta.

Det finns starka band mellan de svenska universitetens forskning och de lokala bioteknikföretagen. Detta i sig positiva förhållande är dock samtidigt ett uttryck för att forskningspolitik i stor utsträckning har fått ersätta närings- och innovationspolitik inom bioteknikssektorn. I jämförelse med företagen i Kalifornien och Japan har de svenska bioteknikföretagen få kontakter utanför regionen och få kontakter med offentlig sektor.

1 Introduction

For more than twenty years, the transition from an industrial society to a knowledge economy and knowledge society has been debated, studied and increasingly become the subject of policies from local to global level. However, it is possible to find the embryos current points of view in the history of the scientific discourse. As early as the 18th century, Adam Smith referred to the "human capital" of "the acquired and useful habits of all the members of society" (Smith 1776, quoted in Blaug 1997, p. 52). Another of the most celebrated economists, Alfred Marshall, pointed out that "knowledge is our most powerful engine of production" (Marshall 1890, quoted in Becker 1993).

The current focus on knowledge economy and knowledge society is based on a large number of contributions from different disciplines, not least economics. Peters (2001) mentions e.g. economics of information (e.g. Marschak 1974), economics of knowledge production and distribution (Machlup 1962), human capital theory (Schultz 1961, Becker 1964), public choice theory (Buchanan & Tollison 1972, Tullock 1966) and the new growth theory (Romer 1986, 1990). Important input has also come from the disciplines of sociology[1], management theory, futurology and communications & IT (Peters 2001). Also the books of Gibbons et al. (1994) and Nowotny et al. (2001) have been very influential for both research and policy development. An early Swedish contribution connected to the discussion about the knowledge society was Andersson & Strömquist's (1988) book on the K-society.

The fact that knowledge economy and knowledge society not only are multidisciplinary academic concepts but also policy concepts is probably an important reason for the lack of common definitions of the concepts. One of the most cited definitions is in fact a policy one, launched in a white paper of the UK's Department of Trade and Industry: "*A knowledge-driven economy is one in which the generation and the exploitation of knowledge has come to play the predominant part in the creation of wealth. It is not simply about pushing back the frontiers of knowledge; it is also about the more effective use and exploitation of* ***all types of knowledge*** *in* ***all manner of economic activity***" (DTI 1998).

The knowledge society is often seen as something that replaces the industrial society in the same way as this replaced the last phase of the pre-industrial society, the mercantilist era. This approach is illustrated in table 1 which compares a number of key attributes of the three societal forms.

[1] *See Stehr (1994) for a presentation. Stehr tracks e.g. the concept back to works of Drucker (1969) and Bell (1973).*

Table 1 Key attributes of the knowledge and industrial societies and of the mercantilist era of the pre-industrial society.

Attribute	Knowledge society	Industrial society	Mercantilist era
Key assets / production factors	Labor with knowledge and information	Physical capital, transportation	Land and trading assets
Market's extension	Global	Mainly national	Mainly local
Polity	"Supra-state" organizations increase in importance	Nation-state democracy	Autocracy /oligarchy
Central principle(s)	Application of know-ledge	Use of non-muscle power, division of labor	Increase muscle power through population growth, organize trade
Owners of decisive production factor	The individuals	Capitalists	Landowners
Central conflict	*Access / rights* to knowledge, information and benefits	*Justice*: Division of social accumulation between labor and capital	*Liberty*: business autonomy, the individual's freedom from feudal restraints
Management principles	Horizontal, cooperative	Vertical	Vertical
Dependency relations	Organization/collective needs the individual who possesses knowledge	The individual needs the organization / collective (enterprise, trade union, etc)	Mutual collective dependencies between crown, nobility, church, burghers and peasants
Central individual qualification	Creativity	Adaptability	Fidelity
Gender relations	Growing equality	Emerging emancipation	Patriarchal
Infrastructure	Digital nets, social infrastructure, airports, roads, rail	Land transportation systems	Waterways and ports
Central spatial units	Metropolitan region	Industrial town	Agricultural region, market town

Source: Westlund (2004).

Comment: The figure is partly based on Lakshmanan (1994) who, however, does not treat the knowledge society. Some aspects are also picked up from Karlsson, Johansson & Stough (2001).

The shift from an economy based on raw materials to a knowledge-based economy has among other things been manifested in the emergence and growth of a number of new industries. The perhaps most extremely knowledge intensive of these new industries is the biotech industry, which in several respects fundamentally differs from traditional manufacturing industries. While the main value of a manufacturing firm resides in its physical capital, the value of a biotechnology firm is in its intellectual property. Whereas a manufacturing firm sells tangible products for consumption or refinement, a biotech firm's products consist of R&D products, including patents, with a *potential* for being commercialized and profitable. Instead of final products, biotechnology business is focused on a number of intermediate outcomes, such as *knowledge production* for increasing the knowledge base, *firm creation* as a proof of commercial potential in research, and *business development* in the form of expanding R&D and/or bringing selected projects closer to commercialization (Nilsson 2001). In these respects, the biotech industry represents an extreme case of tendencies that are found in several sectors of the knowledge economy. With a continued expansion of the role of knowledge for the economy, it is plausible that certain tendencies in the biotech industry of today will become general tendencies in the knowledge economy of the future.

One of the differences between the knowledge society and previous societies, stressed in table 1, is that it is the individuals who are the "owners" of the decisive production factor. Knowledge is an individual asset which is non-productive without being possessed and used by its individual bearers. This characteristic is reflected in the vast human capital literature. On the other hand, knowledge has also some of the qualities of public goods. It is only imperfectly excludable and therefore subject to spillovers (Romer 1990, Fisher & Varga 2003). These characteristics are fundamental for the endogenous growth theory and in particular for the knowledge spillover literature.

Although the two approaches focus on different aspects of knowledge, they have in common the recognition that knowledge is produced, exchanged and used in social systems, which might differ in their ability to produce, exchange and use knowledge. In the institutional theory's perspective, it is the societies' institutions and organizations (see e.g. North 1990) that are more or less adapted to production, exchange and use of knowledge.

Institutions and organizations can be divided into formalized and non-formalized. We can e.g. distinguish between formal rules, charters and laws, and informal rules, norms and attitudes. It is also possible to distinguish between formalized organizations and informal networks and groups. In this perspective, the growing literature on social capital deals to a large extent with the informal parts of institutions and organizations, i.e. the norms and values of organizations, groups or spatially demarcated areas and their internal and external networks (Westlund 2004).[2]

While certain components of social capital can be seen as an inferior substitute for market and formal institutions in developing countries (see e.g. Omori 2001) it has also been argued that social capital plays an increasingly important role in the knowledge-based society as it facilitates and speeds up economic agents' acquisition of information and knowledge (Maskell 2000). It can of course also be argued that social capital promotes production and the exchange of knowledge in research, education and commercial R&D processes.

This paper takes its theoretical starting point in these assumptions. A working hypothesis for this inquiry is that a new kind of social capital characterizes the knowledge-intense sectors of the economy and that the knowledge economy's continued growth is dependent on the development of this new social capital. In a spatial context this means that regions that are not able to transform their social capitals will have great difficulty in changing over to the knowledge economy.

There is no recognized, established definition of social capital in the discipline of economics and even to a lesser extent a common definition that extends over disciplinary boundaries. In this paper, social capital is defined as *social, non-formalized networks that are used by the networks' nodes/actors to distribute norms, values, preferences and other social attributes and characteristics.*[3] An important feature of this definition is that it distinguishes between the networks and the norms, etc that are distributed. Social capital is

[2] *Here it should be noted that social capital in this report (as in Westlund 2004) not only refers to phenomena in the civil society (in the tradition of Putnam 1993, 2000) but also to norms, values and attitudes as well as networks and relations in business life and working life.*

[3] *This definition is a further development of Westlund & Bolton (2003) who "define space-bound social capital as spatially-defined norms, values, knowledge, preferences, and other social attributes or qualities that are reflected in human relations. In network terms this may be expressed as meaning qualities, capacity, objectives, and quantity of the nodes (actors) and qualities, capacity, objectives and quantity of the links in primarily informal, spatially-demarcated social networks."*

considered as a type of infrastructure with nodes and links. The nodes consist of individuals and organizations, which establish links between each other. The construction of links is governed by the individuals'/organizations' norms, preferences and attitudes, which can thus prevent emergence of links between individuals or organizations as well. In the links, different types of information are distributed between the nodes. From an infrastructure perspective, this distribution of information can be compared with traffic in the transport infrastructure. The impact of social capital on society depends on both its quality and quantity. The norms, preferences and attitudes of the nodes, and thereby the kind of information being distributed in the links, are at least as important as the number of links. "Strong" social capital can thus have preservative as well as progressive effects, depending on its qualitative characteristics.[4]

The aim of the paper is to study and compare the social capitals of one on the most knowledge-intense industries, the biotech industry, in Sweden, Japan and California. Section 2 gives a brief overview of biotechnology and the industry that has emerged based on its findings, and presents the leading biotech centers in the three countries, with particular focus on the clusters selected for this study. Section 3 gives an overview of biotech policies in the three countries. Section 4 discusses the concept of social capital with the focus on business life. Section 5 discusses social capital as a spatial externality. Section 6 presents and analyses the empirical results from a questionnaire sent out to biotech companies in Sweden, Japan and the United States and discusses the results from a policy perspective.

[4] *See Westlund (2004) for a more extended discussion.*

2 Biotechnology, concepts and clusters

2.1 Concepts, definitions and peculiarities

Already in prehistoric times, man used biotechnical methods, e.g. collecting and selecting seeds for planting and selective breeding to improve livestock. Beer brewing, wine fermenting, bread baking with yeast and yogurt and cheese making with lactic acid-producing bacteria are other examples of early use of biotechnology. The term biotechnology was coined as early as 1919 by the Hungarian engineer, economist and government minister Károly Ereky, who defined the products of biotechnology as being made "from raw materials with the aid of living organisms" (Fári et al. 2001, quoted in DeVol et al. 2004, p. 12). There is no unitary, international definition of biotechnology, a fact among other things reflected in the very heterogeneous statistical data covering the field. The perhaps the most all-encompassing definition was formulated by the United Nations Convention on Biological Diversity:

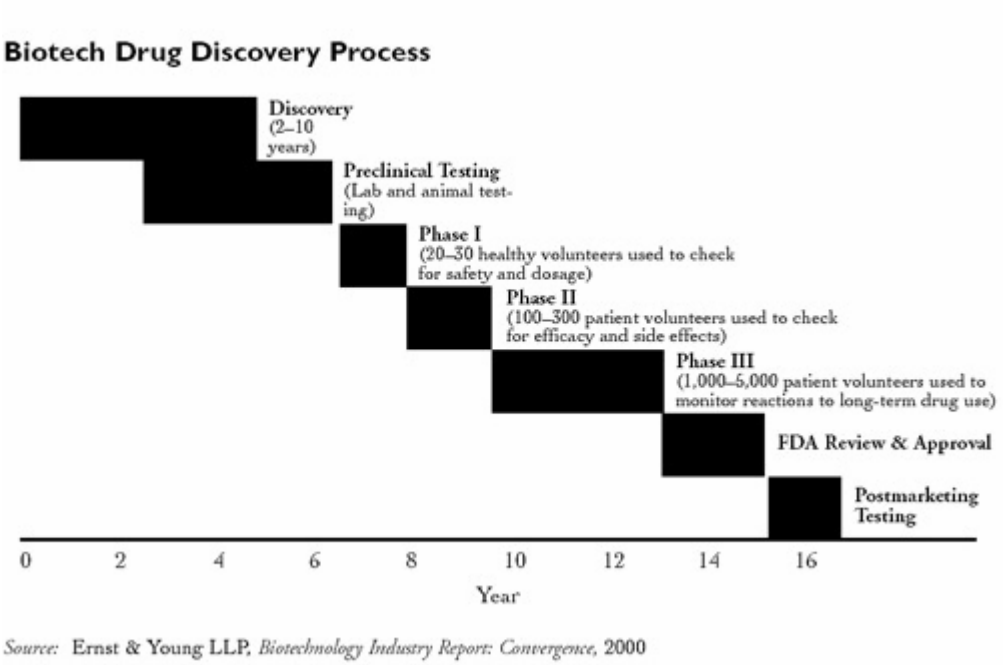
"*Biotechnology is any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use*" (http://www.free-definition.com).

The term *Life Science* is a broader concept, with a number of partly different definitions, of which one is "any of the branches of natural science dealing with the structure and behavior of living organisms" (http://www.thefreedictionary.com). A third term, *bioscience*, is often given the same definition and is used synonymously with life science.

All of the three concepts are used not only for scientific fields but also as denominations in industrial activities. Several authors make a similar distinction as between the scientific fields and define biotechnology as a more narrow term and bioscience as a broader term. One example is DeVol (2000) who considers bioscience industries as consisting of applications of biotechnology and other life sciences, plus medical devices, instruments and software. In addition, related service industries and supplier/vendor companies are normally included. Pollak (2002) uses a more narrow definition, including only applications of DNA science and technology plus medical devices in the bioscience industries. However, in everyday use, *biotechnology industry* (or biotech industry) is the most used term, and then mainly used synonymously for the broader definitions of bioscience industries.

As noted in the introduction, the biotech industry differs in several ways from industries in general. The main value of a biotech firm is its intellectual property; its products consisting of R&D products, including patents; it is one of the most research-intensive industries in the world, etc. figure 1 shows that the time from early research to final product is extremely long in certain biotech sectors, as e.g. drug development. This means special problems when it comes to financing. Therefore, biotechnology has a particular need for venture-capital financing in the early phases of product development, where normal credit institutions do not invest.

Figure 1 Example of product development process in biotech drug development.



Source: Ernst & Young LLP, *Biotechnology Industry Report: Convergence*, 2000

2.2 An international comparison

A number of international overviews of the biotech industry have been made over recent years (Pammolli & Riccabone 2001, Allansdóttir et. al. 2002, Deloitte Touche Tohmatsu 2002, OECD 2003). A common view is that the US is in the lead of the industry's quantitative development and that the industry is growing worldwide in spite of short-term fluctuations.

However, international comparisons are problematic for several reasons. The national studies on which the comparisons are based often have different definitions of biotechnology.[5] As noted in the former section, biotechnology is e.g. sometimes used as another denomination of life sciences, sometimes as a part of life sciences. It has also been suggested that some studies include companies without employees whilst other do not (Sandström & Norgren 2003). Another problem is what should be defined as a "pure" biotech firm. In a comparison of biotechnology in Japan and the US, Zucker & Darby (1994) showed that of all 246 enterprises they defined as biotech firms in Japan, only 5, i.e. 2 percent, were new firms at that time. The remaining 98 percent were subunits or subsidiaries of preexisting firms. In the US, 68 percent of the biotech enterprises were new firms. One of Zucker & Darby's explanations for the extremely low number of start-ups in Japan 1994 was a culture and incentive system discouraging entrepreneurship. Also Japan recently had the lowest rankings in international entrepreneurship comparisons (Reynolds et. al. 2002).

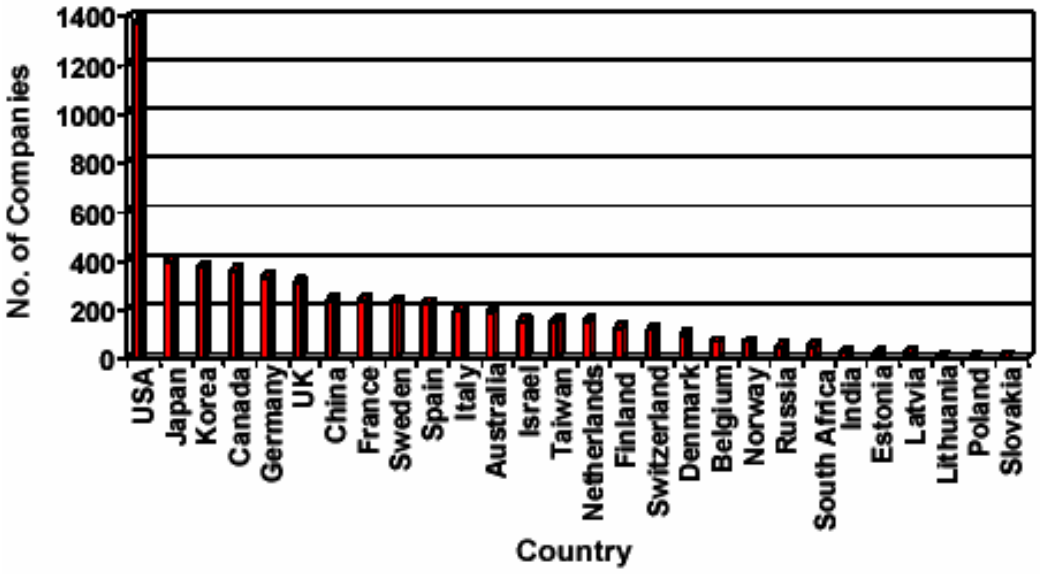
[5] *A report published by the California State Library states e.g.: "Good statistics about the bioscience industries can be hard to come by. Because of their newness, some of its sectors, particularly in biotechnology, are not well-reflected in the system of industrial classification used by the U.S. census and other government agencies. As a result, much of the available data comes from private sources, and different sources use different definitions and methods." (Pollak 2002, p. 29).*

The predominating Japanese strategy to develop new sectors has so far been that established enterprises expand their activities to new sectors (Westlund 2004).

Nine years after Zucker & Darby's study, 2002, the bio-related start-ups (called "bio-ventures" in Japan, having less than 300 employees) registered by the Japan Bioindustry Association (JBA) numbered 334 firms (JBA 2003b). The number of preexisting firms dealing with biotechnology activities is not known. Thus, even if the number of biotech start-ups in Japan has increased considerably as it has in other countries, it is obvious that different entrepreneurship cultures make international comparisons of the number of companies and employees partly misleading.

According to figure 2 the United States in 2000 had about 1400 biotech companies, i.e. almost as many as the following five competitor countries together. Japan was second in the world in the number of companies. Sweden was number nine in the world and number four in Europe. Other sources confirm Sweden's fourth place and the approximate number of Swedish companies, but have quite different figures for most other European countries (Pammolli & Riccabone 2001, Allansdóttir et al. 2002).

Figure 2 The number of biotech companies in different countries 2000.



Source: Swedish Trade Council 2002, quoted in Sandström & Norgren 2003, p. 49.

A survey of the US Department of Commerce illustrates the problem of defining which companies should be regarded as biotech companies. A survey population of 3,189 companies was collected by membership in trade organizations and suggestions from state and federal agencies. Of the companies responding to the questionnaire only 53 percent confirmed that their activities corresponded with the survey's definition of a biotech firm (US Department of Commerce 2003).

Concerning the number of companies by population, Sweden was in the world lead with a figure more than double that of the countries placed two and three i.e. Switzerland and Canada (OECD 2003).

The problems of definitions are also reflected in figures for the number of employees in the biotech industry. The Biotechnology Industry Organization (BIO) refers to Ernst & Young's biotech reports and states that 198,300 were employed in the industry in 2003 and

194,600 in 2002 (BIO 2004). The Milken Institute reports that in the ten largest U.S. biotech clusters (where most of the U.S. biotech activities are concentrated), 103,000 people were employed in the biotech industry and 214,000 in the life sciences in 2002, according to the institute's definitions (DeVol et al. 2004). According to the California Healthcare Institute, 225 000 persons were employed in what was called the biomedical industry, just in California (Pollak 2002).

The number of quantitative estimations of the biotech industry in Sweden and Japan is much smaller than in the U.S. As a result there are not so many conflicting figures. In what, according to the Japan Bioindustry Association, was the first survey of its kind (December 2002) the number of employees in the above mentioned 334 "bioventures" was estimated to be 6,757 (JBA 2003b).[6] The probably most reliable source on the Swedish biotech industry, Sandström & Norgren (2003), reports 3,975 employees in 183 small and medium-sized biotech firms (<500 employees) in 2001.[7] The total pharmaceutical and medical sector in Sweden employed about 30,000 people.

[6] *The JBA stresses that the Japanese definition of bioventures differs from those used in the U.S. and in Europe (JBA 2003a).*

[7] *Two companies with more than 500 employees, Amersham Biosciences with about 1450 employees and Biovitrum with 550 employees, were not included in the study. Thus, in total about 6 000 people were employed in the Swedish biotech industry in 2001.*

Figure 3 Biotechnology patents granted by the USPTO for priority years 1990 and 1997

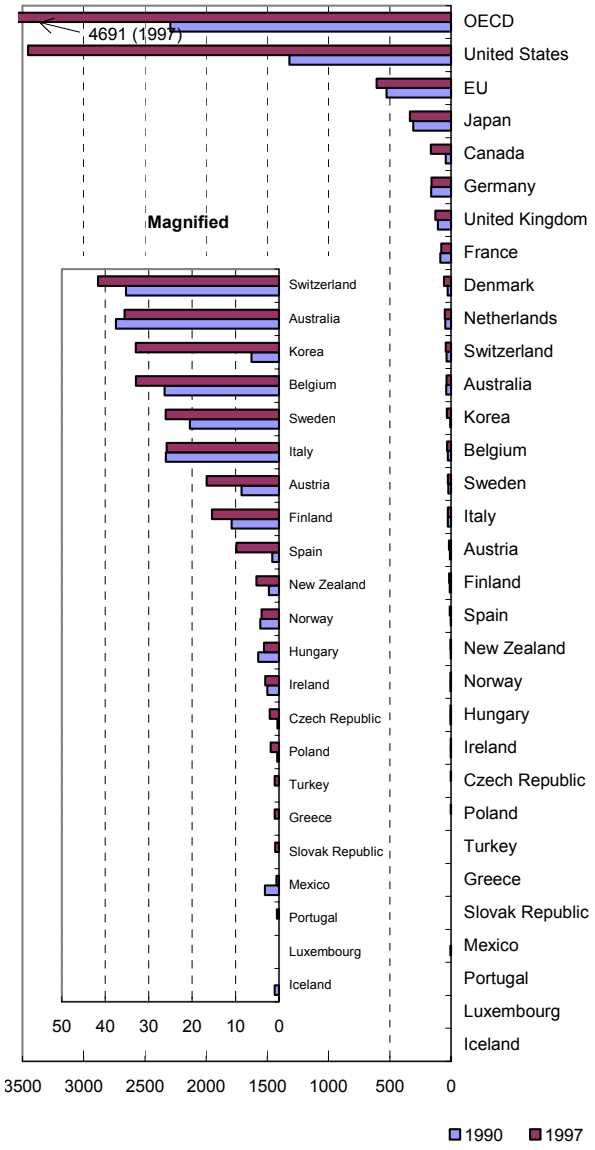
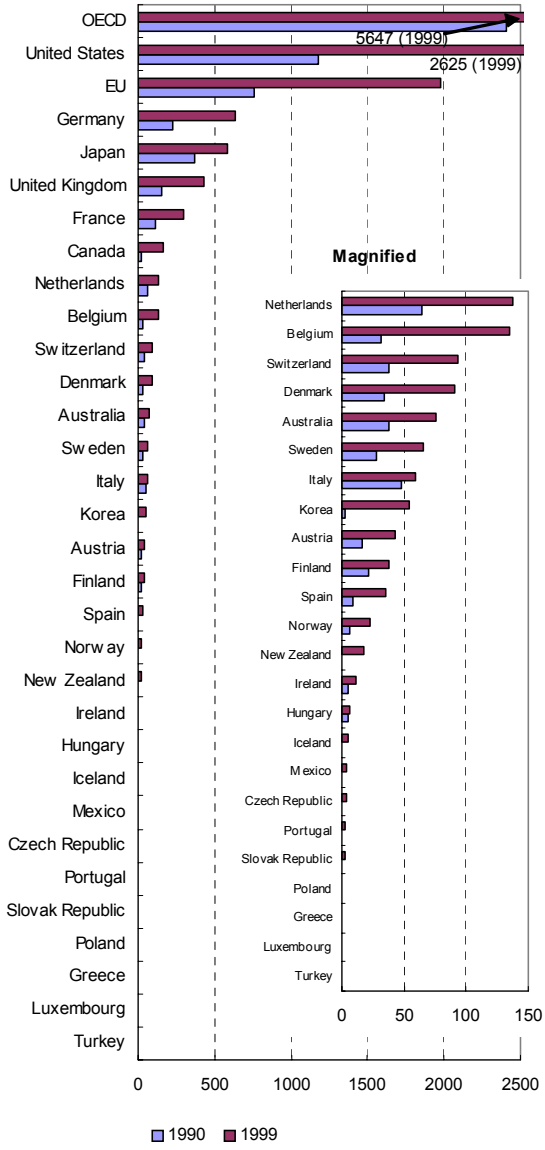


Figure 4 EPO biotechnology patent applications for priority years 1990 and 1999



Source: OECD (2003) p. 14.

Note: The priority year refers to the first patent filing worldwide; it is the closest to the invention date.

An alternative way to compare countries biotech performance is to study patents and patent applications. Patents are often the only commercial output of biotech firms, since many of them have no other activity than R&D. By selling patents or licensing rights to other firms, they sell the right to exploit their inventions. Statistics about countries' biotech patents may therefore be an indication of the industry's level of development.

Figure 3 and 4 shows biotech patents from two patent offices, the United States Patent and Trademark Office (USPTO) 1990 and 1997 and the European Patent Office (EPO) 1990 and 1999.[8] The US had the highest numbers of patents both in the US and in Europe. Japan

[8] *For a detailed explanation of different measures, see OECD (2003).*

was second in the US both years, and in Europe in 1990, but in 1999 Germany had taken second place from Japan. Sweden had a more modest ranking in patents compared to the number of firms.

Concerning the growth of biotech patents, the figures of the American and European patent offices showed larger differences. The OECD average growth 1990-97 was 11 percent in the USPTO data and 10 percent 1990-99 in the EPO data. The Czech Republic, Spain and Korea had the highest growth (more than 25 percent) in the USPTO data. The growth of the United States was above the OECD average, while both Sweden and Japan were well below the average growth. In the EPO data, Korea, New Zealand and Canada had the highest growth rates, Sweden was at the OECD average with the US just below, while Japan had a still lower growth rate (OECD 2003).

To sum up, this international comparison shows that the size of the biotech industry in different countries varies with the definitions used, by the measures used and by the differences in entrepreneurial culture. However, the US seems to be in the undisputed lead in absolute figures, with Japan in second place in most measures. Sweden ranks among the leading European states after Germany, the UK and France. When it comes to growth rates, a number of "new" countries are at the top.

2.3 Biotech industry clusters in the three countries

2.3.1 Sweden

Sweden's biotech industry is normally regarded as concentrated in four clusters, Stockholm, Malmo/Lund, Uppsala and Gothenburg. The empirical study of social capital reported in section 4 comprises companies in all the four clusters and some located outside the clusters. It should also be pointed out that Stockholm/Uppsala in many respects is one joint cluster. The close proximity of Stockholm and Uppsala (65 km) has resulted in an integration of the two cities' labor markets. Biotech and supporting companies (e.g. financial actors) in Uppsala are increasingly viewing Stockholm-Uppsala as one cluster, while actors in regional government and Uppsala University view Uppsala as distinct (Teigland et al. 2004). However, as available biotech statistics make a difference between the two cities, we here present these non-summarized figures.

The development of the Swedish biotech industry has to a large extent been a result of the development of "user industries". This means that the growth of the health-care sector and the pharmaceutical industry from the 1960s and onwards and these industries' close connections to the growing medical research have formed the base of the modern biotech industry in Sweden. In this respect, regional innovation systems in pharmaceutical/medicine-related biotechnology were formed in the regions where the leading academic research hospitals were located. This is reflected in the fact that pharmaceuticals/medicine in the predominant sector of the biotech industry is in both the largest clusters, Stockholm and Malmo/Lund, as well as in Gothenburg. Of the four major clusters, only Uppsala has the highest share of employment in another sector, namely tools & supplies, but even there pharmaceuticals/medicine is the second largest sector.

Table 2 Number of employees in the Swedish biotech industry 2001, by cities/clusters and sectors.

	Stockholm	Malmo/Lund	Uppsala	Gothenburg	Other	All
Pharmaceuticals & Medicine	742	612	318	271	54	1997
Bioproduction	154	260	8	2	134	558
Tools & Supplies	108	23	385	61	11	588
Environmental biotech	5	16	0	2	8	31
Functional food & feed	112	25	3	2	5	147
Agrobiotech	5	0	12	0	603	620
All sectors	1126	936	726	338	815	3941

Source: Sandström & Norgren (2003) p. 108.

Note: 11 companies started in 2001 and with in total 34 employees were not included in the regional division.

By the number of employees, the second largest sector in Sweden is agrobiotechnology, concentrated in a few plant improvement companies in the countryside outside Malmo/Lund. Tools & supplies, as mentioned, concentrated in Uppsala and bioproduction, concentrated in Malmo/Lund and to a certain extent Stockholm are the third and fourth sectors in size.

In the period 1997 to 2001 the total number of employees in the Swedish biotech industry increased by 47 percent and concentration in the four main clusters increased during the period. However, the regional variations in growth were considerable. Uppsala had the highest growth with 174 percent, followed by Gothenburg with 107 percent. In Stockholm the rate was 51 percent and in Malmo/Lund 36 percent.

In all the four leading clusters, connections between one or two pharmaceutical firms and medical faculties seem to have been important for the emergence of the modern biotech industry. One of the most cited examples is the collaboration between Pharmacia and Uppsala University, which started already in the 1940s and increased when Pharmacia relocated its operations from Stockholm to Uppsala 1950. After the merger between Pharmacia and Upjohn 1995 approximately 200 research and managerial positions were relocated from Uppsala, which was seen as a serious blow to the city. However, some years later it was argued that Pharmacia's withdrawal resulted in an entrepreneurial biotech boom when resources and competences were released (see Teigland et al. 2004). This popular myth has been questioned by Waluzewski (2003), but the importance of the long-term cooperation between Pharmacia and Uppsala University for the emergence of the Uppsala biotech cluster seems undisputed.

2.3.2 Japan

As pointed out in section 2.2, the Japanese biotech industry consists in principle of two more or less interrelated spheres: biotech related activities in large, established companies and new, small biotech firms, bioventures. No statistics are available on the size or share of "pure" biotechnology in the former.

For the latter, there is the aforementioned survey by Japan Bioindustry Association (JBA). table 3 shows these firms distributed by regions in December 2002.[9]

Table 3 Number of bioventures in Japan in December 2002, distributed by regions.

Region	Bioventures
Kanto (Greater Tokyo)	191
Kinki/Kansai (Osaka, Kobe, Kyoto)	55
Hokkaido	32
Kyushu & Okinawa	21
Chubu, Tohoku, Chugoku & Shikoku	35
Japan in total	334

Source: JBA (2003b).

As shown in table 3, more than half (57 percent) of the bioventures are concentrated in the Kanto region. 16 are located in Kansai and 10 percent in Hokkaido. The most common field of operation was "pharmaceuticals & diagnostic product development" (94 ventures) followed by bioproduction (78 ventures) and bioinformatics (41 ventures) (JBA 2003b).

For several practical reasons, the empirical study in section 6 was delimited to biotech companies in the Kansai region. The biotech industry of Kansai is focused around three fields: drug development, regenerative medicine and advanced analysis devices (Kansai Bureau of Economy, Trade and Industry 2003).[10]

2.3.3 United States

Already in the middle of the 90s, more than 100,000 people were employed in the American biotech industry. As shown in table 4 this number has almost doubled in ten years. However, the number of companies has shown a much smaller increase, indicating that this variable is not the best measure of development.

[9] *For 2004, JBA state that the number of bioventures had increased to 464 (Source: Swedish Office of Science and Technology in Tokyo).*

[10] *The selection of firms for the empirical study was not governed by this sectoral concentration*

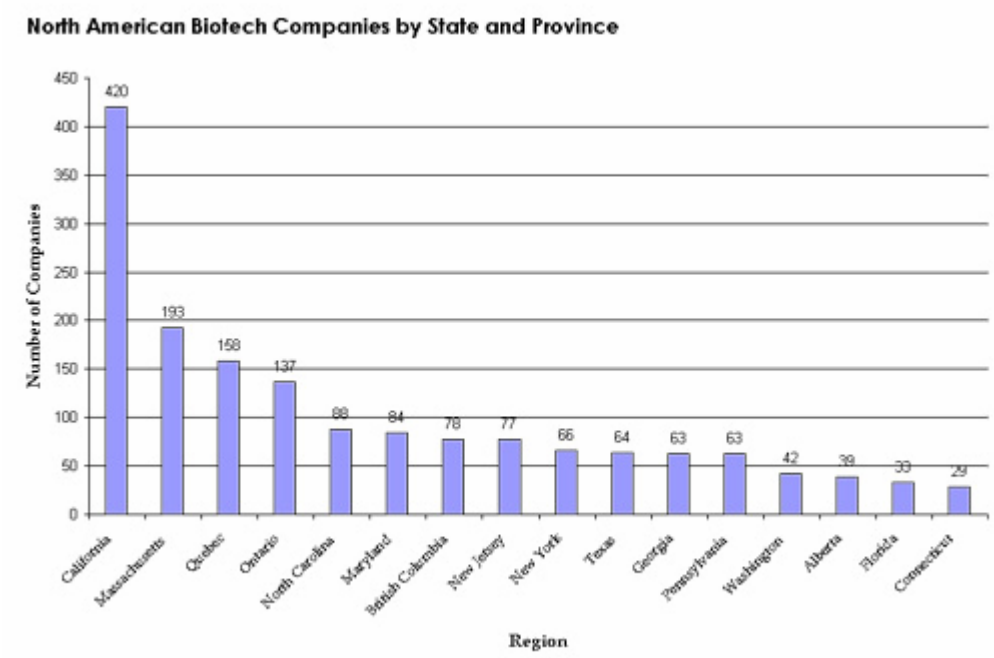
Table 4 U.S. Biotech Industry Statistics: 1994–2003*

Year	2003	2002	2001	2000	1999	1998	1997	1996	1995	1994
Sales*	28.4	24.3	21.4	19.3	16.1	14.5	13	10.8	9.3	7.7
Revenues	39.2	29.6	29.6	26.7	22.3	20.2	17.4	14.6	12.7	11.2
R&D Expense	17.9	20.5	15.7	14.2	10.7	10.6	9.0	7.9	7.7	7.0
Net Loss	5.4	9.4	4.6	5.6	4.4	4.1	4.5	4.6	4.1	3.6
No. of Public Companies	314	318	342	339	300	316	317	294	260	265
No. of Companies	1,473	1,466	1,457	1,379	1,273	1,311	1,274	1,287	1,308	1,311
Employees	198	194	191	174	162	155	141	118	108	103

Sources: Ernst & Young LLP, annual biotechnology industry reports, 1993–2004.
Financial data based primarily on fiscal-year financial statements of publicly traded companies.

**Amounts are U.S. dollars in billions.*

Figure 5 Number of US and Canadian biotech companies by region 2003.



Source: Ernst & Young LLP (2004)

As shown in figure 5, California is the American state having the by far highest number of biotechnology companies. The Californian biotech industry is concentrated in two large agglomerations, the Bay Area and Greater Los Angeles, and a more concentrated spatial cluster, San Diego. We will here give a short description of the emergence of the San Diego biotech cluster.

What is known today as the Scripps Institution of Oceanography (SIO) was founded in 1903 and was the first life-science research body in the region. In 1955 the predecessor of Scripps Research Institute was founded. In 1960 the Salk Institute for Biological Studies was established, as was the San Diego campus of the University of California (UCSD) the following year. The founding of UCSD was a result of instrumental lobbying with a vision to constitute the "MIT of the West" (DeVol et al. 2004).

In the legend of San Diego's biotech boom, the city's first fully-fledged biotech company, Hybritech, plays a decisive role. Founded in 1978 by former Stanford researchers Ivor Royston and Howard Birndorf (recruited to UCSD the year before), and bought by the big pharmaceutical company Eli Lilly eight years later, Hybritech was the cradle for more than a dozen entrepreneurs, which, 25 years after Hybritec's start, had founded more than 50 firms (DeVol et al. 2004).

San Diego's biotech boom is often described as the brilliant example of collaboration between academies, research institutes, hospitals, industry, venture capitalists and government – a collaboration in which the barriers between the different actors are low, permitting people to change positions. One of Hybritech's founders, Howard Birndorf, has described the dense biotech networks of San Diego in the following way:

> *I think that the fact that there's venture capital, management talent, and entrepreneurial attitude here in San Diego, coupled with the fact that you have these mayor research institutions within three square miles supports the whole reason that this cluster is here. Additionally, the networking here through the programs such as [UCSD's] Connect[11] and BIOCOM[12] have created a situation where starting a company is like falling off a log. The network is so in place for not just the money, but the facilities and the legal support, both corporate and patent, the lab supplies, you name it. Everything is here, easily available and even if somebody has no clue as to what this is, there are so many people here that do know now and can help somebody who wants to do it.*[13]

[11] *Founded in 1985 at the urging of San Diego's business community, UCSD Connect is regarded as one of the nation's most successful regional programs linking high-technology and life science entrepreneurs with technology, money, markets, management, partners, and support services.*
[12] *BIOCOM is a life science industry association representing more than 450 member companies in San Diego and Southern California.*
[13] *Quoted from DeVol et al. (2004) p. 16-17.*

3 Policies for the growth of biotech industries in the three countries

3.1 Sweden

That fact that Sweden is among the world's ten countries having the highest numbers of biotech companies and is number one in the world regarding companies per inhabitant would suggest that biotechnology is an area being given highest priority in Swedish industrial policies. However, this is not the case. There are no governmental agencies focusing especially on biotechnology and there is no national coordination among the actors that partly aim at supporting research, commercialization, cluster building, capital access and other fields in development of the industry. This division in actors with different responsibilities goes all the way up to the national government, where research in biotechnology comes under the Ministry of Education while development of the industry comes under the Ministry of Industry.

However, certain aspects of public policies have been important for Sweden's position in the global biotech industry. Sweden has a long tradition of high-level, publicly financed medical research, which has contributed both to Big Pharma's expansion from the 70s onwards and to the expansion of the new biotech industry. The strong expansion of public health-care from the 60s to the 80s had several effects on the life science industries: it generated demand and resources for new research, not least clinical research.

Research councils and foundations, together with the general university funds, are the main financiers of biotechnology research in Sweden. In 1997, the total funding of microbiological and biotechnological research from all sources amounted to SEK 510 million ($69 million)[14] (Sandström et al. 2001). According to a report by the European Commission (1999) comparing biotechnology research in seventeen European countries, Sweden showed up three peculiarities:

- Research financing is provided by a large number of actors, including charities.
- The Swedish research funding system is more focused on science than technology with weak links between science and technology policies.
- Funding is based on open calls for proposals, is based on peer reviews, and is mainly oriented to the universities. There are no biotechnology research institutes and no national research programs, giving priority to certain areas, nor any other co-ordination of funding.

Biotech is the subject of vigorous public debate in a number of different fields, not least stem cell research. Attitudes, ethical and religious values and even fears among the public are often reflected in legislation and regulations as to what kinds of research are permitted. In this respect, Swedish regulations are considered being among the most progressive of the countries with the most developed biotech industries (SwedenBIO 2004).

Public support for commercialization, cluster building and capital access is provided by a number of national agencies all of which have a much broader focus than just the biotech industry. NUTEK, the business development agency, gives grants and loans for the start-up and seed-financing of new companies. In 1999 biotech companies received 13 percent of

[14] *Average exchange rate 1997 was SEK 1= $ 0.1312 (www.oanda.com)*

the available means, while the share was considerably lower the preceding years (Sandström et al. 2001). Other public agencies providing venture capital are ALMI Business Partner, the Technology Link Foundations and the Swedish Industrial Development Fund. Vinnova, the agency for innovation systems, gives priority to 18 "growth areas" of which four are related to biotechnology (pharmaceuticals and diagnostics, biotech supply, biomedical engineering and innovation in foods). Among other things, Vinnova focuses on supporting incubator programs and dynamic regional innovation systems. Vinnova also supports competence centers – aimed at strengthening the links between academic research and industrial R&D – of which a few are biotech-related, and university centers of excellence. Four "knowledge platforms", of which biotechnology is one, are also given priority.

Thus, a number of actors have without much coordination been involved in the Swedish policies for strengthening the biotech sector. Commissioned by the Government, Vinnova has in May 2005 presented a proposal for a national biotech strategy. The proposal suggests an increase of the current yearly allowances on $22 millions to $145 millions. If the proposal is enacted by the Government, Vinnova will be able to play the coordinating role that probably is needed.

The resource issues are highlighted by the biotech industry's organizations, which stress the shortage of seed capital and venture capital. Regarding research, it has been pointed out that the total public research funding of biotech and medicine research in the United States 2003 was more than eight times the per capita funding in Sweden. As a member of the European Union, Sweden has access to the EU frame programs. However, due to bureaucratic application processes, multi-partner requirements, etc, these programs are hardly available for SMEs. Industry organizations also claim that Sweden is losing ground as a number of countries are increasing their efforts to promote the growth of the biotech industry (SwedenBIO 2004).

3.2 Japan

A general opinion among actors of Japanese biotechnology is that they are lagging 10-15 years behind the U.S. and Europe[15] in many respects. It is possible to interpret the Japanese lagging behind as a reflection of the country's problems in transforming its economy from a manufacturing-industry based economy to a knowledge-based one. The Japanese industrial innovation system was based on intimate collaboration between government and big companies, in which government provided R&D grants for developing selected technologies. However, in Japan as in other countries, big companies prefer to invest in good securities and not in insecure potential innovations. The Japanese innovation system – so successful in industrial production – showed it weaknesses when innovations were dependent on university research and risk-taking small entrepreneurial enterprises. Both the formal institutions and the informal social capital of the Japanese economy have constituted severe obstacles to a smooth transformation to a knowledge economy (Westlund 2004). As a consequence, research on biotechnology has not led to a substantial number of start-ups, as in other countries. Instead, the established big companies in biotech-related branches started biotech units within their existing frameworks. Also the Japanese government has hesitated at the prospects of biotechnology. Although the budget for life sciences' R&D doubled between 1995 and 2000, the budget for life sciences in Japan in 2002 was less than 1/7 that of the U.S. (Biotechnology Strategic Council 2002).

[15] *Personal interview with Director Yashima Takehiro, Kansai Bureau of Ministry of Economy and Trade (METI) 2003-12-02; Director Mitsuru Miyata, Nikkei Business Publications, quoted in "BiotechSweden", No 4, 20 April 2004.*

In July 2002 a Biotechnology Strategy Council was formed and in December 2002, the Japanese Prime Minister Junichiro Koizumi himself – a sign of the stress the Japanese government now lays on the sector – launched guidelines for a national biotechnology strategy containing 200 detailed action plans. The strategy covers the whole biotechnology sector, from more than doubling the biotech research budget the following five years, to increasing the so far insufficient collaboration between universities and industry and between disciplines; from promoting start-ups, improving institutions for intellectual property and venture capital, to supporting cluster building and actions for thorough permeation of public understanding (Biotechnology Strategic Council 2002).

Koizumi's biotechnology strategy can be seen as an example of the Japanese type of large-scale, centralized, top-town policies. However, the content shows that the government is ready to try new methods and solutions. The conclusion must be that Japan has formulated one of the most ambitious and comprising biotechnology policies in the world. It remains to be seen at what pace it will be possible to implement the policies and achieve the expected results.

3.3 USA and California

Ever since the early breakthroughs of DNA research in the 70s, the United States has been the most prominent country in the world in the field of biotechnology. This holds both for academic research, industrial R&D and commercialization of the findings.

In 2001, U.S. academic R&D expenditures on biotech sectors totaled $16 billion. The National Science Foundation is one important financier of academic biotech research and granted more than half a billion USD in 2003. By far the largest funding agency for biotech R&D is the National Institutes of Health, which provided $17 billion to biotech and medical R&D in 2002 (DeVol et al. 2004). In contrast to the situation in e.g. Sweden, where "research" is something that should take place at universities, a substantial proportion of NIH's and related agencies' funds are available for SMEs. A federal law states that every federal government department has to allocate a certain percentage of their budget for Small Business Innovative Research (SBIR) grants. Any company fulfilling certain qualifications can apply for these grants. The grants mainly support costs for R&D, personnel training, overheads and some equipment.[16] Another important federal program is the Small Business Technology Transfer (STTR) program, aimed at extending the participation of small businesses in federal R&D and encouraging private sector commercialization of technology.

Thus, the general picture is that biotechnology is a sector given high priority in federal policies. However, one field where some activities within biotechnology are questioned concerns issues related to ethics and religion. The anti-abortion movement and other conservative religious movements have played a mayor role in resistance to research on stem cells from human embryos. Stem cells are "unspecialized" cells that can generate healthy new cells and tissues. As a result, they have the potential to provide life-saving cures for many different diseases and injuries, including diabetes, cancer, heart disease, Alzheimer's, multiple sclerosis, HIV/AIDS, Parkinson's, ALS, osteoporosis and spinal cord injuries. Since 1995, research on embryonic stem cells has not been supported by federal funds. Since 2001, it has been possible to give federal grants for research on stem cell lines that existed prior to September 2001, but not to new ones. In reality this meant that only 21

[16] *Personal communication with CEOs of Californian biotech companies.*

stem cell lines were available for research. More than 100 new stem cell lines have been produced since 2001 (Nilsson 2004).

As a consequence of the resistance to stem cell research in several states and at a federal level, other states have seen the opportunity to support this research in order to increase economic growth and public health. The largest investment is made in California, which, in connection with the elections in November 2004, approved a $3 billion bond measure to fund stem-cell research. The $295 million in annual funding, spread over ten years, is taking place through the creation of the California Institute for Regenerative Medicine. Grants and loans for research and facilities will be made to academic and non-profit research institutions, teaching hospitals, and commercial entities that have demonstrated success in therapy deployment. All grants and facilities funded by the Institute must be located in the state of California. Besides the expected effects on health, the investment aims at making California the undisputed leader of stem cell research in the world.[17]

The new institute did not fall from the sky. As presented in section 2, California is already the state with the highest number of biotech companies. Three of the six largest biotech clusters in the U.S. are situated in California and 43 percent of the biotech workforce is concentrated to the state (ITPS 2004). Already in 2000, Governor Gray Davis launched the California Institute for Bioengineering, Biotechnology & Quantitative Biomedical Research (QB3) as one of four institutes for science and innovations. QB3 has been built up through collaboration between the University of California (UC) system and the bioscience industries. The institute involves more than 100 scientists to be housed in a new building at Mission Bay in San Francisco, the new UCSF campus that will be part of a public/private biomedical research park, in a new building at UC Berkeley and in two new facilities at UC Santa Cruz. A number of other academic-industry collaborations supported by the state are also found in other parts of California (Pollak 2002).

According to a survey by the Biotechnology Industry Organization, as of 2001, ten states had developed or begun developing strategic plans for biotechnology. California does not have a comprehensive strategy for the biotech industry, but the wide diversity and initiatives indicate that biotechnology is among the industries given the highest priority in the industrial policies of California (Pollak 2002).

Thus, in comparison with Sweden and Japan, the public policies (and private initiatives) for growth in the biotech industry in United States in general and California in particular are by far the most developed. This holds well not only for the amount of resources invested, but also for collaboration industry-academy-government.

[17] *Another state supporting stem cell research is New Jersey, which together with California and New Hampshire is the only state so far permitting broader research into embryonic stem cells than federal law permits.*

4 Social capital in a knowledge industry

4.1 Social capital in business life[18]

Figure 5 provides a preliminary attempt to divide what we here call *enterprise-based social capital* into certain component parts.[19] The basic division in the table is between the enterprise's internal and external social capital. The external social capital consists of three components of which the production-related part is connected to production, and the environment-related area is partly connected to production and partly to sales. Market-related social capital is connected to sales.

Table 5 Social capital of the enterprise broken down into different component parts.

Social capital internal to the enterprise	The enterprise's external social capital		
Links/relations filled with attitudes, norms, traditions etc. that are expressed in the form of: - Company spirit - Climate for cooperation - Methods for codifying knowledge, product development, conflict resolution, etc.	Production-related	Environment-related	Market-related
	Links/relations to suppliers, product users, partners in cooperation and development	Links/relations to the local/regional environment, to political decision-makers, universities, (non-production-related links to) other enterprises	General customer relations build through marketing, customer clubs, programs, etc. and expressed in e.g. trademarks.

4.1.1 The enterprise's internal social capital

Internal social capital is made up of all the actors in the enterprise, i.e. both management and employees. Mainly in the disciplines of management, business administration and business sociology, the literature on these topics has expanded considerably, although other terms than social capital have been used.

The internal management of an enterprise can in principle vary on a scale from total top-down governance to total self-governance. Top-down governance is often connected to simple manufacturing, often symbolized by the assembly line whose speed is decided from the top. Decentralized self-governance is on the other hand normally connected to more knowledge-intense production, in which it is considered much harder to use top-down methods successfully. In this perspective, every enterprise should adapt its position on this "management scale" in accordance to its position on a "simple manufacturing – knowledge intense production scale". Expressed in another way, the enterprise's type of production creates the frames for the internal social capital best suited to the needs of the enterprise.

[18] *This section is based on Westlund (2004) and Westlund & Nilsson (2005)*

[19] *A term used in business administration and management for some of the concepts in Table 1 is "corporate culture". The concepts of production-related and environment-related social capital in the table have connections to the concept "relational capital", which, in addition to Johannisson (2001) mentioned above (2001), has been discussed and analyzed by, among others, Camagni (1995) and Capello (2001). In a spatial context these factors are also connected to the concept of "regional milieu".*

Without any ambition to carry out a full discussion on these problems, we focus here on two important fields connected to the enterprise's internal social capital: its *organization of work*, and *workplace relations*.

As noted above, the enterprise's *organization of work*, whether it is predominated by hierarchical or horizontal principles, is dependent on the type of production. The typical industrial hierarchical organization was adapted to replaceable un- or low-skilled labor. The role of management was to organize work in a way that maximized the productivity of this workforce. The gap in knowledge between management and workers was one of the factors that obstructed the creation of positive vertical relations. Instead it contributed to the industrial working class' collective organization and to the class struggle.

As manufacturing has been gradually transformed toward higher complexity, the need for a higher knowledge level in the workforce has risen. Another expression of the knowledge economy's expansion is the emergence of completely new sectors and branches. In both cases, increased competition means increased demand for cost reductions, product development and innovations. In this perspective, the importance of tacit knowledge and methods to transform it into codified knowledge has become important. Both the creation of tacit knowledge and its codification is to a large extent dependent on the organization of work.

The explicit distinction between tacit and codified knowledge was made by Michael Polanyi (1958, 1966). Codified knowledge can be defined as formalized, stored, written or digitalized information, which can be used or tested by another actor than the one that formalized the information (if the actor has access to the information and the necessary competence to use it). "*Tacit* knowledge is defined as knowledge that cannot be obtained by a mere sum of codified (digitalized) information. It can be generated through intimate 'indwelling' (Polanyi 1966:17) within a relevant local domain, or as personal knowledge through particular experiences and/or due to inherently personal qualities and competence; therefore it cannot become immediately available in open markets." (Aoki 2001:308).

The literature in this field has almost entirely focused on enterprises' investments to commercialize tacit knowledge to codified knowledge. Very little attention has been given to how new tacit knowledge is created. However, in its organization of work, an enterprise takes many intentional or unintentional steps that affect its creation of tacit knowledge.

Thus, as a consequence of the growth of the knowledge economy, the simple top-down management becomes less and less efficient. Another, more horizontal organization of work is needed. Two fundamental features in this organization for knowledge-based production are the composition of basic units (teams, groups, units, etc.) and the forming and maintenance of links between units horizontally and between units and higher levels vertically.

The first aspect, the composition of teams and groups, consists of choosing people with supplementary characteristics, without particular personal and/or social tensions between them. Compared with the archetypal workers on the assembly line, labor in the knowledge economy need to both communicate and cooperate in order to fulfill new implicit demands on creating tacit knowledge. While a social capital among the assembly line workers was not needed – from the enterprise's perspective – a team or a work group cannot fulfill its tasks without a certain amount of positive social capital among its members. The enterprise can contribute to this in several ways: team-building courses, training, regular meetings, etc, but a fundamental method is the choice of members of the team.

The second aspect, the forming and maintenance of links, is no news in the vertical perspective (e.g. in the form of foremen and supervisors). Also horizontally, in typical manufacturing production the assembly line was *the* link that connected the workers. However, the links of the knowledge economy are different in the sense that they not only distribute orders or (semi-manufactured) goods but also information and tacit and codified knowledge. As these links have more complex functions in the knowledge economy than before, the selection, training and monitoring of the individuals that form these links has become much more important for the success of the enterprise.

In contrast to tacit knowledge, codified knowledge can be regarded as an asset that the enterprise can use to deliberately increase its competitive power. The task is often formulated in terms of commercializing or capitalizing the tacit knowledge into a controlled input in the production process or a product of its own. In order to succeed with this, an enterprise needs to form trustful links between the bearers of the tacit knowledge – the work groups – and the "codifiers".

In our terms the endeavor to transform tacit knowledge into codified knowledge is an attempt to institutionalize capital that is originally social and non-institutionalized. Not all tacit knowledge should be considered as social capital since some tacit knowledge is strictly personal. However, most tacit knowledge must be regarded as being created in social interactions, which makes it a part of the social capital. From the enterprise's perspective, this means that codifying knowledge should mainly be considered as an investment in order to be able to use parts of the existing social capital in an enterprise, but not as an investment in new social capital in itself.

The organization of work does of course have an important impact on workplace relations but these relations are to a large extent also influenced by other factors, such as national cultures. Market-adapted American workplace relations are built first and foremost on principles of rewarding the individual employee and correspondingly hostility from the enterprise towards trade unions. In contrast, Japanese work-place relations after World War II have centered on creating firm and durable relations between the enterprise, the employee and the local trade union, resulting in an almost non-existent labor market The world's two largest economies representing these extremes indicate that it is not the type of relations that decide their success, but rather their general acceptance.

The individual enterprise in a country must normally adapt its type of workplace relations to the cultural traditions. However, this does not necessarily mean that the Japanese firm has higher costs for these relations – only that its methods for building relations are collective and not included in the individual wages and therefore more visible. In the American case, the individual reward through wages might give the illusion that workplace relations are of less importance.

Apart from these differences between countries in building workplace relations, there are of course also common elements such as company parties and other forms of internal entertainment aimed at affecting the company's spirit, culture and cohesion (Schein 1992). Thus, even if workplace relations vary considerably between countries, they are an indispensable component of the enterprise's internal social capital.

4.1.2 An enterprise's production-related social capital

A striking development in recent research is the discussion of inter-enterprise relations, especially relations between enterprises and their suppliers. This is in sharp contrast to the traditional economic perspective in which the enterprise is a non-cooperative monolith that buys its input from suppliers and sells its output to customers. According to this traditional approach, the production-related networks of an enterprise are technical and economic, and exist only to fulfill the input and output services.

Today, this simplified view is sometimes referred to as production relations of the "Fordist" or manufacturing-industrial age, but that is not a correct description. Social networks, even among the actors of production, are not an invention of the knowledge economy. However, there are arguments that claim that they have become more important in the knowledge economy: "*In a knowledge-based economy the perhaps most significant rent originates from the way in which the easy exchange of knowledge, only partly understood, between and among a constantly changing configuration of enterprises within the community dramatically enhances their innovative capabilities. Reducing your development to commercialization time is often worth virtually whatever you have to pay and social capital contributes by cutting the expenses and reducing the time needed to benefit from knowledge residing elsewhere. As innovative capabilities become increasingly important so does social capital*." (Maskell 2000:116).

Maskell connects social capital not only to the enterprise's internal knowledge production (as we did in the former section) but also to knowledge exchange between enterprises that temporarily or on a more long-term basis have some kind of production-related links. Moreover, he explicitly connects social capital to the innovative capabilities of enterprises. His argument is that social capital cuts expenses and reduces time needed for knowledge exchange between enterprises.

These arguments could be developed further. Social links, between an enterprise (and its labor force) and enterprises with which it has production relations, increase the flows of knowledge and information between the enterprises. Feedback, from the enterprise to its suppliers and to the enterprise from its customers, is increased and speeded up. These links, based on acquaintanceship and trust, are of obvious importance in R&D projects that have the aim of developing new products or production methods. They are probably also essential in the small, invisible development processes that take place in the everyday work of enterprises, which constitute the base of new innovations. These arguments are summarized in figure 6.

Figure 6 Summary of production-related social links and their effects

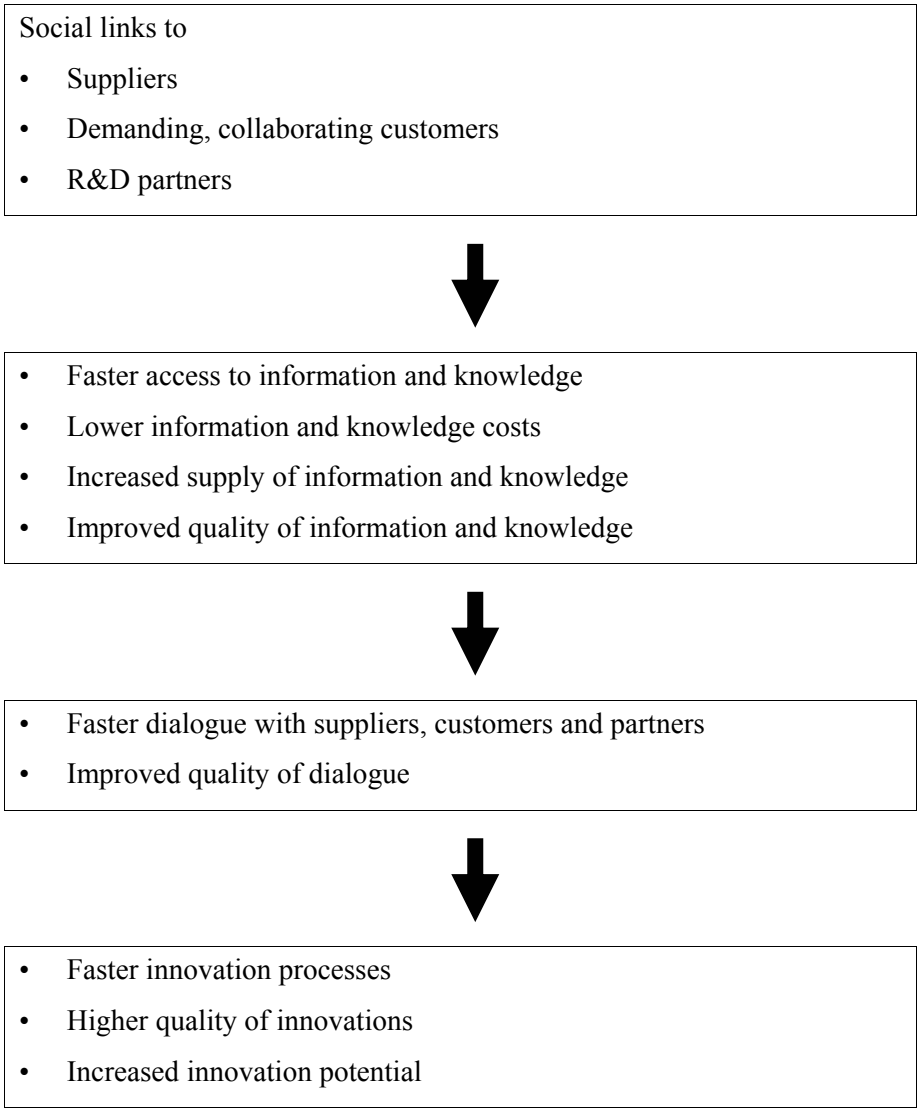


Figure 6 summarizes the positive effects for the enterprise of production-related social links. It must of course be remembered that investments in such links are subject to the usual assumptions of decreasing marginal utility and even negative marginal utility if investments exceed optimum.

4.1.3 The enterprise's environment-related social capital

The borderline between an enterprise's production relations and its environment-related networks is not entirely distinct. In a spatial context, production relations also constitute, in principle, a component of the environment relations. Therefore we are delimiting here the enterprise's environment relations with other enterprises to relations that are not mainly technical-financial.

Even with this delimitation, Maskell's arguments concern the enterprise's environment as well, when he speaks about "community". This adds a spatial aspect to social capital. An enterprise's costs for, among other things, knowledge and information are influenced by social capital through the degree of trust and the climate of cooperation prevailing both in individual workplaces and between enterprises and actors in a region. Marshall described this vividly in his celebrated account of the positive external effects which arise in industrial districts:

> *"The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously. Good work is rightly appreciated, inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed: if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas."*
>
> *Marshall (1920:271)*

For generations of economists, Marshall's industrial districts were merely an odd marginal note in the classic textbook on microeconomics. However, Porter's (1990) book on clusters marked a new and growing interest in the spatial milieu of enterprises (even if Porter 1990 considered clusters as a functional, non-spatial concept as well). In the rapidly expanding literature on clusters, they are normally defined as spatially delimited industrial systems regardless the size of the enterprises, whereas industrial districts are defined as spatial agglomerations of SMEs in one or a few complementary industries. As noted above, both concepts are connected to production relations as well as to more general relations to the enterprise's spatial environment.

The above mentioned examples – Marshall's industrial districts, Porter's clusters and Maskell's community – all refer to an environment consisting of distance-dependent networks *outside the individual enterprise's control*. A standard example of these network types contributing to explaining agglomeration phenomena is that of the IT-industry in Silicon Valley. Enterprises emerge there and choose to locate there because "the air" is full of tacit knowledge and information (including gossip and rumors), potential partners and co-workers in the form of other firms, university researchers and students are there, the competitors are there and it is easier to watch and learn from them if you are near them, etc. Even if the enterprise does business with only a small fraction of all the other enterprises in the region, and cooperates with just one research group, the presence of all the other enterprises and researchers constitutes a positive external effect, a social environment that the enterprise benefits from. The open, innovative spirit that characterizes these agglomerations until they mature and eventually become petrified is closely allied to the encouragement of entrepreneurship.

Thus, even if the environment is something that the individual enterprise normally cannot affect it is affected by its environment and does make steps to associate to it. The enterprise builds networks with links of principally three different types:

- Distance-dependent non-technical-financial links to other enterprises and R&D centers
- Links to politically governed bodies in the community/region
- Links to the citizens of the local/regional civic society and their organizations

The fundamental steps in creating and extending the networks of the first type are the *location decisions* in the establishing and expansion of a firm. Under given conditions the enterprise chooses its environment, be it Silicon Valley or the owner's home town. Depending on the enterprise's type of production (routine or knowledge oriented), location of suppliers and market, etc, the enterprise's needs for building social links to other enterprises and R&D centers varies. It has been argued that a process of global "ubiquitification" has made wage levels the most important location quality and consequently reduced the importance of an enterprise's environment. However, the existence of place-specific experience, tacit knowledge and competence *embedded* in a region are arguments supporting the significance of the local/regional environment of the enterprise (Asheim 2003; Malmberg & Maskell 2003).

The second of these network types is an expression of the enterprise's dependence on a predictable political-institutional infrastructure and the need for favorable political decisions, also in a medium-term and short-term perspective. Those who wish to do so might see these networks as a confirmation of the public choice theory, i.e. that politics does not work in accordance with its ideals. To achieve favorable decisions, to receive non-official information off the record, etc, the enterprise cannot restrict itself to allowing its individuals to take part in the public debate and to vote in elections and referendums. It is in the interest of the enterprise to establish social relations with public decision-makers, either directly or indirectly through branch organizations or lobbyist groups.

The third and last network type is an expression of an enterprise's need to be embedded (Granovetter 1985) in a local social context. This need of embeddedness varies depending on, among other things, the enterprise's size, alternative locations, space-bound capital, type of production, type of customers, type of labor, etc. In general a small enterprise with spatially fixed capital and production for the local market has considerable incentives to build a strong social capital with the local environment. A large, global enterprise with alternative locations, low investments in space-bound capital and production for the world market has much lower incentives. However, local units of global enterprises engage in building good local public relations through sponsoring or giving grants to local non-profit making organizations and other similar purposes. One reason might be that the enterprise's management and employees are individuals with social needs. Some of these needs are often expressed in becoming an accepted and respected part of the local community. Contributions to local civic society and its organizations thus raise the status of both the enterprise and its employees and increase individual welfare. The connections to public choice theory are evident here as well. Other reasons are mainly related to the market and sales of the enterprise (see below).

This subsection has treated the enterprise's environment in the distance-dependent perspective expressed in the theories of clusters and industrial districts. However, an enterprise's environment can of course be interpreted as being much wider than the cluster/industrial district/community. From such an interpretation, some of the arguments

presented here, particularly companies' needs for relations with political decision-makers, are also valid at the national and transnational levels. These aspects are not dealt with here.

4.1.4 Market-related social capital

An enterprise possesses a number of methods to create, expand and defend its market. One of them is to build some types of trustful social relations with its customers. By creating relationships with customers in diverse ways, (advertising, personal contact, customer clubs and programs, etc.) an enterprise attempts to shut out competitors from the network it has established. It can build similar networks with suppliers. An established enterprise with strong customer and supplier networks can use these to shut out competitors, which perhaps have newer and more productive physical and human capital, from the market. In this way, the established enterprise might temporarily substitute renewal of its physical capital with investment in social capital. The new enterprises have to find new, unestablished market segments or else break down parts of the established enterprise's customer and supplier networks in order to force their own way into the market.

The enterprise's customer relations are established toward customer enterprises (through e.g. external entertainment) identified individuals (through e.g. clubs and programs with individual membership) and toward the anonymous mass of customers with whom the enterprise has no personal relations (through e.g. advertising and building of trademarks). Charity and sponsoring non-profit activities can in this perspective be considered as a form of marketing and investment in market-related social capital.

While connections to "good" activities are positive for an enterprise' reputation, being associated to "bad" deeds is negative. Increased consumer awareness of environmental issues, child labor issues and other issues of this type has led many commercial enterprises to initiate a reorganization of their production and distribution networks, which is also a sign that customer relations can no longer be confined to offering anonymous products at the best price. Generally speaking, the increased importance - and market value - of trademarks provides testimony that customer relations are being increasingly impinged on by considerations which must be regarded as social. It is no longer the product alone but also the customer relationship established by the company name and trademark that constitutes an enterprise's market value.

However, including trademarks in the concept of social capital is not without objections. A trademark is an asset which, as opposed to other forms of social capital, is actually property that is not directly linked to a specific owner but can be bought and sold in the same way that enterprises are bought and sold. While social capital in civil society is, to a varying extent, semi-public goods or club goods (see Buchanan 1965), enterprise-related social capital consists of social networks that the enterprise has built up and may dispose of as it wishes. Most of these social networks cannot be separated from the enterprise's productive and/or financial activities, but they can of course be acquired, since an enterprise, or part of it, can be bought and sold. However, the trademark is an example of a type of social network that is not necessarily integrated with other activities of the enterprise. This type of social network is a private good, property in the legal sense of the term, and can thus be directly valued on the market Thus, it is more correct to say that a trademark is based on an enterprise's social capital, but that it is transformed, institutionalized and commercialized in a similar way as tacit knowledge is transformed into codified knowledge.

5 Space, externalities and social capital – a brief overview

More than few other industries, the biotech industry seems to be concentrated in certain locations, often denominated clusters. What are the driving forces for such a development and what is the role of social capital in these spatially concentrated growth processes? What is the role of social capital in the theories that aim to explain phenomena such as industrial districts, clusters, innovation systems and triple helix cooperation? This section discusses these and other questions connected to social capital and space.

Throughout history, space and social capital have affected each other in both cumulative and counteractive ways. *Physical* space, expressed in distance, has in general contributed to the forming of divergent social capitals within groups separated in space. The social capital of groups has been a prerequisite for group cohesion, which in its turn has reduced interaction between groups already separated by space. On the other hand, when a group or organization has been spread out in space, its social capital has contributed to diminishing the role of space in shaping and reshaping social capital. Thus, we can distinguish between social capital as a proximity-strengthening, internalizing factor and social capital as a network-building, externalizing factor, over-bridging space.

Social space, expressed in ethnicity, religion, class, etc is in many cases an original result of physical space. The forming of in particular ethnic groups have been processes where distance has played a crucial role. However, class division is much more of a purely social process in which, if physical distance between classes occurs, it has been the result and not the cause. In the case of social space, social capital has been a fundamental prerequisite behind the cohesion of social groups and their delimitation from each other – but establishment of "critical links" between groups has also contributed to mutual understanding and conflict reduction. Thus, in the case of social space, we can distinguish between social capital as an "intra-action"-promoting, i.e. internalizing factor and social capital as an interaction-promoting, externalizing factor.

This dual role of social capital – under certain circumstances promoting spatial and group internal cohesion, under other circumstances contributing to link-building that promote spatial interaction across physical and social borders – makes social capital a much more complicated factor than the trust-building, transaction-cost-reducing factor often assumed in the modern literature. In the spatial perspective, certain component parts of social capital work internalizing and are governed by the actors in that locality/region, and other component parts give access to externalities which the local/regional actors cannot govern. A similar conclusion can be drawn from the firm's perspective. The internal social capital of a firm is formed by its management and employees and for its survival there are strong incentives to internalize firm-specific knowledge – but by location decisions and other investment the firm also builds links and relations to gain access to externalities such as knowledge and information.

From the perspective of the spatial concentration of firms and their connections to each other and other actors, the character and composition of firms' internal social capital is the first important factor. The basic activities of the firm, its type of production and products, its possession of (partial or temporary) product monopolies, its need for the input of knowledge and information, its position in formal ownership, supplier-customer networks

or other dependencies, etc. – all these characteristics contribute to the firm's internalization and externalization of different actions. A firm with a great need to keep its tacit knowledge internalized – and with the resources to generate new knowledge internally – has low incentives to interact with other firms outside regular market transactions. A firm tied up in formal networks might not even be permitted to engage in certain interaction external to the network. On the other hand, a group of independent firms whose activities complement each other has very strong incentives to share knowledge and cooperate in R&D. Thus, a firm's activities, its ownership and other dependencies govern its opportunity to gain from and need to use the externalities of an agglomeration – and accordingly its location decisions. The firm forms its social capital in accordance with these needs and the social capital becomes a factor that supports and reinforces the firm's positions on the internalization-externalization scale. In this way, the firm's internal social capital is a reflected image of its external social capitals.

On the level of spatial agglomerations the decisive social capitals are 1) the internal social capital of the agglomeration, i.e. firms' and other actors' proximity-related social capital, and 2) the social networks between the agglomeration's actors and the rest of the world. By definition, the internal social capital of agglomerations must be stronger than the external – otherwise the agglomeration would be dissolved, or preserved by other forces than the social.

The kinds of phenomena that in the economic literature are called *externalities* are the fundamental reason for a firm's choice of location and other investment in social capital. The concept of externalities dates back to Marshall (1920 [1890]) and has since then been considered as one of the most elusive and hard-formalized in the economic literature (Scitovsky 1954). Sraffa (1926) considered externalities as the only source of increasing returns under perfect competition and claimed that although externalities are external to the firm they are internal to the industry (cf. the spatial perspective above).

Based on Scitovsky's (1954) classification of externalities as either pecuniary or technological, Johansson (2004) has made a fundamental distinction between firms' *intra-market* and *extra-market* externalities. Intra-market externalities are mediated through the formation of prices, while extra-market externalities comprise links, agreements, networks and other club-like arrangements, but also information and knowledge spillovers, denominated communication externalities by Fujita & Thisse (2002). It should be noted that the establishment of links, networks, etc are deliberate actions of a firm with the aim of internalizing transactions within the network that otherwise would have been market transactions, while the spillover externalities may be both a result of deliberate aims and unintended by-products. Johansson (2004) also makes a difference between *proximity* externalities, within an urban region or district, and *link* externalities, being more or less distance independent. Links can be established both inside and between regions; in the latter case they are substitutes to proximity.

A number of concepts have been formulated to describe and analyze the proximity- or link-based interaction between individual firms and other actors producing externalities. *Industrial districts* – the term coined already by Marshall – are normally defined as spatial agglomerations of SMEs in one or a few complementary industries (Paniccia 2002). In particular, the term has been used for agglomerations of SMEs in Italy. *Cluster*, a concept with a number of slightly different interpretations, has received, through Michael Porter's book *The Competitive Advantage of Nations* (1990), an enormous amount of attention in both research and policy circles. Clusters are often defined as spatially delimited industrial

systems regardless of the size of the enterprises (Paniccia 2002), but it should be noted that Porter (1990) has also considered clusters as being functional industrial systems without a proximity dimension (Malmberg 2002). Another ambiguity is that much of the cluster literature, based on Porter (1990) treats clusters as purely a spatial concentration of related firms (see e.g. Enright 1998), while Porter later (1998, 2000) explicitly includes public institutions, such as government educational institutions and support services, in the definition of clusters. The vast popularity of the concept, not least in industrial policies, has resulted in "cluster" becoming become a possible denomination of almost any agglomeration of economic activity.

Even if clusters are thus sometimes regarded as consisting of firms as well as public institutions, both the cluster and the industrial district approach have their main focus on inter-firm relations. As Johansson (2004) points out, these external relations of a firm can be of an intra- or extra-market character.[20] The latter can be divided in two forms: 1) organized transaction-link externalities (with club characteristics) where knowledge exchange can be a deliberate aim of the relation, and 2) spillover externalities. These inter-firm spillovers can be horizontal, between similar firms imitating each other or in other ways taking advantage of the spillover externalities in "the air".[21] But spillovers between firms in an industrial district or cluster can also be vertical, between an input-buying firm and its suppliers or between an input-selling firm and its customer firms. In both directions, the knowledge spillovers are by-products of the market interaction.

While the terms industrial districts and clusters have mainly been used for local and regional relations between firms, the concept of *innovation systems* was originally formulated for systems at a *national* level and denoted not only inter-firm relations but also links between firms and government, firms and research institutions or between all three of them. It was used for the first time by Freeman (1987) in his analysis of the economic development of Japan after World War II, where government, especially the Ministry of Industry and Trade (MITI) played a crucial role. Leading scholars of this tradition (Lundwall 1992, Nelson 1993) have regarded the nation as the evident level of analysis as "… the policies and programs of national government, the laws of a nation, and the existence of a common language and shared culture define an inside and outside that can broadly affect how technical advance proceeds" (Nelson 1993, p. 16).

In the last decade the concept of *regional* innovation systems (RIS) has yielded a rapidly increasing literature (see e.g. Cooke 1992, 2001 and 2003, De la Mothe & Paquet 1998, Asheim & Gertler 2004, Doloreux & Parto 2004, etc). The regional approach on innovation systems is according to Doloreux & Parto (2004) a normative and descriptive approach, which is based on two main bodies. The first is the national innovation systems approach, based on evolutionary, non-equilibrium theories and in which innovation is a result of processes both internal and external to the firm. These processes are not only technical and economic but also social. *Learning*, through interaction, is a key concept in the innovation processes. The second body of literature is that of regional milieu, embeddedness and the role of proximity.

[20] *In a conceptual paper, Paelinck (2004), in line with rigorous mathematical definitions proposes a similar distinction between a market approach, which includes "vertical", "sectoral" and "industrial" clusters, and "externality clusters" consisting of "knowledge" and "technology" clusters and "new industrial spaces".*

[21] *Johansson (2004) refers to these horizontal spillover externalities as "Porter externalities".*

According to its analysts the concept of regional innovation systems has increasingly become an all-embracing term for firms' interaction with each other and other actors at regional level. In a typology of regional innovation systems Cooke (2003) interprets RIS as a more general one than clusters and industrial districts, and regards these as variants of regional innovation systems. The Italian industrial districts are considered as a "grassroots" type of RIS but also as "classic clusters". Cooke also distinguishes between a German-Austrian type of "integrated" RIS and a French and East European "dirigiste" RIS type.

A fourth concept, strongly linked to the abovementioned is that of *triple helix*, which "… is a spiral model of innovation that captures multiple reciprocal relationships at different points in the process of knowledge capitalization… … The triple helix denotes the university-industry-government relationship as one of relatively equal, yet interdependent, institutional spheres which overlap and take the role of the other." (Etzcowitz 2002:2). It is no coincidence that university is the actor named first. According to Etzcowitz, an important difference between the innovation system and triple helix approaches is that the former has its focus on the firm and views innovation as primarily occurring within the firm. In contrast, the view of the triple helix approach is that "Innovation is increasingly likely to come from outside of the individual firm or even from another institutional sphere such as the university…" (Etzcowitz 2002:1). Triple helix processes are possible at regional, national as well as multi-national level.

The four approaches, very briefly summed up above, have one thing clearly in common: the focus on *interaction* where firms are involved. Apart from that, the approaches show differences between each other but also between different interpretations of the same approach, when it concerns e.g. spatial level, included actors, their size and sectoral scope. The industrial district approach is the most limited as it only comprises interaction at local level between SMEs in one or a few closely related industries. The different interpretations of clusters – from pure industrial districts with only firms involved, to non-spatial, sectoral systems of innovation with several types of actors – is an illustration of the concept's popularity, but also of the concept's weakness as an analytical tool (cf. Marcusen 1999). Similar criticism has been raised against the regional innovation systems concept (Doloreux & Parto 2004), which, as shown, has also been considered as a still wider concept than the cluster. Finally, the triple helix approach is a more delimited normative approach which not only states that three types of actors *should* interact but also that their activities partly *overlap*. Moreover, triple helix' prime focus is not on the firm's knowledge input and innovation process but on the interaction as such and how it transforms the actors.

Although not always explicitly expressed, the four approaches also have something else in common, namely their acknowledgment of externalities in the form of *transfer of (tacit) knowledge* or *knowledge spillovers, emergence of new knowledge* and *(collective) learning* as a primary outcome of the interaction. It is in these knowledge creating and transfer processes that social capital constitutes a ubiquitous but multifaceted factor.

Following Johansson (2004) we can assume that knowledge transfers and collective learning take place through two types of processes:

1. Deliberate, formalized transaction-links, agreements, networks and other club-like arrangements between firms and firms and other actors, and
2. unintended knowledge spillovers between firms or between firms and other actors, caused by non-formalized interactions. These kinds of interactions consist of: a) verti-

cal technical/economic interactions between firms and their suppliers and/or customers, b) spin-offs of new firms from existing ones and turnover and exchange on the labor market, c) horizontal interaction in the form of informal exchange of information and knowledge in the (local/regional) civil society, between individuals connected to firms or other actors.

In the first case, that of formalized transaction-links and networks, the formalization is in itself a confirmation of the firm's willingness to invest in a link with a longer duration than a pure market transaction. In contrast to the "conventional wisdom" on (spatial) clusters, the reasons for the emergence of these fixed links/networks are not the firm's wish to enjoy informal knowledge and information spillovers and other outcomes of flexible inter-actor interactions – but to *internalize* knowledge within the fixed network, often a corporate grouping. McCann & Arita claim that the cluster type of Silicon Valley is more of an exception which should not be generalized, and that the internalizing "industrial complex" type of cluster is "… typical of many firms and sectors, and in particular, of the semiconductor industry" (McCann & Arita 2004:247). In this case, knowledge spillovers within the delimited industrial complex are internalities for the industrial complex, but still extra-market externalities for the individual firms; externalities that are both formalized and institutionalized.

It can be assumed that the motives for a link-investment are completely based on economic considerations, but the outcome of this "long-term" investment is among other things dependent on the social relations between the actors who establish, use and maintain the link. With negative attitudes to the link among these actors, incentives to use the link would be lower, and the link would yield lower returns than in the case of neutral or positive attitudes. Thus, it is in the interest of all the actors who invest in the link or network to establish a positive social capital among its users.

However, it is important to note that this "officially sanctioned" support of positive social capital is restricted to the official activities of the fixed link/network and does not include other activities of the firm. Links and networks, values and attitudes, created and promoted for certain purposes might result in unintended spillovers of information and knowledge. For the network as a whole, as well as for firms below average productivity, knowledge spillovers are likely to be positive since they tend to spread best-practice and raise competition and the average productivity. For firms above average productivity, unintended outflows of knowledge might be negative in the short run if they result in the firm's loss of some of its monopoly assets, bound in tacit knowledge. However, in the long run these firms might gain as well since the increased competition give them stronger incentives to keep up their innovation pace. Firms with best-practice solutions cannot be unaware of these possible (short-term) disadvantages of forming links/networks with worse performing actors. The reason that links/networks are still formed and maintained must be that the best performing firms consider the positive effects of the links to be higher than the negative.

In the second case, the non-formalized interactions consisted of three types, each of them being able to result in unintended knowledge spillovers. The first type, vertical, technical/economic interactions between firms and their suppliers and/or customers, is a similar process to that of intended links having unintended effects discussed above, although there is no formalized link but market transactions. The purpose of these transactions is to buy input or sell output, but as a by-product spillovers of knowledge and information may occur between the involved actors. These spillovers do not necessarily have to happen

through social interaction – it may be sufficient with purely technical/economic information, i.e. the information and knowledge "built-in" in a product, a complicated order or specialized demand.[22] But knowledge spillovers without social interaction between human beings have their limitations. They are one-way, one-occasion spillovers, entirely dependent on the internal absorption and learning capacity of the firm, without any informal external dialogue or support. As the relations between suppliers and customers as a rule are non-competitive in both directions, there are normally no reasons for the involved firms to regard informal links and positive attitudes to limited informal knowledge exchange as a threat. The conclusion is that social capital facilitates this non-competitive informal knowledge exchange and that this is normally in the interests of both (all) parts.

The second type of non-formalized interactions, spin-offs of new firms from existing firms or organizations and turnover and exchange on the labor market, are market interactions with obvious effects on the spread of knowledge and information. For a cluster – or any type of spatial or functional agglomeration – these market interactions are likely to have positive effects similar to those of formalized networks, i.e. they tend to spread best-practice and raise competition and average productivity. For the individual firm, the effects are dependent on whether the interactions are vertical or horizontal, if the firms are leading or lagging, and on the time horizon.

Vertical spin-offs from a firm, by employees forming a new firm with the purpose of being suppliers or customers of the original firm, have results in line with the vertical transaction-links above, in non-competitive interaction where the social capital formed in the original firm continue to facilitate knowledge spillover in both directions. However, if the new firm starts collaboration with a competitor to the original firm, the informal links for knowledge exchange are jeopardized. Similar conditions emerge if the spin-off is horizontal, i.e. if the new firm becomes a competitor to the original firm. Such spin-offs are negative for the original firm in the short run since it will lose some of its knowledge monopoly and employees and will face harder competition. If the spin-off gives the original firm increased incentives to respond to the harder competition by new innovations, and if the firm has the resources to such a response, the spin-off may be positive in the long run for the original firm as well. Here it should also be noted that the potential and incentives for spin-offs will vary with the original firm's position in supplier-customer chains and other dependencies; dependencies that also are reflected in the internal and external social capital of the original firm. As a consequence, the potential for spin-offs from firms in flexible industrial districts should be higher than from firms in a corporate clustered group.

Another form of non-formalized market interactions having an impact on knowledge spillovers is labor market turnover. On a perfect regional labor market, labor is distributed so that maximum productivity is achieved. On an imperfect labor market, the rule is: the larger the labor market, the better the matching. In contrast to spontaneous spin-offs, which from the individual firm's perspective are one-sided outflows of knowledge that the firm might lose its connections to, workforce turnover contains both outflows and inflows of knowledge. Workforce turnover is not only inflows and outflows of knowledge but also of social capital. Just as each firm has an incentive to optimize its blend of knowledge adapted to its activities, so it has an incentive to optimize its blend of social capital. A

[22] *Japanese firms' "reverse engineering" is an excellent example of* deliberate *knowledge spillovers, without social links, through study of products produced in the West. However, the learning processes in the Japanese firms were highly dependent on an* internal *social capital adapted to these tasks.*

workforce with the optimum blend of social capital has the optimum amount and combination of external and internal links and values and attitudes adapted to the firm's activities. Such a workforce is more likely to be found in spatial agglomerations where similar activities are going on. The conclusion is that labor market externalities consist not only of access to labor with the right knowledge but also the right social capital.

The third and last type of informal knowledge spillovers is also the most intangible of the intangible externalities. The informal exchange of information and knowledge in the (local/regional) civil society, between individuals connected to firms or other actors, is a form of horizontal, extra-market interaction, whose extent and content is dependent on the size and diversity of the agglomeration, the types of economic activities located there and the existing social capital of the civil society. Most of these correlations are almost self-evident: the amount of knowledge increases with the agglomeration's size; the economic activities and their diversity influence the content of knowledge and information, etc. The factor whose connections to knowledge externalities need an expounded discussion is civil society's social capital.

A civil society is basically something that is formed and maintained by people during their non-productive time. Voluntary public and club activities and other leisure activities are also what civil society's social capital is focused upon. The networks and values of business life, i.e. of production, play a mainly hidden role in a civil society. In line with the fundamental differences between production and consumption, business life and civil society are based on different principles and belong to different spheres of human activities, with different networks and different norms and values. However, as the two spheres are populated to quite a considerable extent by the same people, i.e. the productive population, there are naturally certain informal interactions between them. These interactions can be divided into two types: a) those mainly based of norms, values, attitudes, etc. and b) those where these values, etc. have developed into the links and networks of a group of individuals.

The first type of interaction comprises general approaches of the importance of "spirit" and similar attributes to the economic development of a region. Putnam's (1993, 2000) view of the impact of civic society on the economy and Florida's (2002) view of creativity as the factor constituting the important difference between a region's economic performance are examples of such spatially connected approaches.[23] Also Schumpeter expressed opinions on the influence of the attitudes of a social environment towards entrepreneurship when he pointed out that:

> *...the reaction of the social environment against one who wishes to do something new... any deviating conduct by a member of a social group is condemned, though in greatly varying degrees according as the social group is used to such conduct or not.... This opposition is stronger in primitive stages of culture than in others, but it is never absent. Even mere astonishment at the deviation, even merely noticing it, exercises a pressure on the individual. The manifestation of condemnation may even come to social ostracism and finally to physical prevention or to direct attack... Surmounting this opposition is always a special kind of task which does not exist in the customary course of life, a task which*

[23] *Weber's (1930) essay on the protestant ethic is the classic example of this approach. Even if Weber focused on differences in norms and values due to religion, the cases he chose gave his essay a spatial dimension.*

> *also requires a special kind of conduct. In matters economic this resistance manifests itself first of all in the groups threatened by the innovation, then in the difficulty in finding the necessary cooperation, finally in the difficulty in winning over consumers. (Schumpeter 1934:76-77; Schumpeter (1950:132) made similar comments)*

It is reasonable to assume that the attitudes of the social environment that have an impact on the production environment in general are formed in interplay between the two spheres. A stable production sphere fosters stable attitudes in the civil society and vice versa. The old industrial regions of the world show up many examples of how this stability of business life and civil life created safe and predictable conditions for stable growth. On the other hand, when the industrial crisis came in the 1970s, these regions lacked the ability to change and, with Schumpeter's words, "do something new".

Thus, Schumpeter's description of how the social environment counteracts changes in the production environment is the general picture. The dynamics of certain industrial districts, which seem to permeate civil society as well and reported in a number of studies (e.g. Piore & Sabel 1984, Scott & Storper 1989, Beccatini 1990) should in that case be regarded as exceptions to a general tendency (cf. Johansson 2004).

The other type of interaction in civil society with implications for business life is a result of the general values of the social environment, in which the values of communities, groups or sub-communities have developed into links and networks. While a community can in principle be based merely on some kind of shared values, the step towards the formation of informal networks of groups or sub-communities means more stable relations between certain actors of the community – and a way to partly avoid general opinion's reactions. Spatial agglomeration as such provides a potential solution to the problem of gaining from the change-promoting elements of social capital and avoiding the restricting elements. This potential solution is based on the fact that agglomerations tend to foster the emergence of diverse groups and sub-communities, based on ethnicity, religion, industry and also interests. Florida (2002) and other scholars on creativity stress the importance of this tolerated diversity in a limited space and regard the interfaces between these groups as an importance source of creativity, innovations and economic development.

Within a group or sub-community that is positive to innovations, an entrepreneur can find the support he needs to "do something new". Outside this sub-community, the entrepreneur can pick-up certain information and knowledge of other groups, being that this knowledge is not too tacit and internalized. In this way, the agglomeration can provide the entrepreneur with access to the social capital that support his activities the most, and provides the best access to useful tacit knowledge. At the same time individuals in the established industries can maintain their communities, with their values and networks, without being confronted with the new.

From the analysis above it is possible do draw some tentative conclusions:

There are a number of different reasons for firms to cluster and/or locate in urban agglomerations, from pure labor market reasons to the need to become embedded in an entrepreneurial environment; from a wish to internalize knowledge and R&D in a closed network of actors to a wish to gain from flexible inter-firm relations and knowledge spillovers. The current literature on clusters and similar phenomena has to a large extent focused on a few of these motives, mainly those related to tacit actor- or space-specific knowledge and its spillovers between firms and other actors. Even if we leave aside the

pure market-related reasons for clustering, there are important reasons behind clustering that are seldom observed and analyzed. One such reason was found in McCann & Arita's (2004) study of semiconductor clusters: companies' needs to internalize vital tacit knowledge and R&D within a small group of close partners (and shut out potential competitors). Proximity facilitates not only external spillovers but also internalization.[24]

It is highly probable that the individual firm will find several, even contradicting reasons for clustering. Regarding knowledge and information, the cluster may on the one hand give the opportunity to form closed partnerships in which vital tacit knowledge can be internalized. On the other hand, the firm may simultaneously be snapping up "semi-tacit" information and knowledge spillovers.

Both these motives are probably relevant for the biotech industry. An industry in which almost all investment consists of R&D investment is by definition extremely sensitive to leaks of vital knowledge. Thus, each firm has strong incentives to internalize its vital knowledge to as few external actors as possible – and to bind these actors with strong ties. However, a firm also needs input of more general relevant information about the industry, and this information is fastest and most easily available through personal contacts, which in its turn is facilitated by proximity to these contacts. In this way, the cluster has the potential to satisfy both these apparently contradicting needs of a firm.

The different motives for clustering contribute to the forming of different social capitals within firms, within formal or informal groups of actors and within spatial agglomerations. What these social capitals have in common are a certain proportion of values and links that internalize specific knowledge and uphold the firm's/group's solidarity, *combined* with a certain proportion of values and links that make the external exchange of non-vital information possible. The respective shares of the internalizing and externalizing components are dependent upon a number of factors discussed above, such as the firm's size, type of production and its knowledge intensity, formal and informal external dependencies, the market, etc.

The knowledge being spilled over and exchanged in the processes analyzed above is to a varying degree tacit, i.e. it is partly non-formalized and dependent on informal links where attitudes and values govern both how it is generated and how and to which actors it is spread. In this way, social capital is a crucial factor in knowledge creation, knowledge internalization and intentional and unintentional knowledge exchange and spillovers.

With a few exceptions, the biotech industry consists of small firms with R&D as their main activity. Their smallness makes collaboration with other firms and research institutions a necessity. A large share of the biotech industry is dealing with products for human health, i.e. something which in general is considered a public good. Therefore, government has a reason to interact with the industry, as financier of R&D and (where health care is to some extent a public sector responsibility) as a demanding customer. Thus, the "golden triangle" of collaboration between companies, research institutions and government seems highly relevant to the success of the biotech industry. This means that the biotech industry has a need to develop a more complex social capital compared with most other industries.

[24] *However, as Johansson (2004) has pointed out, links over distance can substitute for proximity.*

6 Empirical results

6.1 A general picture of the participating enterprises

A questionnaire based on the theoretical structure outlined in section 4 was sent out to biotech companies in the three countries in 2003. A detailed account of the survey is found in Appendix. Here we restrict ourselves to noting that the Japanese companies taking part in the study showed some differences compared with their Swedish and American counterparts. Due to the differences in entrepreneurship culture discussed in section 2, developing biotech activities within existing firms in related sectors has been the predominant strategy for developing the biotech industry in Japan. Not until the Japanese government's new biotech strategy was launched in the end of 2002, was a rapid increase in the number of start-ups considered a primary goal. Thus, due to the limited number of start-ups and after consultation with the Osaka office of the Ministry of economy and trade (METI), the Japanese questionnaire was sent out both to start-ups and traditional companies with biotech activities.

As shown in table 6 the average number of employees in the participating firms varied considerably. The Kansai firms had the highest number of employees, about six times as many as a Swedish average firm. The growth rate also showed up substantial differences. The number of employees in the Californian firms more than doubled (+127 percent) between 2000 and 2002.[25] The small Swedish firms increased by 31 percent, while the Kansai firms remained constant. Turnover roughly varied with the average size of the companies but as shown in table 6, turnover per employee fell in all three areas during the period of study. The largest decrease, 15 percent, was found among the Kansai firms, which also showed an absolute fall in turnover. In Sweden and California, the average fall in turnover per employee seems to have been caused by the increase in number of employees.

Table 6 Average number of employees and turnover in 1000 USD[26] in the companies in 2000-2002

	2000		**2001**		**2002**	
	Employees	Turnover	Employees	Turnover	Employees	Turnover
Sweden	16	1 572	16	1 274	21	1 935
Kansai	121	40 052	121	35 263	121	33 848
California	48	7 776	84	15 796	109	17 053

[25] *This is a much higher figure than the average US growth of 12 percent shown in Table 3, and indicates a possible bias. Companies with higher growth might have felt stronger incentives to answer the questionnaire.*

[26] *The Swedish and Japanese currencies have been converted to US Dollars by the average exchange rate for each year respectively. Exchange rates from www.oanda.com*

Table 7 Average turnover per employee in USD 2000-2002

	2000	2001	2002
Sweden	101 141	77 741	94 203
Kansai	331 367	290 576	280 189
California	162 943	187 858	156 504

The Swedish firms had the highest costs per employee for education/seminars/courses and the Japanese firms the lowest. R&D as a share of turnover was 79 percent in the Swedish companies and 66 percent in the Californian, both reflecting the industry's strong reliance of R&D. The Californian figure is lower than the US average in 2002 of 84 percent. However, the R&D share is relatively volatile between the years (2001 the US average share was 73 percent, see table 8). Thus, the lower Californian figure for 2002 can be interpreted as a temporary deviation, but it is also possible that the Californian companies taking part in the study have reached a stage where different kinds of marketing have become more necessary. The Japanese firms did not provide any authentic figures for R&D costs. Nor, in accordance with Japanese company culture, did they answer other questions that they considered sensitive (see below).

Table 8 Costs in USD for education/seminars/courses, R&D and internal and external entertaining, all per employee, plus R&D as share of turnover, 2002.

	Education costs/employee	R&D/employee	R&D share of turnover
Sweden	672	74 499	79%
Kansai	145	-	-
California	317	102 807	66%

6.2 Enterprise-internal social capital

The enterprise-internal social capital was measured in four ways; staff stability (i.e. inverted staff turnover) in 2002, management's opinion on the importance of organized internal seminars/courses and informal knowledge exchange within the company respectively, and the companies' investment in internal entertaining. The results are shown in table 9.

Table 9 Measures of enterprise-internal social capital in the three areas studied. Percent.

	Staff stability	Importance of internal seminars	Importance of informal internal knowledge exchange	Internal entertain/ employee	Share of firms spending on internal entertaining
Sweden	93%	31%	73%	$277	80%
Kansai	95%	82%	91%	-	-
California	89%	46%	89%	$229	83%

The Japanese companies scored highest in all the three measures they replied on, thereby supporting the general view on Japanese firms' strong focus on internalizing relations. With the three measures taken together, the Californian firms indicated a higher internal social capital than the Swedish. The Swedish firms had almost as high staff stability as the Japanese, but in the other two measures, Sweden scored lowest. The Californian companies had the lowest staff stability, giving support to another conventional wisdom: that of the flexible American labor market. In contrast to these differences between Californian and Japanese firms, the Californian firms valued informal knowledge exchange within the company almost as highly as the Kansai firms. The Swedish firms spent somewhat more on internal entertaining than the Californian, but both areas had a high share of spending companies.

6.3 External production-related social capital

The companies' external production-related social capital was measured by questions about employees' competence nets, companies' methods of recruitment, R&D with external actors and the importance of external knowledge exchange. On questions with several alternative answers, it has been possible to check several alternatives. There are large differences between the regions regarding the number of checked alternatives. E.g. concerning the employees' external competence nets, the Californian companies have checked the highest number of alternatives (4 per company) while the Japanese firms have checked the lowest number (0.6 per company. The Swedish companies checked in average 1.6 alternatives. These differences are approximately the same for the other questions with several answers possible, presented in this and the following section.

Table 10 shows the company managements' opinion about the sectoral and spatial location of their employees' informal competence nets. A number of observations deserve to be noted.

For Swedish employees, their networks are most closely orientated towards the universities in their own region. Regarding both universities and companies, the Swedish employees have at least as strong links to foreign actors as to corresponding extra-regional Swedish units. The employees in the Kansai companies are distinguished by having no foreign links to any of the sectors and by having slightly stronger connections to extra-regional actors than to actors within the Kansai region.

Table 10 Managements' opinion on the sectoral and spatial location of their employees' informal external competence nets (relative frequencies percent for each region) and the importance of these nets (percent).

	Universities			**Companies**			**Government agencies**			**Importance**
	In region	In nation	Abroad	In region	In nation	Abroad	In region	In nation	Abroad	(all nets)
Sweden	33	12	15	13	10	13	5	0	0	85
Kansai	13	16	0	19	22	0	14	16	0	49
California	15	12	10	17	15	9	8	9	5	81

The Japanese employees also have the highest share of links to government agencies. The Californian employees have the most even distribution of networks between the sectors and spatial levels. When it comes to the managements' opinion on the importance of their employees' competence nets, the Swedish and Californian firms showed similar shares; more than 80 percent of the companies found the personal competence nets important. Half of the Japanese companies found their employees' competence nets important.

The results give support to several often expressed views on Japanese firms: the relative strong connections between Japanese firms and governmental agencies and the very national character of the Japanese innovation system. However, certain Swedish results are worth noting. The high share of contacts with universities in the companies' own region compared with other contacts implies that many of the Swedish firms are new start-ups, close to university research but with a long way to go to the final market. The very low share of contacts with Swedish governmental agencies is also worth noting.

While table 10 gave information on employees' competence nets, table 11 presents managements' opinion on the companies' whole external knowledge exchange, i.e. including managements' external competence nets. As in the former table, the Swedish firms valued the nets for informal external knowledge the highest, but here the Californian and Kansai firms had equal shares of positive replies. A possible interpretation of the Kansai firms' higher share in this table might be that the Japanese firms are more focused on managements' (than the employees') knowledge obtainment through their personal networks. The differences for the Californian firms are harder to interpret. table 11 also shows managements' opinion on the importance of formal seminars/courses in cooperation with external actors. Here the Kansai firms had the highest share, indicating that this form of official cooperation is accepted and fairly common in Japan. Correspondingly, the relatively low share among the Californian firms might indicate a lower valuation of this formal type of knowledge exchange.

Table 11 Managements' opinion on the importance for the company of a) the company's (incl. Management) informal external knowledge exchange, and b) seminars/courses in cooperation with external actors.

	The company's informal external knowledge exchange	**Seminars with external actors**
Sweden	71	44
Kansai	57	49
California	57	37

The relative frequencies of methods used in the recruitment of new employees are presented in table 12. Of the different methods, referrals from current employees and the use of personal contacts are here considered as indications of strong external production-related social capital, while advertises in the daily press or branch journals, the use of recruitment agencies and recruitment campaigns at universities are indications of weaker external production-related social links and networks. Measured in this way, the differences in production-related social capital between the companies of the three areas are not particularly accentuated. Referrals from employees and personal contacts are the most frequent recruitment methods in all the three areas and most common in Sweden. Of the indications of weaker social capital, recruitment agencies are those used most in Japan while Swedish companies prefer advertisements. Recruitment campaigns at universities are used most by the Californian companies and least by Swedish ones. It might be worth noting that although the Californian firms are located in regions with world-leading education and research in biotechnology, they still have the highest frequencies for recruitment campaigns on universities outside their home region.

Table 12 Relative frequencies (percent) of methods used in the recruitment of new employees.

	Advertise-ments	Recr. Agencies	Camp loc univ	Camp nat univ	Camp foreign univ	Referrals from employees	Personal contacts
Sweden	22	12	5	1	0	30	31
Kansai	11	24	10	5	2	25	24
California	17	15	13	9	4	20	23

Professional relations are one source of social relations. Thus, production-related social capital can be considered as a by-product of e.g. R&D cooperation, but the cooperation can also be a result of existing social capital. In both cases, R&D cooperation with external actors is an indication of certain components of production-related social capital. table 13 shows that as many as 95 percent of Swedish companies had some form of external R&D cooperation in 2000-2002. Almost 80 percent of the Californian, but just over a third of the Kansai companies had such cooperation. The results support the internalized structure of the Japanese firms. However, it can be assumed that the very high Swedish share is caused by the fact that the Swedish firms also are the smallest in size and have the strongest needs to cooperate on R&D.

Table 13 also shows the share of companies having written and published articles in domestic and/or international biotech journals and the share that have done this in cooperation with external actors. Publishing articles can be considered as a form of marketing and should thus normally be considered as a form of market-related social capital. However, this particular type of marketing is not primarily directed towards customers but towards potential and existing partners in R&D, venture capital, grant-giving public agencies, etc. Therefore, we here consider the publication of articles as a form of investment in production-related relations. More than 70 percent of the Californian and Swedish firms had made such investment in 2000-2002, compared with not more than one of seven Japanese firms. More than half of the Swedish and Californian firms, but only one tenth of the Japanese had produced articles in cooperation with other actors.

Also external entertaining should normally be considered as building market-related relations. However, due to the special character of the biotech industry it is reasonable to regard external entertaining as investment in social, production-related relations. A vast majority of both the Swedish and Californian firms spent money on external entertaining, but average Swedish spending per employee was twice as high as the Californian.

Table 13 Share of companies having a) R&D cooperation with external actor(s), b) written and published articles in domestic and/or international biotech journals, and c) written and published articles in cooperation with external actors, 2000-2002.

	R&D coop	Published articles	Article coop	Share of firms spending on external entertaining	External entertaining/ employee
Sweden	95	71	55	86%	$217
Kansai	36	14	11	-	-
California	78	75	53	83%	$102

One of the most striking differences between the companies in the three areas studied is the presence of financial government support. Contrary to what would be expected, neither Sweden with its large public sector and comprehensive industrial policy, nor Japan with its centralized industrial policy of technological planning has the highest share of companies receiving government support. 43 percent of the Californian companies – a share about three times higher than the Swedish and Japanese companies – had received financial gov-

ernmental support from 20002002. The main reason is probably the special features of the US innovation system, mentioned in section 4 – federal government departments have to spend a certain share of their budget on Small Business Innovative Research grants (SBIR). A few companies have also received grants from the state of California.

Table 14 Percentage share of companies receiving financial support from government agencies 2000-2002.

	Government support
Sweden	15%
Kansai	13%
California	43%

6.4 Environment-related social capital

As pointed out in section 4, the social capital related to the regional environment consists in principle of networks with links of three different types:

- Distance-dependent, non-technical/financial links to other enterprises and R&D centers
- Links to politically governed bodies in the community/region
- Links to the citizens of the local/regional civic society and their organizations

In order to get a brief, approximate picture of the importance of these networks, questions were asked about the companies' contacts with branch & lobby organizations and officials and politicians. The firms' philanthropy/sponsoring costs, recruitment patterns and location reasons were also investigated.

Table 15 shows the Californian firms found heading the list of contacts with branch organizations, public decision-makers as well as philanthropy/sponsoring. However, the share of companies with expenditure on philanthropy/sponsoring was fairly equal in all the three areas studied, possibly indicating that the incentives for being embedded in the local/regional civil society do not vary much between the three countries. The Japanese companies did not answer the questions about branch organizations and contacts with decision-makers.

Table 15 Share of firms taking part of branch & lobby organizations, having contacts with public decision-makers (officials and politicians) and expenditure on philanthropy/sponsoring, 2002

	Branch & lobby organizations	Contact with officials & politicians	Sponsoring charities or events
Sweden	54%	52%	31%
Kansai	-	-	38%
California	61%	75%	39%

Table 16 gives additional support to the notion of Swedish companies' regional embeddedness. Recruitment from universities and firms in the home region are entirely predominant as regards Swedish companies. Regional recruitment is the main source of new labor in companies in the two other regions as well, but to a lesser extent. The Kansai firms recruit from Japanese universities outside the region as much as from intra-regional firms, while recruitment abroad is unusual. The Californian firms have the most dispersed recruitment pattern, even if they mainly rely on recruitment from the home region.

Table 16 Relative frequencies (percent) of firms' employee recruitment.

	New staff from					
	Reg Univ	Nat Univ	Univ Abroad	Reg firms	Nat firms	Firms abroad
Sweden	47	5	5	35	5	3
Kansai	35	36	0	18	11	0
California	27	12	2	35	15	8

Table 17, showing the reasons for the companies' choice of location, presents several notable differences between the regions. The most important reason for the Swedish firms was that the founder(s) was/were living in the region, followed by the proximity of research institutes and universities (R&D centers). The founder'(s') residence was the most important reason for location for the Californian firms as well. Quality of life was the second most important reason, followed by proximity to other firms. The firms in Kansai valued infrastructure for transportation and communication the highest, followed by proximity to customers and the quality of life in the region. The only factor that seemed to be of equal value to the companies of the three regions was the supply of competent labor. The proximity of venture capital and offers of economic support for location from the region were in general of least importance, but Californian firms valued closeness to venture capital more highly than firms from the two other regions. The same holds for the Kansai firms regarding economic support for location.

Table 17 Relative frequencies (percent) of the reasons for the choice of location of the company

	Founder	Other firms	Custom-ers	Competence (Hum Cap)	VC	R&D Centers	Trans-port	Quality of life	Reg. ec. support
Sweden	36	2	2	15	3	24	7	8	3
Kansai	11	5	16	13	3	7	23	14	8
California	21	15	4	14	8	12	6	16	3

The company founder's residence being the most important reason for location has long been confirmed by Swedish studies (see e.g. Lorendal 1974) and is thus not peculiar to the biotech industry. The Swedish firms' close links to university research is once again underlined by the score they set by the proximity of research centers. In contrast, the location of the Kansai firms seems very seldom influenced by where R&D centers are located. One thing the Swedish and Japanese firms have in common seems to be their low valuation of proximity to other firms. Quality of life as a location factor seems fairly important for Californian and Kansai firms but not for the Swedish ones. A plausible explanation might be the, in many respects, small regional differences in Sweden.

6.5 Market-related social capital

Several activities connected to marketing such as external entertainment, publishing articles, sponsoring and philanthropy, were discussed in the sections above. In business in general, such activities would be considered as investment in different fields of market-related social capital. However, in the case of the biotech industry – at least in its current stages – many companies, in particular the small companies on which this study is focused are still in an R&D period, without anything to offer the market. Therefore, these activities should primarily be regarded here as investment in relations with existing or potential partners and the part of the firm's environment that consists of civil society.

6.6 The social capital of the three areas studied – Discussion

The findings of the empirical study can be summarized in the following points.

With very low staff turnover and very high valuation of internal knowledge exchange, the biotech companies of Kansai confirm the general picture of Japanese firms' focus on internalization. Relatively speaking, the Japanese biotech companies' strongest social capital seems to be the firm-internal social capital. The opposite seems to be the case for the Swedish companies, which in our measures scored lowest. The differences between the areas studied indicate the possibility of substituting one type of enterprise-related social capital with another.

The external production-related social capitals of the Swedish and Californian firms have several similarities. Management of the companies of both regions value their employees' competence networks highly. A large share of the companies cooperate with external actors in R&D. The companies market themselves towards potential partners, credit institutions and governmental agencies through publishing scientific articles to a similar extent. These activities are much more internalized in the Kansai companies, which in these respects seem to have a less developed external production-related social capital.

In other aspects of the production-related social capital and also regarding the environment-related social capital, the Swedish companies deviate from their Japanese and Californian counterparts. This holds both for the spatial extensions of their relations and for the actors they have relations with. Concerning the employees' competence nets and the firms' recruitment, the Swedish firms seems to apply *local/regional* internalization that can be depicted as a spatial counterpart to the Japanese firms' corporate internalization. Another peculiarity of the Swedish firms is their limited contacts with government of different levels, reflected in the employees' competence nets and the low share of companies receiving government support. Given that the Japanese companies, which also had a low share of support receivers, are mainly older companies only partly dealing with biotech activities and only a few bioventures, to which government give priority[27] – it seems as though the Swedish biotech companies are those most isolated from and least supported by industrial policies.

The Swedish companies' local/regional internalization and screening off from government contacts could partly be explained by the company population, consisting of young, small, research-oriented firms that in their current stage mainly need contacts with some researchers at the local university and one or a few fellow firms. However, a supplementary explanation might be the traditional Swedish research policy, where universities are supposed to do "everything" and industrial research institutes hardly exist. In a research intensive industry such as the biotech industry, industrial policies and innovation policies have to a certain extent been replaced by policies for university research. As a consequence, Swedish biotech firms have little to gain from contacts with government. The result is that the Swedish biotech clusters have many and dense links between firms and universities, but few and sparse links between these two actors and government. This situation is not in

[27] *The Japanese government's strong focus on creating a support structure for bioventures is illustrated by statements from these. An interviewed management representative of one of the fastest growing biotech companies in Kansai stated e.g. that without support from METI's Osaka office, the company would not have been able to grow in the way it had (Personal interview in Kansai, 2003-12-01).*

accordance with the theoretical ideal of a cluster and the corresponding theories of innovation systems and triple-helix cooperation.

The absence of a national strategy for development of the Swedish biotech sector is also reflected in a lack of coordination between research and the commercializing of research. Beside the activities of mainly Vinnova, policies for biotech development are very oriented towards university research. Of the three pillars forming an ideal innovation system, government seems to be the weakest pillar in Sweden.

If this explanation is correct, one of the three pillars of the Swedish biotech innovation system would be partly missing. The "missing pillar" of innovation policy is also discussed in Japan, but there it is the university that is considered as partly missing. For the biotech industry, this view is partly supported by the empirical results of the study. The employees of the Kansai firms do have stronger contacts with other companies and government than with universities and a relatively small share of the firms cooperate in R&D (with universities, research institutes or other firms). Apart from this, just as in other industries, the peculiarity of the Japanese biotech innovation system seems to be its national character.

A general impression of the Californian companies taking part in the study is their well developed social capital, both internally and externally, as well as its spatial extension and its extension to different actors. The Californian firms score high in the measures of enterprise-internal social capital but have at the same time diversified external networks and relations. In spite of their location in three of the world's leading biotech regions, their networks are the most spatially extended. In contrast to the Swedish and Japanese firms, the Californian firms seems to have well-developed relations with both academy and government. Contrary to the conventional wisdom on American trade, a far higher share of the Californian biotech firms received government support than the Swedish and Japanese.

From a policy perspective, the comparison of the biotech companies' social capitals in the three areas studied lead to the tentative conclusion that American innovation policies in general and Californian policies in particular are those most adapted to the theories of innovation systems, knowledge clusters and triple helix. It is beyond the scope of this study to say to what degree public policies have contributed to American and Californian biotech industries being the world leaders. However, if the modern theories are at least partly right, these policies should have an impact.

Both Sweden and Japan are taking action to improve their systems of innovation. Sweden started a national agency for innovation systems for all industries in 2001. The Government bill on research policy proposed in March 2005 increases resources to Vinnova and the agency has proposed a national biotech strategy. Biotechnology is one of the prioritized research areas in the bill. Japan has launched a comprehensive biotech strategy and is "privatizing" the public universities into foundations, in order to increase the universities' incentives and opportunities to collaborate with private companies. The outcome of these actions remains to be seen.

Appendix 1. The empirical data

The empirical study is based on questionnaires being sent out to biotech companies in June/July 2003 (California), September 2003 (Kansai) and January 2004 (Sweden). Drafts of the questionnaire were discussed with representatives of companies, branch organizations and governmental agencies in Sweden and California and with researchers in Japan. After the discussions, the questionnaire was revised in accordance with the opinions.

The Californian questionnaire was administered by the Swedish Office of Science and Technology in Los Angeles and sent out to 556 companies being members of biotech organizations in the Bay Area, the Los Angeles region and San Diego. Of these 556 companies, 70 had wrong addresses or were not possible to find contact information on due to other reasons. In spite of several reminders by mail, telephone and e-mail, not more than 36 companies (7.7 % of the remaining 466 companies) returned the questionnaire with usable replies. The low response rate means that it is not possible to view the replies as representing anything else than figures and opinions of the participating companies – even if some of the replies indicate that the firms responding to the questionnaire share some well-known general characteristics of American firms.

The Kansai questionnaire was administered by the School of Civil Engineering of the Kyoto University. It was sent out to 800 companies selected by the Osaka office of the Ministry of Economy and Trade (METI). Due to the limited number of start-ups in Japan, the Kansai questionnaire was sent out both to start-ups, traditional companies with biotech activities and to companies planning to start some form of biotech related activities. 101 questionnaires with replies were returned, which meant a reply rate of 12.6 %.

The Swedish questionnaire was administered by the Swedish Institute for Growth Policy Studies. It was sent out to the 131 companies, of the 185 registered by Vinnova as biotech companies 2001 (Sandström & Norgren 2003), which it was possible to find post- web- or e-mail addresses for in 2004. Addresses were sought in the Corporate Database of Karolinska Institutet's Centre for Medical Innovations, the Swedish Biotech Industry Guide (http://biotech.idg.se/industryguide/) and the Internet. Of these 131 companies, 17 had not correct addresses, had been bought up or merged, had changed activity or had been closed down. Of the remaining 114 companies, 56 replied on the questionnaire, which meant a reply rate of 49.1 %.

Appendix 2. Questionnaire

Section 1 – Background information

1.1 Main activity
Which sector of the biotech industry does best describe your company's core business? Check the square of the industry sector below that best describe your core business. Check one box only.

- Agro-biotechnology
- Animal Health
- Biomaterials/Bioprocess
- Biopharmaceuticals
- CRO (clinical research organization)
- Diagnostics
- Drug Delivery
- Genomics/Proteomics
- Informatics
- Instrumentation
- Medical Devices
- Nutraceuticals
- Supply/Service

1.2 Personnel turnover

Estimate your personnel turnover (including retirement) for 2002

_____ %

1.3 Financial support from government agencies
Has the company received any form of financial support from government agencies during the last three years, 2000 - 2002?

(2) Yes (1) No (97) Do not know

1.4 Employees

How many employees has the company had the three last years?

2000 _____ employees

2001 _____ employees

2002 _____ employees

1.5 Financial turnover
Please state the company's financial turnover the last three years.

2000 $ _____

2001 $ _____

2002 $ _____

Section 2 – Recruitment and labor

2.1 Recruitment

Where do your recruits come from?

Instruction: Check **one** box where your most important recruitment source is located.

Recruitment source	Regional (within approx. 60 miles)	Located elsewhere in the US	Located abroad
University/Institute			
Enterprise			

2.2 Method of recruitment

What methods do you use in recruitment of new employees?

Instruction: Check the boxes for the methods you mainly use.

a) Advertisement in daily press or branch journal
b) Recruitment agencies
c) Recruitment at local universities
d) Recruitment at universities elsewhere in the US
e) Recruitment at universities abroad
f) Referrals from current employees
g) Personal networks and/or contacts (e.g. professors)

2.3 The company's location

How important were the following reasons for the choice of location of your company?

Instruction: Check the boxes for the most important reasons.

a) The company's founder(s) was/were living in the region
b) Proximity of other companies in the industry
c) Proximity of potential customers
d) Good supply of competent labor
e) Proximity of venture capital sources
f) Proximity of R&D centers (research institutes/universities)
g) Good infrastructure for transportation and communication
h) Good quality of life in the region
i) Regional actors offered economic support during the establishment

Section 3 – Exchange of information and knowledge

3.1 Informal internal meetings

How many hours per week do the following two groups in average engage in internal **informal** meetings?
Informal meetings could for example be asking for or giving advice or perhaps informal supervision.

Write 0 hours if some of the groups do not engage in internal informal meetings.

a) A typical employee in your company's core activity _____ hours/week

b) A typical manager _____hours/week

3.2 Competence development and exchange of knowledge
Are the following activities for competence development important for your company?

Instruction: Check the boxes if the activities are important.

a) Formal education/courses **within** our company
b) Formal education/seminars in cooperation with external actors
c) Informal exchange of knowledge and networks **within** our company
d) Informal exchange of knowledge and networks **outside** our company

3.4 The location of the private networks of your employees

Where are the contacts within your employees' private networks working?
Instruction: Check **one** box where your employees' most important private contacts are working.

Contacts/persons within:	Regionally located (within approx. 60 miles)	Located elsewhere in the US	Located abroad
Universities/Institutes			
Companies			
Government			

3.5 The importance of the private networks of your employees

How important are the employees' **own networks**, concerning your company's long-term development?

(1) Not important (2) Neither important nor unimportant (3) Important

3.3 Formal education – total costs for all employees

Estimate your **total** costs for formal education/seminars 2002. (Not the cost per employee).

Write 0 $ if you had no costs.

_____ $

Section 4 – Social and informal activities

4.1 Entertainment within your company

Estimate the total costs for entertainment within your company 2002. Examples are activities such as company parties, teambuilding and celebration of birthdays.

Write 0 $ if you had no costs.

_____ $

_____

4.2 Entertaining parties outside of your company

Estimate the total costs for entertaining outside parties 2002. Examples are activities such as taking customers out to dinner.

Write 0 $ if you had no costs.

_____ $

Section 5 – Research and Development

5.1 Research and Development (R&D) costs

Estimate the cost for R&D 2002.
Write 0 $ if you had no R&D costs.

_____ $

5.2 R&D in cooperation

Has your company had any R&D-cooperation with any external actor during the years 2000-2002?

(2) Yes (1) No (97) Do not know

If Yes, continue with question 5.2.1. If No or Do not know, proceed to question 6.1.

5.2.1 R&D-cooperation with external actors

How important is R&D-cooperation with external actors for your company's long-term development?

(1) Not important (2) Neither important nor unimportant (3) Important

Section 6 – Publication of scientific articles

6.1 Publication of articles in Biotech journals
Have employees in your company published article(s) in domestic and international Biotech journals 2000 – 2002?

(2) Yes (1) No (97) Do not know

If Yes, continue with question 6.1.1. If No or Do not know, proceed to question 7.1.

6.1.1 Number of articles written by employees and articles with co-authors
How many articles in biotech journals have been produced "internally" in your company and how many have been co-authored with external actors?
Number of articles written by the company's own employees only: _____

Number of articles co-authored with external actors: _____

Section 7 – Philanthropy, sponsoring and contacts with decision makers

7.1 Philanthropy and sponsoring costs

Estimate the total amount your company spent sponsoring various charities or events 2002. We refer to items such as grants or ”gifts” to sports associations, cultural events, etc, in money and in kind.

Write 0 $ if you had no sponsoring costs.

_____ $

_____

7.2 Business-related contacts with decision makers

Estimate the working hours, that your top management had contacts with leading officials and/or decision makers during 2002.
Write 0 hours if you had no contacts with decision makers.

_____ hours

7.3 Contacts with industry- and lobby organizations

Estimate how many working hours the top management of your company had contacts with industry- and/or lobby organizations during 2002.

Write 0 hours if you had no contacts with industry- or lobby organizations.

_____ $

7.4 Costs for contacts with industry- and lobby organizations

Estimate the company’s total costs for contacts with industry- and/or lobby organizations during 2002. We refer e.g. to membership fees and costs of working hours.

Write 0 $ if you had no contacts with industry- or lobby organizations.

_____ $

Thank you for your participation!

Your name and direct telephone number:_____

_____

Would you like us to send you the completed study of social capital in the biotech industries in which we compare Sweden, California and Japan?

Yes, I would like to receive a free copy of the study. Below is my e-mail address to which you can send the study: _____

_____

No, thank you.

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Changes in policy should be based on:

- Statistic data and analyses of the structure and dynamics of industry
  – to obtain an up-to-date view of future challenges and opportunities.
- Evaluation of results and effects of policy measures and programmes
  – to provide benchmarks and learn from measures implemented earlier.
- Policy intelligence in order to look outwards and ahead
  – what issues are likely to come on the growth policy agenda in the future?

These represent the principal missions of ITPS.

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