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VENTURE CAPITALISM AS A MECHANISM FOR KNOWLEDGE GOVERNANCE

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1. INTRODUCTION

Large empirical evidence confirms that small firms are introducing a substantial and increasing share of innovations. The share of research and development expenditures performed by small firms has been steadily increasing since the late 80'. Small firms are the recipients of the large majority of patents and their share also has been increasing swiftly since the last decades of XX century. Finally, much case study evidence confirms the key role of small firms in the introduction of radical innovations in key technologies such as biotechnology, software and nanotechnology.

The new role of small firms in technological change is an aspect of a broader process of transformation in the organization of the production and dissemination of technological knowledge in the business sector. The organization of the production of knowledge in advanced economic systems is facing a drastic change, with the demise of the corporate model established in the second part of XX century in the US and the emergence of a new model based upon venture capitalism, knowledge outsourcing and technology sharing (Antonelli, 2005, and Chesbrough et alii, 2006).

The old model was based upon the pivotal role of the large corporation and was complemented by the key role of direct public subsidies to firms investing in research and development activities, strong public procurement of knowledge intensive products and an academic system supported by public funding. In the new model, still emerging, small firms play much a stronger role in the process of generation and dissemination of new technologies (Chesbrough, 2003).

In this context the new venture capitalism and the emergence of new surrogate markets for knowledge intensive property rights, that is the result of the blending of financial markets and the markets for knowledge, play a key role. Venture capitalism is a key component of the new open innovation system, and to a large extent the fourth helix of the new organization of the production of knowledge (Etzkowitz and Leydesdorf, 2000).

Venture capitalism is a new type of financial institution introduced in the US. The first recorded company being American Research and Development Corporation founded in 1945. Emergence of the new VC industry and market took place during the 1960's and early 1970's in the US -during the beginnings of the 'entrepreneurial phase' of the ICT Revolution.⁴ Since then, young start up companies would play increasingly important roles in the 'exploration' activities involved in the creation of new innovation-based industries and markets.⁵ This was due to the enormous new opportunities for experimenting and applying the new technologies and the flexibility and high power incentives' possibilities offered by such companies (Chesbrough, 1999).⁶ However, for a number of reasons-asymmetrical information, high

⁴ To be more precise it seemed to have been related to the integrated circuit, to the appearance of the semiconductor industry and to the eventual emergence of Silicon Valley as a high tech cluster. The entrepreneurial phase must, in all likelihood, also be linked to the creation of NASDAQ in the 1970s and its transformation into a public capital market for young, technology companies.

⁵ Larger firms, be they incumbents or former start-up were relatively more involved in 'exploitation' activities rather than in exploration.

⁶ Relative to those made possible by intra-mural R&D within incumbent companies e.g. due 'inertia', increasing costs of coordination and accelerated depreciation of existing products in those companies.

technological and market risk, frequently unknown entrepreneurs and relative absence of tangible assets-traditional financial institutions (banks) were not adapted to provide finance to these enterprises (Gompers and Lerner, 1999 and 2001). The emergence of venture capitalism which focused on equity finance rather than loan finance, and who also adopted a 'hands on', adding value perspective, was society's response to this situation.

The first venture capital company (American Research and Development Corporation-ARD, founded in 1946, see Bylinsky 1976)) preceded by more than 25 years what could be considered emergence of a venture capital industry in the US. During this period, numerous experiments on the adequate form of venture capitalism organization took place-from a publicly traded VC company & a subsequent Small Business Investment Company configuration (frequently associated with Banks) to a Limited Partnership form. Simultaneously the receiving companies also underwent changes e.g. Martin Kenney asserts that entrepreneurs only gradually accepted dilution of their ownership shares (this was not the case under loan finance but was inherent in equity finance)⁷. Finally, it should also be noted that significant changes in the institutional setting in the US were required, particularly concerning the disposition and formal possibility of Pension Funds to invest in venture capital companies (see ERISA and other developments in Gompers and Lerner op. cit).

This paper investigates the basic relationships between institutional and technological change in the context of the rise of venture capitalism and knowledge-intensive property markets. The ICT revolution has led not only to new financial institutions and private capital markets such as venture capitalists but also to new specialized public capital markets for the equity of technology companies including high tech start ups: NASDAQ being the prime example.

The new institutions and markets have directly stimulated foundations of start-ups by enabling entrepreneurs, founders and initial investors to obtain a return to their investments prior to full and profitable commercialization of their technology in product markets. As a direct consequence, research and development expenditures mainly performed and funded by new small companies has increased steadily through the last decades of the XX century in the US.

Applying the basic tools of information economics, this paper elaborates an institutionalist approach to understanding venture capitalism as the emergence of a system of interrelated and complementary institutional innovations as follows. Section 2 recalls the limits of knowledge as a private good and the related problems for its tradability and fundability. Section 3 explores the foundations of venture capitalists as intermediaries in facilitating the transactions of knowledge assets bundled with other assets, identifies the notion of economies of scope in transaction costs and presents a synthetic analytical exposition of the arguments elaborated so far. Section 4 introduces the notion of knowledge intensive property rights. Section 5 examines the merging of financial and knowledge markets as an institution to trade knowledge. The conclusions summarize the results of the analysis and highlight the new knowledge governance model that emerged from the ICT Revolution, its structure, problems and potential economic impact. It argues that the new knowledge governance model could

⁷ Private communication (See Avnimelech, Kenney and Teubal, 2005).

change the nature of innovation system in a transformation that should accompany knowledge-based economic growth.

2. THE FAILURE OF THE MARKETS FOR KNOWLEDGE: THE LIMITS OF KNOWLEDGE AS A PRIVATE GOOD

Our understanding of the dynamics of technological change owes much to the path breaking contributions of Richard Nelson (Nelson 1959) and Kenneth Arrow (Arrow 1962) about knowledge as an economic good. Until then, knowledge was not regarded as a separate item.

The analysis of knowledge as an economic good has immediately made possible to grasp the causes of the radical failure of the market place to perform its traditionally functions and the ensuing severe risks of under-production of knowledge in market systems. Building upon a large literature, the basic argument can be easily articulated as it follows: A) knowledge is the basic intermediary input for the increase of efficiency; B) the incentive, in terms of social desirability to the production of knowledge is huge: any economic system would dedicate most of its resources to the generation of new knowledge as a way to increase the efficiency in the production of all the other goods; however, C) because of the major limitations of knowledge as an economic good in terms of non-appropriability, non-excludability, non-rivalry in use, non-exhaustibility and non-divisibility, the private profitability of knowledge generating activities is well below social desirability; moreover D) because of the high levels of uncertainty both in generation and appropriation, economic systems are unable to fund the correct amount of resources to the generation of new knowledge and hence to increase the production of goods via the increase in the general efficiency of the production process. E) dynamic inefficiency adds to static one: the markets for knowledge, as a stand-alone good, are inefficient and hence the necessary levels of division of labor and specialization cannot be achieved. A radical market failure is the direct consequence of the characteristics of knowledge, as an economic, private, and unbundled good.

The failure of markets for knowledge is twofold: it takes place both in the markets for knowledge as an output, and in the markets for financial resources necessary to undertake its generation. Let us consider these two interrelated aspects more in detail:

A) It is very difficult to sell knowledge as an output for the well-known problems of appropriability and tradability. An intrinsic information asymmetry between vendors and customers is at work. Customers have good reasons to doubt about the real quality of the knowledge on sale before the vendor has revealed the actual content and the range of possible applications. Even high levels of reputation of the vendor do not exclude the possibility of a 'lemon' either for an unprecedented opportunistic conduct of the vendor or because of his own misjudgment. As soon as the vendor reveals the content of the new knowledge, however, the information asymmetry switches on his side: now perspective customers can take advantage of the new knowledge without actual payments and the 'inventor' faces a sharp decline in the chances of appropriation of the stream of benefits stemming from the economic applications of the new knowledge. Intellectual property rights help increasing the appropriability and to a limited extent the tradability of knowledge. Arm's length transactions of knowledge, even with effective intellectual property rights, however, are difficult. Relevant absorption costs require the assistance of vendors within the context of long-

term contractual relations. Transaction costs are very high because of the intrinsic difference between ex-ante and ex-post conditions. Knowledge is often exchanged within the institutional context provided by complementary property rights. A large portion of actual knowledge transactions takes place within global companies and diversified groups (Arora, Fosfuri and Gambardella, 2001; Guilhon, 2004).

B) Credit rationing limits the access to financial markets for innovative projects for the high risks associated to the radical uncertainty that characterize both the generation and the exploitation of new knowledge. Perspective lenders and investors are worried by the combined high levels of risk that a) the activities that have been funded with their own money will not succeed, and b) the new knowledge, occasionally generated, will not be appropriated by the inventor, at least to an extent that makes it possible to repay the credits and remunerate the capital invested. Even in the case of a successful generation, lenders have good reasons to worry about dissipation stemming from uncontrolled leakages of proprietary knowledge. As a consequence, worthy inventive activities and innovative projects risk to be sorted out in the market place (Stiglitz and Weiss, 1981).

The new understanding about the asymmetry between debt and equity in the provision of funds for research activities elaborated by Stiglitz (1985) paves the way to a revolution in financial markets. Equity finance has an important advantage over debt in the provision of funds to innovative undertakings because it can participate into the bottom tail of the highly skewed distribution of positive returns stemming from the generation of new knowledge and the introduction of new technologies (Hall, 2002). This has important consequences both in terms of reduction of both the risks of credit rationing and the costs of financial resources for research activities. Lenders in fact need to charge high interest rates in order to compensate for the risks of failure and to sort out a large portion of the new research activities to avoid as many 'lemons' as possible. Equity investors instead find an equilibrium rate of return at much lower levels because they can participate into the huge profits of a small fraction of the new ventures. The fraction of lemons that equity can support is much larger than that of debt; hence, as a consequence, financial equity can provide a much larger amount of funding for research activities.

Markets for knowledge have been traditionally regarded as missing markets. Yet markets are required for growth and even more for a knowledge-based growth. The analysis of the emergence of a market place for knowledge should be centerpiece in any theory of economic development nowadays.

In this context venture capitalism emerges as a major institutional innovation that helps reducing the typical knowledge market failure. Venture capitalism consists of: a) the identification of venture capitalists, i.e. intermediaries able to combine the selective allocation of financial funds with the provision of competence and rare business skills; b) the selection of new technological knowledge and the assessment of its industrial and commercial viability; c) the creation and growth of new knowledge-intensive firms; The goal of the creation of the new company, here, is not, like in scientific entrepreneurship, just the foundation of a new firm and its eventual growth, but rather its listing into a dedicated stock market, leading to d) the emergence of a dedicated market for knowledge intensive property rights where the shares of the start-ups are traded after initial public offerings.

From this viewpoint venture capitalism can be considered as a fundamental step towards the creation of a surrogate knowledge market.

3. THE VENTURE CAPITALIST AS A KNOWLEDGE ASSEMBLER

Bundling has always been regarded in the economics of antitrust and in competition analysis as an unfair practice by means of which firms try and expand monopolistic control to adjacent markets (Adams and Yellen, 1976; Carlton and Waldman, 2002).

In our analysis instead the positive aspects of knowledge bundling are highlighted. The bundling of knowledge with other complementary goods emerges in this context as an important institutional innovation. Bundling provides positive welfare effects when the combination of diverse goods into one single product makes it possible to reduce overall transaction costs and to create missing markets or improve existing markets. The bundling of two or more goods can improve the overall efficiency of the system when one of the transactions is impossible or exceedingly expensive. In this case a nested transaction makes it possible to perform an exchange otherwise impossible (Antonelli, 2006).

From this viewpoint, the ultimate result of VC is the combination of at least five classes of well distinct types of assets into one: a) technological knowledge, b) managerial competence, c) business services, d) financial assets, e) reputation, and of their transformation into a new special class of financial assets.

Each of these assets could not be easily transacted separately: A) knowledge cannot be traded easily, and it is difficult to organize transactions even with the assistance of intellectual property rights due the problems associated with the unpredictability of the economic results stemming from the application of a new bit of knowledge; B) the complementarity between managerial competence and new technological knowledge is extremely relevant and yet it is very difficult to match competent managers with the promising new technologies in the market place; C) the provision of dedicated business services such as legal assistance to secure effective intellectual property rights plays a key role in this context⁸; D) the screening of new knowledge requires rare dedicated competences; E) the reputation of qualified intermediaries, such as VC, is a key factor to signaling the market place about the reliability and eventual profitability of the new start-up; F) the funding of innovation has always been problematic for the well known knowledge asymmetries between the inventor and the banker.

Venture capitalism can be considered a major organizational innovation based upon the exploitation of latent economies of scope in transaction by active intermediaries. Venture capitalism in fact consists in bundling services and products that cannot be traded separately. More specifically we see that the bundling of such services and products has the direct and clear effect of saving in transaction costs. This case leads to the identification of a new type of economies of scope. Economies of scope in transaction differ radically from economies of scope, traditionally referred to

⁸ From this viewpoint it is clear that intellectual property rights complement venture capitalism rather than substituting for them.

production costs. Economies of scope have first been applied to describe the case where the joint production of two goods costs less than their separate production. Economies of scope in transactions do not apply to the production process: they apply instead to the costs of using the market. There is a case for economies of scope in transaction when and if, *ceteris paribus* production costs, the joint transaction of two goods, combined into one single new product, makes it possible to bear a lower level of transaction costs than it is the case for the use of the markets for each of them.

Formally this can be easily expressed as it follows:

$$(1) \text{TRC}(x, y) < \text{TRC}(x) + \text{TRC}(y)$$

where TRC stands for average transaction costs for good x and y respectively.

It is important to stress here that such economies of scope in transaction costs take place both on the demand and on the supply side. Now perspective knowledge vendors find in venture capitalists an active intermediary that is able to reduce the transaction costs in the supply of knowledge to third parties. The sale of the shares of the startups in the financial markets, in fact, is the ultimate act of a complex process of indirect sale of technological knowledge. Now inventors can better face radical uncertainty about the perspective value of new knowledge and spread the risks. Moreover the large number of shares into which the assets of each startup is divided where each embodies a property right on a fraction of a piece of knowledge, helps increasing knowledge divisibility and hence the implementation of knowledge portfolio strategies.

In other words, knowledge divisibility increases with bundling and its eventual trade, embodied with financial assets and reputation after proper screening, as a knowledge-intensive-property asset. At the same time moreover, also perspective knowledge users benefit from the reduction in transaction costs. Firms can now take advantage of the new financial markets where the knowledge-intensive-property rights are traded as a surrogate market place for technological knowledge. The twin economies of scope in transaction costs can now be specified. The bundling into new startups of technological knowledge, managerial competence, and finance makes it possible to enjoy economies of scope in transactions both on the demand and on the supply side. Hence:

$$(2) \text{TRC}(S(x, y), D(x, y)) < \text{TRC}(S_x) + \text{TRC}(S_y) + \text{TRC}(D_x) + \text{TRC}(D_y)$$

where S and D specify the supply and demand for the goods x and y.

Venture capitalism has made it possible to identify and capitalize the benefits of latent economies of scope in transactions. The use of the markets for technological knowledge, managerial services and finance as separate goods costs much more, both for perspective suppliers and perspective customers, than the trade of a dedicated bundle of these goods. From this point of view the essence of venture capitalism can be grasped in terms of the provision of a new composite vehicle, able to provide the opportunity for the general public, specialized investors, knowledge vendors and knowledge users to act in a new dedicated financial market as a surrogate market for technological knowledge, i.e. an instrument for the valorization, selection and distribution of technological knowledge.

Proactive intermediation activities, specific to venture capitalism, here consist in the design of the composite vehicle of bundled services that can be better traded in the market place. Venture capitalism combines the provision of many bundled services such as: the preliminary screening of new bits of technological knowledge, their combination with the supply of complementary managerial skills, knowledge intensive business services and financial capital. The venture capitalist, as a creative intermediary, assists the birth or early development of new start-ups that build upon the bundle of services, follows the preliminary selection in the market place and organizes the initial public offering in the financial markets. Needless to say, the reputation of venture capitalists plays a key role in this general process, as it is the prime input into the complex task of screening and assessing the actual market value of new technological knowledge.

The creation of this bundle of products is efficient from an economic viewpoint because there are economies of scope in the transaction of the new mix of products while the trading of each of them was hindered by high levels of transaction costs. The role of venture capitalism, as an active intermediary, consists in the identification of the relevant complementarities among services such as managerial competence, knowledge-intensive-business-services and technological knowledge properly screened and their combination with financial capital, or more specifically with the translation of financial capital into industrial capital.

4. THE CREATION OF KNOWLEDGE-INTENSIVE-PROPERTY RIGHTS

The bundling provided by venture capitalism and the creation of new high-tech start-ups implies the necessary corollary of their eventual sale. Without a clear exit strategy venture capital firms would quickly become conglomerates with little opportunity to convert their investments into liquid assets.

In the early stages of venture capitalism the monetization of the profits stemming from the new ventures and the recovery of the initial investment could take place by means of the block sale of the startup companies to single customers. Such customers were other companies interested into the knowledge assets or occasionally new perspective entrepreneurs looking for alternative fields of activity. Alternatively substantial chunks of the capital of startups could be placed in private markets based upon spot transactions. In this case the customers can be financial investors, typically private equity funds, specialized in high-risk investments. In both cases the direct sale to other firms was, de facto, the single opportunity for the conversion of the new companies back into liquid capital

The creation of knowledge intensive property rights can be considered the ultimate result of the increasing density, frequency and thickness of transactions of the property rights of small, technology intensive, young companies. Ultimately this has lead to the trade of knowledge-intensive-property rights in public markets, that is the opportunity to trade technological knowledge combined with managerial competence and industrial capital in the form of a new special kind of financial tool, that is shares of companies whose equity consists mainly of technological knowledge.

Venture capital cannot develop without a dedicated and public market for knowledge-intensive-property-rights. Venture capital in fact needs a market for equity where the

new knowledge intensive companies can be traded by a large variety of possible customers.

This process has the important implication that both the general public and investors, that is specialized financial agents specialized in the allocation of financial resources have now a chance to consider financial assets based mainly on technological knowledge as a possible recipient of their investment strategies. The provision in financial markets of knowledge-intensive-property-rights in the form of shares of new high tech companies makes financial investment possible because of the possibility of spreading risks, because of the higher levels of liquidity achieved, and because the large number of players involved. Now three categories of traders are brought together: the general public interested in the placement of their personal savings, financial investors and industrial companies that are searching for useful technological knowledge that can be acquired and integrated within their on going activities. As a consequence the merging of three distinct demand schedules takes place and the overall demand for knowledge-intensive-property-rights is increased.

Alternatively, venture capitalism provides the opportunity for knowledge holders to sell their knowledge embodied in dedicated financial assets that embody other complementary services such as managerial competence, finance and preliminary screening. Here the reduction of transaction costs on the supply side has powerful effects in terms the creation of a market for knowledge and hence division of labor and specialization on the supply side. On the other hand venture capitalism provides large companies searching for new technological knowledge with the opportunity to take over the new companies incorporating such bits of useful knowledge with consequent de-listing. This has clear positive effects in terms of division of labor and specialization in the generation of new knowledge, on the demand side.

However in this case, financial operators, whether investment companies which operate in the stock market or individual investors, participate in the gains since they can sell the shares of the new companies that are being acquired. In so doing, financial investors contribute to the general process of valorization of technological knowledge and provide a complementary function to that performed by venture capitalists. From the viewpoint of knowledge-users, financial markets provide the opportunity to check and assess the perspective value of the new knowledge embodied in the new companies. Perspective knowledge users are companies that are searching and accessing new technological knowledge in the form of new companies being traded in the financial markets as both a substitute and a complement to technological knowledge developed internally.

The reduction in transaction costs on the supply side engendered by venture capitalism, however, has a direct effect in terms of a reduction of the costs of using the market place. Hence the supply curve for knowledge, after the introduction of knowledge-intensive-property rights by perspective knowledge vendors is likely to shift to the right.

The reduction in transaction costs on the demand side, engendered by venture capitalism, moreover, has a direct effect on the level of the demand curve: now perspective knowledge users enter the new surrogate markets for technological knowledge. On the top of this moreover the demand curve for knowledge-intensive-

property rights in the new financial markets acting as surrogate markets for technological knowledge, shifts towards the right because of the effects of the new demand for financial assets by agents specialized in the management of financial capital and in the allocation of savings. As a consequence the new aggregate demand for shares of new startups after initial public offering is much larger than the demand for non-embodied technological knowledge.

Lower transaction costs have a clear positive effect in terms of the convenience of external knowledge as an intermediary input -that can now be acquired in the market place- in the production of new knowledge ongoing within each firm. Both substitution and revenue effects combined push the derived demand for knowledge towards the right.

The creation of knowledge-intensive-property rights provides the opportunity to transform radical uncertainty into risk and to share the risks, increase divisibility, increase transparency and hence reduce drastically information asymmetries about the economics value of new technological knowledge.

The public market for knowledge intensive property rights has many informational advantages over the private markets where individual investors and sellers occasionally meet. In the latter information can only flow through personal links and networks hence transactions can only take place within a physical market place. Transactions can take place along a geographical area, traditionally up to a distance of 40 km or so where venture capital firms are located: this is complemented by professional associations and high tech meetings which provide market place 'islands' circumscribed in time and place (Saxenian 1994). On the opposite within public markets information about prices and quantities of transactions are open to public disclosure with evident benefits.

5. THE EMERGENCE OF A NEW MARKET: THE MERGING OF KNOWLEDGE MARKETS AND CAPITAL MARKETS

In textbook theory of exchange, markets exist and are self-evident and any transaction presupposes existence of an underlying market. In our approach markets are economic institutions that emerge when an appropriate combination of complementary conditions takes place. Markets are the product of social and institutional change. As such they evolve over time: markets can decline and emerge.

At each point in time markets differ. Originally markets were defined only in geographical terms as locations where a large number of sellers and buyers would meet to trade. Since then, markets have grown into sophisticated institutions characterized by functions and characteristics. The extent to which the process has grown differs. Different stratifications of institutional evolution can be found according to the characteristics of products and agents involved. Markets differ across countries, industries and contexts. Markets differ according to the functions they can perform and their structural characteristics. The emergence and evolution of markets is the result of a process that takes place over time and is shaped by institutional innovations⁹.

⁹ According to Alfred Marshall: "When demand and supply are spoken of in relation to one another, it is of course necessary that the markets to which they refer should be the same. As Cournot says, "Economists understand by the term Market, not any particular market place in which things are bought

The creation of a new specialized and dedicated stock exchange where the shares of knowledge intensive small and young companies could be transacted has been a major and complementary institutional innovation. The separation of NASDAQ from the New York Stock Exchange can be considered such an institutional innovation. In such a dedicated market in fact transactions on equity take place in a context where the focus of investors is directly concentrated upon the knowledge content of firms. The assessment of their perspective performance is much less based upon the evaluation of the quality of the financial and industrial capital, and directly concentrated upon the quality of the knowledge capital, combined with specific managerial competence specialized in managing knowledge intensive new ventures.

The creation of a surrogate market for knowledge embodied in new startups that can be sold by means of IPO and acquired by means of Mergers and Acquisition increases the division of labor and the specialization and hence the general efficiency in the generation of new technological knowledge. Agents can specialize in the generation of knowledge where each has a distinctive and competitive advantage and rely upon external knowledge as an input made available in the market place.

The reputation of the venture capitalists is an essential condition for the emergence and the working of the new surrogate knowledge markets. The certification of venture capitalists and the ex-ante assessment of their reliability and sustainability provide both tentative customers and suppliers with information that are necessary to perform transactions. Without the provision of information about the reliability of partners in trade, both customers and suppliers must bear the costly burden of relevant search and assessment activities. From the viewpoint of the effective working of the new surrogate knowledge market place, moreover, the symmetric distribution of the reputation, as a carrier of information, plays a key role. It is clear in fact that in a system where reputation is distributed unevenly transactions are likely to privilege the few agents that enjoy the advantages of good reputation. A star system is likely to emerge with clear monopolistic effects. Systems where the reputation of agents is certified are likely to work better than systems where reputation is asymmetrically distributed. The latter systems, in turn, are more performing than systems where average levels of reputation are low. Reputation is a key element in the definition of social capital precisely for its positive effects in terms of reduction of transaction costs.

and sold, but the whole of any region in which buyers and sellers are in such free intercourse with one another that the prices of the same goods tend to equality easily and quickly. Or again as Jevons says: "Originally a market was a public place in a town where provisions and other objects were exposed for sale; but the word has been generalized, so as to mean any body of persons who are in intimate business relations and carry on extensive transactions in any commodity. A great city may contain as many markets as there are important branches of trade, and these markets may or may not be localized. The central point of a market is the public exchange, mart or auction rooms, where the traders agree to meet and transact business. In London the Stock Market, the Corn Market, the Coal Market, the Sugar Market, and many others are distinctly localized; in Manchester the Cotton Market, the Cotton Waste Market, and others. But this distinction of locality is not necessary. The traders may be spread over a whole town, or region of country, and yet make a market, if they are, by means of fairs, meetings, published price lists, the post-office or otherwise, in close communication with each other." (Marshall, 1920, Book V, I, § 6).

The new surrogate knowledge markets have by now reached high levels of thickness, frequency and recurrence of transactions¹⁰. This has many positive implications. First of all, the new surrogate markets for knowledge signal to the rest of the economy the need for the specific knowledge-products being traded. The signaling involves a qualitative dimension (the 'need' and the 'product class' satisfying it) and a quantitative dimension reflected in quantities and values purchased and sold. The existence of the new market also minimizes volatility and swings concerning persistence of the 'need' or possibility of obtaining the good. This because a market is more stable than a single user or a single firm and a market –compared to a single transaction- provides relative assurance about the possibility of repetitive transactions- purchases or sales- in the future.

The new surrogate markets for knowledge comprise and cluster within it a set of individual markets, each one involved in trading the shares of a particular high tech company. The trade of knowledge intensive property rights in a public market and specifically the possibility to purchase and sell a few shares of many different companies has the powerful effect to reduce the traditional problems of radical uncertainty and risks associated with knowledge. Now owners of a few shares can spread their risks and buy the shares of many companies. Hence shares of knowledge intensive companies make knowledge divisible. The new market place reduces the uncertainty for investors, and hence increases the desirability to invest in the shares. This in turn becomes a strong incentive to create start up companies to be eventually floated in public markets.

¹⁰ Markets have properties and characteristics. According to such characteristics, markets are more or less able to perform their functions. The properties of markets do not coincide with the properties of the products being exchanged, and the characteristics of agents engaged in trade. Yet there is a strong overlapping between the characteristics of products and agents and the properties of the markets. Beyond the characteristics of the products being exchanged in the market place, and of agents engaged in trade, we can identify at least six main characteristics of markets: **The time horizon** of markets plays a central role. Spot markets are far less effective than regular markets. In effective markets future prices can be identified and a full inter temporal string of prices and quantities can be set. **Market density** is defined by the number of agents both on the demand and on the supply side. It is clear that markets with one player either on the demand or the supply side are highly imperfect. **Market thickness** is relevant both on the demand and the supply side with respect to the volume of transactions. With respect to thickness there is an important issue about the levels of the critical mass, necessary for a good performance of the market. When transactions take place with high levels of **frequency**, the users of markets, both on the demand and the supply side, prices and quantities can adjust swiftly to changing economic conditions. Sporadic transactions limit the performances of markets. **Recurrence** of transactions is most important to reduce opportunistic behavior and to make comparisons possible. Recurrence of transactions is a major source of transparency and hence information. **Concentration of transactions**. Compulsory concentration of transactions is a typical institutional intervention that is enforced in order to increase the density, thickness, frequency and recurrence of transactions. By means of compulsory concentration, sparse, rare and occasional transactions by a myriad of isolated and dispersed agents is brought into the same physical and institutional context with clear advantages in terms of the number of transactions that occur and hence can be compared and observed. The role of compulsory concentration is vital for the emergence of new effective markets and hence it is at the same time an important prerequisite and a threshold factor. Markets differ greatly with respect to their characteristics and as a consequence with respect to the functions they can perform. A well functioning market is able to perform a variety of functions that a set of isolated transactions cannot.

Here a new notion of economies of scale can be grasped: the size of the market, as measured by the number of companies being traded, becomes central as the only way to bring the public to invest in knowledge intensive property rights is to offer them the possibility of investing their financial assets including personal savings in the shares of a large number of companies so as to create a diversified portfolio. Formally we see that:

(2) $\exp P = f(\text{SIZE})$, with $f' > 0$ and $f'' < 0$

The expected profitability ($\exp P$) of the investment in shares of high-risk companies is larger, the larger is the number of such companies (SIZE) traded in the public market. Investors have in fact much a larger chance to participate into the bottom tail of the highly skewed distribution of positive returns that characterize high-tech startups also after IPO. Only a few companies in fact are likely to see the value of their shares increase dramatically. Many remain at the initial levels after the IPO. The larger is the number of companies traded and the larger the opportunity for investors to build appropriate portfolio strategies.

Here the typical self-feeding dynamics of increasing returns take place. Large numbers favor profitability hence large markets attract more IPOs and more customers. The active participation of large pension funds to the NASDAQ may help understanding why NASDAQ has gradually become the single and global surrogate market for knowledge, while many attempts to create surrogate markets for knowledge in Europe failed.

Signaling the existence and persistence of need to be satisfied helps any firm/supplier and any user/consumer respectively, actual or potential, to focus his or her search process towards the relevant 'space' where the market exists or operates. It also facilitates users' (producers) long run decisions concerning purchase (sale) of a new particular product class or service or system traded in a particular market ("the product"). The decisions would involve investment decisions concerning or involving the product or its supply. Nobody would like to create a dependency in a product purchased (sold) whose sources of supply (demand) and mechanisms of purchase (sale) are not highly reliable and stable.

Since the new surrogate knowledge markets concentrate large numbers of users and also reduce transactions' costs; they provide firms with high levels of efficiency with profits above the norm. Hence they push entry, expansion and invention/innovation and symmetrically exit when losses emerge. The new markets are able to perform relevant screening functions when many different knowledge modules and make systematic recombination possible.

By means of their signaling functions the new surrogate knowledge markets make it possible the coordination in the production of complementary knowledge products. For example, users would initially 'come to the market' get knowledge module A but would also signal their need for knowledge module B which together with A conforms the system they want. This would also be signaled to firms (existing or new firms) who would then start offering B or the A+B system.

Specialization of agents in the narrow spectrum of activities where each firm has a competitive advantage can be done by means of the new surrogate knowledge markets. This because in the market all the relevant users are present so a firm may easily know the potential market for that specific component (or components) in the production of which he enjoys a competitive advantage (he also will save on selling costs). The new surrogate knowledge markets make it possible the vertical integration of intermediary knowledge modules within 'filieres'. More generally the new surrogate knowledge markets facilitate both specialization & and integration by producers.

The commercial exploitation of technological knowledge may involve one or more of a number of actions such as accessing complementary assets for the commercial exploitation of knowledge, selling the company to large companies (the A part of M&A) or acquiring other companies (less common for private start-ups), selling shares to private investors, floating the company, selling (or burying) unbundled knowledge to other companies, in-licensing or out-licensing, etc. Due to functional and cross functional economies of scale and scope, cluster effects and synergies NASDAQ-type capital markets for technology companies are capable to exploit the enormous advantages of clustering within one overall structure a number of horizontal functions across individual, firm-specific capital markets. These include the overseeing and regulation of individual transactions; dealing with regulatory demands from Governments (where there are many commonalities across individual markets); the advantages of having a component of 'centralized coordination' over and beyond the coordination which the individual markets themselves provide (when compared to the Over the Counter Markets which preceded NASDAQ as a 'public' market) e.g. 'temporary suspension of trade during crisis'; the provision of information e.g. by analysts; underwriting and other investment bank services; brokerage services; the possibility of accumulating reputation across markets; etc. These factors not only explain the existence of a two-tier level of capital market organization; it also explains why and how company specific markets are linked and why new ones can be added without serious problems.

The above advantages of a two tier capital market for technology companies undoubtedly translate into advantages to investors e.g. reductions in transactions costs both within and across individual markets. No less important are the variety of possible investments, and the divisibility of equity positions that could be bought or sold (all of which enable significant diversification and optimization of expected return and risk). This would explain the massive participation of the public at large in capital markets for technology companies.

The creation of a new global surrogate market for knowledge –namely the NASDAQ– where knowledge intensive property rights can be traded can be considered one of the key features and contributions of venture capitalism. The new financial market (NASDAQ) where knowledge-intensive-property rights are traded can be considered a surrogate knowledge market resulting of the merging of financial and knowledge markets. NASDAQ provides the context into which a new product, the knowledge-intensive-property rights, can be traded and exchanged among a variety of players.

The participation of the general public into NASDAQ as a two tier market place where the markets for many individual KIPR i.e high tech start ups, are traded is most

important. This transforms it into a market for *income streams*, which is a *generic commodity* pertaining to the Savings/Investment versus consumption decision of individuals. The various income streams are substitutes; and the fact that many are traded and it is easy to shift from one to the other (also because of the infrastructure of knowledge and agents which provide advice and information) means that transactions costs of shifting from one to the other are low.

In sum, the emergence of the new market for knowledge-intensive-property rights can be considered a major institutional innovation. The trading of the new knowledge-intensive-property rights is the end step of a process articulated in the entrepreneurial selection and bundling of managerial and financial resources provided by venture capitalism, the creation of start-ups and the initial public offering of their shares. Because of these reasons NASDAQ and similar capital markets for technology companies perform a central function by favoring the social generation and exploitation of knowledge.

6. CONCLUSION: VENTURE CAPITALISM AS AN INSTITUTIONAL INNOVATION

According to the traditional Arrowian approach, the trade of knowledge as an economic good, as well as the provision of financial funds to research activities, is impeded by huge transaction costs both on the supply and the demand side. Radical information, actually knowledge, asymmetries in fact have a powerful negative effect on agents that are looking for reliable and affordable customers of their knowledge and for agents that are looking for reliable suppliers of necessary knowledge. Tentative suppliers are worried about the risks of non-appropriability and dissipation of their proprietary knowledge. Tentative customers face serious problem to assessing the actual value of knowledge acquired in the market place. Spot interactions in the market place for knowledge are constrained by the poor levels of transparency and high risks of opportunistic behavior. The same is true in pure financial markets where investors are reluctant to fund risky research ventures.

Venture capitalism is part of a new institutional setting involving a special class of economic agents specialized in the selection of new technological undertakings and their combination with managerial competence and financial resources. Attached to this is a dedicated market place specialized in knowledge intensive property rights where the shares of new companies can be traded and exchanged. Its innovativeness lies in its internal architecture and on its impact on the economic system at large.

A large literature has explored the emergence of venture capitalism and has provided a detailed analysis of its articulation. This paper has focused the analysis on venture capitalism as a radical and systemic institutional innovation based upon three complementary institutional changes: the bundling of different assets and services into new start-ups, the creation of knowledge intensive property rights and the creation of a new surrogate market for knowledge.

The analysis of the complementarity between knowledge, as an economic good, and other economic goods, such as competence and financial resources makes it possible important departure from a well-established research avenue based upon the analysis of knowledge as a separate and well identifiable economic good.

From the viewpoint of the *architecture*, the bundling of separate and yet complementary activities and resources not yet fully valorized in isolation into an integrated frame appears to be the first distinctive and qualifying element of venture capitalism. Latent economies of scope can be valorized. Such economies stem from the institutional combination and joint organization of distinct processes and activities. Thus venture capitalism is an interesting case of an institutional innovation oriented to exploit and take advantage of joint organization, as distinct from traditional joint production, of different goods and activities, efficient in terms of the reduction of the combined levels of knowledge transaction costs, financial transaction costs and the costs of matching managerial competence with dedicated and idiosyncratic knowledge.

The second distinctive element of venture capitalism consists in the creation of knowledge-intensive-property rights with the important positive effects in terms of divisibility of knowledge, or to better say, divisibility of the risks and opportunities associated with the use of new technological knowledge. The creation of knowledge intensive property rights has increased considerably the tradability of knowledge bundled with new firms.

Thirdly, venture capitalism is also an institutional innovation that reshaped the organizational and architectural configurations of both knowledge supply and knowledge demand and made it possible for a surrogate knowledge market place to come to existence. The new surrogate markets for knowledge are a new financial institution where (equity-based) transactions concern knowledge bundled with other assets and transformed into knowledge-intensive-property rights. Here strong increasing returns take place: the larger are the public surrogate markets for knowledge and the higher the chances that un-sophisticated and risk-adverse investors are able to participate into the exploitation of the economic rents stemming from new knowledge. Such an opportunity to trade knowledge intensive property rights in large public surrogate markets for knowledge attracts additional flows of resources to fund the generation of knowledge.

Venture capitalism consists of the provision active intermediation aimed at solving not only the asymmetric information issues but also and more generally the problems of mutual adaptation of supply with demand, with their eventual transformation in a surrogate market for knowledge and equity. So far venture capitalism provides an original, albeit partial, remedy to the well-known problems of knowledge tradability and fundability. Therefore the new venture capital market provides partial remedy for the actual imperfections of both markets and organizations in the generation and dissemination of the correct amount of knowledge. Venture capitalism is an important institutional innovation for its positive effects on the exploitation of knowledge it has and consequently it is also an important mechanism for the generation of new knowledge. Venture capitalism in fact provides stronger incentives for the generation of knowledge.

As such, venture capitalism has important systemic *effects*. Venture capitalism is indeed a major institutional innovation in enhancing knowledge exploitation with important consequences in terms of higher levels of selection and dissemination (and indirectly, of creation) of technological knowledge within the economic system.

While knowledge cannot be traded as a separate good for its well-known limitations, knowledge can be bundled to other complementary goods and in turn traded. The consequences are quite strong in terms of:

A) Enhanced levels of division of labor in the generation of new technological knowledge and hence specialization with all the well-known positive effects in terms of productivity of the knowledge generating activities,

B) Better definition and separation of the incentives both for the generation and for the application of new technological knowledge and hence a remedy to the traditional market failure in allocating the correct amount of resources for the generation of new knowledge. Thus, to a larger extent than previously the new, equity-based financial markets permit an anticipation or acceleration of the return to investments the generation of knowledge i.e. it could take place prior to the full commercial application of the new knowledge in the production of goods or services. A related point is that in this new context in fact there is a new commonality of interests between the entrepreneur and the venture capitalist. By bundling knowledge with company shares there are fewer deliberate spillovers from the transaction (because of the commonality of interests with the venture capitalist that purchases the knowledge) then those that may arise from simply selling the knowledge to another agent who has no interest in the welfare of the start-up. Also the added value from the venture capital helps the start-ups overcome potential profit reducing externalities through e.g. more effective commercialization and certification effects provided by the venture capitalism.

C) Increased levels of dynamic efficiency both those derived from factors mentioned above (e.g. a specialized start-up segment) and from two additional ones pertaining to venture capitalism: (i) Venture capitalists become loci of experience and knowledge both about technological opportunities and the possibilities for commercially fruitful applications of such opportunities (including knowledge about the capabilities and orientation of the agents and organizations involved); and, related to this, (ii) enhanced coordination among the agents involved in the generation of new knowledge with a reduction in duplications and waste of resources in unfertile activities. The venture capitalist has a broad view of the start-up domain including the fact that he himself is investing in many companies; therefore he is in a better position to 'coordinate' investments compared to an individual investor, which with his limited amount of funding has a narrow view.

D) The dynamic efficiency effects are not only the result of more transaction-effective knowledge markets albeit surrogate and bundled; but also from the central fact that *the public at large*, by demanding/investing in knowledge based income streams, is also, through a derived demand effect, promoting the creation of new knowledge, capabilities and related managerial efficiency. Thus the central point is not only the transition from disconnected transactions to transactions conducted within a market; but the characteristics of the knowledge market itself and the ensuing new system of incentives to fund innovation. Consistently and consequently venture capitalism can be credited an important role in the increase of birth rates of new high-tech firms.

Venture capitalism is an innovative mechanism of knowledge governance and it is a part of a new model of organization of the generation and dissemination of

knowledge. Venture capitalism has caused the incorporation into a country's national innovation system of a distinctive *innovative entrepreneurial subsystem* based on the effective finance and support of a relatively large and distinct segment of high tech start ups which specializes in invention, R&D and experimental development ('applied knowledge') on a wide front. Emergence of these specialized knowledge producers represents a crucial new phase in the process of division of labor, specialization and knowledge-based economic growth. Venture capitalism is indeed emerging as the fourth helix of the new open innovation system.

The regional and international distribution of venture capital companies can help explaining the wide differences in the innovation capability of local economic systems and their differential ability to generate technological knowledge and introduce effectively and timely technological innovations.

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