



WORKING PAPER SERIES

Cristiano Antonelli, Morris Teubal

VENTURE CAPITALISM, NEW MARKETS AND INNOVATION-LED ECONOMIC GROWTH

Working Paper No.03/2009

VENTURE CAPITALISM, NEW MARKETS AND INNOVATION-LED ECONOMIC GROWTH¹

Cristiano Antonelli*
and
Morris Teubal**

This paper explores the new market-mediating mechanisms linking SU invention on the one hand and economic growth on the other. Two such mechanisms come to our mind under venture capitalism (of which venture capitalism is *directly* involved only in the first): 1) a *systemic* rather than haphazard link between radical inventions and the emergence of new product markets; and 2) a link between new product markets on the one hand and invention & unbundled technology markets on the other. The first highlights not only the volatility and precariousness of the R&D companies which operated prior to venture capitalism, but also, and related to this, the weak links that existed then between radical invention and the emergence of new markets. There are two aspects of 2) above: 2a) *derived demand for improvements* in the product and process technology underlying a market (and industry); and 2b) a *demand for a substitute, disruptive technology* which could replace the existing one. In both cases market size signals the ‘benefits’ to be derived from improving or substituting the underlying technology.

* Università di Torino

** The Hebrew University and ICER

¹ Cristiano Antonelli acknowledges the funding of the European Union Directorate for Research, within the context of the Integrated Project EUODITE (Regional Trajectories to the Knowledge Economy: A Dynamic Model) Contract nr° 006187 (CIT3), in progress at the Fondazione Rosselli. Morris Teubal acknowledges the funding and support of ICER (International Center for Economic Research) where he was a Fellow in the period September-October 2008 and to PRIME (NoE), Venture Fund project. The authors are grateful to Gil Avnimelech whose joint work with Morris Teubal has significantly shaped and enhanced this chapter. Preliminary versions have been presented at the workshop “The Emergence of Markets and Their Architecture”, jointly organized by CRIC (University of Manchester) and CEPN-IIDE (University Paris 13) in Paris, May 2006; the workshop “Instituting the Market Process: Innovation, Market Architectures and Market Dynamics” held at the CRIC of the University of Manchester, December 2006; and the workshop “Search Regimes and Knowledge Based Markets” organized by the CEPN Centre d’Economie de Paris Nord at the MSH Paris Nord, February, 2008. A special acknowledgement is due to L. Bakman for illuminating comments especially in relation to Section 3.

1. INTRODUCTION

1.1 Motivation

The information and communication technological revolution has led to a new set of private (venture capital) and public (epitomized by NASDAQ) capital markets for ‘technology companies’ including SUs which, by supporting such companies and enabling the anticipation of returns, have for the first time in history, promoted the creation in advanced economies of a specialized segment of ‘inventor’ companies.² These markets which emerged in the US during the 1970s specialize in knowledge-intensive assets or knowledge intensive property rights (KIPR). For this reasons they have been termed ‘surrogate knowledge markets’(Antonelli and Teubal 2008).

The new financial markets are becoming a key component of an innovation driven novel institutional setting and subsystem termed “Venture Capitalism” which is key for a new model of ‘knowledge-based’ growth potentially relevant not only for information and communication technologies (ICT) but also (with adaptations) for biotechnologies and new technologies at large.

However, the new financial markets by themselves would not be enough to allow the sustainable existence or presence of a significant segment of SU companies. For this to happen the continued process of ‘*invention*’ generated should, via *innovation and* technology diffusion throughout the economic system, lead to higher economic growth (otherwise the support of SU would not be sustainable). In line with this reasoning and with recent views on knowledge/innovation-based growth³ this paper is based on the premise that innovation based growth depends crucially on the creation of new markets and new industries and on the restructuring of existing ones i.e on knowledge/innovation-based structural change⁴. These ‘higher levels of organization’ provide a minimum level of stability and a platform for the diffusion of new technology and its improvement throughout the system.

² There are numerous advantages as far as economic impact is concerned of having an independent, specialized ‘inventor’ segment of companies (relative to having inventions being developed *and commercialized* within existing incumbent companies) e.g motivation, flexibility, learning, avoidance of diseconomies of scope and inherent interest in continuing to commercialize existing products among others.

Throughout the paper the term NASDAQ expresses not only the leading public global capital market for technology companies but the concept itself of *public* market for technology companies’. While transactions involving equity of ‘technology companies’, both SU and well established high tech companies (‘incumbent companies’), are undertaken in NASDAQ, the venture capital market involves *private* equity transactions of high tech SU only(SU are young ‘inventor’ companies whose initial and main activity is R&D. For the definitions of venture capital and of private equity (PE) see Lerner 1999 and Avnimelech and Teubal 2006).

³ See Saviotti and Pyka (2004) and other papers, Fageberg, Guerrieri and Verspagen (1999) and, for industrializing economies, Rodrik (2004).

⁴ In some of the chapters of Fageberg et al it is argued that European growth lags because of weak specialization in new ICT-driven product and services sectors. While the authors correctly point out the relevance of ‘structural policies’ to correct for this weakness their reference to venture capitalism as a set of infrastructures for ICT based growth is almost nil. In this paper ‘markets’ and ‘industries’ go together in the sense that, at this stage of our research, we are assuming a closed economy.

This paper explores the new market-mediating mechanisms linking SU invention on the one hand and economic growth on the other. Two such mechanisms come to our mind under venture capitalism (of which venture capitalism is *directly* involved only in the first): 1) a *systemic* rather than haphazard link between radical inventions and the emergence of new product markets⁵; and 2) a link between new product markets (including post emergence market growth which would include diffusion of technology to other user groups and/or markets) on the one hand and invention & unbundled technology markets on the other. The first highlights not only the volatility and precariousness of the R&D companies which operated prior to venture capitalism, but also, and related to this, the weak links that existed then between radical invention and the emergence of new markets. There are two aspects of 2) above: 2a) *derived demand for improvements* in the product and process technology underlying a market (and industry); and 2b) a *demand for a substitute, disruptive technology* which could replace the existing one. In both cases market size signals the ‘benefits’ to be derived from improving or substituting the underlying technology⁶.

The above themes will be implemented by suggesting an evolutionary theory of the emergence of new markets (based on what markets are as social institutions). Moreover our attempt to begin to unravel the above dynamic will suggest ways to assess the dynamic efficiency of venture capitalism. Thus if venture capitalism enhances the rate of new market (and industry) creation, then venture capitalism could indeed be a dynamically efficient form of modern capitalism.

Focus and Specific Objectives

In line with the works quoted above concerning the role of new industries/markets on economic growth, this chapter is based on the premise that *under venture capitalism the prime mechanism by which invention affects economic growth is through the emergence of new product markets (and industries)*. These would provide a relatively stable quantitative platform for diffusion of new technology originating both in SU and in incumbent companies (thus avoiding *chaos*). Moreover, due to the existence under venture capitalism of an independent inventor segment of companies (SUs), current structural change does not compromise future structural change based on disruptive technologies and new markets/industries (thus avoiding *stasis*).⁷

⁵ Radical *innovations* are defined as those leading to the creation of new markets/industries (they may or may not be *disruptive* of existing markets).

⁶ The former is an extension of Schmookler’s analysis which focuses at the sectoral level, on how demand (expressed by gross investment in capital goods) induces new patents on capital goods’ improvements (see Schmookler 1966) and in some cases may give rise to ‘unbundled’ technology markets; while 2b relates to the analysis of Tushman and others (See Tushman and Andersen, 1986; and Andersen and Tushman, 1990).

⁷ This view is in accordance with evolutionary theory which strives to achieve a balance between variation and selection/development (or reproduction/inheritance/retention) thereby avoiding both *stasis* and *chaos* (Nelson 1995). In this paper ‘variation’ is provided by ‘invention’ (particularly SU invention); while ‘selection/development’ is associated with the creation of new multiagent structures like new markets/industries/clusters etc (in short, MAS, or higher level organizations) and their impact. In this paper ‘markets’ and ‘industries’ go together in the sense that, at this stage of our research, we are assuming a closed economy.

The specific objectives of this chapter are:

(i) identify the *distinctive characteristics of 'markets' conceived as dynamic, social institutions underpinning structural change* and innovation based economic growth; and propose a *dynamic process of emergence of a new market*⁸;

(ii) *Identify specific dynamic sequences* (partly co-evolutionary partly not) linking SU invention to new product markets and indirectly, to new disembodied technology markets (involving both 'improvements' and 'disruptive technologies'); and

(iii) Link the above to selected contributions in the innovation, technological change and growth literature with the objective of *generating an integrative framework for innovation-based growth under venture capitalism*.⁹

(iv) *Implications of the analysis*: the dynamic efficiency of venture capitalism in different contexts (and accompanying policies); and NASDAQ as a paradigmatic new type of 'super/multi' market which enables dynamic coordination

2. BACKGROUND

2.1. Finance and innovation

The relationship between finance and innovation is crucial. Radical uncertainty and hence major knowledge and information asymmetries shape the interaction between perspective funders and perspective innovators. Different institutional solutions have been elaborated through time. Emerging venture capitalism seems to mark a third phase. The 'innovative banker' and the 'corporation' have preceded venture capitalism. Schumpeter was able to identify these two phases.

In his *Theory of economic development* Schumpeter stresses the central role of the provision of appropriate financial resources to entrepreneurs. The natural interface of the entrepreneur, as a matter of fact, is the innovative banker. The banker is innovative when he is able to spot new opportunities and select among the myriads of the business proposals that are daily submitted, those which have higher chances to get through the system. With a given quantity of financial resources the innovative banker should be able to reduce the flow of funds towards traditional activities and switch them towards the new firms. Actually the innovative banker should be able to identify the obsolete incumbents that are going to be forced to exit by the creative destruction that follows the entry of successful innovators.

The amount of competence and expertise that are necessary for a banker to fulfill such a role are clearly impressive. As Schumpeter himself realized this model, although

⁸ See the related paper Antonelli and Teubal 2008b with further develops some aspects of Markets.

⁹ More specifically we will consider Schmookler's 'demand' for improvement innovations in capital goods; Rosenberg's machine tools innovation leading to a separately identifiable machine tool industry (with references to the General Purpose Technologies' literature); Teece's and Gans/Stern's analysis of the strategy of companies undertaking invention (particularly SU); Tushman, Anderson and Christianse's notion of disruptive technologies; and Coase's work on Markets and Transaction Costs.

practiced with some success in Germany in the last decades of the XIX century suffered from a number of limitations.

As Stiglitz (1985; Stiglitz and Weiss, 1981) have shown, 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.

The access to financial markets for innovative projects is seriously limited by 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 a) that the activities that have been funded with their own money will not succeed, and b) that 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 credit market (Stiglitz and Weiss, 1981).

Schumpeter not only realized the limits of the first model but clearly understood the asymmetry between debt and equity in the provision of funds for innovative undertakings. The analysis of the corporation as the institutional alternative to the 'innovative banker' has been laid down in *Capitalism socialism and democracy*. Here Schumpeter identifies the large corporation as the driving institution for the introduction of innovations. His analysis of the corporation as an innovative institutional approach to improving the relationship between finance and innovation has received less attention than other facets (King and Levine, 1993). Yet Schumpeter is very clear in stressing their role as internal markets where the resources extracted by extra-profits can better match the competences of skilled managers and the vision of potential entrepreneurs. Moreover the corporation can act as an intermediary between the credit markets and the provision of funds for new innovative undertakings. The corporation can borrow, acquire financial resources at low costs for the low risks associated with its status of large incumbent with barriers to entry, stir and select new undertakings, fund directly the new ventures and participate directly in the provision of selective equity. The intrinsic asymmetry between the provision of credit and equity to new ventures is solved by means of the internal financial markets that favour the matching between resources, technological knowledge and market competence. Schumpeter praises the large corporation as the institutional device that makes it possible to increase both the incentives and the efficiency of the innovation process. The internal markets of the Schumpeterian corporation substitute external

financial markets in the key role of the effective provision and correct allocation of funds combining financial resources and entrepreneurial vision within competent hierarchies.

The corporation has been able for a long part of the XX century to fulfil the pivotal role of intermediary between finance and innovation. Yet the discontinuities brought about by the ICT revolution have progressively undermined its efficiency. The span of competence of incumbents was unable to match the new radical technologies: a case of lock-in-competence could be observed. Venture capitalism seems more and more likely to emerge as the third major institutional set-up able to manage the complex interplay between finance and innovation when radical changes take place.

2.2 The Emergence of Nasdaq and Venture Capitalism¹⁰

The core of Venture Capitalism is the triplet *SU segment, Venture Capital and NASDAQ* where the latter represents ‘global (public) capital markets for technology companies’. Venture Capitalism as a system arose during the 1960s and 1970s in the US in response to the early phases of the ICT revolution (integrated circuits, minicomputers and microprocessors) which enhanced the relative advantage of specialized inventor companies (SU) viz a viz incumbents. Most inventive activity prior to venture capitalism took place in house within incumbent companies which also were involved in production and/or marketing of goods¹¹. With a background of a continued process of creation of new technological opportunities the central process can be visualized as comprising four phases:

- I) *Bundling in the VC investment market and facilitating KIPR’ asset creation (in SU)*
- II) *Trading KIPR in VC markets*
- III) *Creation/Emergence of Nasdaq as a Public Capital Market focused on IPOs*
- IV) *Transformation/Expansion of Nasdaq into a Public Capital Market for KIPR*

A dynamic, phase analysis leading to emergence of a VC market/industry in Israel can be found in Avnimelech and Teubal 2006 (for a dynamic comparison with VC in the US see Avnimelech et al 2005). We therefore focus below on the emergence of NASDAQ.

Phase I: Bundling in the VC investment market and facilitating KIPRs’ creation (in SU’s)

As mentioned, since the early days of VC the financial product offered was *equity finance* as distinct from *loans* that were the prevailing product offered by existing financial institutions (Banks). Equity finance was offered to SU bundled together with *added value* which included business services +management advice, management services, certification and networking functions as well. This was exchanged for SU

¹⁰ See Antonelli and Teubal 2008a

¹¹ By and large under the prior ‘mass production paradigm’ the producers of new technology i.e incumbent companies undertaking R&D were also the users, there being only a small segment of what then were termed ‘R&D companies’ or ‘contract R&D organizations’. These facts coincide with the view of economists during the 1960s and 1970s which, while acknowledging the existence of some knowledge/technology transactions, assumed that markets for technology were either imperfect or non-existent (see Arrow 1962). For technological revolutions and new techno-economic paradigms (including the mass production paradigm), see Perez chapter 2 (Perez 2003).

shares and other rights concerning the management of the company. The bundling aspect is, for a (new) VC market, an additional dimension of what has been termed the *dominant (product) design* which lies at the origin of what will become a new market.¹² In this early phase of the VC market, venture capital stimulates and co-evolves with the organizations specializing in creating KIPR-high tech start up companies (SU).

Phase II: Trading KIPR's in Private VC Exit Markets

The company shares received were transformed through the passage of time into *bundles of Knowledge, Managerial Competence, Innovation Capabilities, etc* (KIPR) particularly so when the original VC investment took place at the seed or early phase of SU operations where R&D is the main activity (in practice this is defined as the period between SU foundation and early, non-routine sales say during the first 5-6 years of operation).¹³ This was the result of the financial and other added value received by SUs which, together with the experience accumulated, underpinned the inventive activity of such companies.

Since NASDAQ as a fully public market did not yet exist (till approximately the mid 1970s), VC exits took place principally through the sale of SU (or M & A) or so-called trade sales that is sales of A VC shares in a SU to individuals or organizations. These are *private transactions* an increase in the volume of which might eventually have triggered a *private VC exit market*. During the first half of the 1970s we also observe Over The Counter (OTC) initial offerings of shares of SU's undertaken under the aegis of the recently formed new institution-NASDAQ. At the time these were yet another form of *private VC exits* through sales to specific individuals or organizations rather than to the public at large.

Phase III: Creation/Emergence of NASDAQ (Public Capital Market for IPOs)

Eventually NASDAQ became a new market for selling KIPR to the *public at large* rather than only to private individuals or organizations. Our hypothesis is that *initially* NASDAQ was an Initial Public Offering market both for VC-backed SU (a new *public exit option* for VC's) and for non-VC backed SU.

Phase IV: Expansion/Transformation of NASDAQ into a Public Market for KIPR

Emergence of Nasdaq with its focus on IPOs gave an enormous boost to both VCs and SUs and the number of IPOs increases dramatically (see comments at the end of this section). This in turn enabled exploitation of significant economies of scale and

¹² There is a third *precursor* dimension to the emergence of a new VC market—a *new intermediation form* which could be defined as the mutual adaptation of the supply agent (i.e. the new financial intermediary) and the demand agent of the new market, and of both with the underlying institutional structure. In the US during the 1960's and 1970's this involved limited partnerships as the dominant VC organizational structure and a SU organizational form and strategy which allowed for dilution of founder equity positions and a capital (jointly with the prevailing product) market orientation. It also involved liberalization of the constraints on Pension Fund investment in VC funds (Gompers and Lerner 1999)

¹³ To be precise: with the exception of the so-called seed or pre-seed investments the equity transacted during the first VC transaction with a particular SU already embodies an initial bundle of Knowledge, Managerial Competence and Innovation Capabilities. The additional inventive activity which VC investments permit should therefore be visualized as an *accretion* rather than creation of these (bundled) assets.

scope and a momentum for further expansion (dynamic economies or cumulative processes with positive feedback). NASDAQ thereby eventually became the market for KIPR transactions in general. Beyond Initial Public Offerings which involved SU directly, we find various classes of KIPR's transactions involving other agents without SUs participating (i.e. between existing holders of KIPR's and other participants). These include transactions involving specialized investors or demanders/suppliers of KIPR only, transactions involving the public at large as both demanders and suppliers; and other transactions involving both the public on the one hand and specialized agents (e.g. financial investors and specialized demanders/suppliers of KIPR) on the other. Nasdaq in effect became a *Supermarket* for products generating income streams for the general public (see sections 5 & 6).¹⁴

2.3 Innovation strategies of SU companies and SU-incumbent company links

The transition from SU invention to emergence of a new product market may take many forms, depending on numerous factors including SU strategy and its success in accessing the required complementary assets to transform the invention/new technology into an *innovation* (Teece 1986) and in some cases into a new industry/market. In some industries, SU's became the driver of a creation of a new market; in others incumbent companies in existing markets accessed the new technology and became the dynamic factor leading to the new market/industry.

Gans and Stern (2003) have undertaken a systematic theoretical analysis of the strategies of SUs with radical inventions. They follow and extend the analysis of Teece 1986 by considering a number of additional strategic options opened up by Venture Capitalism (only marginally considered by Teece) particularly concerning SU 'cooperation' with incumbent companies in the relevant market. 'Cooperation' in their analysis is an 'aggregate category' essentially linked to *licensing* knowledge/technology (in their terminology, *the market for ideas*) and to related SU-incumbent mergers, strategic partnerships or incumbent acquisition of the SU. The licensing and strategic partnership option played a relatively minor role in Teece since his emphasis lies in profiting from innovation through accessing complementary assets either through vertical integration or through market contracts with external suppliers of inputs e.g. marketing services or 'standard production' services. Teece's emphasis on 'product market' transactions as the main means to profit from innovation reflects the relative underdevelopment of the institutions of venture capitalism at the time¹⁵. Gans and Stern's new 'capital and knowledge transaction

¹⁴ The expansion/transformation of NASDAQ (Phase 4 above) is a post emergence cumulative process with positive feedback involving a number of processes which make the market more and more attractive to increasingly larger sets of agents (both demand side and supply side). The reasons are similar to some extent to those invoked to explain the dynamics of venture capital or cluster emergence. The new sets of agents that participate in the new market include specialized agents providing services to investors or companies e.g. investment banks, brokers, consultants, etc; specialized new intermediaries e.g. VC/PE funds, financial investors, etc. The enhanced volume that their entry induces further reduces transactions costs which further increase the thickness and frequency of transactions. This also reduces uncertainty to individual investors as well as market volatility, etc

¹⁵ While his article appeared in 1986 most of the set of illustrative inventions belonged to the 1970s e.g. the famous CAT scanner invented by EMI. It should be mentioned here that in Teece's analysis and in contrast to Gans and Stern, inventors included not only SU but also

options for profiting from innovation reflect a deepening of the ICT revolution including the emergence of the Internet and the World Wide Web, and the fact that venture capitalism was an established institution/subsystem by the late 1980s and 1990s.¹⁶

Gans and Stern framework for analyzing SU strategies is based on two variables: a) the strength of the IP regime which they term '*excludability*' of the incumbent from the technology of the start up¹⁷ and b) the '*value of incumbent complementary assets*'¹⁸. In some industries like in Drug Development and Printing, incumbents have successfully acquired the new technologies developed by SU inventors. In others e.g. books retail selling and in some software areas, SU have adopted a head on competition strategy viz a viz incumbents and have profited from it (in some cases, like Amazon, eventually becoming the dominant incumbents themselves). The above analysis gives further weight to our presumption that venture capitalism is a sufficiently flexible form of capitalism to allow for specialized inventors of radical inventions to benefit from their inventions. It is however only a first step in the direction of fully showing the implications of venture capitalism for (*new*) *market-mediated* knowledge or innovation based economic growth.

While the above literature has, through the analysis of SU –Incumbent interactions, considered at least aspects of the processes by which inventions are commercialized, there is very little analysis of the subsequent inducements to the creation of new markets and industries. Inventors might make a profit from their invention (and since the 1990s probably more through capital and knowledge transactions than through product market transactions) but this does not assure that the higher rate of growth of SU and SU inventions has led to a higher rate of growth of new markets/industries. This is a major task, a first attempt at which will be done in this chapter.¹⁹

incumbent companies (this reflects at most an intermediate stage in the evolution towards full fledged venture capitalism).

¹⁶ This fact also explains why in their analysis of inventor strategies Gans and Stern only consider SU and SU inventions.

¹⁷ High levels of excludability would correspond to Teece's Strong IP regime and absence of excludability to his Weak IP regime.

¹⁸ A 'low value' could correspond to Teece's generic complementary assets case, while 'high value' could correspond to the specialized complementary asset case with the addition that incumbents hold an important share of these. While the complementary assets variable of Teece and Gans & Stern differ to some extent in both cases their categorization refers to the extent by which these assets represent a 'problem' to inventor companies.

¹⁹ It should be pointed out that neither Teece nor Gans and Stern considered the 'higher level' system implications of 'profiting' or not profiting from invention/innovation. Thus it may be the case that the mechanism for transforming a radical invention/innovation into a new industry/market is or is not a profitable proposition for inventor firms, so the dynamic efficiency implications may well depend on SU-incumbent interactions and on the institutional underpinnings of this process. Alternatively it may be stated that while Arrow pointed out the contradiction between the requirements for 'diffusion' and those of 'invention'(Arrow 1962) *we are interested in the potential incompatibility between profiting from invention and the building of new markets* (the latter being the main source of 'social profitability').

2.4 Schmookler's Demand for Improvement Inventions

The analysis of Schmookler (1966) on the role of demand in pushing innovation can be applied to our concerns. Schmookler found strong empirical evidence of a link between capital good market size (as indicated by gross investment) on the one hand and capital good improvement inventions (as indicated by patents on capital goods, with a lag) on the other (Schmookler 1966). Moreover when it comes to explain the distribution of patents on capital goods improvement inventions across industries, 'demand' overrides any differences in the 'supply' side of inventions. His analysis suggests that the emergence of new product markets in general and not only capital goods' markets will, through a 'demand' effect, *induce improvement inventions* in the underlying product and process technology.²⁰ What Schmookler does not consider is that the size of new product markets, by signaling the 'need' for the underlying 'technology' and therefore of improvements to such a technology, is also indicative of the opportunity for introducing alternative, substitute technologies (section 3)²¹. Thus once a new product market emerges (e.g. as a result of venture capitalism) and begins to grow a point may be reached when the private 'benefit' from developing a disruptive technology may become such to induce 'technology suppliers' like SU companies to undertake disruptive technology development. In contrast to Schmookler's assumptions, it is not possible here to avoid considering substantial supply side differences across industries and technologies (these have also been considered in Rosenberg's critique of Schmookler) so the link between market size and disruptive innovations is probably less clear and much more influenced by supply side considerations than what it appears in Schmookler's analysis of 'improvement innovations'. Also, under venture capitalism and due to the advantages it gives to specialized inventors (incidentally, this is the language used by Schmookler), frequently the source of supply of the new disruptive technology may be high tech SU companies. The result may be one or more technology transactions.

2.5 'Market' and Market Building

An effort to understand the institutional characteristics of markets in a general context seems necessary in order to grasp properly all the implications of the creation of the new financial markets associated with venture capitalism. Markets are social institutions that perform a variety of functions and exhibit different forms, organizations and characteristics. Moreover markets are a dynamical construct. Hence markets are being created, emerge, occasionally their performances and functions improve and possibly decline. In other words, markets evolve.

What is missing in the literature is a Theory of Markets as Social Institutions which includes markets' role not only in the allocation of resources but also in promoting 'knowledge-based growth'. This theory should also make a distinction between simple

²⁰ Schmookler's analysis is based on patents on capital goods in the United States during the late 1930s and early 1940s and on building a concordance between patent classes and industries. It suggests that venture capitalism's force in creating new product markets will also lead to new transactions on technology *improvements*, and given other conditions, to new *unbundled* markets for technology.

²¹ I.e. technological discontinuities which could be either competence enhancing or competence destroying (Tushman and Anderson 1986). These radical changes can also reinforce/change or be disruptive of existing markets.

markets and multilayer super-markets such as NASDAQ which enable participants to relate to a number of markets simultaneously thereby better coordinating their needs to the capabilities offered. A related gap in the literature is an evolutionary theory of Market Building or market creation (the notion of Emergence might be crucial here)

The above issues are also applicable to knowledge markets and there are some additional specificities which should be tackled. Thus there seems not to be a distinction between an unbundled and a bundled knowledge market; and no analysis of the links between the two. Moreover there has been little discussion of the dynamics of the links between radical invention on the one hand and the creation of new knowledge markets and of the link between new product markets and new technology markets. This also has shaped our work and its specific objectives

3. A DYNAMIC PERSPECTIVE TO MARKETS AND MARKET BUILDING

3.1 The Notion of “Market”

There are two well established notions of ‘market’ in the literature: i) textbook, abstract notion where it is self-evident that markets exist so that any transaction presupposes existence of an underlying market; ii) markets as devices for reducing transactions costs and thereby facilitating exchange (Coase).

A major contribution to the discussion of markets comes from Coase whose work clarifies both (i) and (ii) above. “In mainstream economic theory the firm and the market are for the most part assumed to exist and *are not themselves the subject of investigation*” (Coase 1988, Chapt 1, p.5; our italics). By mainstream economic theory Coase means Economic Theory without transaction costs. Transactions costs are the costs of market transactions that include “search and information costs, bargaining and decision costs, and policing and enforcement costs” (Dahlman 1979, quoted by Coase) which of course, includes the costs of contracting. In Coase’s theory, transaction costs exist and can be important; and they explain the existence of the firm: “Markets are institutions that exist to facilitate exchange, that is they exist in order to reduce the cost of carrying out exchange transactions. In Economic Theory which assumes that transaction costs are non-existent markets have no function to perform”(Coase op. cit. p.7).²²

There is a third notion of ‘market’ originally proposed by A. Smith, namely *a device that promotes division of labor, learning/ innovation, and economic growth*. This is the notion we would like to further develop here. Our position is that it is not possible to uncover the distinctive characteristics and functions of such a *dynamic view* of markets exclusively by making reference to Coase’s facilitation of exchange and reduction of transactions costs. This could be one of the outcomes of a market. However if markets have to be built, then the required pre-conditions for emergence became central. This because other factors are in play e.g asymmetric information,

²² Coase (1988) discusses the elements comprising a market e.g. the medieval fairs and markets that comprise both physical facilities and legal rules governing the rights and duties of those carrying out transactions.

and a critical mass of producers and consumers (since there is an important element of collective interaction and of collective transacting); and because, rather than spontaneously making their appearance, markets *emerge* or are built.²³

A related reason for focusing on other factors beyond transactions costs when analyzing the links between markets and growth is that markets could contribute to growth through the incentives they generate to new inventions and innovations, particularly adaptations and improvement innovations leading to diffusion of generic new technologies to an increasingly larger set of uses, sectors and product classes²⁴. While this diffusion process is linked to lower transactions costs there are other important contributory factors such as learning and capabilities' accumulation (Rosenberg 1961). Moreover, effective diffusion and economic impact of generic technologies may depend on the creation of other markets and industries whose creation, as we have seen, depend also on other factors beyond transactions costs.

The upshot is that new markets are required for knowledge-based growth; and analysis of their emergence or building should be centre piece in any theory of economic development nowadays. From this viewpoint the emergence of a perfect market can be considered the result of an articulated institutional process that deserves to be analyzed carefully.

²³ Our agenda is therefore not only to define and explain the role of markets but also to identify the processes of emergence of new markets. This will include analyzing the conditions under which a set of 'precursor' transactions *will not* lead to the emergence of a new market (in terms of Industry Life Cycle Theory this could be termed 'left hand trunkation'). Moreover, explaining emergence will require making reference to other variables e.g. scale economies in building the market place (Antonelli and Teubal, op. cit).

²⁴ Innovations may affect the value chain and increase the degree of 'roundaboutness' in the economy. For an analysis on these lines see Rosenberg's study of the machine tool industry in the US in the 19th Century which resulted from processes of vertical disintegration and technological convergence. It is clear from his analysis that the economic impact of the new set of machine tool innovations depended on the creation of an industry and, by implication, a market (Rosenberg 1976).

3.2 Defining Characteristics and Functions of Markets

Box 1 lists the defining characteristics of markets following the above mentioned dynamic perspective; and Box 2 shows these relate to *market functions*²⁵

Box 1: Defining Characteristics of Markets*

<p>A well defined <i>Product/Service Category</i> A <i>Dominant Design and Product Standards</i> A <i>Market Place</i> ('space', organization or information highway) A <i>Critical Mass of Supply and Demand Agents</i> A <i>Critical Mass of Transactions Volume</i> A <i>Measure of Stability of Supply and Demand</i></p> <p><i>Agent interaction</i> A measure of <i>reputation</i> <i>Transparency of Transactions</i></p> <p><i>Saves Transactions Costs</i> compared to an equivalent but disconnected set of transactions <i>Institutions and Rules</i> underpinnings e.g. in relation to: Product Quality and Standardization, Certification of Agents, Transactions' Transparency, etc. <i>Emergence involves a momentum leading to further growth</i> product category diffusion</p> <p>Other Characteristics Thickness, Frequency and Recurrence of Transactions Density of Agents Formal Institutions</p>
--

²⁵ see Antonelli and Teubal 2008b for further details. The need for a *Critical Mass* of Supply and Demand Agents (also of *reputation*) and of Transactions Volume derives from the need to assure some of the *basic functions* of markets (see Box 2 below): stability/reliability in supply and static efficiency. This point emphasizes the fact that a market does not exist with the first transaction in the corresponding area; rather it builds upon a substratum of prior transactions once a stable threshold volume is achieved.

BOX 2: FUNCTIONS OF A MARKET

<u>BASIC FUNCTION</u>	<u>LINKS TO DEFINING CHARACTERISTICS (and to SPECIFIC FUNCTIONS)</u>
<i>Stability of Supply</i>	<i>Critical Mass of Agents and Transactions Volume</i>
<i>Agent Coordination</i>	<i>Agent Interactions, Transactions transparency</i>
<i>Promoting Static Efficiency</i>	<i>Save transaction costs, incentives to producers, selection, coordination, management of risks</i>
<i>Promoting Dynamic Efficiency</i>	<i>Specific Functions Signaling²⁶, inducing Division of Labor & Learning/Specialization, integration mechanisms, converting uncertainty into risk, drivers of improvement and disruptive technology/invention, and institutions reducing path dependence (market demise/substitution by another market)</i>

3.3 Market Building

A new market may emerge when a set of previously isolated precursor transactions sparks an emergence process. For this to happen a number of conditions may be required (see below) and these may depend on area and specific context. Frequently these will include pre-emergence processes of interaction and information flow among agents together with experimentation and learning concerning product characteristics and user/producer organization and strategy. In some cases like venture capital in the US and in Israel these led to a new, effective intermediation form a qualitative dimension that largely precedes the actual emergence process. Emergence may also require a critical mass of precursor transactions both to underpin the above mentioned interaction, learning and experimental process and to enhance the expected “benefits” derived from creating a new market.²⁷ Moreover, when a new market *place* is also required, the successful emergence of a new market may depend critically on the appearance of an ‘entrepreneur’ or a consortium of agents in charge of undertaking the required planning, coordination and investments. The analysis that follows largely ignores this issue.²⁸

The evolutionary process leading to the emergence of a new market is taken from an *extended* Industry Life Cycle perspective as applied to the VC industry and market in Israel (see Avnimelech and Teubal 2006). A central point is that the transition from a *pre-emergence* phase to *emergence* need not occur²⁹. Another feature is that new industry or new market emergence could be a autocatalytic, cumulative process with

²⁶ By signaling strength of the underlying need a large market may provide a stronger inducement to discontinuous technical change or radical inventions compared to a small market e.g a shift from discrete to continuous process technology in the cement, glass and steel industries (see Tushman and Andersen 1986).

²⁷ The benefits include savings in transactions costs that should cover the fixed costs of creating and the variable costs of operating a new market (see above).

²⁸ Not every case of new market creation requires a new ‘market place’ or at least a new market place requiring significant new investments. The new market can piggy back on existing infrastructures and market places.

²⁹ This phenomenon has been termed *left hand trunkation* of the life cycle (Avnimelech and Teubal 2006).

positive feedback or alternatively, a process characterized by dynamic economies of scale. This process involves creation and utilization of externalities a fact which would explain the acceleration of growth observed in a number of industries and markets which eventually emerged³⁰. The cumulative process does not end with creation of the new industry; rather it continues afterwards at least for a time (provided that external conditions do not deteriorate)³¹. The new (more complex) structure- created by the interaction among elementary components (firms and users) will, once emerged, positively further stimulate such components. This phenomenon provides us with an additional, and much less recognized characteristic of ‘an industry’: once created it will stimulate the creation of new firms³².

Box 3 summarizes the phases of emergence of a new market according to our perspective.

BOX 3: PHASES IN MARKET BUILDING*

1:BackgroundCond. Variation	Phase 2: Pre-Emergence Conditions - Selection	3: Emergence-Development
<i>Appearance of a ‘precursor’ set of transactions; & of a critical mass of such transactions (m1)</i>	<p>I. <i>Focused Business Experiments leads to the identification and adoption/selection of</i></p> <p>(i) <i>Product Class, Dominant Design and Product Bundling</i></p> <p>(ii) <i>supply/demand agent types, and</i></p> <p>(iii) <i>regulatory environment/institutions</i></p> <p>II. <i>Appearance of a critical mass of transactions (m2) with the above characteristics</i></p> <p>III. <i>In some cases, new mechanisms of interaction</i></p>	<p><i>m2 (and possibly policy) sparks a self-sustained cumulative process of growth;</i></p> <p><i>This leads to a new Market with emergent properties</i></p>

* The fourth ‘Post Emergence Market Growth’ phase is not included in the Box (see last paragraph of this section; and 2.2 and footnote 36 for the NASDAQ case).

The above is part of a Market Life Cycle perspective that parallels the extended Industry Life Cycle Perspective with Background and Pre-emergence phases (Phases 1 and 2 respectively). m1 in Box 3 is a critical mass of precursor (Phase 1) transactions required to trigger e.g. *through variation*, a more systematic and focused search and experimentation process leading to *selection* in Phase 2 of a product class and dominant design/product standard with high value to users/demand agents (Abernathy and Utterback 1978). Appropriate product/services’ *bundling* and, depending on case, selection of a *new intermediation form* i.e the mutual adaptation of the organization and strategy of supply and demand agents (and of both to the institutional environment) may be critical (see Petit & Quere 2008 and Avnimelech and Teubal 2008b). Thus in the history of emergence of a Venture Capital market and

³⁰ There are several countries where the venture capital industry/market, when defined appropriately as oriented to early phase investments in high tech SU, did not emerge despite existence of a certain amount of activity and explicit Government policies directed to this end.

³¹ In the case of a market the causes of this post-emergence momentum include lower transactions costs, incentives to invention/innovation, and other factors.

³² Students of high tech clusters such as Saxenian (1994) and Fornahl and Menzel (2004) have intuitively recognized the relevance of such dynamics, but not quite elaborated it.

industry in the US (Gompers and Lerner 1999, 2001, 2004), the supply agents (VC organizations) eventually adopted a Limited Partnership form of organization, while the demand agents (high tech start up companies) had to accept dilution of ownership and other changes. Meanwhile there were significant adaptations of the institutional environment e.g. modifications of the ERISA (Employment Retirement Income Security Act) including the 1979 amendment to the “prudent man” rule governing pension fund investments in the US (Gompers and Lerner, 2004, pp. 8,9).

Sparking or triggering emergence frequently requires a critical mass of transactions involving the selected product class, dominant design and intermediation form (m2). As mentioned these should provide a new value proposition to users. Moreover, whenever a new market *place* involving coordination and heavy investments are required, the existence of such a level of demand may be critical for the appearance of a ‘new market entrepreneur or consortium’ in charge of planning and building such a market place.³³

Left Hand Truncation

The above framework suggests that failed market emergence could be the result of two general causes. One is failed selection processes in phase 2 resulting from too little search/experimentation and/or inappropriate selection mechanisms e.g due to institutional rigidity. The other is failure to spark or sustain an evolutionary cumulative emergence process (e.g. due to system failures which policy has not addressed). Not all radical inventions, even those leading to innovations and having potential, will automatically lead to new product markets.

A related issue is the post emergence growth of new markets, with NASDAQ’s phase 4 being the major and probably paradigmatic example of a multi or supermarket (see, section 2.4 and footnote 37 in the concluding section). This will be termed *Post Emergence Market Growth*. In previous work and in relation to new industries it was pointed out that the momentum leading to emergence also continues beyond this state (Avnimelech and Teubal 2006). Here and in relation to markets we would like to emphasize the following sources of such expansion: (i) the *market place* that serves the initial product market may, through economies of scope and scale, carry new, related categories of products (Antonelli and Teubal op. cit); (ii) *diffusion* of the *underlying product technology* to new applications (see the analysis of the machine tool sector and market by Rosenberg, 1962) and in General Purpose Technologies more generally speaking); and, related to the previous point, (iii) *Diversification and Niche Development by the leading firms* who developed and co-evolved with the new market (this, which is frequent in many new ICT areas e.g the cases of Nokia and Google, could include both new applications and developing specialized products and solutions for different market segments). The last two point to a link between new product markets and new (including ‘unbundled’) technology markets.

³³ The issue of demand is critical. For example, given that frequently medieval fairs were the result of entrepreneurial activity (Coase op. cit) their establishment would have relied on the prior existence of sufficient demand which might have been dispersed geographically. Also, Israel’s VC market/industry emergence depended on the prior existence of a critical mass of SU which represented ‘demand’ for the future VC industry (A&T op. cit.).

4. NEW MARKETS MEDIATED INNOVATION BASED GROWTH

The new financial markets of venture capitalism supported the fledging specialized inventor SU segment. SU are a new institution with, in many areas, potentially strong advantages over incumbent companies as far as invention and beginning of commercial exploitation of the new ICT technologies are concerned. These and their impact on Economic Growth through new market building are summarized below in terms of a number of interlinked relationships (Modules A, B and C).³⁴ Module A links venture capitalism (and the ICT revolution) to an acceleration of radical inventions; Module B links these inventions and related improvements and innovations to the accelerated emergence of new product markets; and Module C focuses on the reverse process, namely, how new product markets stimulate new invention (both radical and incremental) and possible the emergence of unbundled *technology markets*. We can already see that under this perspective, a *push* of radical invention (Module A) will lead to a new market mediated subsequent *pull* i.e dynamic economies of scale in invention at the overall system level.

Module A

(2'') *Venture Capital*
(1) *ICT Revolution* - < (2) *SU segment* - → < - (3) *Accel. Radical Invention*
(2') *NASDAQ*

The above summarizes what we have said in sections 1 and 2 (and in the literature). The links among the three elements of venture capitalism (2) above) are to some extent co- evolutionary. We should also be aware (not shown in the above sequence) that accelerated invention not only 'inputs' Modules B & C but feeds back into (1) the new set of ICT opportunities.

The central issue is: what are the implications of accelerated invention for the *rate and direction of Market Building processes* (element 5 in Module B).³⁵ Radical inventions plus improvements may, through *innovation* and *diffusion*, stimulate the creation of new product markets (Module B) as well as Module C's post emergence market growth (and indirectly, creation of unbundled markets for 'technology/invention', see 8). There are both direct and indirect effects because the link between inventions/innovations and creation of new markets is a two-way,

³⁴ For simplicity we will be assuming in what follows that the Science and Higher Education infrastructure is not a constraining factor.

³⁵ A positive radical invention/innovation-new market link seems to be implied by Teece's analysis. This because his core analysis of the conditions for a positive and significant private profitability of invention is only of interest for those cases where *social profitability* has been high (in our conceptual framework, this implies the creation of new markets/industries, see Section 1 above). This interpretation is consistent with the fact that the sample of inventions considered in his 1986 paper are (or mostly are) 'radical'. We conclude that Teece's conclusion that 'inventors' were frequently non-profitable is applicable only to those inventions which generated new markets/industries. Moreover, while our analysis of Venture Capitalism re-inforces Teece's radical invention-> new market link it also enhances the possibilities that the above mentioned socially beneficial activity of inventors be privately profitable.

possibly co-evolutionary, relationship with the mix between Radical and Improvement Inventions (and Innovations) being a critical dimension. Thus as indicated in Module C the opposite is also true, namely that existing product markets can induce new invention, both improvements in the technology underpinning existing markets (the extension of Schmookler mentioned in 2.4) and radical, disruptive inventions (see 9 in Module C) that reinforce the ICT Revolution's *push*. Needless to say and following the enormous literature on these matters (e.g. Gans and Stern op. cit) SU-Incumbent interactions are critical to analyze the pattern of emergence both of new product and of unbundled technology markets (see 2.3 above).

Module B

- (3) Enhanced Radical Inventions/Impro. + (4) SU \leftrightarrow Incumbent links \rightarrow
(5) Enhanced rate of Emergence of New Product Markets

Module C

- (6) Post Emergence Market Growth + (7) [Growth of New Incumbents & links with SU]->
(8) Improvements Inventions + some New Unbundled Technology Market
+(9) New Radical Inventions

As with Module A the above processes are non-linear; rather they involve numerous feedback loops and co-evolutionary processes e.g. between invention/improvement and product markets; and between both and knowledge markets. As mentioned above, invention spurs emergence of new product markets; and new *product* markets and their size will induce both (8) improvement inventions (and potential emergence of *unbundled Knowledge/Technology markets* for improvement innovations) and (9) *New Radical Inventions* (see section 3 above)³⁶. Moreover, these Module C effects feedback into Module A thus initiating a new invention->market emergence>invention cycle.

SU-incumbent links are crucial both for new market emergence (Module B) and for the subsequent link between post emergence market growth and subsequent invention, technology transactions and emergence of unbundled technology markets. Thus an important pattern underlying Module B's acceleration of new market emergence is the transformation, either through 'cooperation' with incumbents or through a strategy of 'head on competition', of SU invention first into 'innovation' (Gans and Stern op. cit section 2.2 above); and then and in a subset of cases, into the building of new markets. In contrast, in Module C SU-incumbent links are intertwined both with the growth of leading incumbents (which co-evolve with the new markets and their

³⁶ In fact a licensing market for a radical new technology may also emerge with time. This possibility has not yet been incorporated into Module B as presented above. New radical inventions are assumed to feed back into new product market emergence and through these to new unbundled markets for improvements. Alternatively we may say that at this point we assume that while there may be 'technology transactions' around radical inventions, the emergence of 'technology markets' should be based on (subsequent) 'improvement' inventions.

subsequent expansion, see 5 and 6) and with subsequent invention particularly of the improvement type (see 8). These links are related to incumbents' attempts at growing after emergence and during 'maturity' of their main market. Since their possibility of exploring all options is limited, by necessity they develop new links with SU as part of stimulating an appropriate *eco-system* for post emergence growth. Major differences seem to exist between the SU-incumbent links of Module A (especially in the 'early' rounds of the A-><-C cycle) and those of Module C (especially beyond the early rounds of the cycle). This happens because in the former the influence of new markets and associated 'mature' incumbents is not strong enough relative to the latter case. The strong and varied SU-incumbent links of Module C are connected both to the process of diffusion of the new technology underpinning incumbents' main market and to the process of searching for new value for existing users. In these processes, incumbent companies tend to 'cooperate' (through an extended network) with new SU³⁷.

5. CONCLUSIONS AND IMPLICATIONS OF THE ANALYSIS

In previous work we (and others) have analyzed the *nature* of venture capitalism understood as the subsystem comprising a segment of independent inventor companies (SU) *and* a new private and a new public financial market supporting it by trading in what has been termed Knowledge Intensive Property Rights (KIPR, Antonelli and Teubal 2008a). KIPR bundle knowledge/technology with other assets e.g innovation capability, knowledge competence etc. The new financial markets, by virtue of trading in KIPS and therefore constituting *surrogate knowledge markets* (together with the fact that SU create and offer KIPS), have helped to overcome the two central problems with knowledge creation and business sector R&D in market economies: the incentives problem facing inventors and inventor companies (related to externalities on the one hand and to Arrow's *disclosure paradox* and the related non-existence or strong imperfection of knowledge markets on the other); and the invention/R&D finance problem (Gompers and Lerner, 1999).

The present paper extends the analysis to consider the *economic impact* of venture capitalism for what increasingly is being defined as *innovation-based economic growth*. Central to our approach is the view that economic growth requires structural change which first and foremost are new markets & industries (in this paper they go together since we are assuming a closed economy); and this defines our 'market mediated' link between invention/innovation and economic growth. The core of our analysis is three sequential and linked modules involving the same number of sets of variables. Module A represents the link (largely co-evolutionary) between the ICT revolution and associated new technological opportunities on the one hand and (i) venture capitalism (as defined above) and (ii) accelerated invention/innovation (particularly by SU) on the other. Module B links the enhanced invention/innovation generated by venture capitalism to the creation or emergence of new product markets;

³⁷ All three of Gans and Stern's aspects are present: SU licensing of invention (which may lead to 'unbundled' technology markets) acquisitions, strategic partnerships and mergers.

and Module C an almost reverse link, namely that between *post emergence market (or mature market) growth* and new invention and innovation.

A critical aspect of the process throughout is SU-incumbent company links. This is particularly so in Module C where the new incumbent companies that grew with the new markets (think of Nokia, Cisco and Google nowadays) require, in order to sustain growth despite the onset of maturity in their original product class, a strategy of building the required ecosystem both to diversify and to generate specific solutions to particular user segments. At least some of the SU-incumbent links that emerge from this process are part of Gans and Stern's cooperation strategy followed by start up innovation companies (Gans and Stern 2002): they include *SU licensing of technology to incumbents*; acquisition of the SU; strategic partnerships and mergers. It is noteworthy to mention that the new technology generated in response to large and relatively mature markets is both *improvements inventions* and *radical inventions*. The former, which relates to the licensing SU-incumbent link mentioned in the previous sentence, may lead to the emergence of *unbundled knowledge/technology* markets (as a derived demand from the new product markets and based on an extended Schmookler-type framework of analysis). The latter radical inventions, which are signalled by (large) markets (see section 3), may or may not be disruptive of existing markets. They constitute a major feedback link between what can be considered the first round of traversing Modules A→C and the second round.

The outcomes of the above dynamic relationships will be further enhancement both of the SU segment and of the new, ICT related, capital markets serving them (Module A). The Module C stimulus of radical inventions and new SUs represent a 'demand pull' effect which complements the 'supply push' impact of continued new ICT related technological opportunities (which revolution is propelled by other factors both exogenous and endogenous). The *Open Architecture* of NASDAQ and dynamic scale/scope economies explain why these new SU companies and more and more related companies e.g. providing additional services, will be active in and increasingly be listed in NASDAQ (this process may explain both the enormous increase in SUs in many countries, and the shift from Phase 3 in the evolution of NASDAQ to Phase 4, see 2.2).³⁸

³⁸ Through this process NASDAQ evolves to become a *multi/super market* with strong dynamic efficiency implications. While a *regular market* for a specific good e.g. a food item or for shares of a specific company (or group of companies operating in a particular technological area) quoted in Nasdaq coordinates the supply and demand of that good, a multi-market *coordinates a generic need* (e.g. 'nutrition' or *income streams from KIPRs' assets*) to *Capabilities* which could be considered as the 'primitives' of standard demand and supply. While the link in such markets to a need category is clear this is less so in relation to the 'Capabilities' variable. There are two components to the latter: *creation of capabilities* (where the private VC market plays the critical role through its stimulation of SUs) and their actual *coordination with needs* (where NASDAQ plays the central role). Needs-capabilities coordination means not only coordination among agents operating in a specific 'product market' but coordination of agents operating in a large set of related markets. It follows that Venture Capitalism as a system will stimulate invention and, through multiagent and cross market coordination, will also promote innovation-based growth.

The situation prior to Venture Capitalism

We can compare the nature of the SU invention-new (product and also unbundled technology) market-economic growth links under venture capitalism with those prevailing prior to Venture Capitalism. Prior to Venture Capitalism, radical inventor SU (the so-called 'R&D companies', see Freeman 1974) faced difficulties in creating a new market. This takes place because the SU inventor frequently faced many obstacles either to access the complementary assets directly and profit from the invention (Teece 1986) or to sell the technology (see Arrow's disclosure paradox limited or non extant technology markets). *Relatively speaking, prior to venture capitalism, radical inventions by specialized inventor companies only very occasionally led to new product markets*³⁹

It is possible to summarize the *main reasons why the process of transformation of radical inventions into new product markets will become more certain, frequent and routinized under venture capitalism*: (i) increased numbers of new SU with radical inventions; (ii) a new systemic & generic mechanisms of direct or indirect transformation of such inventions into new product markets; (iii) the effect of new markets and more rapid market growth on invention including radical (both disruptive and non disruptive) inventions; (iv) the possible emergence of unbundled markets for technological improvements.

Another implication is that *venture capitalism creates a cumulative process of innovation-based economic growth* (for a time, even without continuation of an exogenous ICT Revolution). This involves a strong feedback process between Module C and Module A i.e the beginning of a new A→C cycle. As mentioned, the key link here is that between post emergence market growth and subsequent *radical inventions*-the *signaling role of markets* (Section 3). The fact that many of these and subsequent improvement inventions are SU based i.e independent companies, means that there also exists a mechanism to *unlock* the existing system from the strong path dependence which the combination of growing mature market and large and powerful incumbents may generate.

The combination of continued generation of new opportunities and the mechanism for 'unlocking' the system from potential, strong path dependence, assures that venture

³⁹ Alternatively it could be said that Venture Capitalism creates an alternative, *indirect and roundabout* route for radical inventions of R&D companies to stimulate the emergence of new product markets. This route is *mediated* by the new capital markets (private-VC; public-NASDAQ) associated with venture capitalism i.e a *systemic effect*. First, with the help of Venture Capital, a SU inventor may transform the invention (e.g. a new product or new process prototype) into an innovation i.e. first sale of new product or utilization of new process at commercial scale (Mansfield 1968). This may facilitate accessing NASDAQ i.e. undergoing an IPO. This in turn could be a step in the creation of a new product market e.g. through the expansion of the SU and its successful 'accessing' of complementary assets; and through the entry of other agents into the same area through imitation or licencing of the technology.

capitalism could become a feature of *sustainable innovation-based growth economic systems* (or of one possible variant of such systems)

5. BIBLIOGRAPHY

Abernathy, W.J., Utterback, J.M. (1978), Patterns of industrial innovation, *Technology Review*, June-July, pp. 40-47.

Anderson, P., Tushman, M.L. (1990) Technological discontinuities and dominant designs: A cyclical model of technological change, *Administrative Science Quarterly* 35, 604-633.

Antonelli, C. (2005), Models of knowledge and systems of governance, *Journal of Institutional Economics* 1, 51-73, 2005

Antonelli, C. (2006), The governance of localized knowledge: an information economics approach for the economics of knowledge, *Industry and Innovation* 13, 227-261.

Antonelli, C., Teubal, M. (2008a), Venture Capitalism as a mechanism for knowledge governance: the emergence of markets for knowledge-intensive property rights, *Journal of Institutional Economics*, forthcoming

Antonelli, C., Teubal, M. (2008b), Venture Capital as a Mechanism for Knowledge Governance: New Markets and Innovation-Based Economic Growth, *typescript*, paper presented at the Conference "Search Regimes and Knowledge-Based Markets", CEPN and DIME, Paris, February.

Arrow, K. (1962), Economic welfare and the allocation of resources to invention, in Nelson (ed.), *The rate and direction of inventive activity*, University of Chicago Press for the National Bureau of Economic Research, Chicago.

Avimelech, G. and Teubal, M. (2004), Venture capital start-up co-evolution and the emergence and development of Israel's new high tech cluster, *Economics of Innovation and New Technology* 13, 33-60.

Avimelech, G., M. Teubal (2006), Creating venture capital industries that co-evolve with high tech: Insights from an extended industry life cycle perspective of the Israeli experience, *Research Policy* 35, 1477-1498

Avimelech, G., Teubal, M. (2008a), From direct support of business sector R&D/Innovation to targeting of venture capital/private equity: A catching up innovation and technology policy cycle perspective, *Economics of Innovation and New Technology*, 17/1, forthcoming

Avimelech, G., Teubal, M. 2008b, Evolutionary Targeting, *Journal of Evolutionary Economics*, special issue

Avimelech, G., Kenney, M., Teubal, M. (2005), A life cycle model for the creation of venture capital industries: Comparing the US and Israeli experiences", in Giuliani,

E., R. Rabellotti, and M. P. van Dijk (eds.) *Clusters facing competition: The importance of external linkages*, Ashgate, London.

Coase, R. (1988), *The firm, the market and the law*, The University of Chicago Press, Chicago.

Dahlman, C.J. (1979), The problem of externality, *Journal of Law and Economics* 22, 141-162.

Fageberg, J., Guerrieri, P., Verspagen, B. (1999), *The economic challenge of Europe: Adapting to innovation based growth*, Edward Elgar, Cheltenham, UK and Northampton, MA, USA

Fornahl, D. and M.P. Menzel (2004), Co-development of firms founding and regional cluster, *Discussion Paper No. 284*, University of Hanover, Faculty of Economics.

Freeman, C. (1974), *The economics of industrial innovation*, Penguin Books, Harmondsworth.

Freeman, C., Perez, C. (1988), Structural crises of adjustment: business cycles and investment behavior, in Dosi, G. et al. (eds.) *Technical change and economic theory*, Pinter, London, pp. 38-66.

Gompers, P., Lerner, J. (1999), *The venture capital cycle*, The MIT Press, Cambridge (See also the 2nd edition, 2004).

Gompers, P. and Lerner, J. (2001), The venture capital revolution, *Journal of Economic Perspectives* 15, 145-168.

King, R.G., Levine, R. (1993), Finance and growth: Schumpeter might be right, *Quarterly Journal of Economics* 107, 717-737.

Lerner, J. (1995), Venture capitalists and the oversight of private firms, *Journal of Finance* 50, 301-318.

Lerner, J. (1999), *Venture capital, private equity: A case book*, Harvard Business School and National Bureau of Economic Research, John Wiley and Sons Inc. New York.

March, J.C. (1991), Exploration and exploitation in organizing learning, *Organization Science* 2, 71-87.

Nelson, R.R. (1959), The simple economics of basic scientific research, *Journal of Political Economy* 67, 297-306.

Nelson, R. (1994), The co-evolution of technology, industrial structure and supporting institutions, *Industrial and Corporate Change* 3, 47-63.

Nelson, R.R. (1995), Recent evolutionary theorizing about economic change, *Journal of Economic Literature* 23, 48-90.

- Odell, J. (1998), Agents and emergence, *Distributed Computing*, October, pp. 1-4
- Perez, C. (2003) *Technological revolutions and financial capital: The dynamics of bubbles and golden ages*, Edgar Elgar, Cheltenham, UK.
- Porter, M. (1998), *On competition*, Harvard Business School Press, Boston.
- Quèrè, M. (2004), National systems of innovation and national systems of governance: A missing link? *Economics of Innovation and New Technology* 13, 77-90.
- Rosenberg, N. (1963), Technological change in the machine tool industry, 1840-1910, *Journal of Economic History* 23, 414-443.
- Rosenberg, N. (1976), *Perspectives on technology*, Cambridge University Press, Cambridge.
- Rodrick, D. (2004), Industrial policy for the twenty-first century, UNIDO Working Paper, September
- Saviotti, P., Pyka, A. (2004), Economic development, variety and employment, *Revue Economique* 55, 459-468.
- Saxenian, A. (1994), *Regional development: Silicon Valley and Route 128*, Harvard University Press, Cambridge.
- Schumpeter, J.A. (1934), *The theory of economic development*, Harvard University Press, Cambridge.
- Schumpeter, J.A. (1942), *Capitalism, socialism and democracy*, Harper and Brothers, New York.
- Stiglitz, J.E. (1985), Credit markets and capital control, *Journal of Money Credit and Banking* 17, 133-152.
- Stiglitz, J.E., Weiss, A. (1981), Credit rationing in markets with imperfect information, *American Economic Review* 71, 912-927.
- Teece, D. (1986), Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy, *Research Policy* 15, 285-305.
- Teece, D.J. (2000), *Managing intellectual capital*, Oxford University Press, Oxford.
- Teubal, M., Avnimelech, G. (2002), Foreign acquisitions and R&D leverage in high tech industries of peripheral economies: Lessons and policy issues from the Israeli experience, *International Journal of Technology Management* 25, 362-385.

Teubal, M., Zuscovitch, E. (1997), Evolutionary product differentiation and market building in turbulent environments, *Economics of Innovation and New Technology* 4, 265-286.

Tushman, M.L., P Anderson, P. (1986), Technological discontinuities and organizational environments, *Administrative Science Quarterly* 31, 439-465.

Yiting L. (1998), Middlemen and private information, *Journal of Monetary Economics* 42, 131-159