

FROM THE CORPORATION TO VENTURE CAPITALISM: NEW SURROGATE MARKETS FOR KNOWLEDGE AND INNOVATION-LED ECONOMIC GROWTH¹

Cristiano Antonelli, Dipartimento di economia, Università di Torino and BRICK, Collegio Carlo Alberto

Morris Teubal, The Hebrew University

1. INTRODUCTION

The corporation has been able for a long part of the XX century to fulfill 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 new leading institutional set-up able to manage the complex interplay between finance and innovation when radical changes take place (Lamoreaux, Sokoloff, 2007).

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 start-up companies (SUs) has for the first time in history, promoted the creation in advanced economies of a specialized segment of 'inventor' companies. 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'. Following Ronald Coase they can be interpreted as hybrid forms of ex-post coordination indeed based upon transactions, yet enriched and complemented by qualified interactions that take place within structured and organized contexts. Their emergence parallels the demise of the Chandlerian corporation and can be considered as a major institutional innovation (Antonelli and Teubal 2010).

2. FROM THE CORPORATION TO VENTURE CAPITALISM

The relationship between finance and innovation is crucial. Radical uncertainty and hence major knowledge and information asymmetries shape the interaction between perspective investors 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.

¹ Cristiano Antonelli acknowledges the funding of European Union D.G. Research with the Grant number 266959 to the research project 'Policy Incentives for the Creation of Knowledge: Methods and Evidence' (PICK-ME), within the context Cooperation Program / Theme 8 / Socio-economic Sciences and Humanities (SSH), in progress at the Collegio Carlo Alberto and the University of Torino. Morris Teubal acknowledges the support of the International Center for Economic Research (ICER) of Torino. Both authors thank Jackie Krafft for useful comments and suggestions.

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 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 innovative 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 practiced with some success in Germany in the last decades of the XIX century suffered from a number of limitations. 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, an insight further developed by Stiglitz (Stiglitz, 1985; Stiglitz and Weiss, 1981). Stiglitz and colleagues have shown that 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. Bankers instead suffer from frequent failures but cannot take advantage of huge extra-profits made by radical breakthrough innovative firms (Hall, 2002).

Schumpeter's insight and 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 its role as nexus of internal markets where the resources extracted by extra-profits can better match the competences of skilled managers and the vision of internal entrepreneurs. Moreover the corporation can act as an intermediary between the credit markets and the provision of funds for new innovative undertakings. 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 (Chandler, 1962, 1977, 1990).

The advantages of corporations as a nexus of internal market however, are limited by the width of their internal expertise. The corporate provision of funds to internal R&D projects, supported by the competence of internal hierarchies, is in fact more able to avoid 'lemons' but incurs more frequently in type 2 errors e.g. rejecting radical breakthrough innovations. Hierarchies are less able to funding radical innovations especially if and when they fall outside the boundaries of corporate competence. From this viewpoint the advantages and the limitations of the corporation mirror banks. Banks, as polyarchies, are in fact better able to identify and fund radical innovations

but incur more often in the high rates of failures stemming from type 1 errors e.g. the higher incidence of ‘lemons’ into their portfolios of funded projects. Venture capitalism can combine the competence of a wide array of external experts with the screening capabilities based upon the experience of learned managers, components of syndicates of investors and venture capital firms.

Venture capitalism is a major institutional innovation based upon the identification of economies of scope in the transactions of technological knowledge bundled with managerial competence, reputation, screening procedures and equity. It has paved the way to the emergence of new surrogate markets for knowledge, i.e. financial markets specialized in the trade of knowledge intensive property rights with important benefits in terms of economies of size in portfolio management and hence profitability of investments in high-tech startups. The emergence of venture capitalism plays an important role in the national system of innovation of advanced countries, and it is a powerful mechanism for the production, dissemination and integration of knowledge in advanced capitalistic economies, and thereby a main driver of a ‘knowledge-based’ growth.

This chapter 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: 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 (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 technologies* which could replace the existing ones. In both cases market size signals the ‘benefits’ to be derived from improving or substituting the underlying technology.

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.

2. THE EMERGENCE OF NASDAQ AND VENTURE CAPITALISM

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 goods. 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

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 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. 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-routinary sales say during the first 5-6 years of operation). This was the result of the financial and other added value received by SUs that, together with the experience accumulated, underpinned the inventive activity of such companies.

Till approximately the mid 1970s when NASDAQ as a fully public market did not yet exist, VC exits took place principally through the sale of SU (or M & A) or so-called trade sales that is sales of SU shares to individuals or organizations. These were *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 (IPO) 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 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 IPO that 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.

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 other industries, incumbent companies were able to access 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

4. A DYNAMIC PERSPECTIVE TO MARKETS 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 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.

There are two well established notions of ‘market’ in the literature: i) the 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, 1937, 1988, 1992).

A major contribution to the discussion of markets comes from Ronald 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).

There is a third notion of ‘market’ originally proposed by Adam 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 rather than spontaneously making their appearance markets *emerge* or are built, then the required pre-conditions for emergence became central. In this other factors are in play e.g. asymmetric information, regulatory changes, a critical mass of producers and consumers (since there is an important element of collective interaction and of collective transacting which must precede actual market emergence), and other factors.

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

BOX 1: DEFINING THE 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, Contracts, Transactions' Transparency, etc. <i>Emergence involves a momentum leading to further growth</i> (diffusion of the product category)</p> <p>Other Characteristics Thickness, Frequency and Recurrence of Transactions Density of Agents Formal Institutions</p>
--

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>	<p>Specific Functions <i>Signaling extent of Need, inducing Division of Labor & Learning/Specialization, drivers of improvement and disruptive technology/invention, integration mechanisms, converting uncertainty into risk and institutions reducing path dependence (market demise/substitution by another market)</i></p>

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 interactions, learning and experimental process and to enhance the expected “benefits” derived from creating a new market. 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. 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</i> (M1)	<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 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). In Box 3 M1 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 & Quéré, 2008 and Avnimelech and Teubal, 2008b). Thus in the history of emergence of a Venture Capital market and 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.

Failed market emergence can 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. 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, 2008); (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.

The changing nature of many markets and the existence of a ‘visible hand component’ in Venture Capitalism also have implications for SU (and VC) organization and strategy. As mentioned in this chapter and by other authors of this Handbook, in order for SU companies to adapt themselves both to VC and to NASDAQ, they had to adopt a ‘born global strategy’ and their commercialization strategy should consider not only the market for goods, but also the capital markets (for IPO and for M&A) and the markets for knowledge. Also owners and founders should be willing to dilute their ownership. As a result this is a completely different inventor company, even when compared to the specialized R&D or small inventor companies considered by Freeman (1974) and Teece (1986) who operated prior to full fledged Venture Capitalism and the new options for such companies opened up by the new financial markets.

5. BEYOND THE DICHOTOMY MARKETS AND HIERARCHIES

Langlois (2002 and 2003) focuses on these issues by contrasting the systems of innovation and nature of firms towards the end of the 19th century up to and including Venture Capitalism at the end of the 20th century. Both are ‘revolutions’ induced by increases in population, income and technology. Following Chandler (1962, 1977, 1990), Langlois emphasizes the two discontinuities brought respectively by the appearance at the end of the 19th C., of the large, integrated corporation which replaced a fragmented and localized structure of production and distribution organized along Adam Smith’s invisible hand of the market, and, subsequently at end of the 20th century, of a new upsurge of the Smithian Forces that replaced the Chandlerian ones. Building upon this analysis Langlois articulates the *Vanishing Hand Hypothesis* according to which population and income growth together with the accompanying technological changes (including improved coordination technology) have led to a new *Enhanced Division of Labor*, based upon high levels of specialization by function and coordination by markets.

Still it is not clear from Langlois’s analysis whether the visible hand has itself disappeared, being replaced by a market based invisible hand like in Smith; or whether –not only with respect to Venture Capitalism and the role of SUs- but more generally a variety of hybrid mechanisms involving both an enhanced role of markets (or market transactions) *cum* a measure of visible hand could co-exist and actually define the specific form of capitalism that is emerging since the end of XX century.

For example, a visible hand is at work when a firm embedded in a network or network of firms wants to undertake complex knowledge-economy-type transactions, where pre-existing links and trust are critical e.g. in connection with SUs or inventors accessing specialized or co-specialized complementary assets. These considerations apply also to other complex transactions involving SU companies under Venture Capitalism e.g. R&D licensing whether or not part of a broader ‘strategic partnership’ with a larger ‘incumbent’ company; acquisition by or merger with another company, etc. They apply to networks of innovators involving the cooperation of large, diversified, incumbent companies and specialized SUs involving complex transactions characterized by ‘asymmetrical information’. Only the organization of a strong framework of systematic interactions enables actual transactions to take place. Markets have indeed been ‘taking over’, yet the invisible hand is not returning: firms must have links, mutual trust and reputation in order to implement and qualify the transactions that take place eventually in the markets.

Our analysis of venture capitalism can be generalized, impinging upon Coase’s legacy (Coase, 1937, 1988, 1992), so as to suggest that the dichotomy between markets and hierarchies needs to be integrated by the appreciation of the hybrid forms of organization that impinge upon different combinations among markets and hierarchies. Two dimensions are relevant for this analysis. The appreciation of the distinction between interactions and transactions and the identification and analysis of the variety of organizational forms that provide the coordination that is necessary to benefit from the division of labor, is crucial to go beyond simplistic dichotomies. As a matter of fact coordination can be either ex-ante or ex-post. It can be obtained by means of managerial action ex-ante, or by means of selective inclusion and exclusion,

ex post. Pure interactions are organized by strong hierarchies. Pure impersonal transactions take place in perfect, impersonal, spot markets.

As Table 1 shows, we can identify a variety of hybrid forms based upon the mix between transactions and interactions that are placed in a continuum between pure transactions and pure interactions. The overlapping between interactions and transactions identifies an interesting area of complementarity where the two forms of organizing the division of labor complement each other. Here the type of coordination, whether ex-ante or ex-post plays a central analytical role. When interactions prevail, coordination is typically ex-ante. When transactions prevail coordination takes place ex-post.

TABLE 1. CROSSING THE BORDERS BETWEEN MARKETS AND HIERARCHIES

	PURE, PERSONAL INTERACTIONS WITH EX-ANTE COORDINATION	INTERACTIONS CUM TRANSACTIONS AND EX-ANTE COORDINATION	TRANSACTIONS CUM INTERACTIONS AND EX-POST COORDINATION	PURE, IMPERSONAL AND SPOT TRANSACTIONS WITH EX-POST COORDINATION
NO HIERARCHY	X	X	X	PERFECT MARKETS
WEAK HIERARCHY	X	CENTERED NETWORKS; ORGANIZED PLATFORMS	LONG-TERM CONTRACTS; 'OPEN' CONTRACTS; VENTURE CAPITALISM	X
FLEXIBLE HIERARCHY	X	INTERNAL MARKETS WITHIN CHANDLERIAN CORPORATIONS	JVC, IN-HOUSE SUBCONTRACTING; CONGLOMERATE GROUPS; MULTINATIONAL CORPORATIONS	X
STRONG HIERARCHY	PERFECT FIRM	X	X	X

Moving along the continuum we can identify interactions-cum-transactions. These hybrid forms take place when transactions among partners take place in a context that is complemented by weak hierarchies. Interactions-cum-transaction are typically found within centered networks and especially structured platforms. In these hybrid forms the coordination that is necessary to achieve and integrate an efficient division of labor is defined ex-ante and implemented by managers and hierarchical control.

Transactions-cum-interaction are typically found when transactions are reinforced by interactions such as in the case of long terms contracts and 'open' contracts: transactions are no longer impersonal and no longer take place in spot markets. Partners in trade are personally identified and transactions are repeated over time. Here coordination, however, is left to the market place and the ensuing competitive forces: coordination is achieved ex-post also by means of selection and exclusion. Partners that are no longer able to meet the requested levels of performances are sanctioned with failure and exit. According to our analysis venture capitalism can be considered a new case of hybrid form based upon interactions-cum-transactions (Bonazzi and Antonelli, 2003).

This view is further reinforced once we recognize that, more generally, most transactions related not only to new technologies, but more generally to the conditions that enable the division of labor both in product and factor markets, are less and less undertaken under the umbrella of pure markets but take place only with the support of strong injections of organization along a continuum of hybrid form between the two extremes of pure transactions within perfect markets and pure interactions within perfect hierarchies.

This confirms the importance for the firm to build and be embedded in networks and for economics to appreciate the systemic character of the structures into which the division of labor takes place (Lane et al., 2009; Antonelli, 2011).

6. SURROGATE MARKETS FOR KNOWLEDGE AND 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).

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). 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'). There are both direct and indirect effects because the link between inventions/innovations and creation of new markets is a two-way, 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 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.

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*. 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) 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 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 and search of new value for existing users. 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 SU.

7. 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, see Antonelli and Teubal, 2008). KIPRs 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 (summarized in Gompers and Lerner, 1999). An additional albeit related conclusion concerning markets versus managerial coordination and the role of the visible hand is that *while markets are or have indeed been ‘increasing their scope’, it does not follow that the invisible hand is returning*, since, as mentioned, firms must have links, network embedment, and mutual trust (and sometimes, reputation) in order to effectively make use of markets.

The present chapter 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 consists in new markets & new industries that make possible the new ‘market mediated’ link between invention/innovation and economic growth. The core of our analysis is captured by 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; 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). That strategy includes *SU licensing of technology to incumbents*; acquisition of the SU; strategic partnerships and mergers. It is noteworthy to mention that the new technology induced by 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 Schmoookler-type framework of analysis). The latter radical inventions, which are signaled by (large) markets, 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.

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). The coordination of needs-capabilities means not only coordination among agents operating in a specific 'product market' but also the coordination of agents operating in a large set of related markets. It follows that Venture Capitalism as a system will stimulate invention and, through multi-agent and cross-markets coordination, will also promote innovation-based growth.

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 (Arrow's disclosure paradox limited or absence of technology markets). *Relatively speaking, prior to venture capitalism, radical inventions by specialized inventor companies only very occasionally led to new product markets.*

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.

The combination of continued generation of new opportunities and the mechanism for 'unlocking' the system from potential, strong path dependence, assures that venture capitalism could become a feature of *sustainable innovation-based growth economic systems* able to complement if not substitute the corporation as the leading institutional mechanism for the generation and exploitation of technological knowledge.

8. BIBLIOGRAPHY

Abernathy, W.J., Utterback, J.M. (1978), Patterns of industrial innovation, *Technology Review* 80, 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. (ed.) (2011), *Handbook on the economic complexity of technological change*, Edward Elgar, Cheltenham.

Antonelli, C., Teubal, M. (2008), Knowledge intensive property rights and the evolution of venture capitalism, *Journal of institutional Economics* 4, 163-182.

Antonelli, C., Teubal, M. (2010), Venture capital as a mechanism for knowledge governance: New markets and innovation-led economic, in Viale, R., Etzkowitz, H. (eds.), *The capitalization of knowledge*, Edward Elgar, Cheltenham, pp. 98-120.

Arrow, K. (1962), Economic welfare and the allocation of resources to invention, in Nelson, R.R. (ed.), *The rate and direction of inventive activity*, University of Chicago Press for the National Bureau of Economic Research, Chicago, pp. 609-625.

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, 153-172.

Avnimelech, G., Teubal, M. 2008b, Evolutionary targeting, *Journal of Evolutionary Economics* 17, 233-257.

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

Bonazzi, G., Antonelli, C. (2003), To make or to sell?: The case of in-house outsourcing at FIAT-Auto, *Organization Studies* 24, 575-594.

Chandler, A. D. (1962), *Strategy and structure: Chapters in the history of the industrial enterprise*, The MIT Press, Cambridge.

Chandler, A. D. (1977), *The visible hand: The managerial revolution in American business*, The Belknap Press of Harvard University Press, Cambridge.

Chandler, A. D. (1990), *Scale and scope: The dynamics of industrial capitalism*, The Belknap Press of Harvard University Press, Cambridge.

Coase, R. (1937), The nature of the firm, *Economica* 4, 386–405.

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

Coase, R. (1992), The institutional structure of production, *American Economic Review* 82, 713-719.

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.

Gans, J.S., Stern, S. (2003), When does funding research by smaller firms bear fruit? Evidence from the SBIR program, *Economics of Innovation and New Technology* 12,

361–84.

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.

Lamoreaux, N.R., Sokoloff, K.L. (eds.) (2007), *Financing innovation in the United States: 1870 to the present*, MIT Press, Cambridge.

Lane, D. A. et al. (2009), *Complexity perspectives in innovation and social change*, Springer, Berlin.

Langlois, R. N. 2003, The vanishing hand: The changing dynamics of industrial capitalism, *Industrial and Corporate Change* 12, 351-385.

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.

- 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.J. (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