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Entrepreneurship, Innovation and Economic Growth

Past experiences, current knowledge and policy implications

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Entrepreneurship, Innovation and Economic Growth

PAST EXPERIENCES, CURRENT KNOWLEDGE AND POLICY IMPLICATIONS[1]

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Abstract

Considerable advances, even breakthroughs, have been made during the last decades in our understanding of the relationship between knowledge and growth on one hand, and entrepreneurship and growth on the other. Similarly, more profound insights have also been gained as to how entrepreneurship, innovation and knowledge are interrelated. Yet, a comprehensive understanding is still lacking concerning the interface of all of those variables: knowledge, innovation, entrepreneurship and growth. The link between the micro-economic origin of growth and the macro-economic outcome is still too rudimentary modeled to grasp the full width of these complex and intersecting forces. The main objective of this paper is hence to shed light on recent advances in our understanding of the forces that underpin the creation of knowledge, its diffusion and commercialization through innovation, and the role of the entrepreneur in the growth process. The policy implications of recent research findings conclude this survey. Particularly important policy implications refer to the design of regulation influencing knowledge production, ownership, entry barriers, labor mobility and (inefficient) financial markets. They all have implication for the efficient diffusion of knowledge through entry. Knowledge creation has to be matched by incentives that induce mechanisms to convert knowledge into societal and useful needs.

Keywords: Entrepreneurs, knowledge, innovation, growth, policy

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"The greatest danger for most of us is not that our aim is too high and we miss it but that it is too low and we reach it " (Michelangelo)

1 .Introduction

Considerable advances, even breakthroughs, have undoubtedly been made during the last decades in our understanding of the relationship between knowledge and growth on one hand, and entrepreneurship and growth on the other. Similarly, more profound insights have also been gained as to how entrepreneurship, innovation and knowledge are interrelated. Yet, a comprehensive understanding is still lacking concerning the interface of all of those variables: knowledge, innovation, entrepreneurship and growth. The knowledge-innovation-entrepreneurship-growth nexus is intricate and influenced by forces that are likely to simultaneously affect all variables, at least partially, while others can be expected to have a unidirectional impact or affect only a few of these variables. The link between the micro-economic origin of growth and the macro-economic outcome is still too rudimentary modelled to grasp the full width of these complex and intersecting forces.

Growth can basically be attributed the following fundamental forces: an increase in factors of production, improvements in the efficiency of allocation across economic activities, knowledge and the rate of innovation. Given full employment and efficient allocation, growth is thus driven by knowledge accumulation and innovation. The process of innovation is typically modeled as a function of the incentive structure, i.e. institutions, assumed access to existing knowledge, and a more systemic part. Innovation also implies that the stock of (economically) useful knowledge increases. In other words, innovation is one vehicle that diffuses and upgrades already existing knowledge, thereby serving as a conduit for realizing knowledge spillovers. The process of innovation is consequently considered to be one of the critical issues in comprehending growth.

Irrespective of the advances made in this vein of economics, a number of basic questions related to the dynamics of the growth process, and the ensuing normative conclusions, are only fragmentally understood and just partially explored. Even quite basic issues, as the definition of the concept innovation are clearly not settled, not to mention how they come about and by whom, i.e. the connection to entrepreneurial activities. Moreover, in precisely what way does innovation contribute to new knowledge (through scientific/technical discoveries or through a much broader view on innovation?) and which knowledge bases and cognitive abilities are critically important for innovation to take place? Exactly how does innovation substantiate into growth and how are the effects spatially diffused? And which policy measures should be taken in order to boost the probability of sustained knowledge based growth? Those are the questions that will be focussed on in this paper through a selected survey of the literature.

The lack of detailed insight into these issues implies that our knowledge concerning the microeconomic foundations of growth is at best partial, but could potentially also be quite flawed. Without accurate microeconomic specification of the growth model there is also an obvious risk that the derived policy implications are incorrect. The recipes for growth are likely to be inconsistent over time and also vary over different stages of economic development. Today's developing countries may learn from policies previously

pursued by the developed countries, while developed countries themselves confront a more difficult task in carving out growth policies for the future. Hence, the relationship between the level of development, entrepreneurship, innovation and growth will also be considered.

Background

Despite the enhanced understanding of the building blocks of dynamic processes, economics-based theories and models largely fall short of addressing the influence of the independent innovator or entrepreneur to important economic outcomes. The accumulation of factors of production, i.e., knowledge, human and/or physical capital, cannot alone explain economic development. Innovation and entrepreneurship are needed to transform these inputs in profitable ways, an insight forwarded already by Adam Smith (Andersson and Tollison 1982).

At the same time there seem to be preconceived perceptions at policy level concerning the effects of activities by entrepreneurs and entrepreneurial firms. For instance, it is more or less taken for granted that setting up a new company, or the performance of new ventures, automatically translate into societal benefits. However, this is an oversimplification; entrepreneurship may under certain conditions reduce rather than enhance economic progress. This would be the case for illegal enterprising, but also when entrepreneurial talent is spent on rent seeking activities such as litigation, or whenever the Coasian transaction costs arguments for internalizing economic activities are violated through policy induced incentives. In other words, it is fully conceivable for successful new enterprise at the micro level to translate into economic regress at the societal level and for a failed entrepreneurship at the micro level to contribute to economic development. The societal implications of the actions of individual entrepreneurs, i.e. how that translates into growth and prosperity, is thus not fully considered.

In connecting knowledge, innovation and entrepreneurship, it is essential to emphasize the non-routine processes that are conspicuous phenomena of the dynamics of economic development. Knowledge driving innovation is frequently thought of as a linear process, being an outcome of activities labeled R&D. Obviously a set of other processes, such as learning-by doing, cognitive abilities, networking, combinatorial insights, etc., also fuse societal knowledge. Uncertainty, search and experiments are crucial parts of the innovative process. The knowledge generating activities of entrepreneurs and small firms have been shown to be spread across a number of different functional areas. Disregarding these aspects means that several studies neglect a substantial share of the knowledge creation relevant to innovation and economic growth.

Consequently, despite making small investments in R&D and other formal knowledge generating activities, entrepreneurs and small firms may still substantially contribute to aggregate innovation, thanks to their entrepreneurial abilities. Still, there is no guarantee that new knowledge with commercial potential is immediately transformed into entrepreneurial initiatives; these effects could fail to show up at all, or appear with a time lag.

Because entrepreneurship entails the actions and activities of individuals working within firms or for themselves, incentives that encourage the risky endeavor of entrepreneurial activity seems essential, as is the infrastructure allowing the transfer of knowledge from knowledge generating actors to knowledge exploiting entrepreneurs. In addition, firms and entrepreneurs have to develop strategies to balance slow knowledge development processes with fleeting windows of opportunity and find ways of speeding up

knowledge generation and exploitation. Here the financial system, by evaluating prospective entrepreneurs, mobilizing and channeling savings to finance the most productivity-enhancing activities, diversifying risks, etc., play a vital role. Thus, the design of financial systems influences growth by increasing the probabilities of successful innovation (King and Levine 1993). The question is how that is accounted for in standard knowledge driven growth models.

The view that entrepreneurship could play an important role in a knowledge-based economy seems to contrast much of the conventional wisdom. According to for instance Gailbraith (1967), Williamson (1968) and Chandler (1977), it seemed inevitable that exploitation of economies of scale by large corporations would become the main engine of innovation and technical change. But also the "late" Joseph Schumpeter (1942) shared these views, albeit with considerably more skepticism about the beneficial outcome than his colleagues. Rather, Schumpeter feared that the replacement of small and medium sized enterprise by large firms would negatively influence entrepreneurial values, innovation and technological change. Despite these early prophecies of prominent scholar, there is ample empirical evidence that the development has actually reversed since the early 1970s for most industrialized countries. The tide has turned; the risk prone entrepreneur has experienced a virtual renaissance and is increasingly seen as indispensable to economic development.

Theoretical advances and empirical research seem to support the view that knowledge generation, innovation and entrepreneurship processes are localized processes. Irrespective of knowledge flows largely being bounded in space, it is however also possible to observe how knowledge, innovations and entrepreneurial initiatives flow between functional urban regions and even countries. Thus, even though regions are characterized by their varying internal economic and infrastructure networks, they are also connected by a multitude of such networks. It is obvious that there is an important interplay between localized processes of knowledge generation, innovation and entrepreneurship, but current insights are basically lacking concerning the relative importance of interregional and international networks. An increasingly global knowledge base serve to enhance and diversify the local knowledge base, i.e. what has been coined "local buzz and global pipelines".

In terms of policy, it is a well-established result that market economies normally do not generate a socially optimal volume of knowledge creation, innovation and entrepreneurship. However, there is no consensus concerning what institutional frameworks and policy measures that might generate such a social optimum given the imperfections of both the economic and the political markets. This has not stopped policy-makers from launching a large number of institutional changes and policy measures to stimulate knowledge creation, innovation and entrepreneurship. Nevertheless, the number of carefully carried through policy evaluations is rather limited, which implies that there is a huge knowledge gap concerning which policies actually work and whether they are worth their costs.

The main objective of this paper is hence to shed light on recent advances in our understanding of the forces that underpin the creation of knowledge, its diffusion and commercialization through innovation, and the role of the entrepreneur in the growth process. The following section 2 discusses the definition, origin and measurement of entrepreneurship, and how it relates to knowledge production, while section 3 is devoted to innovation and the innovation process. Section 4 presents how these components have been integrated into a growth context, and discusses the weak links in current models of growth. In the subsequent section 5

the regional aspects of entrepreneurship, knowledge extraction and growth are highlighted. The paper is concluded by a policy discussion (section 6), and a summary of the main findings, together with suggestions for future research (section 7).

2. Entrepreneurship –Definition, measure and origin

Why do individuals engage in entrepreneurial ventures with uncertain and risky outcomes?

The earlier entrepreneurship literature suggests a plethora of different reasons as to why individuals become entrepreneurs, albeit institutions are always at the heart of the matter when the extent of entrepreneurial activities is explained. The alleged explanations of entrepreneurship comprise a mix of clear-cut economic explanations, specific attributes that are claimed to characterize entrepreneurs, as well as forces related to culture and path-dependency. Sometimes they are classified according to the level of aggregation, starting at the macro-level and working their way down to industry-related factors, micro-economic incentive structures and cognitive abilities of individuals. Alternatively, similar forces triggering entrepreneurship is presented in a supply and demand taxonomy. In this section I will briefly survey the most frequent explanations to entrepreneurial activities, zeroing in at the empirical findings concerning the role of institutions and access to knowledge. The idiosyncrasies pertaining to the definition and production of knowledge are likewise addressed.[1]

The Austrian heritage

Within the last decades we have witnessed an Austrian renaissance in economics - putting the entrepreneur, structural change and creative destruction in the forefront - both from an academic point of view as well as in policymaking. Most contemporary theories of entrepreneurship, and the implications of entrepreneurship, thus build on the seminal contributions by particularly Schumpeter (1911/1934). He stressed the importance of innovative entrepreneurs as the main vehicle to move an economy forward from static equilibrium, based on the combinatorial capabilities of entrepreneurial individuals.[2] In his own words:

"Whatever the type, everyone is an entrepreneur only when he actually carries out new combinations and loses that character as soon as he has built up his business, when he settles down to running it as other people run their business" (Schumpeter 1911/1934, p78).

"And what have they done: they have not accumulated any kind of goods, they have created no original means of production, but have employed means of production differently, more advantageously. They have carried out new combinations! They are the entrepreneurs. And their profit, the surplus to which no liability corresponds, is the entrepreneurial profit." (Schumpeter 1911/1934, p. 132).

Schumpeter viewed the creation of technological opportunity as being basically outside the domain of the entrepreneur. Rather, the identification and exploitation of such opportunities is what distinguishes

[1] The following section includes a brief and partial presentation of some of the most influential thoughts as regards entrepreneurs. For a more thorough survey, see Sexton and Landström (2000), Acs and Audrestch (2003) and Braunerhjelm (2008).

[2] Olsson (2000) and Olsson and Frey (2002) presents a theoretical model of entrepreneurs as undertakers of new combinations of ideas.

entrepreneurs, i.e. innovation. Also in this respect Schumpeter's original thoughts on entrepreneurial opportunity has had a considerable influence on the succeeding generation of entrepreneurship researchers. Nor did Schumpeter view entrepreneurs as risk-takers, even though he did not completely dismiss the idea, and was aware that innovation contains elements of risk also for the entrepreneur. But basically that task was attributed the capitalists who financed entrepreneurial ventures.

A decade later, Knight (1921) proposed the role of the entrepreneur as someone who transforms uncertainty into a calculable risk. Schumpeter's model was thereby complemented by the explicit introduction of cognitive abilities as an explanation of entrepreneurial activity. Somewhat later, the definition of the entrepreneur as someone who moved the economy towards equilibrium (partly contrasting Schumpeter), by taking advantage of arbitrage possibilities, was forwarded by Kirzner's (1973, 1996, 1997). The Austrian heritage can be traced even further back. Menger (1871) stressed the uncertainties and subjectivities that he claimed must be inherent phenomena in economies characterized by extensively distributed and fragmented economic activities.[1] These ideas were further elaborated by von Hayek (1945). Thus, there seems to be a rather clear connection between Menger's view on the subjective economy, von Hayek's ideas about the distribution of knowledge, and Kirzner's arbitraging entrepreneur, which in turn basically links well with Schumpeter's definition of the entrepreneur's innovative capacity, including the detection of new markets.[2]

More recently, the research field of entrepreneurship has been defined as analyses of "how, by whom and with what consequences opportunities to produce future goods and services are discovered, evaluated and exploited" (Shane and Venkataraman 2000). As regards by "whom", an eclectic definition of the entrepreneur, that has become increasingly accepted, is suggested by Wennekers and Thurik (1999). The entrepreneur: i) is innovative, i.e. perceives and creates new opportunities; ii) operates under uncertainty and introduces products to the market, decides on location, and the form and use of resources; and iii) manages his business and competes with others for a share of the market. Apparently, this definition can be linked to all three contributions referred to above. Note that invention is not explicitly mentioned (albeit creation of opportunity is) in this definition, nor excluded from the interpretation of entrepreneurship. A summary of different definitions of entrepreneurs over time is presented in Table 1.

[1] Menger did however not define or include the entrepreneur in his work. Von Mises (1949) did, though much later, define entrepreneurs in terms of unevenly distributed talent.

[2] Schumpeter defined five different types of innovation: the recognition of a new good/quality, a new method/process, a new market, a new source of supply or a new way of organizing the firm/production.

Table 1. Some definitions and characteristics of entrepreneurship, 1755 to 2001.[1]

R. Cantillon (1755)	- Entrepreneurs is defined as self-employed - Self-employed deals with additional uncertainty -Entrepreneurs should balance their activities to market demand
J.B. Say (1803)	- Entrepreneurs shifts economic resources from low to high productivity areas with higher yield - Entrepreneurship implies many obstacles and uncertainties
A.Marshall (1890)	- Entrepreneurs and managers have different but complementing characteristics
J. Schumpeter (1911)	- Entrepreneurship are the main vehicle to move an economy forward from static equilibrium, based on the combinatorial capabilities of entrepreneurial individuals - Combinatorial capabilities results in recognition of a new good/quality, a new method/process, a new market, a new source of supply or a new way of organizing the firm/production - Entrepreneurs' role is distinctly separated from the role of inventors
F. Knight (1921)	- Entrepreneurs are a special social class who direct economic activity - Uncertainty is the primary aspect of entrepreneurship
E. Penrose (1950)	- Entrepreneurial and managerial abilities should be distinguished - Detecting and exploiting opportunities for smaller firms is the basic aspect of entrepreneurship
H. Liebenstein (1968)	- Entrepreneurial activity mainly implies decreasing organizational inefficiencies and reversing organizational entropy - There are two types of entrepreneurs: a managerial who allocates inputs into the production process in an effective manner, and a

[1] Table 1 partly builds on Salgado-Banda (2005).

	Schumpeterian who fills obserbed market gaps by introducing new products or processes
I.Kirzner (1973, 1997)	- Entrepreneurial activity moves the market towards equilibrium as entrepreneurs discover profitable arbitrage possibilities.
M. Casson (1982)	- Entrepreneurs specialize in taking judgmental decisions about the coordination of scarce resources
W. Gartner (1985), H. Aldrich and C. Zimmer (1986)	- Entrepreneurship is the outcome of actions of individuals that act in and are influenced by the organizational and regional environment in which they live and work.
W. Baumol (1990)	- Entrepreneurial activity crucial for (radical) innovation and growth. - Institutions decide the allocation of entrepreneurial activity between productive (innovation) and unproductive activities (rent seeking, organized crime, etc.).
R. Holcombe (1998)	- Entrepreneurs promote a more productive economy due to more efficient and innovative ways of production, it is the foundation for economic growth
OECD (1998)	- Entrepreneurs represents the ability to marshal resources to seize new business opportunities, defined broadly they are central to economic growth
S. Wennekers and R. Thurik (1999)	- Entrepreneurs have multi-task abilities. - Entrepreneurs perceive and creates new opportunities, operate under uncertainty and introduce products to the market, decide on location and the form and use of resources, and, finally manage their business and compete with others for a share of the market.
H. Aldrich and M.Martinez (2001)	- Entrepreneurial activity not necessarily synonoumos with innovation since entrepreneurial activities also involve imitation. - Support the distinction between innovation and reproduction in entrepreneurial activities.

Many explanations but few theories

The above brief and, of course, incomplete presentation theorize and describe the perceived characteristics believed being possessed by the entrepreneur. Even though explanations as to why entrepreneurial activities are embarked upon can be inferred from those entrepreneurial characteristics, this is far from presenting a rigorous theoretical model of entrepreneurship. There exists, few, if any compelling theoretical model of entrepreneurial behavior, which stems from the heterogeneity and stochastic elements that seems to be an undisputable part of entrepreneurship. The closest contemporary attempt to model on entrepreneurship is probably the occupational choice models (Evans and Leighton 1989, Banerjee and Newman 1993, van Praag and Cramer 2001). Still, the distinction between these and other models of profit maximizing agents based on perfect information is thin. Instead entrepreneurship models are based on processes driven by stochastically distributed abilities and learning capacities.[1]

For instance, in Jovanovic's (1982) model new firms, or entrepreneurs, face costs that are not only random but also differ across heterogeneous firms. A central feature of the model is that new firms do not know their cost functions, that is, their relative efficiency, which is discovered through the process of learning from its actual post-entry performance once the business is established. Hence, entry per se is not important and dynamics is characterized by a noisy selection process where performance is partly exogenous. Jovanic and Lach (1989), present a modified version of the 1982 model which also builds on learning by doing, and generates a S-shaped diffusion pattern of innovation (and entry) over time.

Neither of these approaches is particularly satisfactory and whether they can offer insights more valuable than an eclectic approach based on empirical observations is questionable. We therefore restrict the remaining presentation to an overview of the most common empirical regularities as to why entrepreneurship occurs.

Empirical explanations of entrepreneurship

According to the literature the fundamental source of economic development, dynamism and changes can be ascribed the institutional setting in which agents operate. Even though needs may drive individual actions, the way those needs are fulfilled and the efficiency in accomplishing them, depends on institutions. Hence, at an overarching level, the extent and type of entrepreneurship can always be attributed institutions, formal and informal (de Soto 1989, 2000, Baumol 1990, North 1990, 1994, Henrekson 2005).[2] Institutions also appear at all levels of economic activities: the macroeconomic framework, industrial policies, knowledge creation, attitudes and individual incentives.

In the following we will classify the empirical explanations to entrepreneurship on the different factors and levels of aggregations that have been presented in the literature. These will also be briefly related to other

[1] See Shane (2003)

[2] Baumol (1990) emphasize the role of institutions for the allocation between productive (innovation) and unproductive activities (rent seeking, organized crime, etc).

contextual concepts, such as push and pull factors, and the demand and supply of entrepreneurs. The section is concluded with some observation as regards the definition, role and production of knowledge. However, before excavating into the observed empirical regularities in explaining entrepreneurship, the measurement problems related to entrepreneurship will be considered.

Measuring entrepreneurship

Rather than being synonymous with starting a new venture, entrepreneurship refers to a set of abilities embodied within an individual. Adequately capturing such abilities in data that are comparable over individuals, not to mention comparisons across regions or nations are simply not possible. Thus, the measures of entrepreneurship will always be partly erroneous and subject to criticism since empirical studies have to rely on proxies which (hopefully) are correlated with entrepreneurship.

A considerable share of studies on entrepreneurship relies on self-employment data. One obvious reason is that those were simply available for a large number of regions and countries (Evans and Leighton 1989, Blanchflower and Oswald 1998, Georgelis et al 2000, OECD 2000, Audretsch and Thurik 2001, Blanchflower et al 2001, Bruce and Holtz-Eakin 2001, Fonseca et al 2001). Yet, as noted by Blanchlower (2000) and Earle and Sakova (2000), self-employed consists of a very heterogeneous group more or less involved in productive entrepreneurial activities, it could just as well represent employment push factors.

Alternative but related measures of entrepreneurship are the number of establishments (Beck and Levine 2001), density of firms (Klapper et al 2008), or business ownership (Carré, van Stel and Thurik 2002). As pointed out above, self-employed less likely to capture productive entrepreneurship, it could just as well represent entrepreneurial pull as unemployment push. Net birth rate (entry less exits) has also been suggested as an indicator of entrepreneurship, in addition to tracing structural industrial changes (Dejardin 2008). Firm demography is however quite different between industries implying that sectorally adjusted indicators are needed to capture structural changes using net birth rates (Geroski 1995, Caves 1998). But also turbulence (entry plus exits) have been advocated as an approximation of entrepreneurship (Fritsch 1996).

A relatively new set of data has been compiled by the Global Entrepreneurship Monitor (GEM). These data are based on questionnaires designed to capture both potential entrepreneurs and other respondents. The data also contain additional information, such as motives for embarking on entrepreneurial activity, etc. Comparison with other datasets, for instance those collected by Eurostat (Flash Eurobarometer) and the World Bank, reveal a high degree of correlation (Reynolds et al 2005). That they catch about the same phenomena does not however mean that they are good indicators of entrepreneurial activity.

Entrepreneurship is often categorized as opportunity- or necessity-based ventures. The former represents a profitable opportunity as perceived by an individual, while the latter is associated with entrepreneurship as a last resort, i.e., due to impossibility of finding other sources of income. The distinction between opportunity

and necessity based entrepreneurs could also be interpreted as the separation between self-employed and high-growth entrepreneurship (Glaeser and Kerr 2009).[1]

Macro-level explanations of entrepreneurship

The most commonly defined determinants of entrepreneurship at the macro-level in the literature are the level and growth of GDP, together with (un)employment, investments, cost levels, inflation and the interest rate level (Highfield and Smiley 1987, Bosma et al 2005, Wang 2006). Also factors like government spending on education, infrastructure and health seem to be positively correlated with startups (Reynolds and Storey 1993).

Some of these factors relate to the business cycle – i.e. there may be a cyclical component in entrepreneurship activity – while other, albeit less explained, can be associated with long waves influencing economic activity, innovation and entrepreneurship (Schumpeter 1939).[2] See also Fritsch (1996) who shows that entry and exit varies during the product cycle, i.e. it is particularly high in the earlier stages.

Regions, industry and firm level factors

One strand of entrepreneurial economics looks at how differences in regional characteristics and preconditions influence entrepreneurship. Low transportation costs, concentration of human capital and extensive research and development activities together with availability to financial capital, seems to be the most critical factors.[3] Also population (demand), employment and income growth turns out to be important determinants of entrepreneurship (Acs and Armington 2002). We will further elaborate on the regional dimension of entrepreneurship in section 5.

On the industry level the most prominent factors that have been identified to impact entrepreneurship are the level of profits, entry barriers, level of demand, and the extent of agglomerated or urbanized production structures (Reynolds 1992, Reynolds and Storey 1993).[4] The determinants of entrepreneurship thus relate to variables derived in the industrial organization, economic geography and standard micro-economic theories of economics. There are mixed results for different variables in different countries but basically profits, industry growth and industry size are positively related to startups while increasing capital requirements and need for product differentiation seem to negatively impact entrepreneurship.

Disaggregating to the firm level, human capital (education) shows up as one of the fundamental variables explaining entrepreneurship (Evans and Leighton 1990, Kim et al 2006). Overall, the likelihood of becoming an entrepreneur is strongest for skilled individuals, particularly for entrepreneurs seeking to exploit an

[1] We will not consider explanations related to the sociological disciplines (teams, networks, etc.), nor those related to nascent entrepreneurship, "combinators", etc.

[2] An alternative approach is represented by the long wave literature, see e.g. Kitchin (1923, long waves appear due to investments cyscles), Juglar (1862, investments in machinery, Kuznets (1971, investments in real estate) and Kondratieff (1925/1935) who simply conclude that long waves of economic activity seems to be a fact.

[3] See Bartik (1989), Evans and Jovanovic (1989), Reynolds et al (1994), Dunn and Holtz-Eakin (1995), (2000), Quadrini (2000) and Acs et al (2007).

[4] The demand variable goes back to Adam Smith's argument about the size of the market and the scope for specialization.

opportunity. Human capital signals quality, works as a sorting mechanism, helps overcoming barriers in obtaining credit/equity, as well as improving network forming.[1] Social networks can in turn be expected to reduce transaction costs (Williamson 1971), which also has gained empirical support, particularly for opportunity based entrepreneurship.[2]

Regulation as such has been shown to influence entrepreneurship and size of startups (Ciccone and Papaionnou 2006, Ardagna and Lusardi 2009).[3] Particularly detrimental effects are attributed high startup costs (Fonseca et al 2001, 2007). Glaeser and Kerr (2009) presents (regional) evidence that cost levels are one of the major impediments to entrepreneurship, while Gordon (1998), and Cullen and Gordon (2007), conclude that higher taxes has a distinct and significant negative impact on entrepreneurship. Moreover, indirect effects have been reported through the effects of taxes on wealth formation (Evans and Jovanovic 1989, Banerjee and Newman 1993). Individual wealth has been shown to be a robust predictor of the probability of starting a firm.

At the individual level progressive marginal tax rates seem to negatively impact entry, even though the magnitude depends on the difference between taxes on wages and taxes on profits (Gentry and Hubbard 2000, Hansson 2008). It is also noteworthy that individuals in either the highest or the lowest income brackets are most likely to start a firm, which probably mirrors that individual abilities govern whether opportunity- or necessity-based entrepreneurial ventures is embarked upon.

Norms and culture

A number of studies find that social norms, or entrepreneurial culture, do influence entrepreneurship.[4] An obvious indicator of this is the parent effect, that is, the likelihood of becoming a firm-owner or starting a new firm increases if the parents had their own firms (Dunn and Holtz-Eakin 2000, Davidsson and Honig 2003, Gianetti and Simonov 2004). There also seem to be the case that an environment dominated by smaller and independent firms become more conducive to entrepreneurship than environments hosting larger firms (Glaeser et al 2009, Glaeser and Kerr 2009). Holding an industry's establishment size constant (or/and city), entrepreneurs increase when the surrounding city has a greater number of small establishments. In addition, there is a remarkably strong correlation between average establishment size and subsequent employment growth through startups, particularly in manufacturing (see also Rosenthal and Strange 2009). Growth of new start-ups is thus correlated to the number of existing establishments in the area. The direction of causality is however not clear.

Glaeser and Kerr (2009) also finds that higher amenities (defined as exogenous regional differences in climate factors) tend to drive up the price of land which attract low fixed cost industries that tend to have a

[1] Though, as argued by Leff (1979), capital market imperfections should not be enough to explain entrepreneurial differences, since it could be argued that overcoming such difficulties constitutes parts of entrepreneurial abilities.

[2] See Ardagan and Lusardi (2008) where it is shown that knowing someone with entrepreneurial experience increases the likelihood of becoming an entrepreneur by three percent. See also Djankov et al (2006), Guiso et al (2004), Nanda and Sorenson (2007).

[3] Gordon (2004) and Bosma and Harding (2007) claim that institutional differences explains the growth differences between Europe and the US.

[4] An exception, based on US data, is Kim (2006).

higher share of entrepreneurship. Hence, high amenity places attract people and firms, labor intensive industries, thereby inducing a positive impact on entrepreneurship.[1] A related observation is that the fraction of entrepreneurs that are active in the region where they were born is significantly higher than the corresponding fraction for workers. This local preference is strongest in developed regions with well developed financial sectors. In addition, Michalecci and Silva (2006) show that firms created by locals are more valuable, bigger, more capital intensive and obtain more financing per unit of capital invested.

Individual and cognitive factors

A considerable part of the literature is pre-occupied with the cognitive processes by which individuals discover opportunities and take the decision to start a new firm (Braunerhjelm 2008). These studies confer that a number of individual abilities and cognitive capabilities are characteristic for entrepreneurs. For instance, risk acceptance (Knighterian uncertainly) is claimed to distinguished entrepreneurs from other individual, as is their tolerance for ambiguity. They are also claimed to have a stronger need to achieve, for self-efficacy as well as preferences for autonomy.[2] In some studies such individual characteristics are broken down at the regional level in order to capture how variations in social capital, creativity and tolerance may influence entrepreneurship (Coleman 1988, 1990, Putnam 1993, Lee et al 2004, Florida 2002, Florida et al 2008).[3]

In a recent empirical analysis, Sutter (2009) sets out to test the impact of a composite factor defined as "psychological capital". Compared to previous studies, Sutter's embrace a more varied set of individually defined characteristics, such as those related to enjoying other people's and one's own life, ability to control emotions, capability to enthusiasm other people, etc., which are all incorporated in a "psychological capital" index. Controlling for other individual factors related to access to opportunities, education, social capital, creativity and trust, the empirical analysis conclude that the psychological index is an important determinant of entrepreneurial endeavor.

Demand and supply side explanations of entrepreneurship

In the previous literature there are frequent references to demand- and supply side determinants of entrepreneurship.[4] I am not convinced that this is the path forward to a better understanding of entrepreneurship and its effects. Empirically it also seems hard to pin down whether entrepreneurial activities descend from the demand or supply factors, some places just seem to have greater supply of entrepreneurs (cf. Chinitiz 1961, Sassens 2006, Glaeser and Kerr 2009). Such regional differences are likely to be a consequence of local norms, traditions, serendipitous events, i.e. a residual of "unmeasurables".

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[1] Compare the studies by Black et al (1996), Hurst and Lusardi (2004) and Nanda (2009), where it is shown how higher real estate process ease liquidity constraints and positively influences entrepreneurship.

[2] See McClelland 1961, Williamson 1971, Timmons 1976, Kihlstrom and Laffont 1979, Brockhaus 1980, Budner 1982, Schere 1982, Chell 1986, Begley and Boyd 1987, Chen et al 1998, Zucker et al 1998, van Praag and Cramer 2001, Markman et al 2002, Agrawal et al 2006, Sorenson and Singh 2007, Benz and Frey 2008.

[3] Note the analogy to successful organizations, where psychological capital has been defined as one important explanatory factor (Luthans et al 2007 and Luthans and Youssef 2007).

[4] See for instance Fritsch Mueller (2007), Koster and Karlsson (2009).

Moreover, in some cases the distribution between supply side and demand side forces seem somewhat ambiguous. Is, for instance, unemployment a variable that can be derived from the demand or the supply side of the economy?

Framing the sources as entrepreneurship in terms of demand and supply implicitly also seems to suggest that equilibrium could be attained, i.e. a stationary point exists where either entries equal exits or that dynamics cease. That is of course quite contradictory when one is discussing phenomena featured by extensive dynamics, non-linear behavior and experimentally organized processes.

Notwithstanding that the distinction between demand and supply side factors may be imprecise, previous research seem to allot most explanatory power to the latter. Among those are knowledge, broadly defined, and how it ties in with human capital and knowledge resources for production, most important.[1]

Knowledge, its organization and entrepreneurship

Knowledge

It could be argued that there is a dividing line in economics where knowledge is defined as either an object or a process. Preceding that discussion is the question how information and knowledge are related to each other. Sometimes information is defined as data that can be easily codified, transmitted, received, transferred and stored. Knowledge, on the other hand, is seen as consisting of structured information that is difficult to codify and interpret due to its intrinsic indivisibility. Hence, it is embodied in individuals and organizations. Even though the ability to indulge knowledge relate to human cognitive abilities to absorb and select among available information, individual competence may have little or no value in isolation, but combined with other competencies in an organization it may constitute an important part of the organization's knowledge capital. Part of knowledge is likely to always remain "tacit" and thus non-codifiable (Polyani, 1966).

In contrast to information that may be interpreted as factual, knowledge may be considered as establishing generalizations and correlations between variables. Knowledge is also cumulative in the sense that the better known a field, the easier it is to assimilate new pieces of knowledge within this field. Generally, knowledge can be described somewhere between the completely tacit and the completely codified. Tacit, sticky or complex knowledge, i.e. highly contextual and uncertain knowledge, seems best transferred via face-to-face interactions (von Hippel 1988). Proximity thus matters since knowledge developed for any particular application can easily spill over and find additional applications.

There will always be limitations in accessing knowledge. Measures concerning access and level of knowledge tend likewise to be partial. Indeed, even if the total stock of knowledge were freely available, knowledge about its existence would not necessarily be. The knowledge space is in itself unbounded, implying that decisions are made under "bounded rationality" (Simon 1959). Hence, partiality and subjectivity tend to

[1] Globalization is claimed to influence both the demand (lower transport costs, expansion of markets, etc.) and supply side factors (migration, FDI, spin-offs, etc.) of entrepreneurship (Karlsson et al 2009).

influence decisions. Building on these insights, Hayek (1945) concluded that a key feature of a market economy is the distribution of knowledge across a large number of individuals. Consequently, divergence in the valuation of new ideas across economic agents, or between economic agents and decision-making hierarchies of incumbent enterprises, can also be expected. That constitutes one fundamental source of entrepreneurial opportunity and also implies a market structures dominated by imperfect information and imperfect competition.

Another typical characteristic of knowledge is its non-excludability, implying that only part can be appropriated by the "owner" while part of knowledge diffuse to an indefinite number of users. Low costs in transmitting codified knowledge, together with considerable fixed costs in acquiring and compiling knowledge, points to the difficulties in knowledge producing activities.

Organization of knowledge production and entrepreneurship

The way knowledge production is organized has shifted over the years and distinct differences can also be observed between Europe and the US (Carlsson et al 2009). Furthermore, its organization is shown to have influenced the rate of entry of new firms. In the 19th century an interdependence emerged between the needs of the growing US economy and the contemporary rise of university education – what Rosenberg (1985) has called "endogenous institutions". In Europe the role of the universities was more oriented towards independent and basic research, as manifested by the Humboldt University in 1809. The difference in knowledge production seems to have given the US a technological lead in the 20th century, even though basic science was weak in the US until the 1930s/40s. The research university in the US was a post world war two institution, basically designed as a modified version of the Humboldt system, where competition and pluralism was kept.

To develop and improve the findings/inventions that were the base of the 2nd industrial revolution in the late 19th century, the beginning of the 20th century saw the development of corporate lab, where also basic research was conducted (the first corporate lab was set up in Germany in the 1870s). The close links between industry and science, characterized by collaborative research and two-way knowledge flows, were thus reinforced. Within firm research was much higher in the US than in Europe, employment of scientists and engineers grew tenfold in the US between 1921 and 1940.

During the 1940s there was a huge increase in R&D-spending driven by the war, while the following decades saw a decrease in R&D relative to GDP. Basic research diminished, but also firms cut down on their R&D spending. As a result, firms seemed to lose touch with their knowledge base, spin-offs declined and there was also less growth in large firms.

In the beginning of the 1980s the situation switched again, propelled by a number of institutional reforms directed towards intellectual property rights, pension capital and taxes. That was paired with a partly new set-up of organizations, such as SBIR where 2,5 percent of federal agencies research funding must go the SMEs, and deregulations of large part of the US economy that gave rise to new entrepreneurial opportunities. Thus, entrepreneurial opportunities were created through scientific and technical discoveries which were paralleled by governmental policies which inserted a new dynamism in the US economy. A shift followed away from large incumbent firms to small, innovative, skilled-labor intensive and entrepreneurial entities (Carlsson et al 2009).

To conclude this section, even though entrepreneurship is shown to be important for opportunity recognition, discovery and creation (Shane and Venkatamaran 2000), little is said about the origin of opportunities in the entrepreneurship literature. This thread is taken up by Acs et al (2009), suggesting that knowledge endowments, and the way knowledge spillovers are materialized, constitutes the perhaps most important source for entry and entrepreneurship. Obviously, new insights – knowledge – should be instrumental in the dynamics described by Schumpeter in the following way: "[I]ncessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one" (Schumpeter 1942, p. 83). How higher rates of entrepreneurship augments the possibilities of turning knowledge in to innovations and set forces of creative destruction into motion, will be further considered in the next section.

3. Entrepreneurship, opportunities and innovation

As discussed in section 2 the idea that opportunities are objective but the perception of opportunities is subjective has persisted in economic theory since long. The realm of opportunities is always present, it is the ability to identify such opportunities that determine whether they are revealed and exploited. Thus, there is a virtual consensus taken in the contemporary literature on entrepreneurship that it revolves around the recognition of opportunities and the pursuit of those opportunities (Venkataraman, 1997).[1] Identification of innovation opportunities is thus argued to constitute the specific tool of entrepreneurs (Drucker 1985).

For this tool to be efficiently used, a proper institutional setting is required to exploit entrepreneurial opportunities. Intellectual property rights have been shown critical in making entrepreneurship attractive (Murphy et al 1991), but a broader perspective on institutions are required, including incentive structures, market structures, openness, etc. Obviously, these are factors that largely fall under the control of a society and thus impact the opportunity space for entrepreneurs. Thus, the predominant view that the opportunity space is assumed exogenous in relation to entrepreneurship, whereas the individual abilities determine how entrepreneurs can exploit the given opportunities, seems too agnostic. From a policy point of view, such fated attitude towards the possibilities to influence entrepreneurial activity within an economy is far too passive. We will return to the policy implications in Section 6.

Hence, the previous section emphasized the role of innovation but said little about the prime source of entrepreneurial opportunities. The rest of this section will focus on the role of knowledge in creating opportunities that can be exploited through innovation, how different types of entrepreneurs accomplish different tasks, and also give a brief account of the empirical evidence in this strand of research. Initially we will discuss the differences between innovation and imitation, and the measurement problems related to innovations.

How to define and measure innovation?

Perhaps more than any other economist, Schumpeter (1911/1934) is explicit about the economic function of the entrepreneur. According to Schumpeter, the process of economic development could be divided into three clearly separate stages. The first stage implies technical discovery of new things or new ways of doing things, which Schumpeter refers to as invention. In the subsequent stage innovation occurs, i.e. the successful commercialization of a new good or service stemming from technical discoveries or, more generally, a new combination of knowledge (new and old). The final step in this three-stage process – imitation – concerns a more general adoption and diffusion of new products or processes to markets.[2]

[1] Shane (2003) presents a discussion concerning the differences between Schumpeterian and Kirznerian sources of opportunity where it is claimed that only Schumpeterian type of opportunity requires "creation" by the entrepreneur.

[2] Also Baumol (1990) separates between the innovator and firm creator (imitator).

Schumpeter was also clear about the difference between roles played by the inventor as compared to the innovator. Even though he foresaw situations when the roles could coincide, that was according to Schumpeter exceptions to the rule.

Obviously there are numerous pitfalls in the measurement of inventions and innovations. No matter what scale that is applied, measurement difficulties and subjective evaluation criteria may to a various extent distort data on knowledge and can always be subject to criticism.[1] Some frequently implemented knowledge variables are likely to miss essential parts, while others tend to exaggerate the knowledge content. The most commonly applied measure of knowledge exploitation and innovative activities are R&D-expenditures or patents. [2]

R&D-expenditures suffer from the apparent drawback of applying input measures in order to approximate innovative output. Patent is a better performance variable but does also suffer from serious limitations. Patents can be expected to reflect conditions (red tape, financial sector quality, etc) that affect the decision to innovate.[3] It is also likely to be more closely related to the type of innovative and productive entrepreneurship that has been emphasized by Schumpeter and Baumol (Earle and Sakova 2000). Patent authorities do however rarely know whether patents been commercialized, nor do they know whether commercialization was successful, or the size of the inventing firm. Still, patents are widely used and is also claimed to be a fairly reasonable measure of innovativeness (Acs et al 2002).

An interesting and more relevant measure to separate between invention and innovation using patent data is to implement quality adjusted patents (Lanjouw and Schankerman 1999, Hall et al 2000). As shown by for instance Ejermo (2008, 2009), regional innovation is better explained by quality-adjusted patent data and is shown to be highly correlated with regional R&D, whereas inter-regional R&D fails to reveal any significant impact on regional innovation.[4]

Turbulence, i.e. entry and exit of firms, is yet another indicator proposed to capture innovative activity. However, firms' death and birth seem correlated with many factors whereof some are internal to firms (mismanagement, inexperience, retirement, etc.) while others are associated with innovation by incumbents and threat of entry (Baumol, Panzar and Willig 1982). In addition, some sectors with many entry and exits (for instance consumer services) can hardly be identifies as innovative, rather entry takes place due to imitation. Net entry, supposed to capture expansion of new and innovative industries, has therefore been suggested as a better proxy for innovative entry.[5]

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[1] Obviously the same measure weaknesses appear with regard to countries' knowledge capital.

[2] Patents, and patents citations, are also frequently used as a proxy for knowledge spillovers (Jaffe et al 1993, 2000, Acs et al 2002, Furman et al 2002).

[3] See Braunerhjelm and Svensson (2009) and the references there.

[4] Mairesse and Mohnen (2001) suggest using an alternatives measure based on the composite of the share in sales attributed innovative products, R&D, proximity to basic research and market structure (competitiveness).

[5] Gort and Klepper (1982), Klepper and Graddy (1990), Jovanovic and McDonald (1994), Klepper (1996) and Agarwal and Gort (1996).

A symbiotic relationship between large and small firms?

The Schumpeterian separation between the inventor and the entrepreneur has repeatedly been challenged (see for instance Schmookler 1966). At the same time good reasons for integrating the inventive and innovative stages has been presented in the industrial organization literature. Grossman and Hart's (1986) seminal article refers to the contractual problems when information is asymmetric, which could be overcome through vertical integration. On a more aggregate level, the merging of the inventive and innovative stages is present in the earlier neo-Schumpeterian growth models.[1] Baumol (2002) emphasize the symbiosis between small and large firms in his David and Goliath innovation framework.

In the management literature Teece (1986, 2006) presents a "nascent neo-Schumpeterian theory", where he outlines the strategic implications of commercializing an invention in an independent firms set up by inventors, as compared to licensing it to an incumbent firm. He identifies three key factors that determine whether it would be the inventor, the following firms, or firms with related capacity – or complementary assets – that extract the profits from an invention: i) the institutions tied to IPRs, ii) the extent to which complementary assets were needed for commercialization, and, iii) the emergence of a dominant design. Teece was thus not primarily preoccupied with the organizational regime between the inventor and the innovator rather he stressed the prerequisites governing the entry mode irrespective of whether it was the inventor or the innovator/entrepreneur that was about to launch a new product. Furthermore, the presence of large incumbents could be essential for the emergence of a market for "ideas", i.e. large firms could procure and develop small firms' inventions (Norbäck and Persson 2010).

Thus, there seems to be a number of important reasons why small and large firms complement each other which is likely to influence the innovation processes. The gains of specialization are at the bottom of this argument where entrepreneurs/small firms simply perform better than large firms with respect to certain activities. And vice versa. Related to this is also the issue of agglomeration and knowledge spillovers to which we return in Section 5.

Leads, laggards and technological regime

In a series of papers Aghion et al (2001, 2004, 2005, 2006) has examined the innovative activities in technologically leading industries as compared to other industries (laggards). A number of interesting results originates from those studies.[2] In particular, the induced effects of entry on incumbents' innovation and productivity are shown to differ across heterogeneous industries. How does firm entry influence innovation incentives and productivity growth in incumbent firms? In the earlier contributions it was shown that incumbents in more advanced industries increase their innovative activities, hoping to circumvent the negative effects of competition based on innovative entry. The authors refer to this mechanism as the "escape entry effect through innovation". However, laggards have no or little hope of winning against

[1] See Braunerhjelm (2008) and Aghion and Griffith (2005) for surveys.

[2] For references to related papers in the industrial organization vein, see those papers. See also Aghion and Griffith (2005).

entrants, thus they rather tend to reduce innovation due to entry, which is referred to as the Schumpeterian appropriability effect of product market competition.

In Aghion et al (2006) the analysis is extended to account for entry by foreign firms, i.e. foreign direct investments. A similar dynamics is shown to induce incumbents in technologically advanced industries to increase their innovative efforts due to foreign entry (or threat of), whereas the opposite prevails in laggard industries. Successful innovation prevents entry. In laggard industries it discourages innovation since entry reduces the expected return from innovating, which is labeled the discouragement effect.

Thus, entry of new firms – domestic or foreign – initiates an improved allocation of inputs and outputs tend to trigger knowledge spillovers and affect innovation incentives among incumbents. But the dynamics will differ between industries and in order to reap the potential welfare effects of a structural adjustment within and between industries, different policies are required for different industries.

In the evolutionary framework developed by Nelson and Winter (1982) the questions of the origin of variation (innovation), how selection of innovations take place, and the way in which such selected variation is transmitted between periods, are addressed. According to Nelson and Winter, the answer refers to routines that are claimed to have gene-like stability (inheritance) properties, combined with an ability to mutate, i.e. induce variation. Thus, routines drives evolution and different modes of innovation are suggested to occur through the exploitation of opportunities due to specific knowledge regimes associated by the particular industry context. Hence, large incumbent firms are modeled as investors of R&D and other knowledge creating efforts, which are referred to as a routinized technological regime. These are then exploited by the same firms, where the selection of winners (innovation and higher productivity) is influenced by exogenous, stochastic factors.[1] Alternatively, other regimes based on imitations or where entrepreneurs or the small firms are considered to have the capacity of exploiting commercial opportunities without relying on R&D, may also exist. Winter (1964, 1984) refer to those as entrepreneurial technological regime.[2]

Endogenous entrepreneurship

Summarizing the above discussion and drawing on the discussion in Section 2, knowledge, broadly defined, and the institutions governing the diffusion and ownership of knowledge, seems to constitute the most important aspects of innovative entrepreneurship. Individuals with a certain mix of abilities and characters described in the previous section, tend to engage in entrepreneurial processes which are characterized by search, uncertainty and randomness. A conspicuous feature of entrepreneurs seems to be that they

[1] Implying that the difference for this sector as compared the neoclassical innovation production function (Dasgupta and Stiglitz 1981, Pakes and Griliches 1984), Mairesse et al 1991, 1993, 2004), perhaps is not that large.

[2] See Witt (2002) for a criticism of the evolutionary dynamics in the Nelson and Winter model. Winter (1984) introduces entry and exit where firm level productivity is stochastically determined. The entering firm decides ex post whether it should belong to the routinized regime, which yields lower but safer returns, or the entrepreneurial regime where potential profits are higher but also uncertain

constantly get involved in experiments, where many different varieties and models may be tried out before the right one is found (Rosenberg and Birdzell 1986). In order to function, such an experimentally organized economy requires a proper institutional setting. Property rights, intellectual as well as to the entrepreneurial rent, and non-stigmatizing failure mechanisms, seems to be some of the cornerstones of an appropriate institutional setting that is conducive to entrepreneurial activities.[1]

Taking that as their point of departure, Acs et al. (2004, 2009) argue that the exploitation of knowledge depends on the broad spectrum of institutions, rules and regulations, or, in their terminology, an economy's knowledge filter. The knowledge filter is the gap between new knowledge and economic knowledge or commercialized knowledge. The thicker is the knowledge filter, the more pronounced is the gap between new knowledge and new economic – i.e. commercialized – knowledge. This relates to Arrow's (1962) perception of knowledge, stressing that knowledge differs from other factors of production. The expected value of any new idea is highly uncertain, and as Arrow pointed out, has a much greater variance than would be associated with the deployment of traditional factors of production. Arrow emphasized that when it comes to innovation, there is uncertainty about whether the new product can be produced, how it can be produced, and whether sufficient demand for that visualized new product might actually materialize.

Thus, both the individuals and the contexts in which agents operate have to be integrated in the model. In other words, the individual-opportunity nexus has to be operationalized. The key issue – often disregarded – is that even though new knowledge leads to opportunities that can be exploited commercially, it has to be converted into commercial applications. Such opportunities rarely present themselves in neat packages; rather they have to be discovered and applied commercially (Shane and Eckhardt, 2003). In particular, the uncertainty, asymmetries and high transaction costs inherent in knowledge generate a divergence in the assessment and evaluation of the expected value of new ideas. It means that ability to commercialize knowledge – to become entrepreneurs – also vary across individuals.

Building on these insights, Acs et al (2004, 2009) model the supply of entrepreneurs as a function of i) the societal investments in knowledge, i.e. the existing knowledge stock at a given point in time, and ii) how efficient the economy works (the knowledge filter, i.e. the design of the institutional setup), and iii) the given individual entrepreneurial ability. In addition, culture and traditions and institutions, i.e. country- or region-specific factors, influence entrepreneurship. Those are the building blocks of the knowledge spillover theory of entrepreneurship, presented by Acs et al. (2004, 2009). More precisely, production of new products/qualities can either occur due to an invention of incumbent firms investing in R&D, or by entrepreneurial start-ups where existing knowledge is combined in innovative ways which do not require any investment in R&D. [2] Instead, individuals combine their given entrepreneurial ability (where higher

[1] See Baumol (1990), Eliasson (2007), Johnson et al (2000), Boetke and Coyne (2003), Acemouglu et al (2004) and Powell (2008).

[2] Compare the resource-based views (Penrose 1959, Barney 1991) which stressed heterogeneous internal resources and capabilities. The early evolutionary neo-Schumpeter also acknowledged the role of internal factors but focused on sector characteristics and technological regimes (Malerba and Orsenigo 1993).

ability increases the probability of success) with the overall knowledge stock within an economy to discover commercial opportunities. The societal knowledge stock is a composite of previous knowledge stemming from activities by incumbents and start-ups, i.e., knowledge refers not only to scientific discoveries but also to knowledge associated with novel ways of producing and distributing in traditional businesses, changing business models, new marketing strategies, etc.

To summarize, endogenous entrepreneurs seem to be one crucial vehicle in transforming knowledge into useful goods and services. In other words, spillovers are actually generated through entrepreneurs, simultaneously as commercial opportunities is increasing in a larger stock of knowledge. By serving as a conduit for the spillover of knowledge that might not otherwise be commercialized, entrepreneurship is one mechanism that links knowledge to commercialization and economic growth (see section 4). A mobile working force may be another mechanism. From that perspective there are undoubtedly many mechanisms that may also impede the commercialization of knowledge – and growth – which opens up a new field of economic policies as compared to the traditional growth instruments of taxes and subsidies (see section 6).

Innovation, entrepreneurs and small firms: ´The empirical evidence

As pointed out by Audretsch et al. (2006), there is an interesting contrast between most predominant theories of the firm and the entrepreneurial literature's assumption on opportunity. According to the former, innovative opportunities are the result of systematic and purposeful efforts to create knowledge and new ideas by investing in R&D, which subsequently are appropriated through commercialization of such investments (Griliches 1979, Chandler 1990, Cohen and Levinthal 1989, Warsh 2006), which stands in sharp contrast to the entrepreneurial tradition of a given, exogenous opportunity space.

As regards the empirical evidence, several studies reach the conclusion that irrespective of modest R&D investments, small and entrepreneurial firms contribute substantially to aggregate innovation (Audretsch 1995b, Feldman and Audretsch 1999). Micro studies also suggest that entrepreneurs/small firms have their knowledge producing activities spread across a number of different functional areas apart from formal R&D activities (Freel 2003) and that these firms draw on many knowledge sources other than R&D in their innovation (Shane 2000).

In a couple of papers Acs and Audretsch (1988, 1990) provide interesting results for the U.S. Notwithstanding that the large corporations account for most of the country's private R&D investments, there are substantial differences across industries and large firms did not account for the greatest amount of innovative activity in all industries. For example, in the pharmaceutical and aircraft industries the large firms were much more innovative, while in computers and process control instruments small firms contributed the bulk of innovations. More precisely, their results indicate a small-firm innovation rate in manufacturing of 0.309, compared to a large-firm innovation rate of 0.202. Their findings links to the suggested restraints on innovation capacities in large firms discussed in section 2.3. Similar results are obtained by Baldwin and Johnson (1999), who confer a particular important role to small firm innovations in the electronics, instruments, medical equipment and biotechnology industry. Baldwin (1995) suggests that more successful firms adopt more innovative strategies.

Based on a detailed Swedish data set, Andersson and Lööf (2009) show that one third of patent applications in the manufacturing sector emanates from firms with less than 25 employees. Moreover, compared to non-patenting firms, firms engaged in patenting have more skilled labor, larger profit margin and better access to bank loans, and also belongs to the high-technology segment of industry. In addition, a substantial share of patenting small firms has links to a Swedish multinational enterprise (MNE). Persistence is also shown to be high, 99 percent of those not applying in one year did not do so in the subsequent year, while 50 percent firms with more than 25 employees applied in the subsequent year and 17 percent of those with less than 25 employees. Access to skill, internationalization (export share) and links to an MNE are most strongly correlated with small firm patenting.

Patent data have also been used to examine differences in commercialization performance between new firms and existing firms. Braunerhjelm and Svensson (2009), also using a Swedish data-set, show that commercialization performance is superior when a patent is sold or licensed, or when the inventor is employed in an already existing firm, as compared to the alternative when the inventor commercializes in his own existing or new firm. This supports Schumpeter's view that entrepreneurs have superior skills in commercializing new knowledge (innovating). On the other hand, the analysis also shows inventor participation during the commercialization is important. One interpretation is that the inventor is crucial for further adaptation (custom specific, etc.) of the innovation, but also in order to reduce uncertainty about the firm's capacity.

Thus, entrepreneurs and small firms exploit existing knowledge – through their network and links to other knowledge producers – to satisfy their specific needs in the production of goods and services. Thereby they also produce new knowledge, even if it does not show up in the R&D-statistics. Sometime they do so independently, some time in conjunction with other firms, e.g. inventors or MNEs. But the process differs radically as compared to large, R&D-investing, firm.

Another difference relates to the intertemporal dynamics within large enterprises. As they set out to attain established growth targets, it tends to make incumbents less adapt to change a system that may affect the usefulness or value of an existing production structure (Christensen 1997). Similarly, Aldrich and Auster (1990) make the simpler argument that the larger and older the firm, the less receptive to change the organization becomes. As a result, incumbents have an inherent tendency to develop and introduce less-risky, incremental innovations into the market.

Contrast that with new ventures. These are more prone to develop, use, and introduce radical, market-making products that give the firm a competitive edge over incumbents (Casson 2002a, 2002b, Baumol 2007a). Thus, new firms are not constrained by path dependencies and partial lock-in effects; rather they compete through innovation and Schumpeterian manners of creative destruction.[1] That also suggests that radical innovations will more likely stem from new ventures (Scherer 1980, Baumol 2004), in particular if new firms have access to knowledge spillovers from the available stock of knowledge. Therefore they are

[1]Creative destruction is though not solely a function of entry and small but also relate to innovation within large firms as well as mergers and acquisitions (Jovanovic and Rosseau 2002, Eliasson and Eliasson 2002).

likely to play a distinct and decisive role in the transformation of knowledge-based economies. Moreover, an impressive share of radical breakthrough innovations stem from entrepreneurs and small firms. Almeida and Kogut (1997), and Almeida (1999), show that small firms innovate in relatively unexplored fields of technology.[1]

Also Block et al (2009) emphasize the role entrepreneurs and small firms in their empirical test of the knowledge spillover theory. As a starting point they conclude that knowledge (in terms of R&D-outlays) has been shown to positively influence growth, but that there remain large and unexplained differences across countries. They attribute those differences to varying thickness of the respective country's knowledge filter. The empirical analysis covers 21 European countries for the period 1998-2006, and innovation is defined as either the share of turnover accounted for by new products in firms, or the share of turnover from new or improved goods that are new to the market. Country's level of knowledge is defined as the share of firms that have applied for at least one patent. In the empirical analysis, where community innovation data is pooled with country level data, they find statistical support for entrepreneurship being an important vehicle for turning knowledge into innovative product, contrasting imitating firms/products where no such effect could be detected. They also show that innovative activities have increased compared to imitative in the investigated period. Their interpretation is that this reflects a switch to a more entrepreneurial regime, replacing the traditional managerial regime.

Thus, empirical evidence stress the new and growing firms role in introducing new products and processes, come up with business model innovations, and develop new markets as well as changing the rules of the game of their industries (Bhide 2000). Apart from those changes, they also generate employment. Apparently those processes are in turn likely to render substantial knowledge spillovers. The implication is that only a subset of innovations are normally taken into account in the most commonly applied measures, such as patents and outlays on R&D.

So far we have explored how entrepreneurial activity impact innovation, the measurement difficulties in identifying innovative activities, and the role of institutions. In particular, we have emphasized the role of institutions that governs ownership, knowledge production and knowledge diffusion and its interface with entrepreneurship. In the next section the objective is to show how these processes integrates into the growth process, and the extent to which this is captured in contemporary growth models.

[1] Rothwell and Zegveld (1982), Baumol (2004), Ortega-Argilés, Vivarelli and Voight (2009).

4. Entrepreneurship and growth

Contemporary models of economic growth are based on investment and exploitation of knowledge as the prime source of economic development. Growth performance may however differ across countries, even though countries may have similar, albeit not identical, knowledge endowments and institutional design. Simultaneously, a frequent empirical regularity seems to suggest that economic growth is highly correlated with abundance of small, entrepreneurial firms. In fact, an emerging empirical literature suggests that entrepreneurial startups are important links between knowledge creation and the commercialization of such knowledge, particularly at the early stage when knowledge is still fluid. About two thirds of all empirical studies on entrepreneurship/small firms and growth reach the conclusion that there is a positive, and generally quite strong, correlation between these variables (Karlsson and Nyström 2007).[1] Hence, knowledge by itself may only constitute a necessary – but far from sufficient – condition for growth.

In this section we will review the theoretical growth models and present the empirical evidence concerning the relationship between knowledge, entrepreneurship and economic growth.

Knowledge-based growth

The seminal contribution of the knowledge-based (endogenous) growth models that appeared in the mid 1980s was to show that investments in knowledge and human capital were undertaken by profit-maximizing firms in a general equilibrium setting.[2] Whereas firms invested in R&D to get a competitive edge over its competitors, part of that knowledge spilled over to a societal knowledge stock that influenced the production function of all other firms, augmenting their productivity. Hence, growth was disentangled from investments in capital and increases in labor supply: even if those remained constant, increases in knowledge meant that growth would increase.

The first wave of endogenous growth models (Romer 1986, Lucas 1988, Rebelo 1991, and others) emphasized the influence of knowledge spillovers on growth without specifying how knowledge spills over.[3] Yet, the critical issue in modeling knowledge-based growth rests on the spillover of knowledge. That is, even though an economy invests heavily into R&D, the mechanisms by which this knowledge spills over and is converted into goods and services, is basically unknown.

This was to some extent remedied in the second generation of endogenous growth models (Schmitz 1989, Segerstrom, Anant and Dinopoulos 1990, Segerstrom 1991, Aghion and Howitt 1992, Cheng and Dinopoulos 1992, Segerstrom 1995). Predominantly the neo-Schumpeterian models designed entry as an R&D race where a fraction of R&D turns into successful innovations. While this implies a step forward, the essence of

[1] See Braunerhjelm (2008) and van Praag and Versloot (2007) for surveys.

[2] For a survey of neoclassical growth models, see Braunerhjelm (2008).

[3] See also Precsott and Boyd (1987) who modeled production externalities as a function of coalition contracts between senior, experienced workers and younger less experienced. Diminishing return set as in the numbers of younger workers increased. Compare Lucas (1978) work on the role of talented management and the allocation of resources.

the Schumpeterian entrepreneur is missed. The innovation process stretches far beyond R&D races that predominantly involve large incumbents and concern quality improvements of existing goods.

In the most recent vein of knowledge-based growth models the focus is narrowed and more well-defined. Most prominent among those are the effects of technology-based entry on the innovativeness and productivity of incumbents, and the implications of firm heterogeneity on creative destruction and growth (Aghion and Griffith, 2005). As regards the first issue, the analysis follows an industrial organization tradition that examines the effects of preemption, entry regulation, strategic interaction, etc. (Gilbert and Newbery 1982, Tirole 1988, Laffont and Tirole 1993, Nickell 1996, Blundell et al. 1999, Berry and Pakes 2003, Aghion et al. 2006). The new element is that these models take into account the effects of competition and innovation of both incumbents and new firms. For instance, Aghion et al. (2006) has shown that entry – or entry threats – has positive effects on the innovative behavior by incumbents close to the technological frontier, while no such effects could be found for technological laggards (see the discussion in Section 3).

Concerning the analysis of firm heterogeneity, entry, and productivity, the basic reasoning is that elevated firm specificity in performance (stock evaluation, profits, etc.) is associated with a growing number of smaller and new firms (Pastor and Veronesi 2005, Fink et al., 2005). Moreover, firm specificity is seen as reflecting creative destruction, enhanced efficiency and higher productivity and growth (Durnev et al. 2004, Aghion et al. 2004, 2005, Acemoglu et al. 2003, 2006 and Chun et al., 2007). An increased influence of small firms and start-ups is associated with deregulation, increased competition, etc., but also because new and young firms are more prone to exploit new technologies or knowledge (Jovanovic and Rousseau 2005).

Klette and Kortum (2004), building on Penrose's (1959) resource based theory of the firm, present a multi-firm, multi-variety model where the innovation production function combine codified (or known) knowledge with current ongoing R&D to produce new or improved goods. Entry occurs when startups produce higher quality products as compared to those varieties produced by the incumbents. Embarking from a standard endogenous growth model, Acs et al (2004) and Braunerhjelm et al (2009) present at theoretical model which includes the Schumpeterian entrepreneurs that innovate but are not involved in R&D-activities (see the appendix).

Thus, notwithstanding that knowledge-based growth models implied a huge step forward in understanding growth, the precise microeconomic mechanisms needs to be further pinned down. A number of empirical studies find ambiguous support for knowledge variables as explanations of aggregate growth (Jones 1995a, 1995b, 2006). Based on these empirical irregularities, and the discussion in section 2 and 3 concerning knowledge dissemination and innovation, the key issue in growth still revolves around the exact implementation and transformation of knowledge into commercial value, i.e. knowledge spillovers. A conceivable missing link in much of the contemporary growth literature relates to the incorporation of the "true" Schumpeterian entrepreneur. The latter, as shown in previous sections, constitute a bridge between opportunity and economic outcome, thereby influencing how knowledge is more or less smoothly filtered and substantiated into business activity. Coming to grips with the microeconomic foundations of growth also have important bearings on the effectiveness of policy recommendations.

The microeconomic foundation of contemporary growth models

Scrutinizing the knowledge-based growth models reveals that they rest on three cornerstones: knowledge externalities, increasing returns in the production of goods, and decreasing returns in the production of knowledge. These are considered to provide a microeconomic foundation for explaining the mechanisms that promote growth at the macro level. Here we narrow down the discussion to how representative some of the properties of these building blocks are for real world behavior.

First, the ability of incumbents to absorb knowledge spillovers can be questioned (as discussed in the previous section). As shown above, the potential advantages in knowledge sourcing are often impeded by the inherit incentive structures within the firm. If we take the view proposed by Cohen and Levinthal (1990) that at any given point in time absorption capacity depends on the knowledge accumulated in prior periods, i.e. the need to remain within a well-defined product space when innovating, it is not surprising that absorption and transformation of knowledge becomes path dependent. Empirical evidence quite persuasively also reveals that a large number of radical breakthrough innovations originate in small, less R&D-intensive, but entrepreneurially geared firms. Some of the current examples are Microsoft and Google, who exploit, develop and use existing technologies but had none – or modest – R&D facilities initially. In fact, the entrepreneurs behind these firms share several of the typical characteristics of the Austrian prototype entrepreneur. Other likely examples of growth enhancing entrepreneurial firms are Ikea and HM of Sweden, and Walmart and Starbuck of the US. These firms have no research departments (but do undertake activities that could be labeled development), but has certainly contributed to knowledge by introducing new business models and developing new markets.[1]

Whereas the production of knowledge shifted from being exogenous in neoclassical growth model to becoming endogenous in the knowledge-based models, the critical issue for growth - diffusion of knowledge - is by and large still exogenous. Knowledge is thus a necessary but far from sufficient condition in order to attain growth (Nelson and Pack 1999, Acs et al 2009). In a sense, the Solowian technical residual can be argued to have been transformed into an entrepreneurial residual.

As second strand of criticism concern the inter-temporal and indirect effects of entrepreneurship on aggregate growth. Also these are largely unaccounted for. Assuming an influx of firms that intensifies forces of creative destruction and raises the "adjustment pressure", knowledge regarding "when and how" is still quite rudimentary.[2] The indirect effects – such as increasing competition, the replacement of older and less productive firms – may be more important than the direct effects (Robinson et al 2006). These dynamic effects have largely been ignored. Similarly, exits, being the other critical component of creative destruction

[1] Kim et al (2006) conclude that startups promote new and more flexible organizations.

[2] This has been noted since long by e.g. Kirzner (1973), Geroski (1995) and Nickell (1996) and the previous references to Aghion et al in section 3. Johnson and Parker (1996), Dejardin (2008) and Thurik and Carré (2008) show that net entry have a positive lagged effect on regional growth while Dejardin (1998) failed to find such a relationship. As argued the entry/exit process is characterized by a considerable degree of heterogeneity and will not necessarily generate creative destruction and economic progress (Manjón-Antolin 2004, Vivarelli 2007). Cabral (1997) even claims that most entrepreneurial ventures are entry mistakes.

and dynamics, not least because it releases the resources needed in expanding other parts of the economy, is much less researched than entry. [1]

The empirical evidence

Entrepreneurship, knowledge and national growth

The link between knowledge production and productivity at the micro-level is well established.[2] At a higher level of aggregation, empirical analyses become more intricate as endogenity and causality issues make the interpretation of the results considerably harder. Still, a number of recent empirical studies suggest that entrepreneurship – measured as startup rates, the relative share of SMEs, self-employment rates, etc. – is instrumental in converting knowledge into products and thereby propelling growth.

For example, Thurik (1999) provided empirical evidence from a 1984-1994 cross-sectional study of the 23 countries that are part of the Organization OECD, that increased entrepreneurship, as measured by business ownership rates, was associated with higher rates of employment growth at the country level. Similarly, Audretsch et al. (2002) and Carree and Thurik (1999) find that OECD c countries exhibiting higher increases in entrepreneurship also have experienced greater rates of growth and lower levels of unemployment. See also Wennekers and Thurik (1999).

In a study for the OECD, Audretsch and Thurik (2002) undertook two separate empirical analyses to identify the impact of changes in entrepreneurship on growth. Each one uses a different measure of entrepreneurship, sample of countries and specification. This provides some sense of robustness across different measures of entrepreneurship, data sets, time periods and specifications. The first analysis measures entrepreneurship in terms of the relative share of economic activity accounted for by small firms. It links changes in entrepreneurship to growth rates for a panel of 18 OECD countries spanning five years to test the hypothesis that higher rates of entrepreneurship lead to greater subsequent growth rates. The second analysis uses a measure of self-employment as an index of entrepreneurship and links changes in entrepreneurship to unemployment at the country level between 1974 and 1998. The different samples including OECD countries over different time periods reach consistent results – increases in entrepreneurial activity tends to result in higher subsequent growth rates and a reduction of unemployment.

Acs et al. (2004) and Braunerhjelm et al. (2009) find a positive relationship between entrepreneurship and growth at the country level examining 20 OECD-countries for the period 1981-2002. The impact is considerably stronger in the 1990s than in the 1980s, while the importance of R&D seems to diminish in the latter time period. Salgado-Banda (2005) implements a measure of innovative entrepreneurship based on quality adjusted patent data for 22 OECD countries, which is reported to positively influence growth while no such effect could be established for self-employment.

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[1] Bartelsman et al (2004) show that the faster pace of exits in the US as compared to Europe has had positive structural effects.

[2] See Adams (1990), Lichtenberg (1993), Caballero and Jaffe (1993), Coe and Helpman (1995), Baumol (2007), LeSage and Fischer (2008) and Naudé 2008).

Acs and Armington (2002) asked the question what the relative contribution of new firms is in terms of new jobs? They conclude that new firm start-ups play a far more important role in the economy than has previously been recognized. For the U.S. economy as a whole they show that for the first half of the 1990s new establishments accounted for a considerably larger share of job creation than already existing establishments. As discussed in a previous section, at more disaggregated spatial units – i.e. a city, region or state – the empirical evidence corroborates the results at the national level. They also find that new firms are more important than the stock of firms in a region, but the manufacturing sector appears to be an exception. This is consistent with prior research on manufacturing.

Similar results are found in studies by van Stel and Storey (2004), Baptista et al (2008) and van Stel and Suddle (2008). In addition, Fritsch and Muellers (2004) argue that these effects are strongest in the earliest stage of the firm's life cycle. In a recent paper by Glaeser and Kerr (2009) it is shown how a 10 percent increase in the number of firms per worker increase employment growth with 9 percent, while a 10 percent increase in average size of firms is claimed to result in a seven percent decrease in employment growth due to new startups.[1]

At the firm level, startups are more likely to grow and create new jobs (Johnson et al 2000, Lingelbach et al 2006). The pattern seem however to differ between the U.S. and Europe. The probable reasons to these differences is allotted the institutional set-up (Storey 1994, Davies and Henrekson 1997).While in Europe the main effect accrues to firms employing one or two new persons (Wiklund 1998, Andersson and Delmar 2000), growth in the U.S. is claimed to be dominated by a small number of new entrepreneurial firms exhibiting extraordinary growth ("gazelles"). Of course, gazelle effects also exist in other countries (Wiklund and Shepherd 2004). They can also be found in all types of industries even though they seem to emerge more frequently from exploiting new knowledge (at least in the U.S.). As shown by Henrekson and Johansson (2009), the importance of gazelles seems to have increased over the years.

At the regional level numerous studies – which has the advantage of being exposed to basically the same institutional setup – appear where regional entrepreneurship but also knowledge seems significantly related to regional prosperity.[2] Different variables have been used to capture entrepreneurial activities. Using an industry turbulence variable Fritsch (1996) concluded that entry and exits impact growth. Dejardin (2008), implementing a net entry variable to capture entrepreneurship, found positive lagged effects for entry in the service sector 1982-1996 on growth.

A recent study by Sutter (2009) on US data attributes 90 percent of regional variation in growth (total factor productivity) to the regional knowledge stock (patent) and regional new firm formation. Entrepreneurship is

[1] The results are corroborated by MacMillan and Woodruff (2002) and Audretsch et al (2006).

[2] See Ashcroft and Love (1996), Fritsch (1997), Audretsch and Fritsch (2002), Acs and Armington (2002), van Stel and Storey (2002), Carre et al (2002) and Klapper et al (2006). A number of studies report a positive correlation between knowledge and regional prosperity. However, as stressed by several scholars, these studies suffers from numerous problems, e.g. the complex dynamics between R&D and its commercial applications (Disney 2003, Scarpetta et al 2002, Erken et al 2008), fail to account for physical and human capital factors/stocks (Holtz-Eakin and Kao 2003, Heden 2005, Foster et al 2006). Thus, much of the variation in productivities may have little to do with differences in knowledge or technology.

however claimed to have an effect on growth that is five times larger than knowledge.[1] Thus, the empirical evidence hints at knowledge being important for steady-state economic growth simultaneously as its commercial introduction through new ventures/firms has a dramatically larger impact.

Countries at different level of economic development

Do the effects of entrepreneurship on growth and productivity differ with respect to countries' level of development? We take Rostow (1960) as our point of departure, who suggested that countries go through five different stages of economic growth in as they develop, ending in a stage labeled the age of high mass-consumption. Following that thread, Porter et al (2002) presented a growth cycle consisting of three stages: the factor driven, the efficiency driven and the innovation driven. Hence, countries at different level of development can be expected to display not only diverging production structures, but also when it comes to smaller firms and entrepreneurs (Acs and Szerb 2009).

In a neo-Schumpeterian growth model context, innovative entrepreneurship is claimed to be the specific mechanism through which productivity growth is introduced in advanced economics, contrasting less developed countries where diffusion of previous innovations and previously developed technology spur productivity growth (Acemouglu et al 2006). Hence, technological innovation is brought about through the creation of new knowledge made manifest in production by entrepreneurs in developed economies, while diffusion to a larger extent is driven by capital investment channeled through established firms (Ertur and Koch 2008). The presence of technological interdependence between countries is claimed to facilitate the diffusion of technologies from leading to lagging economies, thereby speeding up productivity among laggards.

The causes of structural change thus differ between economies at different level of development (Nelson and Pack 1999, Gries and Naudé 2008, 2010). In developing countries with advantageous cost structures, entrepreneurship based on imitation together with inflows of foreign firms and investments by large incumbents, serve to achieve this end (Rodrik 2007). In more advanced economies innovation and structural change is more likely to take place through the combined efforts by entrepreneurial small ventures and large innovative firms (organized R&D), complementing each other (Nooteboom 1994, Baumol 2002).

Some empirical support for the different kind of technology diffusion and dynamics is provided by Stam and van Stel (2009). They pool microeconomics data (GEM) with more aggregate data and find that entrepreneurship has no growth effect in low income countries.[2] In high income and transition countries the opposite prevails, particularly with regard to opportunity based entrepreneurship. The positive effects are most pronounced in the transition economies which is attributed ample entrepreneurial opportunities, a

[1] See also Glaeser et al (1992), Miracky (1993), Reynolds et al (1994), Acs and Armington (2006), Stam (2006) Glaeser (2007) and Naudé et al (2008) for analyses on the relationship between entrepreneurship and growth, the product cycle, technological progress and competition.

[2] Simultaneously as the average entrepreneurship rate is shown to be much higher in low- and middle income countries than in high-income countries (Ardagna and Lusardi 2008). In addition, in the former two categories of countries, necessity entrepreneurship accounts for about two thirds of startups, while that drops to 22 percent in high-income countries. EU has the lowest rate of entrepreneurial activity. This complements Wennekers (2005) U-shape model, where higher entrepreneurial activities are expected in low- and high-income countries, by stressing the type of entrepreneurship.

highly educated people and qualified entrepreneurs that are well connected to local networks. In addition, opportunity costs are low for potential entrants since alternative occupations are sparse.

To summarize section 4, theoretical advances, supported by empirical findings, clearly point to an increasing role for entrepreneurs in the growth process. Simultaneously, there are considerable gaps in our understanding of the structure and working of the microeconomic mechanisms in the growth process.

5. The geography of entrepreneurship, innovation and growth

The following section is devoted to a brief exploration of some of the dominant explanations as regards the spatial distribution, more precisely, the lumpiness of entrepreneurship and knowledge, which seems to be a distinct feature of the economic landscape. We will also touch upon the expected, and actual, consequences of geographically concentrated structures of economic activities. The mechanisms that have been identified tend to generate geographically concentrated production structures more generally is however beyond the scope of the current presentation. Rather, the ambition is to highlight some aspects of particular interest when it comes to the inter-locus of entrepreneurs and knowledge on one hand, and geographic proximity and growth, on the other.[1]

Why is geographical proximity important?

The modeling pillars of the geographical distribution of economic activities are transport and trade costs together with pecuniary and non-pecuniary externalities. The former type of externality refers to demand- and supply-linkages while the latter has to do with knowledge spillovers. If trade and transport costs are high, economic production structures will be dispersed with no or little trade. On the other hand, if they are very low or even zero, then location of economic activity is arbitrary.[2] It is somewhere in between where the largest consequences for the spatial distribution of production can be expected. Changing trade costs could thus induce an endogenous change in the location of production.[3] Once a critical mass has been established, self-reinforcing and centripetal forces set into motion. The counter effects, i.e. those that hinders all economic activities from being located in one place, are associated with congestion costs and rising costs of locally fixed production factors.

Serendipity is also involved when it comes to explaining spatial differences, particularly in the initial stages of the emergence of a cluster or agglomerated production milieu (Chinitz 1961, Kenney and Patton 2006, Scott 2006, Glaeser and Kerr 2009). One frequently cited example is the move by William Schockley's semiconductor business from the east coast to San Francisco. It was not the abnormal – if any – difference in returns that made Schockley relocate, but the fact that his sick mother lived close to San Francisco.

Entrepreneurship

When it comes to entrepreneurship and firm location, there is a large literature pointing to a positive effect of geographically concentrated environment on the location of firms and entrepreneurs. For instance, access

[1] For more general surveys of economic geography models, see Fujita et al (1999), Fujita and Thisse (2002), Thisse and Henderson (2004) and Braunerhjelm and Feldman (2006).

[2] For electronically transmitted products, trade and transports costs approaches zero.

[3] Note that the European economy has a considerably more geographically dispersed production than the US, which is explained by higher transport and trade costs (Braunerhjelm et al 2000). As those costs become lower due to European integration, a reshuffling of production and stronger geographic concentration can be expected. That will have implications at the regional level.

to finance and services, higher flow of ideas, larger markets and less swings in demand, together with lower entry costs, are among the most commonly cited advantages of agglomerated economic milieus.[1] A theoretical model of regional differences in startups has been presented by Greis and Naudé (2008), where, amongst other dynamic features, entrepreneurs can identify and exploit region specific opportunities, either through imitation or innovation. They supply intermediates to final goods producers, which link entrepreneurs to qualitative and structural change, and increased numbers of startups imply more of diversity and higher regional growth.

It is also claimed that environments characterized by small firm's causes more entrepreneurship by lowering the effective cost of entry through the development of independent suppliers, together with a larger and a more diversified supply of venture capital where risk capital investors more easily can spread risks.[2] Grek et al (2009) argues that the impact of regional size (local and external accessibility to gross regional product) is found to positively influence entrepreneurship (implementing several variables) in the service sector, whereas a negative influence of entrepreneurship seems to prevail in manufacturing and primary sectors. Verheul et al (2001) presents an overview of how decision at individual level are influenced by regional characteristics, including culture but also other region-specific institutions as well as demand and supply factors, generating differences in regional entrepreneurship.

The regional economic milieu as manifested in culture, knowledge base and business attitude, is also reported to be important for regional success and entrepreneurship (Camagni 1991). Nijkamp (2003) claims that access to knowledge, skills, density, opportunities, networks offers more favorable conditions for innovative entrepreneurship. In addition, new firms are frequently built around product knowledge that is geographically bounded (Wong et al 2005, Koster 2006). Van Ort and Stam (2007) argue that agglomeration effects have a stronger impact on entrepreneurship than on growth of incumbents (examining the information and communication industry). The reasons are alleged spatially more distributed organizations of large incumbents and a propensity to internalize their knowledge base.

An interesting empirical observation is that once entrepreneurs have established themselves I a region, they rarely move (Stam 2007), which seems to be particularly prevalent in high tech firms (Cooper and Folta 2000). Entrepreneurs are also more likely to be from the region of birth than workers and they operate stronger businesses than moved in entrepreneurs (Klepper 2001, Figueiredo et al 2002, Michelacci and Silva 2007). These findings suggest that at least semi-permanent differences and path-dependence exist in the spatial distribution of entrepreneurs.

The dynamics due to entry may differ over time.[3] In the short-run entry may yield price competition which in turn tends to increase purchasing power and over time also boost profits and diversity. It could also attract

[1] See for instance Chinitz (1961), Jacobs (1970), Mills and Hamilton (1984), Hansen (1987), Saxenian (1994), Guimarães, Figueiredo and Woodward (2000, 2002) and Braunerhjelm and Feldman (2006).

[2] See Thornton and Flynne (2003), Backman (2009) and Glaeser (2009).

[3] Another dynamic feature is the expected correlation between regional entry and exit (Keeble and Walker 1994, Reynolds, Storey and Westhead 1994). A more dense environment tend to lower survival rate but also implies higher growth prospects for survivors (Fritsch et al 2006, Weyh 2006).

purchasing power from outside the region and overall make the region more attractive.[1] The region may than gain from both a pull on outside customers, leading to an increase in total regional expenditure, simultaneously as there is modest leakage of demand to other regions due to more varied and qualitative supply. In longer run, or if there are credible innovations-based entry (see previous sections) threats in the short-run, innovative activities can be expected to follow suit. Thus, entry and expansion of new industries can be expected to strengthen regional attractiveness.

Knowledge

Also with regard to knowledge production, a number of advantages of geographically concentrated structures have been observed. Proximity advantages present themselves in facilitating knowledge diffusion and creating proximity-based communications externalities. The importance of proximity to specific knowledge nodes, such as universities, has also been investigated. It is shown that the innovativeness is substantial and increasing in the presence of universities.[2] The effect is attributed to knowledge spillovers.

There is a virtual consensus that spillovers are locally bounded. The distance decay effect has also been established in a large number of studies.[3] Knowledge spillovers tend to be stronger for more technologically sophisticated production, and in more fluid and early stages of production of new knowledge. Innovative processes assessed by either patents, or quality adjusted measure of patents, indicate that innovation is more concentrated than inventive or production activities (Paci and Usai 1999, Ejermo 2009).

Consequently, innovation processes and entrepreneurial activity are to a high extent localized processes, one reason being that innovation frequently involves the exchange of complex knowledge which mainly takes place within the borders of a region. Innovation processes are thus governed by interdependencies, complementarities and networking between the different actors. Hence, innovation capabilities seem to stem from the interplay between generic knowledge and learning processes ´that are highly "localized" and embedded in the knowledge and market environment of each region.[4]

Regional growth

Apparently there is ample empirical evidence of the importance of geographical proximity for knowledge spillovers and innovativeness. But to what extent is that reflected in differences in regional productivity? As shown in Braunerhjelm (2008), a large number of empirical studies covering different geographical units and

[1] The effect is known as Reilly's Law (1931).

[2] The reader is referred to Braunerhjelm (2008) for a more detailed description of the studies regarding the proximity to universities, spillovers and growth.

[3] This literature goes way back. For more contemporary contributions, see for instance Hoover and Vernon (1959), Vernon (1962), Pred (1977), Leone and Struyck (1976), Acs et al. (1994), Acs (1996), Audretsch and Vivarelli (1996), Anselin et al (1997), Glaeser (1999), Feldman and Audretsch (1999), Anselin et al (2000), Keller (2002), Fischer and Varga (2003), Bottazi and Peri (2003), and the refences in those articles.

[4] Though Breschi and Lissoni (2001) argues in a critical article that a careful scrutiny reveals that spillovers are more of a pecuniary, market based nature rather than related to knowledge spillovers.

industries, reach the conclusion that geographical concentration of entrepreneurship and knowledge is associated with higher productivity.

One of the first studies on regional productivity was undertaken Ciccone and Hall (1996). They undertook a cross sectional study, based on U.S. data from 1988, on labor productivity and concentration at the county level. Controlling for knowledge (as measured by education levels) and capital-intensity, they found that the major explanatory power could be attributed regional employment density. In fact, according to their estimations, doubling the employment density at the county level increased labor productivity by six percent. Still, the issues addressed focused on density and knowledge while the impact of entrepreneurs was not included in the analysis. In a subsequent analysis (Ciccone, 2002) on European regions similar results were obtained.

Within the last decade there have been several attempts to pin down the relationship between entrepreneurship and regional growth. Reynold's (1999) study indicated a positive relationship for the United States, as did Holtz-Eakin and Kao (2003) analysis of the impact of entrepreneurship on productivity change over time. It is shown that variations in the birth rate and the death rate for firms are related to positive changes in productivity. Corresponding analyses on European data covering roughly the same time period report more ambiguous results. For instance, Audretsch and Fritsch (1996) and Fritsch (1997), implemented data on Germany from the 1980s and beginning of the 1990s, failed to detect any signs of entrepreneurship augmenting growth. However, rerunning their estimations for a later time period, Audretsch and Fritsch (2002) found that regions with a higher startup rate exhibited higher growth rates. Their interpretation was that Germany had changed over time, implying that the engine of growth was shifting towards entrepreneurship.

Callejon and Segarra (1999) used a data set of Spanish manufacturing industries between 1980-1992 to link new-firm birth rates and death rates, which taken together constitute a measure of turbulence, to total factor productivity growth in industries and regions. They adopt a model based on a vintage capital framework in which new entrants embody the edge technologies available and exiting businesses represent marginal obsolete plants. They find that both new-firm startup rates and exit rates contribute positively to the growth of total factor productivity in regions as well as industries. Similar results are reported by Bosma and Nieuwenhuijsen (2002), looking at 40 regions in Netherlands 1988 to 1996 and separating between service and manufacturing sector. Positive total factor productivity effects were observed for the service sector. The analysis is extended to the 2002 in Bosma et al (2008).

The positive relationship between entrepreneurship and growth at the regional level has also been concluded to prevail in Sweden. For example, Fölster (2000) and Braunerhjelm and Borgman (2004), find similar effects using Swedish data. Fölster (2000) examines not just the employment impact within new and small firms but the overall link between increases in self-employment and total employment in Sweden between 1976-1995. By using a Layard-Nickell framework, he provides a link between micro behavior and macroeconomic performance, and shows that increased self-employment shares have had a positive impact on regional employment rates in Sweden. Braunerhjelm and Borgman (2004) established a positive impact of entrepreneurs on regional growth measured as labor productivity. They also found that the effect was most pronounced for knowledge-intensive industries.

Regional performance may also be affected by the composition of industries (Klepper 2002, Rosenthal and Strange 2003). Even though a considerable number of studies have shown how innovative activities and growth seem to be higher in more diversified regions (Glaeser et al. 1992, Feldman and Audretsch 1999, Henderson and Thisse 2004), the issue of diversity versus specialization in regional composition of industries has been examined by pooling regional data with information on innovative activities. The empirical evidence as to whether knowledge externalities occur between industries (Jacobian externalities) or within industries (Marshall-Arrow-Romer externalities), is inconclusive (Braunerhjelm 2008).

Romanelli and Feldman (2006) looking at biotechnology clusters in the U.S. conclude that three ingredients are particularly decisive for regional development. First, their study reveals that about two thirds of the clusters were founded by local entrepreneurs and investors. Second, regions that exhibited sustained growth revealed a higher degree of spin-offs from local, i.e. first generation, firms. Third, a quite sizeable share (one third) of the entrepreneurs relocated from one metropolitan region to another to found new firms. The conclusion is that entrepreneurs are scanning attractive locations to which they relocate. These results corroborate the findings of Klepper (1996, 2002).

More recently LeSage and Fischer (2008) and LeSage and Pace (2009), assess the impact of regional knowledge stocks on regional total factor productivity (TFP), reached the conclusion that spatial factors must be taken into account. Both spatial and technological proximity are found to be important when examining the extent of regional spillovers. They implement an extended version of regional knowledge stocks to fully grasp available regional technical knowledge.

Sutter (2009), shows that entrepreneurship is clustered in space, and that there are latent unobservable and region-specific sources of variation in entrepreneurial activities which have an important influence on entrepreneurial activity. Growth in high-tech output as a share of regional output, per capita income and total private employment were the most important structural economic variables in determining regional entrepreneurship, suggesting path dependency in the high-technology. Also Sutter, implementing recent improvements in spatial econometric techniques, concludes that knowledge and entrepreneurship positively influence regional total factor productivity. In addition, distance to the technological frontiers seems to have no or modest impact on the contribution by entrepreneurs to total factor productivity. Discovery and exploitation of opportunities seem allied to both individuals and place (Schoonhoven and Romanelli 2005).

To conclude, a larger number of studies confirm that entrepreneurship, agglomerated knowledge structures and regional growth are interconnected in a complex way, but that the dominant share of spillovers seems to have a local origin.

6. Implications for economic policies

The previous sections generate some general observations. First, to achieve sustainable growth, policies have to embrace different but complementary parts of an economy. Apparently, economic performance cannot be disentangled from the legal and institutional context of an economy (North and Thomas 1973, Rosenberg and Birdzell, 1986).[1] In addition, a discrepancy between economic policies at the macro- and the micro-level may lead to a suboptimal growth path. A suboptimal policy mix as regards the conditions for diffusion of knowledge, as compared to accumulating knowledge, could impede countries and regions from reaching their potential growth trajectories (Jovanovic 2004, Miccelachi 2004).

Thus, irrespective of fact that the macro-economic setting has improved over the last decade (set aside the present macroeconomic turmoil), which has been paired by the ambition to augment countries' knowledge base, the leverage on those changes may turn out to be quite disappointing if too little attention is directed towards the micro-economic conditions for knowledge based growth.

Second, despite technological advances in terms of facilitating information flows and communication channels, proximity still seem to matter. Costs of communication thus remain important, as do institutional and cultural barriers between countries (Hofstede 2001). That also holds at a finer geographical level judging from the more ample spillovers within regions.

Third, an emerging empirical literature where micro-level data is pooled with country-data, provides statistical support for a negative relationship between regulation and aggregate income, while the opposite seems to prevail as regards ownership rights and entry of new firms (Loayza et al 2004). A couple of studies also suggest that high-tech firms and knowledge intensive start-ups seems to play major role in influencing growth (Audretsch and Keilbach 2004, Mueller 2007).

Altogether these observations carry interesting implications for the design of policies. Particularly important components in the micro-economic setting refer to the design of regulation effecting knowledge production, ownership, entry barriers, labor mobility and inefficient financial markets. These all refer to the diffusion of knowledge through entry. Knowledge creation has to be matched by incentives to exploit knowledge.[2]

Policy implications

Knowledge production, ownership and entry

The US university research system seems to be more pluralistic and decentralized as compared to the Europe's (Carlsson et al 2009). It has been argued Europe's universities achieved organizational rationality

[1] The remarkable growth in Sweden between 1870 and 1950 was preceded by a number of important institutional changes; compulsory schooling was initiated in 1842, local monopolies (guilds) were abolished in 1846, whereas a new law for firms with limited liabilities was passed in 1847, followed 1862 by freedom of trade. Hence, the Swedish case illustrates the significance of the institutional set-up (Braunerhjelm 2005).

[2] Theoretically different views on regulation van be found in the public choice (Buchanan and Tullock 1962) and public interest (Pigou 1938) theories. The former claim that public intervention hinders dynamics and economic development while the latter argue that interventions are necessary to protect the interest of the public.

and bureaucratic efficiency at the expense of competition and innovation. The degree to which universities should be autonomous, governed in an alternative and more exposed to competition, is widely debated (Braunerhjelm 2009). The US system seems however to have better links to the commercial sector and a more rapid pace of commercializing of new knowledge. That is likely to entail lessons for the European university system.

It would however be a mistake to conclude that these differences predominantly can be attributed the changes in the intellectual property rights (IPRs) that resulted due to Bayh-Dole Act (1980), i.e. where IPRs were transferred to universities. Without policies that promote entrepreneurial activity, commercialization of new knowledge is less likely to be attained. If we believe that growth and economic development is driven by innovation and creative destruction processes, leading to temporary monopolies, a balanced design of IPRs can be expected to yield such an outcome. Also this view has, however, been debated. Still, without having the legal rights to appropriate the returns from innovations the incentives to engage in such high-risk activities are likely to decline.

In addition, legal protection of investors has been shown to enhance access to credit for potential entrepreneurs and facilitate entry (Ardagna and Lusardi 2008). In general, contract enforcement regulation which affects the efficiency of the legal system tends to improve the possibilities for entry and enhance innovation (Djankov 2008, La Porta 2008, Aidis et al 2009). Djankov (2008) shows that the differences in entry between countries with little regulation as compared to the most heavily regulated, influences entry rate by five percent annually. Thus, well-defined and credible ownership institutions should have a positive impact on the rate of innovation and entry.

Regulation of entry

In general terms regulation is shown to deter growth, but exactly how is less clear, albeit the negative effect incurred on entrepreneurship is one suggested mechanism, together with taxes and liquidity constraints.[1] Ciccone and Papaioannou (2006) provide evidence that entry regulation can delay introduction of new varieties/goods in industries that experience expansionary global demand and/or technology shocks.

The extent of regulation has interesting indirect effects that influence entry. As shown by Ardagna and Lusardi (2008), the positive effect associated with skills (education) diminishes considerably in more regulated countries, particularly for opportunity-based entrepreneurship. In addition, it significantly reduces the propensity for marginalized groups to start up firms. Similarly, the positive effects of knowing people who are entrepreneurs, run their own firms, i.e. network and belongs to an entrepreneurial culture, is curbed.[2] The results comply with earlier findings of Klapper et al (2006) and also of Ciccone and Papaioannou (2006), referred to above.

[1] See Evans and Jovanovic (1989), Hurst and Lusardi (2004), Alesina et al (2005), Djankov et al (2007), Fiori et al (2007), Gentry and Hubbard (2000), Nicoletti and Scarpetta (2003), Djankov (2008) and Arnold et al (2008). Delmar and Wennberg (2010) discuss the need for a multi-level (individual, firm, industry) policy approach. La Porta (2008) claims that a French legal origin (civil law) tends to weaken the effect of innovation on growth as compared to an anglosaxian (common law).

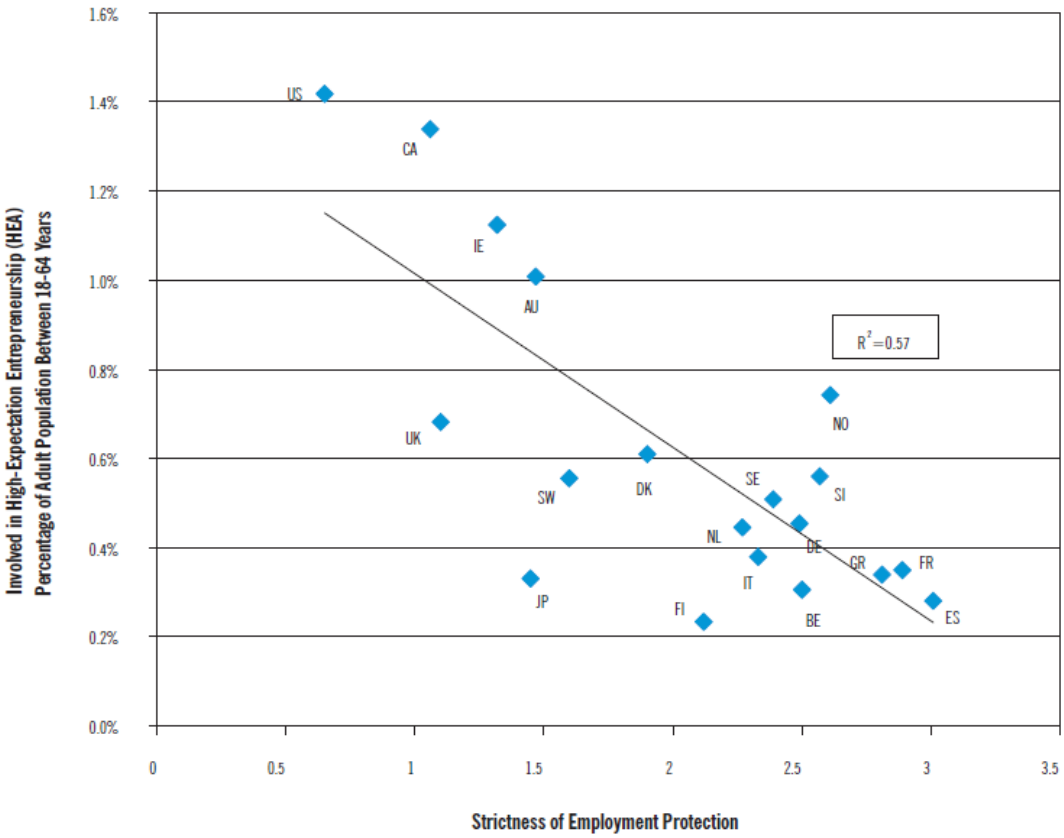
[2] These effects are quantified by Ardagna and Lusardi (2008). For example, the positive network effects are reduced by more than two thirds.

The results by Agion et al (2006) of entry on innovation imply that entry barriers may reduce the innovation rate, productivity and growth. Put differently, more of employees in foreign firms may spur productivity growth in incumbents. Openness to encourage an influx of firms, workers and potential entrepreneurs is consequently important. Internationalized firms are also observed to be most innovative (Suddle and Hessels 2007).

Regulation of labor markets and entry

The impact of regulated labor markets is somewhat more mixed. However, Micco and Pagès (2006), Author et al (2007) and Kugler and Pica (2008) all report a significant negative impact on entry of higher regulated labor markets, as well as a slower restructuring of the economy. Similarly, studies on the determinants of foreign direct investments find a negative effects of regulated labor markets (Jarvorcik et al 2006, Gross and Ryan 2008). In addition, productivity seems to decrease as labor market regulations become more severe (Bassanini and Venn 2007, Martins 2009), and the number of fast growing firms – gazelles – seems to be negatively impacted (Figure 1).

Figure 1. Strictness of employment protection (2004) and high-expectation of early-stage entrepreneurship 2004-2009.



Source: Bosma and Levie (2009 Source: Bosma and Levie (2009)

Ciccone and Papaioannou (2006) report several interesting results interacting different variables, i.e. regulated labor market negatively influence entry by lowering the social network factor discussed above, particularly for opportunity based entrepreneurship. In addition, more regulated labor markets imply that individuals risk taking attitudes become more important. Hence, the perceived threshold to climb before taking the step to become an entrepreneur increases. Ardagna and Lusardi (2008) conclude that labor market regulation has its strongest impact on opportunity based entrepreneurship while Caballero and Hammour (2000) stress that "constrained contractual capabilities" at labor markets (and in the financial system) may hamper the process of creative destruction.[1]

Taxes and entry

There is an extensive literature on the effect of taxes on entrepreneurship embracing the structure of taxes, the overall tax pressure and marginal tax rates. Most of the empirical studies are based on American, or anglosaxian, data. The results are a bit inconclusive, but the overall conclusion of these studies seems to be that the level of individual taxes is ambiguous (and even positive), while increased marginal rates have a clearly discerned negative effects on the propensity to become entrepreneur. The impact on entrepreneurship is however sensitive for the possibilities to arbitrage between tax bases (Gentry and Hubbard 2000, Parker and Robson 2003, Cullen and Gordon 2007). Taxes that lower the possibilities for individual wealth, thereby adding to financial constraints are also reported to have a negative effect on entrepreneurship (Hansson 2008). Note also that the administrative burden associated with taxes only affects entrepreneurs negatively (Djankov et al 2008).[2]

In a recent study by Djankov et al (2008), looking at effective corporate taxes in 85 countries 2004 for a standardized firm, a large negative impact is found on investments (by incumbents and foreign direct investments) and on entrepreneurial activity. A 10 percent increase in corporate tax is shown to reduces aggregate investment in relation to GDP by two percent and reduce entry with between two and five percent. A tax raise is also negatively correlated with growth but positively associated with growth of the informal sector.[3]Another statistically significant result is that corporate debt of firms is much higher (lower solidity) in countries with higher corporate taxes , i.e. debt financing more is common than equity financing.

Sectors and the stage of firms' life cycle

Depending on the stage of the firm's life cycle, different set of policies are conceivable. In the very early phases of an entrepreneurial venture, individuals' economic status may be hard to disentangle from their firms (Autio and Wennberg 2009). In general, there is little policy attention looking at the joint implication of public policies at different stages of new firm evolution such as entry, growth and exit. In addition, firms grow at different pace and the requirements of slow-growing firms and gazelles may be quite different. The

[1] See also Djankov et al (2002), Desai et al (2003) and La Porta et al (1998, 2000).

[2] See Hansson (2008) for a survey. La Porta (2008) reach the conclusion that the tax burden is substantially higher in civil law countries and the tax rate higher.

[3] The empirical analysis controls for other taxes (VAT, personal, etc).

importance of gazelles for job creation seems to have increased over time. All in all, it is likely that policy variables influencing growth differ over firms' evolutionary stages.

In addition, there are also sectoral differences. For instance, removing entry barriers may not increase productivity and growth in all industries. Hence, removing entry barriers should be complemented with means that facilitates the reallocation of resources towards sectors that react positively to entry, thereby releasing resources to be employed in expanding sectors. Exits are often neglected, but constitute a policy area (bankruptcy institutions etc.) as important as policies geared towards entry.

Level of economic development

The design of policies may also vary with level of economic development of countries. As discussed above, the mechanism for structural changes and implementation of new technology looks different in developing and developed countries large. Building institutions that foster private sector development and provide credible enforcement to protect private ownership, encourage education and attract foreign direct investments and imitative entrepreneurship, should be high-priority issues in developing countries(van Stel 2005, Saxenian 2006, Rodrik 2007). In more developed economies attention should to a larger extent be directed production and diffusion of knowledge, together with well functioning and experimentally organized innovation processes.

The point emphasized in this section is that a supplementary set of policies focusing on strengthening the conduits of knowledge spill-over also plays a central role in promoting economic growth. Without the appropriate incentive structure for labor, entrepreneurs and investors, the potential beneficial effect of appropriately designed policies will not be attained. Therefore policies that aim to set economies on their potentially long-run sustainable growth trajectory, must implement coherent strategies that embrace both the macro- and micro-level. The different policy areas must be coordinated and addressed simultaneously. If entry barriers are reduced but exit possibilities are inferior and property right weak, the result in term of startups, knowledge diffusion and productivity may be modest.

7. Conclusion

A society's ability to increase its wealth and welfare over time critically hinges on its potential to develop, exploit and diffuse knowledge, thereby influencing growth. The more pronounced step in the evolution of mankind has been preceded by discontinuous, or lumpy, augmentations of knowledge and technical progress. As knowledge has advanced and reached new levels, periods followed of economic development characterized by uncertainty, market experiments, redistribution of wealth, and the generation of new structures and industries. This pattern mirrors the evolution during the first and second industrial revolution in the 18th and 19th centuries, and is also a conspicuous feature of the "third", and still ongoing, digital revolution.

Despite the fact that there is a general presumption within the economic disciplines that micro-level processes play a vital role in the diffusion of knowledge, and thus the growth process, there is a lack of stringent theoretical framework but also of empirical analyses to support this allegation. The economic variables knowledge, entrepreneurship, innovation hang together in a complex manner but are treated as different and separate entities, or reduced to a constant or a stochastic process. It is not until the last 10-15 years that a literature has emerged that aims at integrating these economic concepts into a coherent framework.

Thus, knowledge concerning the microeconomic processes that leads to growth is still incomplete. In the neoclassical growth models production of knowledge was exogenous – the technical residual – whereas the diffusion of knowledge is either exogenous, stochastic or allotted large firms that more resembles the pharmaceutical companies where research departments tries to come up with next combination of molecules that will be turned into the next block-buster. But knowledge is developed, applied and diffused in many other ways, often through smaller innovative firms and by entrepreneurs. The uncertainty, asymmetries and high transaction costs inherent in knowledge also generate a divergence in the assessment and evaluation of the expected value of new ideas. This divergence in valuation of knowledge across economic agents and within the decision-making process of incumbent firms can induce agents to start new firms as a mechanism to appropriate the (expected) value of their knowledge. This would suggest that entrepreneurship facilitates the spillover of knowledge in the form of starting a new firm.

How do we account for that kind of dynamics in the present growth models? To what extent are lagged effects and interaction effects included in an appropriate way? And what is actually endogenized through knowledge accumulation? Should knowledge be seen as the engine of growth, or is it a better metaphor to view knowledge as fuel that feeds into the mechanism that converts knowledge into growth, e.g. entrepreneurs, innovation, labor mobility, etc? Has, indeed, the Solowian technical residual been transformed to an entrepreneurial residual?

This paper has strived to illustrate the relationship between knowledge, entrepreneurship and innovation on the one hand, and how that relates to growth on the other. Based on a (partial) survey of recent and previous theoretical and empirical contributions in this vein of research, the ambition has been to pinpoint some of the weak spots in our current understanding of growth, and to provide some recent insight to the growth process. In addition, policy areas of importance for the microeconomic foundations for growth have

also been discussed, stressing the importance of a holistic approach implying that a multitude of measures and instruments has to be considered to attain sustainable economic development.

To paraphrase Voltaire: “Doubt is not a pleasant condition but certainty is absurd” and we can be assured that we do not yet fully comprehend the micro-economic mechanisms of growth. Thus, the challenges are still there – let us deal with them!

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Appendix. Endogenous growth with knowledge exploiting entrepreneurs[1]

Research departments within incumbent firms employ labor (L_R) as the only production factor, and research activities are influenced by the available stock of knowledge (A) and an efficiency parameter (σ_R) related to research activities. The production function can be written as,

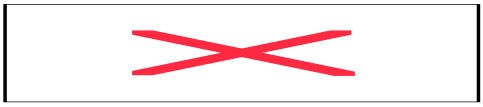
$$Z_R\left(L_R\right) = \sigma_R L_R A \qquad (1)$$

where research production is positively influenced by a larger knowledge stock and higher efficiency.

In order to include the Schumpeterian entrepreneur, we first assume that entrepreneurial ability is embodied in labour but in contrast to raw labour it is distributed unevenly across the population. Thus, entrepreneurial activities are assumed characterized by decreasing returns to scale ($\gamma < 1$). The production function for entrepreneurial activities takes the following form,

. (2)

Hence, similar to R&D-workers, the representative entrepreneur takes advantage of existing knowledge. On the other hand, the production technology differs (decreasing returns to scale) and they do not engage in research. Rather, they combine their entrepreneurial ability with the existing stock of knowledge to introduce new products and business models. The different varieties of capital goods (x_i) produced by entrepreneurs and researchers is employed in the final goods (Y) sector together with labor,



(3)

where α (0<α<1) represents the scale parameter. Given that the demand for all varieties in equilibrium is symmetric, i.e. $x_i = \bar{x}$ for all $i \leq A$, we rewrite equation 6 as

$$Y = (L - L_E - L_R)^{\alpha} A\bar{x}^{(1-\alpha)} \qquad (4)$$

Assume that capital goods (K) are produced with the same technology as final goods and that it takes κ units of capital goods to produce one unit of capital. Then it can be shown that,

$$K = \kappa A\bar{x} \qquad (5)$$

Substituting equation 5 into 4 gives,

(6)

[1] See also Braunerhjelm et al (2009).

Thus, the economy employs three factors of production, i.e. raw labor (producing finals), together with researchers and entrepreneurs that produces varieties of capital goods. Labor market equilibrium is attained when employment in R&D, entrepreneurship and final production equals total supply,

(7)

As a side effect of their efforts, researchers and entrepreneurs produce new knowledge that will be publicly available for use in future capital good development, positively influencing coming generations of research and entrepreneurial activities. Equation 8 describes the production of new knowledge, i.e. the evolution of the stock of knowledge, in relation to the amount of labor channelled into R&D (L_R) and entrepreneurial activity (L_E),

$$\dot{A} = Z_R(L_R) + Z_E(L_E) \qquad (8)$$

Substituting from equation 1 and 2,

$$\dot{A} / A = \sigma_R L_R + \sigma_E L_E^{\gamma} \qquad (9)$$

where, again, the  represents the knowledge efficiency in invention activities (R&D) and innovation (entrepreneurship), whereas A is the stock of available knowledge at a given point in time. The rate of technological progress is thus an increasing function in R&D, entrepreneurship and the efficiency of these two activities.

Assuming that demand is governed by consumer preferences characterized by constant intertemporal elasticity of substitution ($1/\theta$) the maximization problem can be expressed in following way:

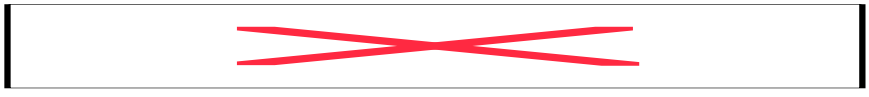
$$\max_{C,L_E,L_R} \int_0^{\infty} \frac{C^{1-\theta}}{1-\theta} e^{-\rho t} dt \qquad (10)$$

subject to the law of motions for knowledge and capital.

$$\dot{A} = \sigma_R L_R A + \sigma_E L_E^{\gamma} A \qquad (11)$$

$$\dot{K} = Y - C = \left(L - L_E - L_R\right)^{\alpha} A^{\alpha} K^{1-\alpha} \kappa^{\alpha-1} - C . \qquad (12)$$

The current value Hamiltonian for the representative consumer is then



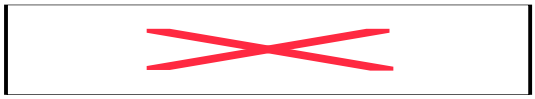
(13)

The first order conditions for maximum, letting  , are as follows:

$$\frac{\partial H_C}{\partial C} = C^{-\theta} - \lambda_K = 0,$$

$$\lambda_K = C^{-\theta} \rightarrow \frac{\dot{\lambda}_K}{\lambda_K} = -\theta \frac{\dot{C}}{C} \qquad (14)$$

$$\frac{\partial H_C}{\partial L_E} = \lambda_A \gamma \sigma_E L_E^{\gamma-1} A - \lambda_K \alpha \left(L - L_E - L_R\right)^{-1} \Delta = 0 \qquad (15)$$



(16)

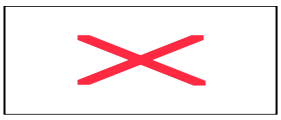
Combining equations 15 and 16 gives

$$L_E = \left(\frac{\sigma_R}{\gamma \sigma_E}\right)^{\frac{1}{\gamma-1}} \qquad (17)$$

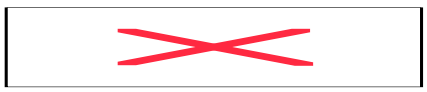
Thus, on a balanced growth path, where both R&D and entrepreneurship is profitable, the amount of resources engaged in entrepreneurial activities is independent of consumer preferences (ρ). As γ is less than 1, entry into entrepreneurship is increasing in σ_E and decreasing in σ_R.

The maximization of equation 13 also gives the equations of motion for the shadow prices of capital (K) and knowledge (A) as

$$\frac{\partial H_C}{\partial A} = \lambda_A \left(\sigma_R L_R + \sigma_E L_E^{\gamma}\right) + \lambda_K \alpha A^{-1} \Delta = \rho \lambda_A - \dot{\lambda}_A,$$



(18)



,

$$\frac{\dot{\lambda}_A}{\lambda_A} = \rho + \sigma_R L_E - \sigma_R L - \sigma_E L_E^{\gamma} \qquad (19)$$

$$\frac{\partial H_C}{\partial \lambda_A} = \dot{A} \qquad (20)$$

$$\frac{\partial H_C}{\partial \lambda_K} = \dot{K} \qquad (21)$$

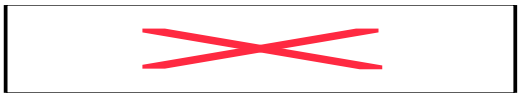
A balanced growth path, i.e. where  , requires that $\frac{\dot{\lambda}_K}{\lambda_K} = \frac{\dot{\lambda}_A}{\lambda_A}$. From (14) and the law of motion for knowledge (11),

$$\frac{\dot{\lambda}_K}{\lambda_K} = -\theta\frac{\dot{C}}{C} = -\theta\frac{\dot{A}}{A} = -\theta\left(\sigma_R L_R + \sigma_E L_E^{\gamma}\right) \qquad (22)$$

Equalizing equations 18 and 19, using equation 22, yields the following expression,

$$-\theta\left(\sigma_R L_R + \sigma_E L_E^{\gamma}\right) = \rho + \sigma_R L_E - \sigma_R L - \sigma_E L_E^{\gamma} \qquad (23)$$

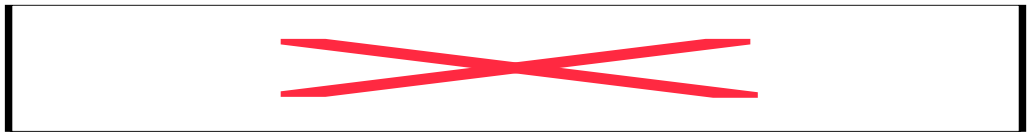
Solving for employment in the research sector gives

 (24)

Inserting the expressions for equilibrium employment in the entrepreneurial (17) and research sectors (24) into the law of motion for knowledge, the steady state growth rate (*g*) can be derived as,

$$g = \frac{\dot{A}}{A} = \sigma_R L_R + \sigma_E L_E^{\gamma}$$

$$g = \sigma_R\left(\frac{1}{\theta\sigma_R}\left(\sigma_R\left(L - L_E\right) + \left(1-\theta\right)\sigma_E L_E^{\gamma} - \rho\right)\right) + \sigma_E L_E^{\gamma}$$



$$g = \frac{1}{\theta}\left(\sigma_R L - \rho + \left(1-\gamma\right)\gamma^{\gamma/(1-\gamma)}\left(\frac{\sigma_E}{\sigma_R^{\gamma}}\right)^{1/(1-\gamma)}\right) \qquad (25)$$

Note that some entrepreneurial activity (equation 17) will always be profitable – i.e. $L_E > 0$ – as long as the stock of knowledge exceeds zero (), which does not however always apply to R&D activities (equation 24).

[1] The model shares a number of characteristics with previous models, e.g. growth is decreasing in the discount factor (ρ) and increasing in a larger labour force.

[1] This depends in a non-trivial way on a range of parameters. The degree of entrepreneurial activity is, for instance, decreasing in the productivity of R&D as long as R&D is profitable. Thus, R&D and entrepreneurship are to some extent substitutes. If R&D is not sufficiently profitable, then we cannot combine equations 14, 15, 18 and 19 to derive the reduced-form growth. The resulting expression provides little insight and is not shown here.

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