Regional industrial development

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REGIONAL INDUSTRIAL DEVELOPMENT: MOVING BEYOND SPECIALISATION

"Finance and Industrial Policy: Beyond Financial Regulation in Europe"

Oxford University Press

Introductory Notes

The impact of the current economic crisis is contributing to reshape the industrial structure of various OECD economies and beyond. Manufacturing sectors are particularly exposed to competition from emerging countries (OECD 2012) and fiscal pressures are pushing governments to reflect on how to invest more strategically in new domains of growth. Regional administrations are increasingly seen as key actors to design resilient economies in the face of global competition (Barca, 2009; OECD 2011a; Hudson 2010; Birch et al 2011). While this renewed interest in regional development coincides with a shift away from old structuralist or neo-classical approaches to industrial policy, a number of questions regarding the conceptual strength and practical implementation of some recent approaches to regional development and policy need to be addressed. Our central concern is with the strategic approach termed 'smart specialisation' (SmSp) and its focus on prioritising economic activities with greater potential for growth by relying on processes of 'entrepreneurial discovery' (Foray et al 2011; Foray and Goenaga 2013), a notion that draws on Hausmann and Rodrik's (2003) view of development as a "self-discovery process". However, not enough advancement has been made in either the theory or the practice of SmSp (Mastroeni et al 2013). There are unresolved issues regarding how to deal with the complexity of institutional structures and internal and external networks that make up innovation systems, and the approach does not deal with the constantly evolving nature of the institutional structures as new practices are established, new market niches opened, and new functions needed to help the process of innovation to continue. We will put forward the challenges that face regional innovation policy and the features that will be necessary for an effective framework, and illustrate these with empirical examples in the area of venture capital and risk finance policy.

Regional Innovation Policy

Policy focusing on regional systems of innovation (RSI) has, for the last two to three decades, been pursued by governments as a way to spur economic growth and prompt high value economic activity. The justification for innovation policy has always been based on the economic growth that innovation is expected to cause through temporary monopolies and the new market spaces created in the process of delivering new products, services and processes to the market/end-user. Initially, policy intervention to promote this kind of growth has been based on market failures and correcting the inability of entrepreneurs to capture a large portion of the benefits of knowledge creation due to its nature as a public good (McCann and Ortega-Argiles, 2013). More recently, however, market failure rationales were seen to "provide important rationales for public sector intervention, but rarely sufficient guidance for the degree of intervention in particular instances; nor do they address the many other potential institutional and connection failures which may arise in an innovation system (McCann and Ortega-Argiles, 2013 quoting Hughes, 2012; pg. 38)," therefore the rationale for intervention has switched to a systems approach. Systems approaches look at, in addition to market failures, failure of knowledge flows, system lock-in, and institutional incompatibilities that may stifle innovation (McCann and Ortega-Argiles, 2013).

Innovation systems, with all their component parts, are complex systems – the complexity means that each system differs from another since the unique characteristics, strengths, history and

structure of each component will impact the whole (Martin and Sunley, 2011, Camagni and Capello 2012). Policy therefore needs to be implemented with this in mind: different components of an RSI will evolve along different timelines, and basing policy on the success of other RSIs is not adequate since the unique evolutionary path of such a system does not guarantee similar results if "best practices" are simply cut and paste (Uyarra 2010).

A dynamic approach is therefore necessary both to understanding the function of systems of innovation and to plan policy that nudges, pushes and pulls the features to match strategic objectives. In this regard, it is our view that an effective policy approach will be based on initial assessment of region's strengths, capacities, resources and limitations, and cyclical reassessments that track the evolution of the different system features according to how they compare to a strategic outline. In order to do this, a life cycle approach is generally recommended by scholars based on an industry's evolution from an emergent phase through to a growth stage, expansion, stagnation and reorganization/failure (Avnimelech and Teubal 2006, 2008). As industries evolve business models and behaviour patterns stabilize, and the knowledge, skills and capital requirements for the industry change from phase to phase; policy needs to take these changes into consideration.

At the same time, the *individual* features of *a region* are crucial to an innovation systems' evolution, therefore not only is an industry's life cycle important, (which spreads across regions and is generally global for knowledge-based industries) but also the life cycle of the local cluster which may ebb, flow and change to a different rhythm. Martin and Sunley (2011) highlight these differences very clearly noting that there are many diverse evolutionary paths that local clusters or regional systems may take, both in terms of positive growth and development, but also in terms of random change, contraction and/or failure and disappearance. Clusters, and RSIs, are complex adaptive (i.e. evolving) systems that "are made up of numerous components with functions and interrelationships that imbue the system as a whole with a particular identity," (pg. 1303) and with differing levels of connectivity internally but also to external components.

Menzel and Fornahl (2009) also describe how different clusters belonging to the same industry can follow different growth paths, citing Saxenian's 1994 comparison of Boston and Silicon Valley. They also note that some clusters may dissolve if they become too locked-in to a particular path with little flexibility for change, while others can become renewed, depending on the ability of firms to take advantage of exogenous events such as changing technological frameworks or a lead company's restructuring, or on the ability of firms to interact with each other and continue to find related but equally new and profitable pathways to new innovations.

According to Cooke (2012), the ability of clusters to renew themselves depends upon the ability of the actors involved to consider the broad and overlapping activities occurring in the regional economy in a way that allow for the reconstruction of knowledge so that new ideas and new solutions can emerge and facilitate new niches of activity to arise. This echoes Hall and Clark's (2010) statement that successful innovation systems, being complex adaptive systems, are those that allow for "mobilizing different pieces of information to resolve a changing series of challenges and opportunities," (pg. 322). The signature of innovation is no longer a single node of expertise but rather one of multiple nodes of expertise interacting with each other.

Innovative capacity will depend on features such as the mix of extant knowledge (Asheim et al 2011) or older (but related) industries (Birch et al 2011), the resultant absorptive capacity, and other such pre-held features which can have been put in place by "accident" or through earlier strategic policy. Like Martin and Sunley, Menzel and Fornahl note that it is the specific elements – or functions – that operate within the innovative space defined as a cluster or system of innovation a that determine the ability of the system to evolve, change, grow or decline.

The Policy planning therefore needs to reflect this contextual complexity, identify the unique strengths and weakness of system functions (see also Cooke 2012 and Mastroeni, et al, 2013), and

maintain an analytical viewpoint that moves from the local to national to the global levels of interaction, knowledge exchange and impact.

Smart Specialisation as the European Approach

In Europe, the economic crisis of 2008 has meant that policy is being anchored by two principles: (i) long-term growth through innovation, (ii) but with a more frugal and efficient use of resources and public investments. In order to achieve this, the concept of Smart Specialisation has been introduced by the Knowledge for Growth working group (Foray et al, 2011) and adapted by the European Commission in its Rationale for Action (2010); and further developed by the OECD (2012). For the EC, SmSp is based on the idea that General Purpose Technologies (GPTs - such as information technology, biotechnology, and nanotechnology) have become prevalent in society and the economy, and these GPTs are (or are becoming) a factor in increased productivity. In terms of where the GPTs are developed, however, Europe is made up of regions that are R&D and innovation "hotspots" (e.g. Cambridge, UK, the Oresund region of Denmark and Sweden), and regions that are lagging in the development/absorption of these technologies (and the underlying scientific base). SmSp, therefore, involves the targeting of these current "hotspots" to further develop the GPTs, sharing this knowledge with other regions of Europe so that more specialised applications of the technologies could be developed in regionally-specific industries (i.e. a localised process of incremental innovation), leading to improved productivity and creating an overall and more equitable rate of economic growth across all European regions. Duplication of R&D efforts in GPTs across European regions is seen as an unnecessary waste of resources when synergies of radical and incremental innovation can feasibly be developed across those same regions.

As currently proposed by the Knowledge for Growth Working Group and EC documents, SmSp depends on private sector entrepreneurs discovering and pursuing the opportunities for innovative applications of GPTs in the various European regions, with public policy lending support to these efforts. Such support will include many of the resources often discussed in the innovation studies literature such as education, skills development, and infrastructure though in a more targeted manner. Supporting entrepreneurial efforts will also include providing finance or facilitating the availability of capital to support the creation of small and medium sized firms, often touted as being important sites of innovative activity and the main locus of entrepreneurial efforts. This is not a new argument or revelation, though SmSp may argue for more specific targeting; however, some key points that must be considered that have not yet been addressed by proponents of SmSp, and are described below as challenges or concerns facing RSI policy.

The first concern is that policy emphasis on specialisation may induce lock-in effects on the basis of existing path-dependencies, rather than strategic differentiation via exploitation of technological convergence and related (knowledge variety (Cooke 2012). A second concern is the already mentioned potential of relying on a static view of RSI rather than taking a dynamic or evolutionary view of a region's development and the different aspects that make up a functioning innovative milieau (within cluster of RSI). For example, with SmSp, the assumption is that there will be entrepreneurs present in a local economy to identify the opportunities for GPT exploitation and with the capacities to pursue them; it may be that the skills base or local practices are inadequate for the kind of activity necessary for successful SmSp. Policy must therefore reflect and be timed to meet the different system needs, to optimize the investment of resources and minimize the failures of policies, avoiding the commitment of resources where users may be unprepared or incapable of utilizing them. The current thinking around SmSp, beside some few examples, has not shown the necessary acknowledgement of complexity, and seems to default into a static view of policy addressing RSI weakness in a one-off manner. This concern is particularly relevant to finance that aids or provides risk capital investment – if a pipeline of opportunities does not exist upon which investors can realistically invest, then the resources may be wasted or misused. According to Foray and Geonaga (2013), identifying windows of opportunity for policy intervention along the regional development cycle represents a key and yet very problematic challenge.

Finally, while SmSp and regional innovation policy in general is targeted at a particular region or local jurisdiction, neglecting the broader national and international links is a third concern, given the importance of knowledge networks and knowledge flows (both within and across regions) for innovation systems to function. Overall, therefore, without a dynamic multi-level approach to planning regional policy the assorted problems discussed above would not be overcome.

Venture Capital: a (key) component of the RSI

In the area of risk finance the complexity of the system is particularly high and the policy challenges seem particularly difficult. When evaluating innovation policy or performing the initial analysis upon which to base policy, at the very least two over-lapping cycles or system progressions must be considered: the endogenously driven cluster life cycle and the exogenously (to the local setting) driven industry life cycle. However, the complexity can increase when looking at risk capital as invested in a knowledge-intensive sector. Analysing the effect of venture capital on an emerging tech cluster, let alone planning policy to support it, must contend with the emerging cluster's life cycle, the related industrial life cycle, the global venture capital cycle of expansion and contraction, and the experience and growth of the local venture capitalists (i.e. the local VC cluster). Risk financing and venture capital investment on innovation-based sectors means that the strengths and weaknesses of the industry receiving investment must be considered (hence consideration of the related industry and cluster life cycles). Venture capital itself, however, is a sub-sector of the financial industry subject to the expansion and contraction cycles of global finance, as well as the local knowledge base, network connections and "smart money" of investors that would be operating in a particular region; as many VC investors tend to operate locally, this means that they can be seen through a "local cluster " lens as well.

While the complexity of investing in, or supporting through policy, a venture capital/risk finance market in a region is high, the importance that has been given to the availability of this kind of capital for the knowledge economy has meant that policy will still be directed to it. Much of the attention to venture capital in the knowledge economy is closely tied to the importance given to small high technology firms as they are seen as important locally-based sources of innovative activity and job creation. Sjogren and Zackrisson (2005) explain how such firms display higher risk, few fixed assets (or bricks and mortar) and whose products/services may be problematic for investors to understand, thereby making traditional bank financing or traded stock activity difficult to engage in right away. Bartzokas and Mani (2004) and Pfirmann (1997) all highlight the challenge that small or start-up high tech companies face in terms of attracting finance because of the high information asymmetries and associated risk. In terms of building entrepreneurial capacity, venture capital is therefore important because investors are more willing to engage with this uncertainty than others, many times investing based on their knowledge of the management team rather than the company or product, and working from a different risk/return ratio than more traditional funders.

Moreover, the importance of venture capital investors is not simply in their provision of funds, but also in their provision of market expertise and networks to the young firms (Lerner, 1999; von Burg and Kenney, 2000). Financiers not only provide the funds, but also explicitly help to shape the firms that operate in the industry. Financiers often have to rely on tacit knowledge, visceral instincts and personal trust in their decisions due to information asymmetry, a lack of "benchmarks" for new product or new market performance, and the inherent risk in innovation (Von Burg and Kenney, 2000). Financiers manipulate the market and bring to the arena various contacts in different areas of the innovation process. These contacts range from other firms along the production line to researchers and potential clients, effectively creating and shaping markets for the innovative products in which they are investing. North et al (2013) re-emphasize the difficulties small high tech firms face in terms of finance, but also note that because of their particular informational constraints, it is "reasonable to expect [these firms] to have been particularly adversely affected by the recent financial crisis. Indeed, it has been suggested that those small business most capable of

creating new jobs and stimulating economic growth are being prevented from doing so by limited access to investment capital," (pg. 238).

Pierrakis (2010) notes the cyclical behaviour of venture capital investment in the UK, how venture capital retreated after the dot.com crisis, and a greater retreat and retrenchment with the more current financial crisis (falling each year from 2007 to 2009). New firms in particular faced difficulties, as many investors sought to maintain their existing portfolio of investments. Both crisis periods showed that seed and first round companies (i.e. early investments), were the most vulnerable. North et al (2013) highlight the fact that many venture capital investors are lowering their risk by investing later in a technology firm's life cycle, less in seed and very early stage investments. North et al describe a "finance escalator" that in theory should exist in a system of innovation with a functioning risk capital market; the escalator begins with (i) public seed grants, (ii) private equity from business angels and public supported venture capital, (iii) corporate and institutional venture capital, and finally (iv) bank debt finance. The implication of venture capital investors moving towards later stage investments means that the finance escalator, at least in the case of the UK studied by North et al, is not functioning as well as it should, again emphasising the complexity of engaging this sector with policy.

The image that is presented to policymakers looking to enhance growth and move their national or regional economy beyond the difficulties and contractions of the economic crisis is that innovation is still a mechanism to expand the economic sphere of activity of a region, as well as capturing growth and encouraging productivity. We also see the complexity of the innovative process and the system within which it occurs, given its multiple components and constantly evolving nature. The finance of this whole process remains of paramount importance; if anything, however, rather than becoming smoother over time with market failures being removed, the various layers of activity impacting venture capital provision and the risk perceived by investors means that policy to support or provide venture capital must take into account, regional, national and global influences. Most important, as Harrison et al (2010) state, besides a flow of risk capital,

> there is a parallel requirement for a flow of entrepreneurial capital – individuals and teams able to see and willing to exploit entrepreneurial opportunities – and a pool of managerial talent (human talent) with the experience and expertise to successfully manage the business growth and market development process. To these must be added deep pools of *intellectual capital* (the ideas and creativity on which business is based) and *market capital* (deep knowledge of and experience in relevant markets) (Harrison et al, 2010: pg. 212-13).

As already noted by authors such as Mason and Harrison (2003) and Rosiello and Parris (2009),this means that the different functions and components of an innovation system are intertwined, and the different cycles of evolution must be considered and engaged with appropriately if policy decisions are made to intervene. In particular, entrepreneurs are attracted by money as much as investors are attracted by pools of 'investor ready' opportunities; the two tend to co-evolve in the context of emergent RIS within their areas of specialisation:

> emergence coincides with processes of cumulative and collective learning: formal and informal networks and knowledge flows, collective adaptation to changing conditions, forms of coordinated behaviour to deal with transactional problems (dilution and internal conflicts), technical challenges (moving compounds through R&D stages) and managerial risks (high attrition rates and regulatory uncertainty). All of these mechanisms allow learning through direct interaction and apprenticeship (Rosiello and Parris 2009: pg 204).

In the rest of the chapter, we will be illustrating the points with different empirical examples. Israel will be discussed to illustrate how policy to launch venture capital can fail yet also spark a learning process that can lead to future success in venture capital provision to the IT sector. Scotland's experience in the biotech domain will be discussed to illustrate how venture capital can ebb and flow at different times, and how system adaptations to early challenges can influence the ability of

the system to make future change or grow (i.e. initial VC growth and investment followed by retraction; angel funding filling the gap but currently conflicting with expansion capita). Ireland in the period following the dot.com bubble bursting (i.e. circa 2003), demonstrates the combined impact of practices conditioned by the global venture capital industry's contraction, as well as the inexperience of the local investors using public funds to reduce or share their risk in the Irish indigenous software sector. Sweden in the period following the dot.com bubble bursting and later in 2010 shows the impact of the local corporate network strengths conditioning investor behaviour in the newly established venture capital market and the country's specialisms in IT and life sciences. At the same time it shows how it responded to changes in the global economy and in the technology sectors as SMEs' innovative performance and importance grew in an economy normally characterized by multinational firms.

Case Studies

The cases discussed in this paper have been selected because they represent different attempts to strengthen systems of innovation through government intervention, and the creation of a venture capital market or provision of risk finance. As s result, they are representative of how similar policy starting points will diverge based on the local conditions, but also how global exogenous factors will have an impact on the system. Furthermore, the cases were selected because of the availability of data from academic literature, grey literature, and interviews which the authors have gathered from 2003 to 2013. The authors analysed the cases of Scotland, Ireland and Sweden by first reviewing the published data on the innovation systems and investment practices for each case, and then contributed to this data by analysing government and industry documents, and drawing on interviews with regional stakeholders on the issues of innovation policy and investment. The case of Israel as analysed mostly through a literature review, and in this case the authors also drew on insights shared by colleagues on the Israeli innovation system during a European Commission Framework 7 project (TARGET).

Israel

The case of Israel's development of a venture capital industry demonstrates some of the key points highlighted above: the preceding creation and growth of entrepreneurial activity, the uncertainty of policy efforts and the high chance of risk, the importance of learning in policy, the importance of international networks, and the impact that exogenous events may have on the development of an industry. The venture capital industry did not develop smoothly in Israel, but ultimately it shows a positive combination of policy learning, and the identification and leveraging of opportunities from very unique characteristics of the Israeli economy.

Jeng and Wells (2000) describe the Israeli VC industry as nascent between 1988-97, with only one fund of 30 million US, and most of the funds coming from large investment holding groups. In 1992, the Likud government set up the Yozma program both to invest in funds as well as directly into companies; in 1993 Yozma provided 100 million in nine VC funds, by 1996 the VC industry had leveraged this to raise 1 billion and the government decided to leave the market. In doing this, to insure that investors remained in Israel, the government enacted temporary legislation for tax free investing in VC funds by large funds that had tax free status in their home (i.e. foreign) country. The growth of the Israeli VC market was not stand-alone, however; it was intimately connected to the development of the software industry and the nationally-specific strengths that allowed that sector to develop.

Avnimelech and Teubal (2004) describe how the Six Day War and the boycott of technological trade by France led to Israeli policymakers emphasising self-sufficiency, spurring heavy investment and support in R&D. This security-oriented decision led to the simultaneous development of the military and civilian IT sector, with the military having the most resources to invest in the actual R&D but also in human capital development in terms of training and hands-on experience. Breznitz (2005) argues that the military not only trained personnel and provided R&D space and experience, but also

provided a space for formal and informal knowledge exchange and network development, leading to a well connected and skilled pool of technicians and engineers. Breznitz (2007) also argues that Israel's development of the IT sector and VC industry was possible from the close links with the US financial and IT sectors. Early Israeli IT firms were developed without risk capital, but had managed access to the US market and managed to "bootstrap" or self-fund themselves to successful initial public offerings (IPOs), building confidence and momentum in the industry. The period of relative stability of the 1980s meant many engineers were released from the military, and many were immigrating to Israel from the Soviet Union, so that the talent pool increased. The Office of the Chief Scientist continued to invest in IT, and the Binational Industrial Research and Development Foundation (BIRD, US and Israel) supported firms without equity investment, leading to the creation of entrepreneurial opportunity, some of which needed the spark of funding (Jeng and Wells, 2000; Breznitz, 2007; Avnimelech and Teubal, 2004).

What is particularly noteworthy is that the Israeli government attempted to spur venture capital creation with the Inbal program in 1992. The program was set-up to guarantee the investment of publicly-traded VC funds, but was too constraining in terms of how funds could invest and how quickly and flexibly funds could operate in their investments (Avnimelech and Teubal, 2006). This failure, however, facilitated success later on in that it created a learning process that fed into the subsequent Yozma program; this program corrected the errors of the previous program, required Israeli funds to partner with foreign funds (enhancing their skill set), and provided an environment of learning in terms of due diligence work, deal flow, and exits. The policy intervention in the area of venture capital creation was therefore inseparable from the decisions made in the sphere of security and industrial policy leading to the development of an internationally connected IT sector. Furthermore, the timing of the programs should be noted in that Inbal and Yozma coincided with the global growth of the IT sector, with sufficient time to build experience and establish a critical mass of firms (both in IT and venture capital firms) before the dot.com crisis set in.

Scotland

While Israel was able to build a venture capital industry *in tandem* with an entrepreneurial IT sector which provided the entrepreneurial, intellectual and market capital necessary for a critical mass to build a growth oriented regional system of innovation, Harrison et al note that Scotland has struggled to achieve the same levels of entrepreneurial capital. The Scottish economy has been dominated for a long time by a "small number of large, international competitive corporations," (pg. 213); but these same companies do not provide sufficient traction for an innovation system to develop and create an internal or indigenous dynamic of innovation-based growth.

Scottish policymakers recognized this deficiency and sought to encourage the creation of Scottish start-ups across the knowledge-based sectors, in particular ICT and the life sciences. In order to do this, the Scottish public sector, mostly through Scottish Enterprise, launched a set of horizontal (i.e. non-industry specific) policies aimed at providing risk capital to start-up firms such as the Scottish Co-Investment Fund (investing up to £500K per firm), the Seed Fund (£100K per firm), as well as funds to facilitate proof of concept development and to support innovative projects in small firms (Rosiello et al, 2011). The Scottish case shows policy heterogeneity and a completely different development trajectory of systems of innovation, including components of those systems such as risk finance (Rosiello et al, 2011).

In Scotland most risk finance is provided by the public sector, London-based VC funds, and small angel investors based in Scotland, rather than locally-based private limited partnership funds as the majority of VC providers have become in Israel. While this looked like an adequate alternative development path for Scotland's risk finance, it has also meant that it is less resilient in the face of exogenous shocks – firm failures and downturns in financial markets means that private VC investors in London and abroad are more hesitant than before to invest in new ventures in Scotland (Pierrakis, 2011; Harrison et al 2010; Mason et al 2013) Over the past few years, venture capital investment

over 2 million GBP has been constantly decreasing and almost halved between 2010 and 2011, from 62.8 m to 33.8m (Harrison and Mason 2012), with some large VC being made predominantly in the IT/media, life sciences and renewables domains (Young Company Finance 2012). Harrison et al note that much of the fluctuations in Scotland's risk capital investments after 2001 and 2005 came from large "blockbuster" deals financed by external investors and their later retreat, while there is a steady rate of investment amongst Scottish angel and public sector investors throughout the period. Moreover, as noted by Harrison et al (2010), many of Scotland's successful firms grow to a certain size and become acquisition targets for larger firms based elsewhere – maintaining a cycle of firm creation therefore becomes important in order to maintain any kind of local mass of knowledge-based firms.

The current new investments in Scotland, however, are dominated by angel investors whose contribution has been constantly increasing between 2003 and 2011, coinciding with the setting up and implementation of the Co-Investment Fund policy by the Scottish Enterprise (Mason et al 2013) which offers up to 1 million GBP equity funding for deals up to 2 million GBP. However, year to year fluctuations in the level of venture capital investment (with a recent decrease for deals over 2 million GBP) suggest that collaborations with larger and/or specialist foreign or London based investors – which appeared to be significant especially in the biopharmaceutical and life sciences domains up to 2006 (Rosiello and Parris 2009) – may have recently dropped. Interviews with industry representatives in the life sciences and IT has revealed that angel investors are resisting cooperation with larger investors in follow-on funds because of loss of control and valuation. Mason et al (2013) note that newer firms may be increasingly limited to angel-only funding from "cradle to grave" due to this hesitation, and that the paucity of exits is limiting the amount of capital available to be re-invested as well as discouraging more angels to join existing syndicates . The implication is that the risk capital market for new technology companies has become extremely problematic (Young Company Finance 2012).

What are notable are that Scotland's public sector efforts to create risk capital paralleled Israel's to some extent in that funding was meant to lower the risk for private investors and spur an increase in start-up activity from the scientific and technical talent that was already present in Scotland's universities; in contrast to Israel which had a base level of indigenous entrepreneurial activity before a venture capital market was set-up, in Scotland the idea was that the missing entrepreneurial behaviour could be coaxed out of the universities or research base (which is particularly strong in the medical and life science)with seed funds and other Scottish Enterprise incentives. In spite of the success of the Scottish Co-Investment Fund and in contrast to Israel and its development of a venture capital market, while start-up activity has increased in Scotland, links with foreign investors and mutual learning effects did not occur and the venture capital market in Scotland has remained fragmented. While knowledge-based firms are marketing themselves internationally, the risk finance is less global (angel-dominated), though still subject to the cyclical effects of the global financial markets (ebb and flow of London-based capital), and the growth potential of local Scottish firms is therefore impacted.

Ireland

Ireland's government intervention to develop venture capital was based on the motivation to create indigenous start-up firms, which was seen as a longer-term solution to creating high-value employment in contrast to the increasingly foot-loose foreign manufacturing plants that had initially been courted by the Irish Industrial Development Agency. While the growing number of foreign technology firms in Ireland did little in terms of high value work such as R&D, and kept most operations to simple manufacturing or back office functions, their presence created an opportunity for Irish managers to gain experience, and for local firms to appear that provided software services and bespoke products for the large foreign firms (Mastroeni, 2011; Mastroeni, 2013; O'Riain, 2004). This formed the base for the Irish indigenous software companies which continued to develop their

products and look for export markets. Ireland's venture capital development in the early millennium was tied to the development of the indigenous software sector.

Much like Scotland, government provision of risk finance and the sharing of risk with the private sector was provided to encourage the creation of start-ups, and the software sector was explicitly championed by the Irish government. During the late 1990s up to and including 2003, the convergence of the dot.com success and hype, and Silicon Valley being marketed as an ideal to emulate, meant that Irish policy and industrial stakeholders saw it necessary to try to adopt Silicon Valley's "standard" format for venture capital funds in the form of limited partnerships. Repatriated Irish talent, which had built up business and managerial experience in the US, helped to cement this view of how risk finance and the sectors it supported were to be developed (Mastroeni, 2011).

Enterprise Ireland, the public sector organization tasked to encourage the growth of indigenous companies, began with the Seed and Venture Capital Fund programme investing € 40 million into privately managed funds – matching private investments on a one-to-one basis, while also investing directly into the market.[1] The funds Enterprise Ireland helped create were not limited to any one sector, but initially they were limited regionally to investments in Ireland (Mastroeni, 2011; Sunday Tribune, 2010). As the funds have grown, they must still continue to put twice the amount EI has committed back into Ireland, but can invest the rest at the managers' discretion; in 2007 to 2009 Irish funds invested 27% abroad, up from 19% during the preceding seven year period (Sunday Tribune, 2010). EI's direct investments were, in contrast, as first investor – in the nascent software sector this meant essentially establishing company valuations from scratch as there was no previous market benchmark.

EI therefore led the market, reducing the private sector's risk, and the private sector followed. The Irish venture capital investors saw a way of further reducing their risk encouraging – and effectively limiting their investments to – firms which created a cash flow through consultancy or bespoke product development before moving to off-the-shelf solutions which would have required longer timelines and more development resources. The software sector in Ireland was therefore impacted directly by these interventions in the capital market. Ireland emulated very closely the structures and investment practices of US venture capital, and invested heavily in the one area of the knowledge economy that Ireland was demonstrating strength during that period of time. The lack of diversity in the economy, however, meant that when the dot.com crisis occurred, followed by the later economic crisis, foreign investment would ebb and flow accordingly, and local investment would look to invest in foreign markets while at the same time "increasing their due diligence" on local opportunities. Much like VC markets in other regions, Irish VC also shifted away from start-up and seed funding in 2007, dropping from 45% to 29% in seed and early stage companies (IVCA, 2007). The director-general of the Irish Venture Capital Association explained the drop in investment activity during the financial crisis by stating that "there isn't a recession in venture capital or the tech industry at the moment; the question is whether entrepreneurs have the ability to build a business in this environment," reflecting the impact of global markets on the local economy as well as the risk adjustments local investors made (Sunday Tribune, 2010). Barry et al (2012) note how venture capital investment dropped from over 90% of equity investment in 2002 to just over 30% in 2003, and from just under 90% in 2006 to approximately 20% in 2007; again reflecting the global financial cycles.

Ireland reflects a risk finance market where equity investment through limited partnerships is the most commonly used format, but it was one selected (unlike in Scotland) by policymakers and stakeholders copying the perceived best practices of other economies (i.e. Silicon Valley and Israel). It raises questions, however, about how risk accepting such investors are when it comes to business

[1] A second Seed and Venture Capital Fund round was launched in 2001-2006 with €95 million of Irish public and EU funds with the objective of leveraging €400 million (having reached €500 million by 2004) (Barry et al, 2012).

models and new niches of economic activity that do not correspond to the preferred models developed during the Irish software sector's development. If such financiers are the main source of start-up funding beside informal/public sector seed funding, then the flexibility of the Irish innovation system may be impaired.

Sweden

The case of Sweden shows levels of complexity, and corresponding strategic level policy interventions, which cases like Ireland and Scotland do not because of the interconnected nature of the institutional structures related to the innovation system. Sweden's economy was described as having a relatively small stock market and long-term relations between financiers and corporate leaders (Reiter, 2003). The system of family-owned trust companies – which traditionally had controlling shares in the major Swedish multi-national firms and banks – is still evident in the new economy: new spin-offs were supported by large parent companies, and capital resources were provided by traditional industrial financiers and state organisations. Like Ireland and Scotland, Sweden's desire to increase the number of high technology start ups and spin-off companies was linked to their perceived contribution to economic growth and employment creation. The Swedish economy in the late 1980s and early 1990s was going through a contraction which the traditional social democratic and corporatist system of large indigenous multi-nationals, cross-board power sharing between banks and major firms, and life time employment, was increasingly struggling to deal with. Small high tech firms were therefore seen as part of the solution, and the larger technology firms and the high quality talent and research in the university sector were seen as the source of these companies. What was missing was the entrepreneurial culture, and incentive structures had to be created to spur entrepreneurial activity (Mastroeni, 2011; Henreksson and Jacobsson, 2003; Henreksson and Rosenberg, 2001). To this extent, a series of changes coordinated by the public agencies Nutek and later Vinnova were initiated throughout the mid 1990s to 2003. The first was a series of deregulations in markets, in particular in the stock market, that would allow greater foreign and individual ownership of stocks, and which would create greater capital availability (Henreksson and Rosenberg, 2001). Such changes would also create greater exit opportunities for venture capital investors; like Ireland, Swedish policymakers, investors and industrial stakeholders saw the limited partnership model of venture capital as one which should be emulated. Funds were co-created with public money, and the large banks also invested in funds and created their own venture capital branches which operated under different expectations regarding rates of return (Mastroeni, 2011; Solvell et al, 1993).

The public industrial investor Industrifonden, which traditionally provided finance to the large Swedish multinationals for their activities, had their focus shifted along with their expected ROI in order to act as venture capital investors and move towards creating a critical mass of capital in the market. According to Industrifonden representatives, while the ROI was lowered to break-even in order to encourage start-up creation, they also brought "grey hairs" to the market in terms of experience and network access, only investing in firms that passed extensive due diligence and working with market valuations rather than cutting them.

As mentioned above, there was also a need to ensure that there was a deal flow for investors. The IT sector, among others was seen as one of the best bets due to the high expectations of growth in the 1990s as well as Swedish strength in the area due to anchor firms such as Ericsson. Spin-offs from large firms did begin to occur as capital was made available to them and the underlying incentives were adjusted for people to see entrepreneurialism as an option, multinational firms helped create spin-offs by providing in-kind capital in terms of office space and salary for a year in order to determine of ideas developed might later be of interest in terms of acquisition, and the dot.com crisis actually led to more of these kinds of arrangements as companies such as Ericsson narrowed their market focus (Mastroeni, 2011). The coordinated shifts in activity between the banks and large anchor firms indicated a shift in how the traditional networks were applied, from large multinationals to a new focus on spin-offs and start-ups; in other words Sweden's traditional spheres

of influence such as the Wallenberg group (Ericsson and SEB bank) were key to facilitating a high tech entrepreneurial system of innovation and the capital market necessary to support it.

Government policy was also used to increase the pipeline, with the universities required by law to begin commercialisation activities in addition to their research and teaching in order to remain as recognized universities. This policy resulted in universities setting up their own incubators, holding companies and venture capital funds so that students and faculty (who owned the IP in the Swedish system) could create start-up companies. The end result of these myriad changes across different institutional systems, and the long-term adjustments, re-evaluation and re-adjustment under coordinated guidance has meant that the Swedish venture capital market has become one of the ten most active VC markets in the world (Lerner and Tag, 2013).

Despite this success, however, the Swedish VC market is, like the others, heavily impacted by global financial markets. For example, Sweden's venture capital investments in the life sciences reflected broader trends in other areas where investors were hesitant to invest in the risky therapeutics sub-sector. The sub-sector itself was changing with shifting business models and firm re-structuring, so the investor behaviour was reflecting more the limitations in the biotechnology global markets than financial markets and local investors reacting to the perceived risk.

Lerner and Tag note that the capital under management and the number of transactions both dropped sharply in 2001-03 and later in 2007-08.[2] A Nordic Venture Association report also shows that venture investment in Sweden dropped in 2008 from just under €400 million to €200 million in 2009 (Menon, 2010).

The relative success, yet continued impact of exogenous capital market shocks, means that regardless of how well planned policy is relating to venture capital creation, public sector funds in Sweden have retained their importance and have remained stable at a level of SEK 1 billion from 2008-2011 (Tillvaxtanalys, 2013). Data from the SVCA noted that private venture capital investment continued to show a clear downward trend from SEK 4.8 billion in 2008, falling over 60% to SEK 1.8 billion in 2012 (Tillvaxtanalys, 2013). The importance of market intervention policy is evident in the Swedish case; however it must also be emphasised that it would be extremely difficult for other regions to duplicate Swedish efforts without the history of industrial activity and corporate collaboration that are part of the Swedish story, and regardless of the relative success, the impact of global shift and trends on local industrial development must still be accounted for.

Regional Innovation System Policy in Post-Crisis Europe

In a post-crisis Europe, the harnessing of innovation and the creation of new market niches has not only remained, but increased, in importance. Innovation is seen as necessary to create high-value production and manufacturing jobs, stimulate local industry and locally-based firms into new competitiveness and increase their employment requirements. Given innovation's importance, RSIs and government policy to support them are a centre-piece of EC strategy, and SmSp is seen as the approach to be used in terms of helping regions harness their economic potential.

While the focus on local capacity is correct, the lack of dynamism in SmSp as currently concerned is problematic; RSI policy requires a constant evolutionary view of changing system needs and the multiple levels of activity impacting RSI's development, from the local to the global. The cases of Israel, Scotland, Ireland and Sweden illustrate the changing dynamic of the innovation system over time, and how a component of the innovation system – a market in and of itself – changes, ebbs and flows based on both local VC firms as well as global market aspects.

The cases also offer lessons on system resilience and learning. Israel demonstrated how the venture capital industry was inherently tied with other industries (IT) in that it required a healthy pipeline of opportunities to exist for investors to commit to. It also showed, however, the reality of failure as

[2] The percentage drop of venture capital as percentage of GDP was from 5.0% in 2001 to 3.0% of GDP in 2003.

the Inbal program led to a lack of critical mass and limited investor activity. What is important about the Israeli case, however, is that it provides an example of policy learning – identifying the weakness of the system functions and the fixes that were necessary – that led to the better networked and ultimately successful Yozma program. By the same token, it also shows how without Israel's military-industrial development of IT and skills, and its links to US markets and investors, the same efforts may not have led to anything.

Sweden's success would not have been possible without its ability to draw on the collaborative culture between government and industry. The policies and institutional changes such as those impacting stockmarket investment, and university activity in commercialisation, occurred at the same time as the venture capital market was being created and helps to illustrate how RSI policy cannot be isolated to a few issues.

Scotland and Ireland, while successful in their initial build-up of entrepreneurial firms and entry into different innovative sectors through state-led provision of risk capital, do not seem to share the same resilience of Swedish and Israeli VC markets and innovation systems. While determining the particular weaknesses that have led to Scotland's dependence on angel investment and entrepreneurial stasis and Ireland's narrow industrial focus and risk averse private investors is beyond the scope of this paper, part of the explanation may be that longer timelines (and locally appropriate solutions) are needed in both case to build up the economic diversity and entrenched collaborative networks that are demonstrated in Sweden and Israel.

This chapter has argued, and the cases have demonstrated, that RSI policy requires a context-specific and dynamic approach. Especially in a post-crisis Europe, where resources are constrained, an understanding of local capacity in an innovation system, the missing pieces, and how these elements interact with national and international factors is crucial in order to minimize squandered resources. Analysts and policymakers must consider the local cluster or RSI's development over time, the more international industrial life cycles, and those of related industries. Finally, given that the knowledge economy and the pursuit of innovation by their nature are uncertain and risky, government intervention will always play a role, though it too will have to change according to the dynamic needs of the innovation systems.

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