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Study**

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Executive Summary

“The more inventors we have, the more ideas we discover, and the richer we all are”
Jones (2005)¹

Knowledge, learning and innovation are key ingredients for economic development and competitiveness for firms, regions and nations. Recent studies in economic growth theory research place heavy emphasis on the role of ideas and innovation in generating growth. Innovation is a complex concept and is difficult to define. Innovation can be defined as “the process by which existing knowledge and inputs are creatively and efficiently recombined to create new and valuable outputs.”² A simpler explanation of innovation is the process of translating an idea into something that creates value, the basic difference between invention and innovation being value.

Innovation can be viewed as a value chain comprising three key phases: idea generation, conversion and diffusion.³ For policy-makers, innovation is ranking on the top of policy agendas today, with innovation policy aiming to promote the commercial exploitation of new ideas as products, processes, and organisational techniques,⁴ designed to narrow the gap between the socially optimal and the privately optimal levels of Research and Development (R&D).⁵

In developing an economic strategy that will strengthen and grow a sustainable eco-system requires a consistent collaborative partnership between stakeholders, as Howlett and Ramesh, (2003) put it: “In reality, making and implementing public policy is rarely the preserve of a single actor or group of actors”⁶. Key stakeholders in economic and innovations policy development include inter alia firms (MNCs, SMEs, etc), higher education institutions, public research institutes, and independent innovators. Research in this area regularly emphasises the need for collaboration and cooperation between stakeholders in innovation policy development, with the ‘triple helix approach’ one of the underpinning paradigms that has informed national innovation and entrepreneurship policies.⁷ With this approach, government, industry and higher education institutional (HEIs) and public research organisation (PROs) are equal players in promoting innovation and sustaining a knowledge-based society. Research has put strong emphasis on the interactions between relevant stakeholders in effective policy development - “Institutions and networks of interactions are the key forces shaping the direction and rate of learning and innovation.”⁸

For the purposes of this White Paper on Innovation we focus on three core themes - what is innovation, developing firms level innovation capacity and conditions, supporting mechanisms and institutions. These themes are relevant to understanding how Galway City and County can support economic growth through innovation. Galway City and County has natural advantages in terms of location of Higher Education Institutions, Public Research Organisations, a diverse

¹ Jones, C. I. (2005). “Growth and ideas.” Handbook of economic growth 1: 1063-1111.

² Felin, T. and T. R. Zenger (2014). “Closed or open innovation? Problem solving and the governance choice.” Research Policy 43(5): 914-925.

³ Hansen and Birkinshaw (2007) “The Innovation Value Chain.” Harvard Business Review, June, p. 121-130.

⁴ OECD (2003). “Tax Incentives for Research and Development: Trends and Issues”, Paris

⁵ Czarnitzki, D. and O. Toivanen (2013). “Innovation policy and economic growth,” Directorate General Economic and Monetary Affairs (DG ECFIN), European Commission.

⁶ Howlett, M. and M. Ramesh (2003) Studying Public Policy: Policy Cycles and Policy Subsystems, Oxford University Press

⁷ Etzkowitz, H., & Leydesdorff, L. (2000). “The Dynamics of Innovation: From National Systems and ‘Mode-2’ to a Triple Helix of University-Industry-Government Relations.” Research Policy, 29(2), 109-123

⁸ Hirst, P. (1994). “Associative Democracy.” Cambridge: Polity.

industrial base, a creative economy that has an international reputation, a distinct identity and natural environment. These elements provide a unique set of advantages that will enable the Galway City and County to grow both economically and socially with the appropriate supports at local, regional and national levels.

Introduction

Since 2008 the economic crisis has severely reduced the short-term willingness of firms to invest in innovation.⁹ The main issue for peripheral regions is “a low level of R&D and innovation due to the dominance of SMEs in traditional industries, weakly developed firm clusters, few knowledge providers and a weak endowment with innovation support institutions.”¹⁰ Future competitiveness is no longer defined as the struggle to remain competitive in current markets but primarily as the creation of new markets, underpinned by innovation¹¹.

The word innovation is used frequently in daily discourse. Organisations, individuals and economies are being encouraged to become innovative. New industries are being created through various types of innovation. For a firm innovation does matter and goes to the heart of unique differences of a firm’s offerings and in the articulation of specified value propositions. The pursuit of innovation means that organisations are constantly refining the uniqueness and relevance of their offering for customers.¹²

1.1 What is Innovation?

There are so many different perspectives and meanings about what is innovation. Kanter (2006)¹³ simply describes innovation as ‘ideas that create the future.’ These ideas can change industries, customer experiences and the industry business models. Firms pursuing innovation can fall into some traps which include: strategy mistakes - hurdles too high, scope too narrow; process mistakes - control too tight; structure mistakes - connections too loose, separations too sharp and skill mistakes: leadership too weak, communication too poor (Kanter, 2006). Firms can overcome these innovation traps by widening innovation searchers and broadening the scope; adding flexibility to planning and control systems; facilitate close connections between innovators and mainstream businesses; and select leadership and interpersonal skills, and surround innovators with a supportive culture of collaboration. The remedies require firms to explore and exploit innovation in equal measures.

1.2 Types of Innovation

One way of understanding what innovation is, is to consider four innovation forms, namely product innovation, process innovation, service innovation and horizontal innovation.

⁹ OECD (2009) Policy Responses to the Economic Crisis: investing in Innovation for Long-Term Growth. Paris; Archibugi, D., A. Filippetti and M. Frenz (2013), Economic Crisis and Innovation: Is Destruction Prevailing over Accumulation? Research Policy 42(2013), 303-314.

¹⁰ Tödtling, F. and Trippl M. (2005). "One size fits all?: Towards a differentiated regional innovation policy approach." Research Policy 34(8): 1203-1219.

¹¹ Montalvo, C., Diaz-Lopez, F., & Brandes, F. (2011). "Eco-innovation Opportunities in Nine Sectors of 569 the European Economy." European Sector Innovation Watch. European Commission, 570 Directorate General Enterprise and Industry, Brussels.

¹² Tushman, M. (1997) Winning through innovation. *Strategy and Leadership*, 25(4):14-20.

¹³ Kanter, R. M. 2006. Innovation: The Classic Traps. *Harvard Business Review*, 84(11): 72-83.

- *Product innovation* is where the firm makes changes to the product or service they offer. These changes can range from developing a new totally new product or increasing the functionality of an existing product or increasing the customer experience if it is a services business. Product innovation is one of the least successful forms of innovation in terms of returns compared to other forms of innovation. In some sectors product innovation is costly and time consuming.
- *Process innovation* is where the firm makes changes to how the product is developed or how a service is delivered. This form of innovation is usually internally driven and is linked to a particular business model that firms are pursuing.
- *Service innovation* focuses on the product performance, customer service and product suite which enhances the customer experience and or usage of the firms product or service.
- *Horizontal innovation* can involve firstly a different competitive context in which the firm is positioning its offering and secondly, how the firm uses and leverages multiple stakeholders to ensure dominance of its product or service offering. Thirdly, it involves the reuse of product or service innovation in other context or marketplaces.

1.3 From Closed to Open Innovation

The traditional view of innovation for firms was based on a closed innovation paradigm. This meant that the firm controlled and owned all of the processes and activities in development of new products or services. The firm did not rely or use any outside firms or agencies. The assumption was based on the fact that the firm has the best human capital and required full control of the innovation process in order to realise profits. Following a closed innovation model would mean that firms were first to the market with new products and services and therefore could create market dominance.

However the closed innovation paradigm began to evolve into an open innovation due to increased risks associated with R&D costs, the proliferation new ideas, the advanced rate of technological and scientific breakthroughs and the real market opportunities around convergent technologies. The pursuing of a closed innovation had become obsolete in many industries. The principal of the open innovation paradigm is based on harnessing external and internal sources of innovation (Chesbrough, 2003)¹⁴.

Effective open innovation requires external cooperative partners, be it with customers, competitors, universities, consultants or using external sources to support firm innovation. Chesbrough (2003) argues that “open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as firms look to advance their technology. ... Open innovation practices, in general, provide greater opportunities for firms to advance and commercialise their technologies and, hence, enhance their innovation capability and international competitiveness.”¹⁵ The underlying mechanisms for accessing external knowledge and fostering open innovation have, in turn, encompassed a range of alternatives including contests and tournaments, alliances and joint ventures, corporate venture capital, licensing, open source platforms, and participation in

¹⁴ Chesbrough, H. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Boston, MA. Harvard Business School Press.

¹⁵ Chesbrough, H. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology*, Boston, MA. Harvard Business School Press.

various development communities. Many examples are cited of firms pursuing open innovation strategies. The most cited is Proctor and Gamble where they have committed to acquiring 50 per of its innovations outside the firm.

For firms the focus of pursuing an open innovations strategy is to be open to engaging and partnering with external organisations. The central intuition, whether we are talking about formal governance arrangements, or informal search¹⁶ is that an increase in the number of external linkages and breadth of search can have beneficial outcomes for organizations striving to innovate. Along these lines, Leiponen and Helfat (2010) also find that an increased number of external knowledge sources leads to increased innovation and better financial performance.¹⁷

Vanhaverbeke et al. (2008) have identified four broad advantages associated with open innovation practices, namely:

1. benefit from early involvement in new technologies and/or business opportunities;
2. access to other organisations' technological capabilities and R&D, through the combination of internal and external channels to market;
3. accessing venture capital funds; and
4. providing educational investments and joint venturing in potential projects at universities or research laboratories.¹⁸

Furthermore, Felin and Zenger (2014) argue that "certain types of innovation problems are best addressed by certain types of governance forms, whether open or closed" and, more specifically, that "disparate governance forms offer access to (a) different types of communication channels, (b) different types of incentives and (c) different types of property rights."¹⁹

Mina et al (2014), in their study of UK business service firms, found that:

- Overall, engagement in open innovation increases with firm size and R&D expenditure
- Business services are more active open innovators than manufacturers; they are more engaged in informal relative to formal open innovation practices than manufacturers; and they attach more importance to scientific and technical knowledge than to market knowledge compared to manufacturing firms.²⁰

Reasons for open innovation focus include vertical disintegration pressures, modularisation and outsourcing, the growth of specialised technology markets, and difficulties in appropriating internal investments in intangibles. Open innovation approaches have informed and shaped the design and structure of EU Horizon 2020 research programmes.

¹⁶ Tether, B. S., & Tajar, A. (2008). Beyond industry–university links: Sourcing knowledge for innovation from consultants, private research organisations and the public science-base. *Research Policy*, 37(6), 1079–1095.

¹⁷ Leiponen, A. and C. E. Helfat. 2010. Innovation Opportunities, Knowledge Sources, and the Benefits of Breadth. *Strategic Management Journal* 31(2), 224–236.

¹⁸ Vanhaverbeke, W., Van De Vrande, V., Chesbrough, H.W. (2008). Understanding the advantages of open innovation practices in corporate venturing in term of real options. *Creativity and Innovation Management* 17, 251–258.

¹⁹ Felin, T. and T. R. Zenger (2014). "Closed or open innovation? Problem solving and the governance choice." *Research Policy* 43(5): 914–925.

²⁰ Mina, A., E. Bascavusoglu-Moreau, et al. (2014). "Open service innovation and the firm's search for external knowledge." *Research Policy* 43(5): 853–866.

Developing Firm Level Innovation Capabilities

Irrespective of the firm size, innovation capabilities is core to sustaining a business. Some firms pursue multiple types of innovation – product, process, service and horizontal – where other firms just pursue one type due to knowhow, resource and human capital constraints. The purpose of innovation is to improve the performance of the firm as Ertürk (2014) posits: “The ultimate reason why firms innovate is to improve firm performance and profitability by gaining a competitive advantage over its competitors and increasing consumer satisfaction in terms of better quality, price, value, innovations by enhancing productivity, reducing costs, product differentiation and supplying new unique innovative values for the market and customers.”²¹

The ability of firms to develop their innovative capabilities is widely recognised as a critical determinant of firm performance, “particularly the combination of product and process innovations that significantly improves firm growth.”²² Developing these innovation capabilities can include hiring in innovation expertise, upskilling of existing staff, changing processes, partnering with firms for product development, collaborating with universities or availing of state supports. A recent study found that firms that innovate in products or processes, or that have attained higher total factor productivity, exhibit higher employment growth than non-innovative firms.²³ Another study looking at the impact of innovation on firm growth, analysing firm growth in Chile, found that product innovation stimulated firm growth but found no relationship between process innovation and growth.²⁴

Innovation in any firm requires different functions and people working together from ideation through to implementation. Walsh et al (2009) present a useful multidisciplinary conceptual framework for understanding how firm-level innovativeness can be achieved is presented in Figure 1.²⁵ This shows the internal and external foundations of innovation within a firm. Management and leadership are crucial to achieving effective firm-level innovation. A climate supportive of innovation is typified by extensive dynamism, flexibility, trust, pro-activeness, empowerment, and support.²⁶ Innovation requires the consistent support of the leadership, but also a willingness by all within a firm to be innovative in terms of their thinking, practices and policies. Such an approach can deeply impact on firm culture that supports sustained innovation activities. For entrepreneurs and start-up teams a high level of creativity on the part of founding entrepreneurs may produce an organisational culture that values both creativity and innovation. Several studies indicate that founding entrepreneurs exert a powerful impact on the cultures of their developing organisations.²⁷

²¹ Erturk, M. (2014). “Determinants And Effects Of Innovation On The Firm Level: An Empirical Investigation.” *International Journal of Research in Business and Social Science* (ISSN: 2147-4478), 3(1), 118-129.

²² Goedhuys, M., & Veugelers, R. (2012). “Innovation strategies, process and product innovations and growth: Firm-level evidence from Brazil.” *Structural change and economic dynamics*, 23(4), 516-529 Micheline and Veugelers, 2011

²³ Dutz, M.A., Kessides, I., O’Connell, S. and Willig, R.D. (2011) *Competition and Innovation-Driven Inclusive Growth*. World Bank Policy Research Working Paper Series No.5852. Washington D.C: World Bank

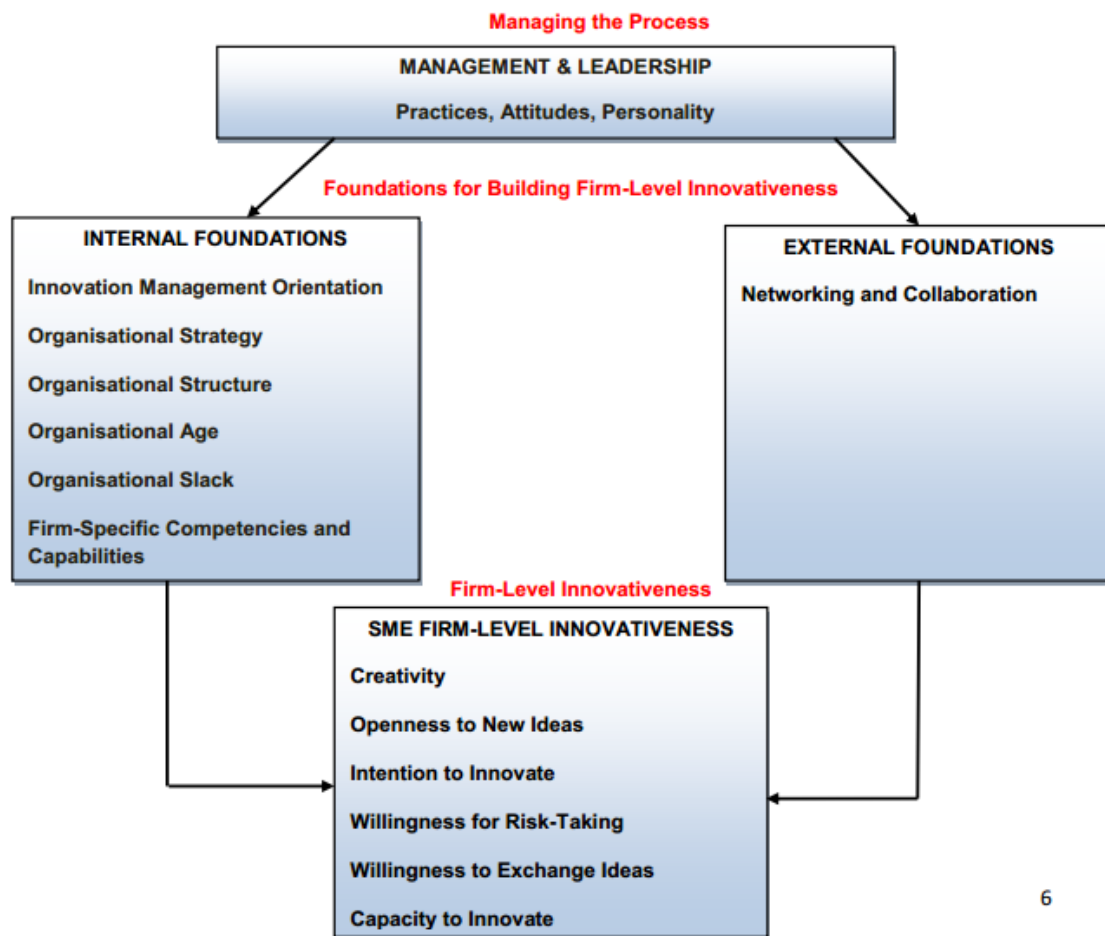
²⁴ Benavente, JM and R. Lauterbach (2008): “Technological Innovation and Employment: Complements or Substitutes?,” *The European Journal of Development Research*, 20(2): 318 -329.

²⁵ Walsh, M., Harrington, D. and Lynch, P. (2009) “Proposing a Framework of Truly Innovative Small and Medium Sized Organisations (RIKON Group)” In: *The European Conference on Creativity and Innovation*, October 28- 30, Brussels

²⁶ Gilbert, DH (2007). Firm innovativeness in SMEs: lessons from Japan. *International Journal of Organisational Behaviour*, 12(1), 126-143.

²⁷ e.g. Gartner, W., Shaver, K., Gatewood, E. and Katz J. (1994), ‘Finding the Entrepreneur in Entrepreneurship,’ *Entrepreneurship Theory and Practice*, 18 (3), 5-9.

Figure 1:
A Conceptual Framework for Achieving Firm-Level Innovativeness



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Some key factors of firm-level innovation include innovation clusters, a firm's organisational strategy and structure, networking and collaboration, the quality of the regional innovation system, management and leadership. While the foundations for building firm-level innovation include both internal and external factors, research suggests that, on balance, internal factors have a greater influence on a firm's capacity to innovate than external factors.²⁸ Some literature suggests that to be innovative, firms have to possess competencies relating to technology, a combination of competencies making the firm more innovative. Souitaris (2002) considers four main competencies that produce innovative capabilities; technical, market, human resources, and organisational competencies. Table 1 provides us with an extensive but not exhaustive list of internal determinants of the innovative process for firms. Another, lesser discussed, factor of firm-level innovation is emotion capability, which Huy (1999) defined as "a firm's ability to perceive, understand, monitor, regulate, and use its members' emotions and to manifest them in the organisation's routines and structures."²⁹ Akgün et al (2009) found that "the dynamics of encouragement and experiencing were found to have a positive association with both firm product and process

²⁸ Hoffman, K. , Parejo, M. , Bessant, J. and Perren, L. (1998) 'Small firms, R&D, Technology and Innovation in the UK: A Literature Review' , *Technovation* 18(1):39–55

²⁹ Huy, Q. N. (1999). "Emotional capability, emotional intelligence, and radical change." *Academy of Management review* 24(2): 325-345.

innovativeness; and the dynamics of displaying freedom have a positive relationship with firm process innovativeness.³⁰ Moreover, certain strategic properties facilitate firm-level innovation, in particular, market and learning orientation, and technology policy.³¹

Table 1:
Internal Factors and Innovation

Factor	Theoretical Arguments
Size	Large : Economies, risk, market, appropriation Small: Flexibility, communication, specialization, informal controls
Debt	Negative: Specificity, risk, information asymmetries
Human resources	Positive: Qualification, experience
Commercial Resources	Positive: Reputation, image, complementary resources, information
Organisational resources	Positive: Coordination, communication, integration, absorptive capacity
Diversification	Negative: Formal and Financial Controls
Internationalisation	Positive: Competitiveness, market

Source: Galende Jesús, Manuel de la Fuente Juan (2003), "Internal factors determining a firm's innovative behaviour", *Research Policy*, Volume 32, Issue 5, May 2003, Pages 715-736.

Place matters and export orientation of firms influence innovation. Firms pursuing open innovation strategies interact with firms, universities, customers etc in their locality but also nationally and internationally. Moreover, the quality of the regional innovation system directly influences the likelihood of a firm to innovate and that this effect decreases with the size of the firm.³²

With respect to exporting firms, several studies have found a positive correlation between exporting and innovation activity, that exporters are more productive and more innovative than non-exporters. Whereby innovating status increases the probability of exporting it does not increase the probability of becoming a first time exporter, and vice versa.³³ Given that exporting helps innovation, further efforts to deepen trade links and facilitate domestic firms to enter international markets would be advantageous.

2.1 Sources of Innovation

What are the typical sources of innovation for firms? The typical external sources of innovative ideas and innovation comes from employees, business partners and customers. An empirical

³⁰ Akgün , A. E., H. Keskin, et al. (2009). "Organizational emotional capability, product and process innovation, and firm performance: An empirical analysis." *Journal of Engineering and Technology Management* 26(3): 103-130.

³¹ Salavou, H., Baltas, G. and Lioukas, S. (2004), "Organisational innovation in SMEs: The importance of strategic orientation and competitive structure", *European Journal of Marketing*, Vol. 38 No. 9/10, pp. 1091-1112

³² Srholec, M. (2010). "A Multilevel Approach to Geography of Innovation." *Regional Studies* 44(9): 1207-1220.

³³ Kostevc, C., & Damijan, J. (2008). Causal Link between Exporting and Innovation Activity. Evidence from Slovenian Firms (No. DYNREG22).

study by Cohen et al (2002)³⁴ study of information sources for new R&D projects found that customers, owned manufacturing operations and co-operative ventures were the three main information sources. Moreover, Segarra-Blasco and Arauzo-Carod (2008)³⁵ found that propensity to engage in R&D cooperation is higher for firms from sectors with high R&D intensity, especially in services and firms that perform both product and process innovation, having a high propensity to engage in R&D cooperation agreements. They also found that public funding programs (EU and national) affect the propensity to engage in R&D cooperation agreements. Internal sources of innovation are unexpected occurrences, incongruities, process needs and industry and market changes (Drucker, 1985)³⁶. Empirical evidence substantiate that sources of innovation outside the organisation are more important than inside, with customers and collaborative arrangement with external parties the really key sources of innovation.

2.2 Barriers to Innovation

Firms can face internal and external barriers to innovation. Internal barriers are focused around people, strategy and structures and external barriers tend to focus on government, market issues and an assortment of other issues. Economic uncertainty and inadequate enabling technologies can also be external barriers to innovation. Table 2 outlines examples of internal and external barriers. To overcome barriers firms should use mechanisms to tie employees to various knowledge sources, very important for innovation performance³⁷.

Table 2:
External and Internal Barriers to Innovation³⁸

External Barriers		Internal Barriers	
Sources	Examples	Sources	Examples
Market	Financial, short-termism, market failure, market risk, etc	People	Fear, lack of creativity, etc
Government	Policies, regulations, standards, institutions, etc	Structure	Power centralisation, poor reward/incentive systems, etc
Others	Technical, societal, Inter-organisational, etc	Strategy	Unclear goals, poor marketing, service and legal skills, etc

2.3 Small and Medium Enterprises (SMEs) vs Multinational Corporations (MNCs)

There are marked differences in the scope and focus of the innovation strategies of smaller and larger firms. In a product based strategy, small firms are expected to rely more on innovative

³⁴ Cohen, W. M., Nelson, R. R., & Walsh, J. P. (2002). Links and impacts: the influence of public research on industrial R&D. *Management science*, 48(1), 1-23.

³⁵ Segarra-Blasco, A. and Arauzo-Carod, J.M. (2008) Sources of innovation and industry-university interaction: Evidence from Spanish Firms, *Research Policy*, 38(8):1283-1295.

³⁶ Drucker, P. (1985) *Innovation and Entrepreneurship: Practice and Principles*, Butterworth-Heinemann.

³⁷ Rodan, S. & Galunic, C. (2004) More that network structure: How knowledge heterogeneity influences managerial performance and innovativeness. *Strategic Management Journal*. 25(6): 541-562..

³⁸ Hadjimanolis, A. (2003), "The Barriers Approach to Innovation", in Shavinina, L. (Ed.) *The International Handbook on Innovation Part VIII*, Ch. 1, Elsevier Science Ltd, Oxford, pp. 559-573.

dynamics, while large firms are expected to rely more on market power strategies. In a strategy based on process innovations, small firms critically depend on greater production flexibility, while large firms may invest more in new machinery and search for larger markets.

Much literature has explored the relationship between firm size and innovation, showing a frequent division between a creative destruction view, where innovation leads to concentration and market power of new dynamic firms, and the firm level accumulation whereby high present output leads to high future output and innovation is incremental. A common theory from many of these studies is that small firms are more innovative, or more efficient innovators, than large firms.

Small firms appear to be better at exploiting external economies deriving from a more innovative environment, due to the proximity to universities and to R&D centres of large firms.³⁹ Acs and Audretsch (1987) also found that large firms are more innovative in monopolistic markets and concentrated industries with high barriers to entry, whereas small ones perform better in competitive markets,⁴⁰ with the role of small firms more relevant where entry costs are lower and niche markets exist. Another potential reason for small firm innovation being more efficient is that small firms enjoy advantages over large firms in crafting effective, incentive-intensive employment contracts that spur innovation.

In peripheral regions the main problems are a low level of R&D and innovation due to a dominance of SMEs in traditional industries, weakly developed firm clusters, few knowledge providers and a weak endowment with innovation support institutions.

Conditions, Supporting Mechanisms and Institutional Settings

3.1 Local Socioeconomic Conditions

One theme that emerges from recent research is the importance of having favourable socioeconomic conditions to foster innovation and growth. Some studies argue that, much more than the presence or absence of clusters, having “a good level of education, a strong endowment of skills in the population, or a workforce with sufficient high-tech skills is not just crucial to generating and absorbing innovation but also the best way to ultimately promote greater economic growth.”⁴¹ More importantly, local social structures, interaction, and collective learning processes within clusters are viewed as making firms located in close physical proximity more innovative and more dynamic than isolated firms.⁴² Furthermore, “social

³⁹ Acs, Z. J., & Audretsch, D. B. and Feldman, M.P. (1994). “R&D Spillovers and Recipients Firms Sizes”, *Review of Economics and Statistics*, 76(2), 336-339. See also: Audretsch, D. and Vivarelli, M. (1996) ‘Firms Size and R&D Spillovers: Evidence from Italy’, *Small Business Economics* 8(3): 249–58; Autant-Bernard, C. (2001) ‘Science and Knowledge Flows: Evidence from the French Case’, *Research Policy* 30(7): 1069–78.

⁴⁰ Acs, Z. J., & Audretsch, D. B. (1987). “Innovation, market structure, and firm size.” *The review of Economics and Statistics*, 567-574.

⁴¹ Rodríguez-Pose, A. and F. Comptour (2012). “Do clusters generate greater innovation and growth? An analysis of European regions.” *The Professional Geographer* 64(2): 211-231.

⁴² Baptista, R. and Swann, G. (1998). “Do Firms in Clusters Innovate More?” *Research Policy*, 27(6), 525-540

closeness facilitates firms' capacity to learn, absorb external knowledge and innovate since social nearness breeds trust which, in turn, lowers transaction costs and facilitates collaboration."⁴³ In the context of developing an economic plan for Galway City and County further enhancing the local socioeconomic conditions are critical to support sustainable growth and development.

3.2 R&D Investment Subsidies and Tax Credits

A large body of scholarly literature has tended to identify local R&D investments as the key driver for innovative performance. Focusing only on internal R&D and the development of internal capabilities and routines is no longer sufficient to cope with increasing costs, shorter product life cycles and greater technological complexities.

All OECD countries use R&D subsidies, and an increasing number of countries use some form of R&D tax incentives to enhance private sector investments in R&D. Typical policies usually include some R&D subsidies and R&D tax incentives that are vital to the promotion and development of innovation investments in organisations.

Takalo and Tanayama (2010) study an adverse selection model whereby firms first apply to the public agency for a subsidy, and then for additional financing from private financiers. In their model, the agency screens the project of an applicant and finds out its quality. They show that subsidies have two effects. Firstly, they lower the cost of external finance. Secondly, a subsidy is a signal to private financiers about the quality of the project, thus generating a "certification" effect - a mark of quality.⁴⁴

A recurring theme in the relevant literature on both R&D subsidies and on R&D tax credits has been the so-called additionality effect on R&D: does a government subsidy lead to an increase in private R&D (additionality or crowding in), or to a reduction in private R&D spending (crowding out)? Görg and Ströbl (2007) study R&D subsidies in Ireland and find that for domestic firms, small subsidies lead to crowding in while large ones may crowd out private investment. It is also worth noting that since it is likely to be cheaper for firms to apply for a government grant than to raise funds in the capital market, some projects may be funded that would have been undertaken even if they did not receive government support.⁴⁵

In peripheral regions the main problems are a low level of R&D and innovation due to a dominance of SMEs in traditional industries, weakly developed firm clusters, few knowledge providers and a weak endowment with innovation support institutions. Marrocu et al (2013)⁴⁶ note "It is widely recognised that the capacity of a region to generate, transmit and acquire knowledge and innovation depends on a multifaceted set of factors: investment in R&D, work force experience, education and training, collaboration networks, technology transfer mechanisms, researchers' and workers' mobility, among many others."

⁴³ Marrocu, E., R. Paci, et al. (2013). "Proximity, networking and knowledge production in Europe: What lessons for innovation policy?" *Technological Forecasting and Social Change* 80(8): 1484-1498.

⁴⁴ Takalo, T. and T. Tanayama (2010). "Adverse selection and financing of innovation: is there a need for R&D subsidies?" *The Journal of Technology Transfer* 35(1): 16-41.

⁴⁵ Görg, H. and E. Strobl (2007). "The Effect of R&D Subsidies on Private R&D." *Economica* 74(294): 215-234.

⁴⁶ Marrocu, E., R. Paci, et al. (2013). "Proximity, networking and knowledge production in Europe: What lessons for innovation policy?" *Technological Forecasting and Social Change* 80(8): 1484-1498.

3.3 Industry Clusters

As already mentioned, interactions between stakeholders is an important factor in effective policy development, the easier the access between business and universities, the more it will foster university-business R&D collaborations.⁴⁷ Another interlinking factor to drive innovation is proximity/closeness of businesses. Spatial concentration is believed to be critical in the dynamics of innovation, thanks mainly to local spill-overs. These overlapping factors emphasise the importance of industry clusters.

Much of the literature aiming to understand and describe the link between innovation and economic growth is focused on clusters, or “the geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions.”⁴⁸ Regional clusters have a strong association with economic growth, especially when they help increase the knowledge flow in already highly integrated communities, well endowed with firms, skilled workers, researchers, and scientists.⁴⁹

Clusters are able to provide personnel and entrepreneurs with high-end facilities and typically contain networks of individuals and companies with complementary skills. For example, in Sweden, Stockholm has over 50% of Sweden’s creative industry companies based in the city. Sallet *et al*, (2009) note that “Geographic regions that are bounded by a network of shared advantages create virtuous circles of innovation that succeed by emphasizing the key strengths of local business, universities and other research and development institutions, and non-profit organization... Think information technology in Silicon Valley, music in Nashville, manufacturing in the Pacific Northwest, or life sciences in Massachusetts.”⁵⁰

Clusters are important to innovation policy development as they “reflect the nature of the real economy and as a matter of policymaking, clusters provide a framework for rethinking and refocusing economic policy.”⁵¹ Katz and Muro (2011) argue that in pursuing cluster-based economic development strategies, policy leaders should not try to create clusters. Policy makers should:

- Use data to target interventions, drive design, and track performance
- Focus initiatives on addressing discrete gaps in performance or binding constraints on cluster growth
- Maximize impact by leveraging pre-existing cluster-relevant programs
- Align efforts vertically as well as horizontally; and
- Let the private sector lead

Nevertheless, Marrocu *et al*, (2013) note: “Local relations go often together with wider links and networks. In this respect, the spatial dimension may be just a counterpart of other forms of a-

⁴⁷ Cunningham, J and Link A. (2014) Fostering University-Industry R&D Collaborations in European Union Countries. Whitaker Institute Working Paper no. 42. Galway

⁴⁸ Porter, M. E. (2008). On competition. Harvard Business Press.

⁴⁹ Rodríguez-Pose, A. and F. Comptour (2012). "Do clusters generate greater innovation and growth? An analysis of European regions." *The Professional Geographer* 64(2): 211-231.

⁵⁰ Sallet, J., Paisley, E., & Masterman, J. (2009). *The Geography of Innovation*. Progress of Science. Ilet, Paisley, and Justin 2009

⁵¹ Katz, B. and M. Muro (2011). Chapter 5 The New Cluster Moment: How Regional Innovation Clusters can Foster the Next Economy. *Entrepreneurship and Global Competitiveness in Regional Economies: Determinants and Policy Implications*: 93-140.

spatial proximity: institutional, cognitive or technological, social or relational and organisational.”⁵²

Extensive research has been undertaken on the evolution of the medical device cluster in Galway⁵³. These studies have shown the importance and benefits of clusters as well as the dangers of creating technological lock-in. The Galway medical device cluster research also has highlighted the growth of other potential clusters and serial entrepreneurship within the cluster. It also highlights the role of different triple helix actors collaborating in developing the sector and promoting the cluster internationally. The promotion of the Galway medical device cluster actors has contributed to the international visibility and reputation of the cluster.

3.4 The Role of Higher Education Institutions

Key actors in place based innovation are Higher Education Institutions (HEIs). HEIs provide education opportunities, are at the forefront of new knowledge and thinking, are connected to international research and technology networks and are involved in the exploitation of technology and knowledge through their Technology Transfer Offices (TTOs). Technology transfer from HEIs is one of the key drivers of economic growth^{54 55}. HEI TTOs role has expanded beyond protecting intellectual property but to promoting entrepreneurship on campuses and within the localities they are based. TTOs are involved in exploiting of IP through different technology transfer mechanisms such as patents, licenses, material transfer agreements, spin-out and spin-in firms.

Some TTOs are involved in the provision and managing of incubators and providing incubators services that support new venture creation. These are where spin-out and spin-in firms are located and they provide programmes and supports for would be entrepreneurs located on campus or within their region. Grimaldi and Grandi (2004)⁵⁶ provide a clear definition of the incubator concept as: ‘...an effective means to link technology, capital and know-how in order to leverage entrepreneurial talent, accelerate the development of new companies and thus speed the exploitation of technology.’ Research-intensive HEIs are regarded as an important element of the ‘innovative infrastructure’ in supporting spin-offs and encouraging new enterprise creation and may even influence the extent of new venture success⁵⁷. Such incubation environments facilitate networking and social capital building beyond the formal training and advisory sessions.⁵⁸ The benefits of incubation are outlined in Table 2 and incubator firms have been

⁵² Marrocu, E., R. Paci, et al. (2013). "Proximity, networking and knowledge production in Europe: What lessons for innovation policy?" *Technological Forecasting and Social Change* 80(8): 1484-1498.

⁵³ Giblin, M. and Ryan, P. (2012) Tight Clusters or loose networks? The critical role of inward foreign direct investment in cluster creation, *Regional Studies*, 46(2):245-258.

⁵⁴ Grimaldi, R., Kenney, M., Siegel, D.S. and M. Wright (2011), '30 years after Bayh-Dole: Reassessing Academic Entrepreneurship', *Research Policy*, 40 (8), 1045-1057.

⁵⁵ Aldridge, T.T. and D. Audretsch (2011), 'The Bayh-Dole Act, and scientist entrepreneurship', *Research Policy*, 40 (8), 1058-1067.

⁵⁶ Grimaldi, R. and Grandi, A. (2004) Business Incubators and New Venture Creation: An assessment of incubating models. *Technovation*, Vol. 25, Issue. 2, pp 111-121.

⁵⁷ Cooper, S. (2000) 'Technical Entrepreneurship'. in Carter, S and Jones – Evans, D. (eds), *Enterprise and Small Business: Principles Practices and Policy*, Financial Times/Prentice Hall : UK, Chapter 13, pp 220 – 241; Prodan, I. (2007) A Model of Technological Entrepreneurship In Thérin, F. (Editor) *Handbook of Research on Techno-Entrepreneurship*. USA: Edward Elgar Publishing.

⁵⁸ Low, M.B. and MacMillan, I.C. (1988) 'Entrepreneurship: Past research and future challenges', *Journal of Management*, 14(2):139 – 161; Pages, E., Freedman, D. and Von Bargen, P. (2001) What Makes a Region Entrepreneurial? *Economic Development Commentary*.

found to have higher growth and better at adopting new technology⁵⁹. As well as these benefits, incubator firms can gain credibility by locating in an incubator⁶⁰. This is important in the early stages of their development. Incubators provide opportunities for entrepreneurs to build relational intellectual capital through the development of networks and contacts, relationship building, accessing and leveraging knowledge experts and members of associations⁶¹. Incubator structured new venture creation programmes also supports entrepreneurs to write their business plan as well as contributing to the start-up processes with respect to financial resource appropriation, preliminary business and industry intelligence, market feedback, network mapping and development⁶².

Table 3:
Incubation Benefits to Incubatees

- Access to information and networks
- Provision of supports and services for
- Developing business plans
- Marketing plan
- Building management teams
- New product development
- Customer validation
- Obtaining capital
- Mentors
- Advisory sessions

Source: Abetti, P.A. (2004) *Government-supported Incubators in the Helsinki Region, Finland: Infrastructure, Results and Best Practices*, *Journal of Technology Transfer*, 29 (1): 19-40.

Technology transfer from universities to industry contributes to the growth and internationalisation of firms. The level of business investment in R&D in the region, proximity to industrial clusters, support of development agencies and research councils, government support and investment and cost effective patenting processes are macro level factors that stimulate technology transfer from HEIs to industry⁶³.

Moreover, empirical research on university industry R&D collaborations highlights several benefits including increasing the probability of an R&D project commercialisation and the productivity of business R&D increase as well economies of technological scope increases.⁶⁴ Firms also benefit by leveraging research investment, sharing R&D expenditure and gaining access to HEI research discoveries⁶⁵. There are increasing R&D collaborations between HEIs

⁵⁹ Colombo, M. G. and Delmastro, M. (2002) How effective are technology incubators?: Evidence from Italy. *Research Policy*, 31(7), 1103-1122.

⁶⁰ Totterman, H. and Sten, J. (2005) 'Start-ups: Business Incubation and Social Capital', *International Small Business Journal*, Vol. 23, pp 487-511.

⁶¹ Gately, C. and Cunningham, J. (2014) Building intellectual capital in incubated technology firms, *Journal of Intellectual Capital* 15(4):516-536.

⁶² Gately, C. and Cunningham, J. (2014) The Contributions and Disconnections Between Writing a Business Plan and the Start-Up Process for Incubator Technology Entrepreneurs, *Academic Entrepreneurships Creating an Entrepreneurial Ecosystem in Advances in Entrepreneurship, Firms Emergence and Growth*, 16: 197-240.

⁶³ Evers, Natasha., James Cunningham, and Thomas Hoholm, (2014) *Technology Entrepreneurship: Bringing Innovation to the Marketplace*, Basingstoke, Hampshire, UK: Palgrave McMillian.

⁶⁴ Link, A.N. and J. Rees (1990) Firm Size, University-Based Research, and the Returns to R&D, *Small Business Economics* 2: 25-31; Link, A.N. and C.J. Ruhm (2009) Bringing Science to Market: Commercializing from NIH SBIR Awards," *Economics of Innovation and New Technology* 18: 381-402.

⁶⁵ Graff, G., Heimen, A., and Zilberman, D. (2002) University Research and Offices of Technology Transfer *California Management Review*, 45: 88-115; Lee, Y. (2000) The Sustainability of University-Industry Research Collaboration: An Empirical Assessment, *Journal of Technology Transfer* 25:2:111-131; Sheehan, J. and A. Wyckoff (2003) Targeting

and industry if the business is mature and large, engaged in exploratory internal R&D, there are no intellectual property issues and if the researcher or faculty members is part of a university research centre⁶⁶. Furthermore, access – the extent to which access to business sector R&D facilities facilitates university cooperative with business – is another positive and statistically significant factor⁶⁷.

Finally, HEIs have economic impact across its core missions of teaching, research and entrepreneurial contributions. For example, a recent study of the economic impact of 147 entrepreneurial universities in the UK reveals the positive and significant economic impact of teaching, research and entrepreneurial activities⁶⁸. Higher economic impact of UK's entrepreneurial universities (the Russell Group) is explained by entrepreneurial spin-off. Of the rest of the country's universities, the highest impact is associated with knowledge transfer (knowledge capital). This reinforces the important, economic benefit of technology transfer and knowledge capital.

3.5 Role of Scientists

One of the significant advantages Galway has over other locations is the scientific community that is located at NUI Galway, GMIT, the Marine Institute and Teagasc. Scientists play a critical role in sustaining place based innovation and PIs 'are the linchpin of the transformation, shaping research avenues, articulating actors within programs, bridging academia and industry.'⁶⁹ Scientists are motivated by the prioritisation of new knowledge and, in realising this, they are involved in competing and securing public research funding from national and international sources. In doing so they take on the role of principal investigator (PI) which is seen as prestigious and a significant career milestone. Scientists in the PI role bridge between academia, TTOs, firms, regulators, society and policy makers. These large-scale public research programmes where scientists take on the role of PI include technology transfer activities. This means that scientists are engaging with industry with more frequency and intensity. Furthermore, by responding, interpreting and articulating scientific trajectories in response to public research programmes, scientists as PIs are in a central position to shape science and markets through technology transfer. PIs have become knowledge and technology transfer agents and brokers of science⁷⁰.

R&D: Economic and Policy Implications of Increasing R&D Spending, *STI Working Paper 2003/8*, Science and Innovation Unit, OECD, Paris.

⁶⁶ Bercovitz, J.E.L. and M.P. Feldman (2007) Fishing Upstream: Firm Innovation Strategy and University Research Alliances, *Research Policy* 36: 930-948.; Boardman, P.C. and E.A. Corley (2008) University Research Centers and the Composition of Research Collaborations, *Research Policy* 37: 900-913; Hall, B.H. (2004) University-Industry Research Partnerships in the United States, in J. Contzen, D. Gibson, and M. V. Heitor (eds.), *Rethinking Science Systems and Innovation Policies*, West Lafayette: Purdue University Press, pp. 1-31.

⁶⁷ Cunningham, J.A. and A.N. Link, (2014), Fostering university-industry R&D collaborations in European Union countries, *International Entrepreneurship and Management Journal*.

⁶⁸ Guerrero, M., Cunningham, J.A. and D. Urbano, (Forthcoming) 'Economic impact of entrepreneurial universities' activities: An exploratory study of the United Kingdom', *Research Policy*, <http://dx.doi.org/10.1016/j.respol.2014.10.008>.

⁶⁹ Mangematin, V., O'Reilly, P., and J. Cunningham (2014), PIs as boundary spanners, science and market shapers, *Journal of Technology Transfer*, 39 (1),1-10.

⁷⁰ Cunningham, J.A., O'Reilly, P., O'Kane, C., and V. Mangematin, (2015), 'Managerial challenges of publicly funded principal investigators', *International Journal of Technology Management*.

3.6 Innovation Districts

The notion of innovation districts came as a result of the focus in the past on firms moving their operations from city centres to suburban areas, these new business campuses not as easily accessible “with little emphasis on quality of life or on integrating work, housing, and recreation.”⁷¹ Thus, a new complementary urban model is now emerging giving rise to what Katz and Wagner have labelled as innovation districts. Katz and Wagner have defined Innovation Districts as follows: “Innovation districts constitute the ultimate mash up of entrepreneurs and educational institutions, start-ups and schools, mixed-use development and medical innovations, bike-sharing and bankable investments—all connected by transit, powered by clean energy, wired for digital technology, and fueled by caffeine.” They go on to identify three different models that explain how these collaboration-friendly innovation districts could be created.

- **Anchor-Plus Model** – The key characteristic of this model would be the presence of one or more anchor institutions, i.e. research universities and research-oriented medical hospitals with extensive R&D. The other important trait for this model would be that the district is located in mixed-use developments in one of the city’s central areas
- **Re-imagined Urban Areas Model** – This model, focusing on the rejuvenation of industrial areas, requires the availability of renovated buildings, possibly along city waterfronts, in high rent cities, and that the district be close in proximity to research institutions and anchor companies
- **Urbanised Science Park Model** – With this model, the old trend of companies moving their operations to isolated suburbs would be reversed so that the urbanised science park would become increasingly dense with businesses, residential housing and restaurants.

Recently there has been a push for a similar model in Galway, starting with one building to attract young technology companies with strong growth potential to the city centre, and then expanding to a cluster of buildings as part of a Galway City Innovation District. As part of this initiative, NUI Galway is hosting a one-day summit in March 2015, “Innovating West”, to showcase success stories, and more importantly, to kick-start discussions on what will be required to create an Innovation District in the city.

⁷¹ Katz, B., & Wagner, J. (2014). “The Rise of Innovation Districts: A New Geography of Innovation in America.” Washington: Brookings Institution.



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