

Market failures in open innovation: implications and policy responses

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ABSTRACT

Open innovation provides significant advantages for individual firms and may generate wider social benefits. Positive externalities related to knowledge sharing may result from openness itself, and enhanced levels of innovation may lead to otherwise unachieved innovation spillovers. A number of studies have suggested, however, that average levels of OI activity remain well below the level which maximises innovation outputs. Here, we identify four market failures which arise in the process of OI partnership formation and which may be limiting firms OI engagement. Information failures occur which mean firms are unaware of the benefits of OI, lack information on the capabilities of partners and their trustworthiness. Appropriability issues may also mean that levels of OI remain below the social optimum. We develop policy responses to each market failure linked to the development of an OI intermediary and develop a related logic model.

Keywords: Open Innovation, intermediary, market failure

JEL Codes: O32, L1, O38; Q34; L26

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1. INTRODUCTION

To date research on open innovation (OI) has focussed largely on the benefits to individual firms and the strategic and operational requirements of implementing open innovation (Sieg, Wallin, and von Krogh 2010; Hung and Chiang 2010; Lichtenthaler and Lichtenthaler 2009). For example, partnering in the innovation process has been found to stimulate creativity, reduce risk, accelerate or upgrade the quality of the innovations made, and signal the quality of firms' innovation activities (Powell 1998). In addition to the private benefits for firms engaging in OI there is also emerging evidence of the wider social benefits that may arise. Stronger social and relational capital arising from OI partnerships will strengthen the innovation system generating externalities from openness during the innovation process (Roper et al. 2014) and externalities from resulting innovation (Beugelsdijck and Cornet 2001). Yet, despite our knowledge of the antecedents and consequences of OI from an organisational and strategic management perspective, we understand less well how firms' operating context can influence the adoption of OI practices. Specifically, are there market failures that reduce levels of OI activity and the related benefits? And, if so how should policy-makers respond?

Interest in policy intervention to overcome weaknesses in innovation systems is well-established, particularly in terms of measures to stimulate R&D and innovation. By contrast, and despite the potential for benefits accruing to both individual firms as well as the wider innovation system, relatively little attention has been focussed on the policy implications of OI¹. This is surprising given that research on innovation systems has consistently emphasised the potential value of innovation partnering and the level of 'association' in a particular region (Cooke and Morgan 1998). Where systemic failures are limiting flows of knowledge or impeding the functioning of the innovation system (OECD 1999) there may be a role for

¹ Although see Chesbrough, H and Vanhaverbeke, W (2011) 'Open innovation and public policy in Europe', ESADE Business School which provides some broadly based recommendations for the development of OI in Europe.

policy intervention to creating regional advantages (Asheim et al. 2007; Shyu and Chiu 2002 ; Hewitt-Dundas and Roper 2011).

Our argument proceeds as follows. In Section 2 we outline the empirical regularity we seek to understand - a situation where observed levels of OI activity are well below the level which would maximise firms' and regions' innovation performance. Our conceptualisation of the issues involved focusses on the private and wider social benefits of open innovation, and identifies four market failures which mean that these benefits are not generally realised. Informational failures relating to the likely rewards from OI mean that firms cannot fully appreciate the potential private benefits, and therefore under-invest in OI. More standard market failures relating to firms' inability to appropriate the wider social benefits which arise from OI also prove important. The market failures we identify suggest a case for policy intervention to broaden the adoption of OI and, in Section 4, we develop policy responses designed to address each market failure. Our analysis contributes to the conceptual understanding of OI decisions by firms, and the implications in terms of the private and social benefits which may arise.

2. PROFILING THE BENEFITS OF OPEN INNOVATION

2.1 Private benefits

Open Innovation (OI) has been defined as '... the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively' (Chesborough 2006, p. 1). OI activity may therefore be: through inbound mechanisms, and knowledge flows from outside to inside the firm; through outbound mechanisms, where knowledge flows from inside the firm to the outside; or, through a blend of both inbound and outbound mechanisms. In their analysis of the responses to a survey of innovators in the UK Cosh et al. (2011) identified three clusters of innovators: 'Closed' innovators – those

not engaging with any external partners for innovation - who accounted for 32.1 per cent of innovative firms; 'Hunters' engaged primarily in inbound open innovation, which accounted for 41.9 per cent of innovators; and, 'ambidextrous innovators' - the 25.9 per cent of firms who were engaged both in inbound and outbound open innovation. It is perhaps unsurprising therefore that the majority of empirical studies of OI have focused on inbound OI partnerships (Love and Roper 2013).

There is substantial evidence of the positive relationship between innovation and productivity (Crepon et al. 1998; Loof and Heshmati 2002) and innovation and business growth (Anyadike-Danes et al. 2009). The evidence suggests that openness in innovation can also significantly enhance business' financial and strategic performance (Love, Roper, and Bryson 2011)². Nambisan and Sawhney (2007) succinctly organise the private benefits arising from OI along four dimensions: increasing the *reach* of firms in identifying new ideas, technologies and markets; reducing the *cost* of innovation through partnerships with other organisations; similarly, reducing the *risk* of commercialising new ideas, technologies or products; and increasing the *speed* of development from idea to innovation³. These private benefits arise from the asymmetric nature of firms' (and other non-corporate organisations') resources and competencies. Heterogeneity in capabilities creates the potential for learning (Dosi 1997) through inter-organisational collaboration and the subsequent transfer of tacit and explicit knowledge: also referred to as 'vicarious learning' (Ingram and Baum, 1997). At the same time, the knowledge and learning that is gained from external sources tends to be complementary to internal capabilities - and in particular R&D - in shaping innovation performance (Roper, Du, and Love 2008). As a result, considerable attention has been paid to firms'

² Performance benefits arising from OI engagement reflect partnering benefits associated with other organisational activities such as supply chain management (Bharadwaj, 2000) with Dyer and Singh (1998) identifying mutually beneficial relational rents arising from suppliers and firms combining knowledge in novel ways.

³ The innovation benefits of inward OI have been observed across both manufacturing and service sector firms (Love, Roper, and Bryson 2011) as well as traditional and high-tech manufacturing sectors (Spithoven, Clarysse, and Knockaert 2011; Chiaroni, Chiesa, and Frattini 2010; Huang 2011).

absorptive capacity (Cosh et al. 2011) as a proxy for their ability to engage in OI, how the strength of absorptive capacity varies for engaging in supply chain as compared to university OI collaborations (Schmidt 2010), and in particular, how SMEs may be constrained in engaging in OI due to weaker absorptive capacity (Chesbrough 2010; Van de Vrande et al. 2009). Weaker absorptive capacity in SMEs may also render them as less attractive innovation partners to large firms and other innovation public sector organisations.

Learning may be evident in various ways, e.g. financially where external linkages increase firms' ability to appropriate the returns from innovation, or technologically as firms search the environment systematically, facilitating access to improved technology developed elsewhere (Laursen and Salter, 2006; Niosi, 2003). Because the success of any innovation process is uncertain, firms may also have an incentive to develop several external linkages at the same time: having more linkages or more different types of linkages increases the probability of obtaining useful knowledge from outside of the firm (Leiponen and Helfat 2010).

Alongside its innovation benefits, disadvantages may also arise from engaging in OI. For example, firms may limit their use of OI partnerships due to difficulties in defending their own intellectual property rights (Lichtenthaler 2010). Transaction and coordination costs (Alston and Gillespie, 1989) may also deter firms' engagement in OI: the costs of searching for new OI partnerships may be substantial, and having a larger number of partnerships may lead to monitoring and management problems in addition to the absorption of knowledge simultaneously from a large number of sources (Sieg, Wallin, and von Krogh 2010; Laursen and Salter 2006). Due to these cognitive limits firms are likely to have a 'saturation' level in the number of partnerships, where the innovation benefits are maximised. Beyond this level, the addition of another partnership will result in diminishing innovation performance.

The benefits of OI therefore have limits, with a standard finding being an inverted U-shape relationship between the number of partnerships and firms' innovation performance (Laursen and Salter 2006; Leiponen and

Helfat 2010; Vahter, Love, and Roper 2014). This suggests a tipping-point or optimum beyond which the innovation benefits of openness actually decline. Table 1 summarises the result of a series of econometric studies using different innovation indicators which identify an inverted U-shape relationship between openness and innovation and highlights two standard characteristics of these studies. First, the shape of the openness-innovation relationship, and therefore the position of the tipping-point or optimum level of openness, differs significantly between micro, small and larger firms. Second, in each study the actual mean level of openness observed is well to the left of the tipping point or optimum. In other words, by developing additional open innovation relationships firms have, on average, the potential to benefit from increased levels of innovation.

Kim et al (2010) provide a useful process framework for assessing how these benefits may arise in inter-firm or other inter-organisational relationships. They identify four distinct stages in the development of such relationships: (i) identifying strategic needs, (ii) assessing and selecting a partner, (iii) implementing a partnership, and (iv) re-assessing and re-shaping the partnership (Kim et al., 2010). The first three of these stages are of particular relevance to our analysis as they represent the process which occurs prior to any returns from OI being realised⁴. The first stage - 'identifying strategic needs' - relates to the firm developing an awareness of the need to form a collaborative relationship and the value of such a relationship. It also involves preparatory work by the company in determining its expectations and requirements from the partnership. In the second stage - 'assessing and selecting a partner' - active search and selection of potential partners occurs. This may involve establishing clear criteria for partner selection along with mechanisms and measures to evaluate potential partners. Third, having selected a partner or partners, the next stage - 'implementing a partnership'- involves formalising the collaboration, operationalising the activity surrounding the engagement and managing the relationship. Finally 'reassessing and reshaping the

⁴ These stages have however tended to be overlooked in the literature in preference for focusing on value creation and performance benefits e.g. new products, arising from collaborative partnerships (Lee et al. 2010).

partnership' is concerned with the longer term strategic development of the partnership where engagement is monitored, evaluated and the relationship refined over time.

Information failures may occur at each of these stages which collectively reduce firms' engagement with OI. In relation to the first stage of identifying strategic needs, information failures may exist which mean that firms are unaware of the potential benefits of OI, or are unable to predict the likely (private) returns. This *lack of awareness* of the benefits of OI seems likely to mean that firms will either fail to engage in OI activity or, where they do engage in OI, that they will under-invest in forming OI partnerships and potentially in the internal capabilities required for effective open innovation (Spithoven, Clarysse, and Knockaert 2011). For example, extant research has pointed to a learning effect from innovation partnerships, which is strengthened as firms increase the number of alliances and diversity of partners (Reuer et al. 2002; Laursen and Salter 2006; Leiponen and Helfat 2010). This may reflect learning-by-using as firms which undertake OI – or observe others undertaking open innovation learn to appreciate the potential benefits and are better able to predict and maximise the private returns (McWilliams and Zilberman 1996).

The second stage in the partnership formation process (Kim et al. 2010) involves assessing and selecting partners. At this stage, incomplete or asymmetric information on potential partners' functional capabilities may lead either to a failure to identify appropriate partners or the establishment of OI relationships with the wrong partners. That is, a market failure occurs through *limited information on the functional capabilities* of potential partners. This has been described as adverse selection and occurs pre-contractually. Where the wrong partners are selected this can result in inferior outputs (Kivisto, 2005). Lee et al. (2010, 293) suggest that this information failure and the potential to select the wrong partner is particularly acute for small businesses due to more limited capability and financial resources to acquire partner information as compared to larger firms 'who can often afford professional intelligence processes for scanning and monitoring their technological environments'. Both may mean that

firms fail to maximise the potential private benefits of OI.

In the third stage of the partnership formation process (Kim et al. 2010) - implementing the partnership - market failures may arise through *limited information on the trustworthiness* of partners. Even where firms have complete information on the functional capabilities of potential OI partners, asymmetric information in terms of potential partners' strategic aspirations or trustworthiness may result in the establishment of relationships with inappropriate or inadequate governance mechanisms. Innovation undertaken through OI partnerships may be more complex than internal or closed innovation activities therefore creating greater potential for moral hazard and opportunistic behaviour (Kwon and Suh, 2005), which is exacerbated where behaviour is difficult to observe and monitor (Kivisto, 2008).

Effective supply chain partnerships have been found to depend on mutual trust, openness and shared risk and rewards (Lambert et al. 2004). This is perhaps even more important for OI relationships where R&D activities and associated outputs and outcomes are difficult to articulate and behaviour is hard to monitor (Kivisto 2008). In such circumstances a partner may act in their own self-interest or may devote insufficient effort, leading to poor quality outputs (Kivisto 2008). Innovation partners may therefore misrepresent their performance with this again reducing the returns to OI below the private optimal level. One approach to overcoming a lack of trust between partners is through legally enforceable contracts. This then safeguards the innovation process between partners and the appropriation of rents. However, research on buyer-supplier relationships (Wang et al. 2008) found that trust between partners was more important than contractual arrangements in stimulating creativity.

Any of these information failures which mean that firms are unable to accurately assess the benefits of OI, assess partners' capabilities or trustworthiness may lead firms to under-invest in OI relative to their private optimum. This may explain why in empirical studies the average levels of OI activity observed are always significantly lower than the level which would make the maximum contribution to innovation (Table 1). Reducing

the extent of these information failures may encourage firms to move closer to the optimum level of OI, the point where the marginal costs and benefits of openness are equal. This is not the whole story, however, as OI can have wider social benefits and these are the focus of the next section.

2.2 Social benefits

Over and above the benefits to an individual firm from adopting OI, there may also be wider social benefits. These social benefits arise through two main mechanisms: externalities of openness and externalities from improved innovation. Innovation externalities occur as a result of the outputs of firms' innovation processes, i.e. the new products, services or processes they introduce. The benefits arising from these innovation are not confined to the firm conducting the activity, but instead extend to other organisations ⁵. Such innovation spillovers arise when 'quality improvements by a supplier are not fully translated into higher prices for the buyer(s). Productivity gains are then recorded in a different firm or industry than the one that generated the productivity gains in the first place. Rent spillovers occur in input-output relations' (Beugelsdijck and Cornet 2001, p. 3). The extent of innovation spillovers therefore depends crucially on the scope of value-chain interactions between a firm and other regional organisations. The implication of this is that where the regional business ecosystem is strong (Clarysse et al. 2014) there is potential to further strengthen it. For example, the stronger are local supply chains and other market interactions (e.g. joint-ventures or licensing agreements), the stronger will be any OI spillovers. Where local linkages are weaker, localised 'rent-based' OI spillovers will also be more limited. Indeed, Clarysse et al. (2014) suggest that where firms operate mainly in non-regional markets and the regional business ecosystem is weak, then it is questionable the extent to which promoting greater OI will strengthen the business ecosystem. Yet, assuming some supply chain and collaborative

⁵ Menon (2015) suggests that these externalities are geographically constrained with the benefits being shaped by the extent of coherence between organisations through feedback systems or loops, common developmental trajectories and complementary competencies between agents (Edquist, 2004).

development within the region, OI will enhance private organisational benefits and innovation spillovers (Czarnitzki and Kraft 2012; Kesidou and Romijn 2008; Moreno, Paci, and Usai 2005; Audretsch 2005; Beugelsdijck and Cornet 2001) alongside strengthening of the knowledge and business ecosystem (Clarysse et al. 2014).

Empirical investigation of the externalities of openness which occur during, and as a result of the innovation process, is at an early stage. However, one recent study concludes that ‘... the presence of firms that have a large range of knowledge linkages appears to benefit other firms in the same sector in terms of innovation productivity. The econometric evidence clearly suggests the presence of externalities of openness, even after accounting for other sector or time-specific effects and other controls a one unit increase in the average breadth of sectoral linkages is associated with 18-29 per cent higher innovation performance at the firm level’ (Roper, Vahter, and Love 2013).

Externalities of openness may arise from more extensive knowledge diffusion in sectors in which technology has some of the characteristics of a public good, and/or sectors which are more densely networked (Kovacs et al. 2006). Knowledge diffusion may also be greater where spatially bounded or concentrated networks facilitate ‘buzz’, or intensive face-to-face interaction between network members (Storper and Venables 2004). In particular, in knowledge intensive industries, the importance of buzz and face-to-face interaction have been associated with the diffusion of tacit knowledge or emerging knowledge which has yet to be codified (Asheim, Coenen, and Vang 2007). Combinations of buzz and the availability of knowledge which has quasi-public characteristics may be particularly powerful in generating positive externalities of openness, raising firms innovation productivity above that suggested by firms’ private investments in knowledge creation and external search.

Externalities of openness might also occur in relation to imitation and demonstration effects similar to those suggested in the technology adoption literature (Rao and Kishore 2010). Here, externalities of openness may arise as firms respond to openness in the sector by becoming more

open themselves. Similarly, labour mobility may spread an awareness of the benefits of openness as employees move between firms or establish new companies.

Positive spillovers from innovation and externalities from openness itself mean that the socially optimal level of OI will be greater than which reflects purely the private benefits. Even in a situation of full information – where firms are able to accurately assess the benefits of OI and partners’ capabilities and trustworthiness – firms would stop investing in OI at the private optimum. Encouraging firms to continue to invest in OI beyond the private optimum will require public intervention to shift firms’ cost-benefit calculation to maximise the potential for positive externalities from OI. This argument directly parallels the standard justification for public R&D and innovation support with its benefits to generate positive externalities (Crespo, Fontoura, and Proenca 2009; Norberg-Bohm 2000; Mohnen 1996)⁶.

3. POLICY RESPONSES TO MARKET FAILURES

Having established the process through which firms initiate and undertake partnerships (Kim et al. 2010) and the related market failures, we are interested here in how policy can respond to increase level of OI activity towards the social optimum.

One possible approach is the establishment and support of intermediary organisations. While the notion of intermediary organisations in supporting business activities is not new, the move towards more open innovation processes has refocused policy interest on the value of mediation⁷. This is

⁶ This is warranted by analysis of the positive externalities from R&D and innovation which suggest that these effects can be significant (Mansfield et al. 1977), strongly localised (Ceh 2009; Feldman 2003) and vary markedly by technology type (van Beers and van der Panne 2011; Kesidou, Caniels, and Romijn 2009; Moreno, Paci, and Usai 2005; Fritsch and Franke 2004).

⁷ See, for example, Watkins and Horley (1986) who explored the role of intermediaries in supporting technology transfer to small firms. See also Mantel and Rosseger (1987) and Gould and Fernandez (1989).

particularly the case in regions where there are inherent institutional weaknesses in their innovation systems.

Clarysse et al. (2014) emphasize the importance of an 'anchor/keystone player' (p. 1174) in efforts to strengthen the local business- or knowledge-ecosystem. However, as they found in Flanders, and in common with many peripheral regions, leading corporations or knowledge generators such as universities may be absent, resulting in system failure (Woolthuis et al. 2005). In this situation, policy makers may attempt to overcome system imperfections through public procurement initiatives to stimulate the business ecosystem (e.g. SBIR in the USA), or through establishing intermediaries to act as boundary spanners (Howells 2006; Clarysse et al. 2014). Yet, even in regions where an anchor player is present, a role for intermediaries may still exist in overcoming the limitations of technological or value-chain networks associated with an anchor player.

Intermediaries have been defined in different ways, largely reflecting the activities that they were established to perform. In most cases they act as a broker in facilitating relationships between at least two actors. In other words, they are 'actors who create spaces and opportunities for appropriation and generation of emerging technical or cultural products by others who might be described as developers and users' (Stewart and Hyysalo 2008, p. 296). A number of recent studies have focused specifically on the role of intermediaries in promoting innovation. For example, Howells (2006) in synthesising existing research on intermediaries in the innovation process presents a typology of intermediaries. Similar to other authors (Seaton and Cordey-Hayes 1993; Hargadon and Sutton 1997), Howells finds that while the activities undertaken by an intermediary are often heterogeneous, and much broader than originally conceived, they tend to centre around three activities: 'scanning and recognition; communication and assimilation; and application' (Howells 2006, p. 720). As such, intermediaries' efforts are aligned with the market failures outlined earlier: helping firms to overcome the limitations of incomplete information through promoting recognition of the potential benefits of OI; reducing the risk of adverse selection of

innovation partner by communicating information on the functional capabilities of other firms and non-private sector organisations; and, helping to mitigate risk associated with the trustworthiness of partners by strengthening social ties and facilitating contractual agreements⁸. More specifically, we can define the potential roles of an intermediary focussed on promoting OI activity in terms of seven activities designed to address the market failures defined earlier (Table 2).

3.1 Building awareness and capacity

An intermediary organisation may help overcome firms' lack of awareness of the benefits of OI in three ways: (a) building firms' awareness of OI as a beneficial approach to innovation; (b) acting as an advocate in policy and cultural efforts to promote OI; (c) supporting the development of firms' capabilities to engage in OI. Each may help to address the related market failure.

Measures to build awareness of the benefits of collaborative and open-innovation could include events or network based activities, involve broadcast and other media and the compilation and publication of case-study evidence. Benefits arising from these activities are largely cultural and social. An example of a publicly funded intermediary seeking to build awareness of OI is the European Regional Development Fund supported Innovation-University Enterprise Network (I-UEN) based at Coventry University, UK. This was formed as a response to low levels of innovative activity in the West Midlands with I-UEN performing a range of intermediary

⁸ Although Howells (2006) acknowledges the potential for intermediaries to make a systemic contribution 'in improving connectedness within a system, particularly through bridging ties, but also in its 'animateur' role of creating new possibilities and dynamism within a system' (p. 726), the nature of this is not developed. Some other attempts e.g. Lee et al. (2010) have sought to develop this further, arguing that the role played by intermediaries comprises three activities: developing a network database to enable partner matching; network construction in providing objective information on each partner; and network management in supporting the collaboration process.

activities including awareness and capability building, network facilitation and structuring⁹.

An OI intermediary could also work as a champion or advocate for OI within a regional innovation system, supporting and encouraging the development of policy measures which strengthen collaboration. Advocacy may also involve promoting a region externally as one characterised by OI (Luukkonen 2005; Oke, Idiagbon-Oke, and Walumbwa 2008). An example is the Holst Centre, established in 2005 as a joint initiative by the Dutch and Flemish governments “to facilitate cross-fertilisation of university and industry research towards the development of technologies at a pre-competitive stage” (Mina et al. 2009, p.20). It aims to create a neutral platform for all partners to make new contacts and initiate new business relationships as well as strengthening the current ones. The Centre similarly takes on the advocacy and the network construction roles (Mina, Connell, and Hughes 2009)¹⁰.

Capability building may also be an OI intermediary function to help firms develop OI capabilities for managing external relationships or collaborative innovation. This is essentially associated with firm’s absorptive capacity - the ability to acquire, assimilate, transform and exploit knowledge – and the ability to benefit from OI. Weaker absorptive capacity may be less detrimental at the stage of scanning the external environment but it becomes much more critical as firms attempt to assimilate, transform and exploit this knowledge (Abrussa and Coenders, 2007). Indeed, where absorptive capacity is particularly low ‘it neither offers anything of value to other firms nor provides a capacity to acquire and exploit knowledge that others may have’ (Giuliani and Bell 2005, p.50). There are relatively few examples of public sector efforts to support capability building for OI, however the InnovationXchange (IXC) UK Ltd run a programme called ‘IXC

⁹ Sources: <http://wwwm.coventry.ac.uk/researchnet/enterprise/business/Pages/I-UEN.aspx> accessed 6th March 2016; <http://www.j4bgrants.co.uk/News.aspx?WCI=htmResults&WCU=CBC=View,SEARCH=FT%3DBusiness%2BFunding~pFF%3D255,DSCODE=J4BGRB,NEWSITEMID=38-N39821> accessed 6th March 2016.

¹⁰ See also: www.holstcentre.com.

Connect' focused on training staff in businesses on core innovation skills, designed to increase the target organisation's capacity to want, find, get and manage innovation opportunities¹¹.

3.2 Enabling partner selection

As discussed earlier, OI is multi-dimensional, involving inbound technology acquisition, outbound technology and knowledge exploitation or a combination of both (Gassman and Enkel, 2004). Some evidence exists to suggest that for medium and low-tech sectors, inbound OI dominates with firms searching the external environment for technologies or knowledge that can complement and diversify existing capabilities. In other words, inbound OI acts as a substitute to internal R&D investment. In these sectors third parties such as OI intermediaries may be important in helping to scan the market for emerging technologies, develop the ability to absorb the technology acquired and to perform complementary R&D if needed (Spithoven et al. 2011). By contrast, for firms in high-tech sectors, outbound OI may be more common with absorptive capacity (R&D investment and skills) enhancing the stock of accumulated knowledge within the firm and the possibility of this being exploited externally. In these sectors, OI intermediaries play a potentially different role with less focus on capability building and more on assisting firms to identify and collaborate with potential exploitation partners.

An OI intermediary might also help firms to identify potential OI partners. Where the resource and capability requirements belong to a distant partner then the role of the intermediary will be more important in overcoming both physical and cognitive distances. An OI intermediary might also promote the capabilities of firms as potential partners to organisations elsewhere. This is primarily a marketing and/or promotional activity and again may best be delivered through partnership with external facing organisations. An example of an organisation playing both roles is the Enterprise Europe Network. This is a Europe-wide network of 600 partner organisations

¹¹ Source: <http://www.ixc-uk.com/> accessed 7 March 2016.

spanning over 50 countries. Targeting SMEs it provides ‘a trustworthy source of information, advisory and partnership services for European companies looking to innovate and expand’. The Enterprise Europe Network reports that it supports c. 380k businesses per year through c. 90k business connections per year¹².

3.3 Brokering effective relationships

The potential for cheating in OI relationships suggests the importance of trust and that a public intermediary organisation should act as an honest and independent broker in facilitating network, technology and knowledge partnerships. This impartiality is likely to be fundamental to the success of public intervention, particularly in terms of the partner search, facilitation and structuring activities. For smaller firms in particular, innovation processes are generally less formally structured and professionalised than those in larger firms (Van de Vrande et al. 2009). Here, the intermediary may proactively facilitate cooperative partnerships with firms in a way which fosters trust between the partners and/or actively engage in structuring the partnerships through developing contractual agreements.

Through brokering activity an intermediary works with individual firms to establish new innovation partnerships. This is likely to involve trust-building activities alongside more detailed investigation of the value added in specific partnerships and may involve elements of network building with both local and potentially external partners¹³. Intermediaries may also assist with the structuring of partnerships and collaboration to assist firms with the structuring of OI relationships and is likely to require detailed work with the partners on the development of contractual and managerial structures. For example, Technology advisors in the Collective Research Centres (CRCs) in Belgium function as a bridge between businesses and the Collective Research Centres (Spithoven, Clarysse, and Knockaert 2011). They act as the first point of contact for businesses in a specific

¹² Source: <http://een.ec.europa.eu/news/news/bringing-success-26-million-smes> accessed 7 March 2016.

¹³ The credibility of individual brokers is likely to be key to success in this activity - see (Lee et al. 2010) and (Zeng, Xie, and Tam 2010).

industry looking to resolve technical problems and broker relationships between the CRCs and individual businesses. Similar to the CRCs, brokering activity is also typical of innovation focussed incubators e.g. Chalmers Innovation which is linked to the broader Swedish Incubators and Science parks (SISP) network, the Innovationsbron Sweden which is a nationwide network of the strongest incubators in Sweden, with both of these networks enhancing the opportunities for OI and growth potential of tenants¹⁴.

Overcoming the three informational market failures in Stages 1 to 3 above, may encourage firms to increase levels of OI towards the private optimum with potential private and social benefits. But this will not be sufficient on their own to encourage firms beyond the private optimum and so maximise social benefits of OI. Here the fourth market failure arises, associated with firms' inability to appropriate positive innovation and openness externalities. This is similar to arguments associated with the under-investment in R&D or innovation (Arrow, 1962) and is standardly addressed through provision of grants or subsidies for R&D or innovative activity.

3.4 Maximising social returns from OI

Public incentives for collaborative R&D and innovation can positively influence the cost-benefit ratio which firms perceive in considering their OI activity and increasing activity levels. Evidence from a number of studies suggest that innovation grants and subsidies (Cunningham et al. 2013) make collaboration more attractive, with evidence that this leads to an overall increase in the level of collaborative activity (Falk, 2007; Breschi et al. 2009, Knockaert et al. 2014). Similarly, a review of R&D programme evaluations across 11 countries concluded that firms in receipt of public support were more likely to collaborate with other businesses (OECD

¹⁴ See: np.netpublicator.com/np/n88592986/SiSP-catalogue_low2010.pdf. In addition to this, widely cited examples of innovation intermediaries that draw on crowdsourcing to solve technical and market problems include NineSigma, Innocentive, Yet2.com and YourEncoure.

2006). In other words, RDI support led to the development of inter-organisational collaboration with the associated knowledge transfer and learning. This suggests that where public subsidies for innovation encourage firms to broaden or deepen their external innovation linkages this generates inter-organisational additionality.

3.5 Logic model and evaluation

A logic model links the objectives of any policy intervention to its goals, activities and anticipated inputs, outputs and outcomes (Donaldson and Gooler 2003). The logic model also provides a type of balanced scorecard ensuring that any OI intermediary balances its efforts across the range of possible activities (Figure 2). To facilitate accurate evaluation of the effectiveness of intervention a baseline level of awareness of OI would need to be determined, with objectives then set, against which developments in the output and outcome metrics could then be compared. The manner by which intervention is operationalised will be reflected in the programme activities reflecting the stages in partnership formation and efforts to overcome associated market failures. (Figure 2). As such Stage 1 of identifying strategic needs driving OI will be reflected in activities addressing issues of lack of awareness, advocacy and capacity development. Stage 2 of assessing and selecting a partner will be addressed through activities providing partner information, while Stage 3 of implementing a partnership will arise through facilitation and structuring activities. For each activity we provide an illustrative set of measurable input indicators, short-term output indicators and longer-term outcome measures. Input indicators and output indicators are in the main activity specific, whereas outcome indicators reflect the longer-term progress of the OI intermediary towards its main objective of increasing the level of OI in a region.

Another element of any logic model relates to the contingencies associated with any intervention. In terms of an OI intermediary, for example, a significant difference may exist in the timeframe for achieving outputs and outcomes: impact and output measures would be available in a relatively

short time-scale, but outcome indicators would only be measurable over perhaps a 3-5 year time horizon. Second, it may be difficult to attribute causality to any one activity of an OI intermediary as firms working with the intermediary are likely to take part in a range of activities. Indeed, this may be desirable. Third, it will be important to recognise the extent to which the intermediary itself has 'control' over the various activities being supported or services being provided. Clearly where these are within the intermediary these will be within its control. However, a clear possibility is that services will be provided in partnership with other organisations – either public or private sector – and the quality of these activities will often be outside the control of the intermediary. Fourth, it will be important to recognise the strongly contingent nature of outcomes. These may, for example, be strongly conditional on market conditions. Strong growth in Europe for example may encourage firms to develop new products for European markets with clear implications for the outcome measures. Slow growth in Europe may have the opposite effect. Over the time horizon of the outcome measures such contingent factors are likely to be a significant influence. However, one possibility of mitigating the effect of such contingent factors may be to compare outcome indicators in the region to similar metrics for other regions or economies.

4. CONCLUSION

As the innovation process becomes more distributed and iterative, OI becomes more central to an effective and efficient business innovation process. The private returns from engaging in OI are well documented although less attention has been paid to the wider social benefits. In this paper we contribute to existing conceptualisations of the determinants of OI by adopting a public policy perspective. In particular, we consider the process by which OI partnerships are formed and related market failures which may help explain the empirical regularity that observed levels of OI activity are always below the level which would maximise its innovation benefits (Table 1). These market failures are predominantly associated with: (i) information asymmetries concerning an awareness of the potential benefits of OI; (ii) limited information on the functional capabilities of

potential partners whether for inbound or outbound OI; and, (iii) limited information on the trustworthiness of potential partners. In addition, we argue that given the potential for positive spillovers from both openness itself and the enhanced level of innovation resulting from OI, addressing these three market failures would still result in levels of OI activity below the socially optimum. As a result there is the case for further intervention through incentives to directly promote OI. Drawing on prior research on intermediary organisations we propose seven roles which intermediaries might perform in addressing the market failures and provide examples of each type of policy intervention – an eighth being direct subsidies for OI (collaborative innovation) activities.

While the underlying mechanisms of OI partnership formation and the associated market failures are generic to all regions and firms, their impact will be context specific. The extent to which system failures exist in the business or knowledge-ecosystem will vary (Woolthuis et al. 2005), with institutional failures most apparent in peripheral regions (Clarysse et al. 2014). Variations will also exist in the organisational and industrial structure across peripheral and less economically advanced regions. This contextual complexity (Zhara and Wright 2011) may affect intermediary's priorities across each of the OI stages and market failures. For example, where firms are aware of the importance of OI and have the internal capability and capacity to engage in OI, then greater emphasis may be needed on identifying appropriate partners and structuring the relationships. Alternatively, in those regions with particularly low levels of innovation and/or OI, greater emphasis may be needed in raising firms' awareness of the benefits of OI and developing the capability to engage.

In addition to the innovation capability of a region's firms, differences will also exist between regions in industrial structure and the presence of appropriate OI partners. Where suitable innovation partners are absent in a region then an intermediary's focus will need to be more inter-regional and international. Activities around identifying appropriate partners and providing information, along with managing the OI engagement are likely to be important in such contexts. The challenge for intervention here is in

balancing a state-centred policy in an international environment where the benefits are not all captured in the political jurisdiction (Kuhlmann et al. 2010).

Beyond contextual specificities which influence an OI intermediary's priorities, variations may also exist in the need for, and potential impact of, intervention across the population of firms. As discussed earlier, smaller firms are significantly less likely to engage in OI although the benefits may be greater than those for larger firms (Vahter et al. 2014). Evidence on the importance of each market failure for firms of different sizes is limited, however, although for micro-firms market failures around the lack of trustworthiness of OI partners are more common than a lack of awareness of the benefits of OI or information on potential partners (Hewitt-Dundas and Roper, 2016). Organisational characteristics may mean that some firms are also less inclined or capable of engaging in external knowledge sourcing. Managerial attitudes towards risk tolerance (Garcia-Granero et al. 2014), or willingness to source knowledge from outside the firm (Bucharth et al. 2014), may impact on the relative importance of each market failure and the potential value of intervention.

To develop our understanding of the importance of market failures in OI engagement, further research would be beneficial in examining the relative importance of these stages of OI engagement and associated market failures in different economic and innovation systems. Empirical analyses could also adopt organisational perspectives in considering the relative importance of each market failure in the light of managerial and organisational characteristics.

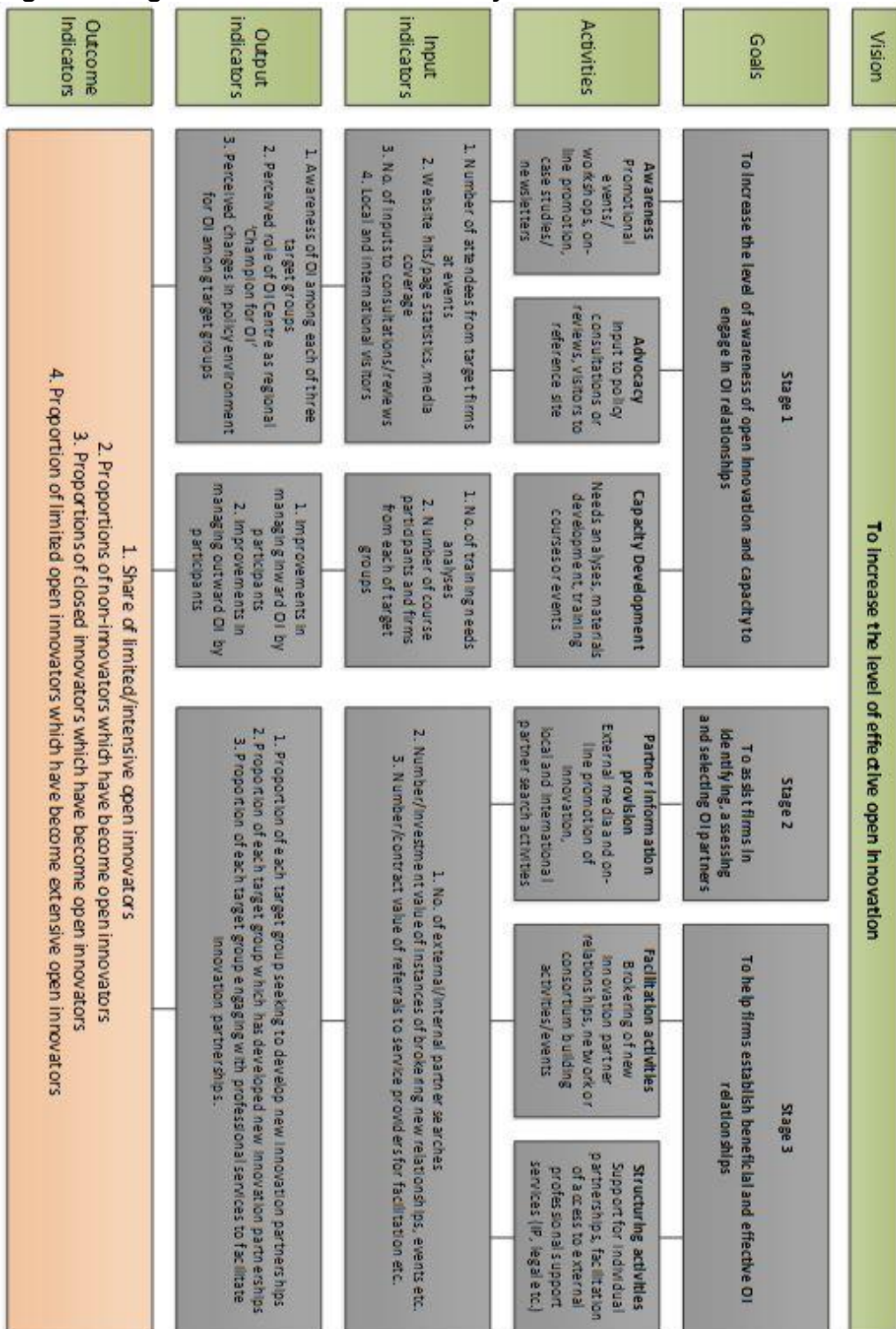
Table 1: Studies illustrating average and estimated optimal levels of search breadth and depth

Sources	Coverage	Search measure	Innovation measures	Optimum breadth/depth	Average Breadth/depth	Average as % optimum
<u>Laursen and Salter</u> (2006), Figure 1, Table 3	UK manufacturing firms, UK Innovation Survey	Breadth of search – count variable of number of sources (max: 16)	New to the world innovation (% sales)	11.0	7.22	65.6
<u>Laursen and Salter</u> (2006), Figure 2, Table 3	UK manufacturing firms, UK Innovation Survey	Depth of search – count variable of number of sources of high importance (max: 16)	New to the world innovation (% sales)	2.80	0.96	34.2
<u>Leiponen and Helfat</u> (2010), Tables 2 and 7	Manufacturing plants in Finland	Number of types of innovation collaborators (max: 12)	Binary innovation indicator, % sales	8.0	5.08	63.5
<u>Vahter et al</u> (2014), Figure 2	Small Irish manufacturing plants (<50 employees)	Number of types of innovation collaborators (max: 8)	New or improved products (% sales)	4.2	0.82	19.5
<u>Vahter et al</u> (2014), Figure 2	Larger Irish manufacturing plants (>50 employees)	Number of types of innovation collaborators (max: 8)	New or improved products (% sales)	>8.0	1.64	<20.5
<u>Roper and Hewitt-Dundas</u> (2016), Figure 1	Micro-businesses in Northern Ireland (<10 employees)	Number of types of innovation collaboration (max 8)	Binary innovation indicator	5.2	0.87	16.7

Table 2: Partnership development stages, market failures and intermediary roles

Partnership Stages	Development	Market failure	Intermediary role
1. Identifying needs	strategic	Lack of awareness	<p>Building Awareness - increasing the awareness of the benefits of collaborative and open-innovation.</p> <p>Advocacy – championing OI, supporting and encouraging the development of policy measures which strengthen collaboration.</p> <p>Capability building – help firms develop OI capabilities for managing external relationships or collaborative innovation.</p>
2. Assessing and selecting a partner		Limited information on functional capabilities	<p>Inbound provision of partner information – help firms to identify potential innovation partners either locally or externally.</p> <p>Outbound promotion of partner information – promote the capabilities of firms as potential partners to organisations elsewhere.</p>
3. Implementing a partnership		Limited information on trustworthiness	<p>Facilitation or brokering of partnerships and collaboration – this type of brokering activity aims to work with individual firms to establish innovation partnerships.</p> <p>Structuring of partnerships and collaboration – this activity is aimed at assisting firms with the structuring of open innovation relationships and is likely to require detailed work with the partners.</p>
4. Maximising social returns from OI		Incomplete markets and the inability to appropriate positive <u>spillovers</u>	<p>Incentives for collaborative innovation – public incentives for collaboration make this more attractive, raising the overall level of collaborative activity.</p>

Figure 1: Logic model for OI Intermediary



REFERENCES

- Alston, L.J. and Gillespie, W., 1989. Resource coordination and transaction costs: A framework for analyzing the firm/market boundary. *Journal of Economic Behavior & Organization*, 11, 2, 191-212.
- Arbussa, A., Coenders, G., 2007. Innovation activities, use of appropriation instruments and absorptive capacity: evidence from Spanish firms. *Research Policy* 36, 1545–1558.
- Anyadike-Danes, M.; K. Bonner; M. Hart; and C. Mason. 2009. Measuring business growth: high growth firms and their contribution to employment in the UK. London: NESTA.
- Arrow, K., 1962. Economic welfare and the allocation of resources for invention. In *The rate and direction of inventive activity: Economic and social factors*. pp. 609-626. Princeton University Press.
- Asheim, B.; L. Coenen; J. Moodysson; and J. Vang. 2007. Constructing knowledge-based regional advantage: implications for regional innovation policy. *International Journal of Entrepreneurship and Innovation Management*, 7:140-155.
- Asheim, B.; L. Coenen; and J. Vang. 2007. Face-to-face, buzz, and knowledge bases: sociospatial implications for learning, innovation, and innovation policy. *Environment and Planning C: Government and Policy* 25:655-670.
- Audretsch, D.B. 2005. The knowledge spillover theory of entrepreneurship and economic growth In *The emergence of entrepreneurial economics* ed. G.T. Vinig and R.C. van der Voort, 37-54: Elsevier
- Beugelsdijck, P.J. and M. Cornet. 2001. How far do they reach? The localisation of industrial and academic spillovers in the Netherlands. *Centre discussion paper*:47.
- Bharadwaj, A.S., 2000. A resource-based perspective on information technology capability and firm performance: an empirical investigation. *MIS quarterly*, 169-196.
- Breschi, S. and Lissoni, F., 2009. Mobility of skilled workers and co-invention networks: an anatomy of localized knowledge flows. *Journal of Economic Geography*, p.lbp008.
- Burcharth, A.L.D.A., Knudsen, M.P. and Sondergaard, H.A. 2014. Neither

- invented nor shared here: The impact and management of attitudes for the adoption of open innovation practices. *Technovation*. 34, 3: 149-161.
- Ceh, B. 2009. A Review of Knowledge Externalities, Innovation Clusters and Regional Development. *Professional Geographer* 61:275-277.
- Chesborough, H.W. 2006. *Open Innovation: a new paradigm for understanding industrial innovation*. Oxford: Oxford University Press.
- Chesbrough, H., 2010. Business model innovation: opportunities and barriers. *Long range planning*, 43, 2, 354-363.
- Chesbrough, H. and Vanhaverbeke, W., 2011. Open innovation and public policy in Europe. ESADE Business School, Barcelona, Spain.
- Chiaroni, D.; V. Chiesa; and F. Frattini. 2010. Unravelling the process from Closed to Open Innovation: evidence from mature, asset-intensive industries. *R & D Management* 40:222-245.
- CMI. 2012. Maximising the Commercial and Economic impact of the Northern Ireland Publicly funded Research Base, A Report by CM International for Invest Northern Ireland. Cardiff.
- Clarysse, B., Wright, M., Bruneel, J. and Mahajan, A., 2014. Creating value in ecosystems: Crossing the chasm between knowledge and business ecosystems. *Research Policy*, 43, 7:1164-1176.
- Cooke, P., Roper, S. and Wylie, P., 2002. *Developing a regional innovation strategy for Northern Ireland*. Belfast, Northern Ireland Economic Council.
- Cooke, P. and K. Morgan. 1998. *The associational economy: Firms, regions and innovation*. Oxford Oxford University Press.
- Cosh, A.; J. Zhang; A. Bullock; and I. Milner. 2011. Open Innovation Choices - What is British enterprise doing? . Cambridge UK-Innovation Research Centre
- Crepon, A.; A. Hughes; P. Lee; and J. Mairesse. 1998. Research, Innovation and Productivity: An econometric analysis at the firm level. *Economics of Innovation and New Technology* 7:115-158.
- Crespo, N.; M.P. Fontoura; and I. Proenca. 2009. FDI spillovers at regional level: Evidence from Portugal. *Papers in Regional Science* 88:591-607.
- Cunningham, P., Gok, A. and Laredo, P., 2013. *The impact of direct support to R&D and innovation in firms*. NESTA Working Paper. Manchester: NESTA.
- Czarnitzki, D. and K. Kraft. 2012. Spillovers of innovation activities and

- their profitability. *Oxford Economic Papers-New Series* 64:302-322.
- Donaldson, S. I. & Gooler, L. E. 2003. Theory-driven evaluation in action: lessons from and \$20 million statewide Work and Health Initiative. *Evaluation and Program Planning*, 26, 355-366.
- Dosi, G., 1997. Opportunities, incentive and the collective patterns of technological change. *The Economic Journal* 107,444:1530-1547.
- Dyer, J.H. and Singh, H., 1998. The relational view: Cooperative strategy and sources of interorganizational competitive advantage. *Academy of management review*, 23, 4, 660-679.
- Economics, O. 2008. Study of the impact of the Intermediate Research and Technology Sector on the UK economy. Oxford: Oxford Economics.
- Falk, R., 2007. Measuring the effects of public support schemes on firms' innovation activities: Survey evidence from Austria. *Research Policy*, 36,5: 665-679.
- Feldman, M.P. 2003. The locational dynamics of the US biotech industry: knowledge externalities and the anchor hypothesis. *Industry and Innovation* 10:311–329.
- Fritsch, M. and G. Franke. 2004. Innovation, regional knowledge spillovers and R&D cooperation. *Research Policy* 33:245-255.
- Garcia-Granero, A., Llopis, O., Fernandez-Mesa, A. and Alegre, J., 2014. Unravelling the link between managerial risk-taking and innovation: The mediating role of a risk-taking climate. *Journal of Business Research*.
- Gassman, O., & Enkel, E. 2004. "Towards a Theory of Open Innovation: Three Core Process Archetypes," in *Proceedings of the R&D Management Conference*, Lisbon, Portugal, July 6-9 (<http://www.alexandria.unisg.ch/Publikationen/274>).
- Gemser, G. and N.M. Wijnberg. 1995. Horizontal networks, appropriability conditions and industry life cycles. *Journal of Industry Studies* 2:129-140.
- Giuliani, E. & Bell, M. 2005. The micro-determinants of meso-level learning and innovation. Evidence from a Chilean wine cluster, *Research Policy*, 34.1, pp. 47–68.
- Gould, R.V. and Fernandez, R.M. 1989. Structures of Mediation: A Formal Approach to Brokerage in Transaction Networks, *Sociological Methodology*, 19, 1989:89-126.
- Hargadon, A. and Sutton, R.I., 1997. Technology brokering and innovation

- in a product development firm. *Administrative science quarterly*, 716-749.
- Hewitt-Dundas, N. and S. Roper. 2011. Creating advantage in peripheral regions: the role of publicly funded R&D centres. *Research Policy* 40:832-841.
- Howells, J. 2006. Intermediation and the role of intermediaries in innovation. *Research Policy*, 35:715-728
- Huang, H.-C. 2011. Technological innovation capability creation potential of open innovation: a cross-level analysis in the biotechnology industry. *Technology Analysis & Strategic Management* 23:49-63.
- Hung, K.-P. and Y.-H. Chiang. 2010. Open innovation proclivity, entrepreneurial orientation, and perceived firm performance. *International Journal Of Technology Management* 52:257-274.
- Ingram, P. and Baum, J.A., 1997. Opportunity and constraint: Organizations' learning from the operating and competitive experience of industries. *Strategic Management Journal*, 18,1:75-98.
- Kesidou, E.; M.C.J. Caniels; and H.A. Romijn. 2009. Local Knowledge Spillovers and Development: An Exploration of the Software Cluster in Uruguay. *Industry and Innovation* 16:247-272.
- Kesidou, E. and H. Romijn. 2008. Do Local Knowledge Spillovers Matter for Development? An Empirical Study of Uruguay's Software Cluster. *World Development* 36:2004-2028.
- Kim, D.-Y., Kumar, V. and Kumar, U. 2010. Performance assessment framework for supply chain partnership, Supply Chain Management: An International Journal 15,3:187 – 195
- Kivistö, J., 2005. The government-higher education institution relationship: Theoretical considerations from the perspective of agency theory. *Tertiary Education and Management*, 11,1:1-17.
- Knockaert, M., Spithoven, A. and Clarysse, B., 2014. The impact of technology intermediaries on firm cognitive capacity additionality. *Technology Forecasting and Social Change*, 81(1), pp. 376-387.
- Kovacs, G.; S. Kopacsi; G. Haidegger; and R. Michelini. 2006. Ambient intelligence in product life-cycle management. *Engineering Applications of Artificial Intelligence* 19:953-965.
- Kuhlmann, S., Shapira, P. & Smits, R. 2010. *Introduction. A Systemic Perspective: The Innovation Policy Dance*. In R. Smits, S. Kuhlmann & P.

- Shapira (Eds.), *The Theory and Practice of Innovation Policy*. An International Research Handbook. Cheltenham, UK: Edward Elgar.
- Kwon, I.W.G. and Suh, T., 2005. Trust, commitment and relationships in supply chain management: a path analysis. *Supply chain management: an international journal*, 10, 1, 26-33.
- Lambert, D.M., Knemeyer, A.M. and Gardner, J.T. 2004. Supply chain partnerships: model validation and implementation. *Journal of Business Logistics*, 25, 2, 21-42.
- Laursen, K. and A. Salter. 2006. Open for Innovation: The role of openness in explaining innovation performance among UK manufacturing firms. *Strategic Management Journal* 27:131-150.
- Lee, S.; G. Park; B. Yoon; and J. Park. 2010. Open innovation in SMEs-An intermediated network model. *Research Policy* 39:290-300.
- Leiponen, A. and C.E. Helfat. 2010. Innovation objectives, knowledge sources, and the benefits of breadth. *Strategic Management Journal* 31:224-236.
- Lichtenthaler, U. 2010. Intellectual property and open innovation: an empirical analysis. *International Journal Of Technology Management* 52:372-391.
- Lichtenthaler, U. and E. Lichtenthaler. 2009. A Capability-Based Framework for Open Innovation: Complementing Absorptive Capacity. *Journal of Management Studies* 46:1315-1338.
- Lokshin, B., Hagedoorn, J. and Letterie, W., 2011. The bumpy road of technology partnerships: Understanding causes and consequences of partnership mal-functioning. *Research Policy*, 40, 2, 297-308.
- Loof, H. and A. Heshmati. 2002. Knowledge capital and performance heterogeneity: A firm level innovation study. *International Journal of Production Economics* 76:61-85.
- Love, J.H. and S. Roper. 2013. SME innovation, exporting and growth: A review of existing evidence. In *White Paper No. 5*. Warwick Business School: Enterprise Research Centre.
- Love, J.H.; S. Roper; and J. Bryson. 2011. Knowledge, Openness, Innovation and Growth in UK Business Services. *Research Policy* 40:1438-1452.
- Love, J.H., Roper, S. and Vahter, P., 2014. Dynamic complementarities in

- innovation strategies. *Research policy*, 43, 10, 1774-1784.
- Luukkonen, T. 2005. Variability in organisational forms of biotechnology firms. *Research Policy* 34:555-570.
- Mansfield, E.; J. Rapoport; A. Romeo; S. Wagner; and G. Beardsley. 1977. Social and Private Rates of Return from Industrial Innovations. *Quarterly Journal of Economics* 91:221-240.
- Mantel, S.J. & Rosegger, G., 1987. *The role of third-parties in the diffusion of innovations: a survey*. In: Rothwell, R., Bessant, J. (Eds.), *Innovation: Adaptation and Growth*. Elsevier, Amsterdam, 123–134.
- McWilliams, B. and D. Zilbermanfr. 1996. "Time of Technology Adoption and Learning By Using." *Economics of Innovation and New Technology* 4: 139-154.
- Menon, C. 2015. Spreading big ideas? The effect of top inventing companies on local inventors, *Journal of Economic Geography*, 15: 743-768.
- Mina, A.; D. Connell; and A. Hughes. 2009. Models of Technology Development in Intermediate Research Organisations. In *Centre for Business Research, University of Cambridge*.
- Mohnen, P. 1996. R&D Externalities and Productivity Growth. *STI Review* 18:39-66.
- Moreno, R.; R. Paci; and S. Usai. 2005. Spatial spillovers and innovation activity in European regions. *Environment and Planning A* 37:1793-1812.
- Nambisan, S. and Sawhney, M., 2011. Orchestration processes in network-centric innovation: Evidence from the field. *The Academy of Management Perspectives*, 25, 3:40-57.
- NESTA. 2008. Innovation by Adoption – Measuring and mapping absorptive capacity in UK nations and regions. In *October*. London.
- Niosi, J. 2003. "Alliances are not enough for explaining rapid growth in biotechnology firms." *Research Policy*, 32: 737-750.
- Norberg-Bohm, V. 2000. Creating incentives for environmentally enhancing technological change: Lessons from 30 years of US energy technology policy. *Technological Forecasting And Social Change* 65:125-148.
- OECD. 1999. *Managing National Innovation Systems* Paris.
- Oke, A.; M. Idiagbon-Oke; and F. Walumbwa. 2008. The relationship between brokers' influence, strength of ties and NPD project outcomes in

innovation-driven horizontal networks. *Journal of Operations Management* 26:571-589.

Powell, W.W. 1998. Learning from Collaboration: Knowledge and Networks in the Biotechnology and Pharmaceutical Industries. *California Management Review* 40:228-240.

Rao, K.U. and V.V.N. Kishore. 2010. A review of technology diffusion models with special reference to renewable energy technologies. *Renewable & Sustainable Energy Reviews* 14:1070-1078.

Reuer, J.J., Zollo, M. and Singh, H., 2002. Post-formation dynamics in strategic alliances. *Strategic Management Journal*, 23, 2:135-151.

Roper, S. 2009. Stepping forwards – Northern Ireland's Innovation Future. London NESTA.

Roper, S.; J. Du; and J.H. Love. 2008. Modelling the Innovation Value Chain. *Research Policy* 37:961-977.

Roper, S. and Hewitt-Dundas, N. 2016 Investigation Schumpeter's creative army: what drives new-to-the-market innovation in micro-enterprises? ERC, Research paper No. 36.

Roper, S.; P. Vahter; and J.H. Love. 2013. Externalities of openness in innovation. *Research Policy* 42:1544-1554.

Schmidt, T. 2010. Absorptive Capacity - One Size Fits All? A Firm-Level Analysis of Absorptive Capacity for Different Kinds of Knowledge. *Managerial and Decision Economics* 31:1-18.

Seaton, R.A. and Cordey-Hayes, M., 1993. The development and application of interactive models of industrial technology transfer. *Technovation*, 13(1), pp.45-53.

Shyu, J.Z. and Y.C. Chiu. 2002. Innovation policy for developing Taiwan's competitive advantages. *R & D Management* 32:369-374.

Sieg, J.; M. Wallin; and G. von Krogh. 2010. Managerial challenges in open innovation: a study of innovation intermediation in the chemical industry. 40:281-291.

Spithoven, A.; B. Clarysse; and M. Knockaert. 2011. Building absorptive capacity to organize inbound open innovation in traditional industries. *Technovation* 31:10-21.

Stewart, J. and Hyysalo, S., 2008. Intermediaries, users and social learning in technological innovation. *International Journal of Innovation*

Management, 12, 3:295-325.

Storper, M. and A.J. Venables. 2004. Buzz: the economic force of the city. *Journal Of Economic Geography* 4:351-370.

van Beers, C. and G. van der Panne. 2011. Geography, knowledge spillovers and small firms' exports: an empirical examination for The Netherlands. *Small Business Economics* 37:325-339.

van de Vrande, V.; J.P.J. de Jong; W. Vanhaverbeke; and M. de Rochemont. 2009. Open innovation in SMEs: trends, motives and management challenges. *Technovation* 29:423–437.

Vahter, P Love, J H and Roper, S (2014) 'Openness and innovation performance: are small firms different?' *Innovation and Industry*, 21, 7-8, 553-573.

Walker, W. 1993. *National Innovation Systems: Britain*. Oxford University Press.

Wang, Q., Bradford, K., Xu, J. and Weitz, B., 2008. Creativity in buyer–seller relationships: The role of governance. *International Journal of Research in Marketing*, 25, 2:109-118.

Watkins, D. & Horley, G., 1986. *Transferring technology from large to small firms: the role of intermediaries*. In: Webb, T., Quince, T., Watkins, D. (Eds.), *Small Business Research*. Gower, Aldershot, pp. 215–251.

Woolthuis, R.K., Lankhuizen, M. and Gilsing, V. 2005. A system failure framework for innovation policy design. *Technovation*. 25, 6: 609-619.

Zeng, S.X.; X.M. Xie; and C.M. Tam. 2010. Relationship between cooperation networks and innovation pperformance of SMEs. *Technovation* 30: 181-194.

Zahra, S.A. and Wright, M., 2011. Entrepreneurship's next act. *The Academy of Management Perspectives*, 25, 4, 67-83.



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