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Stephen Roper
Nola Hewitt-Dundas

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Stephen Roper
University of Warwick
stephen.roper@wbs.ac.uk

Nola Hewitt-Dundas
Queen's University Belfast
Nm.Hewitt@qub.ac.uk

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ABSTRACT

Schumpeterian arguments related to creative destruction place small, entrepreneurial firms at the centre of the innovation process. The exclusion of micro-enterprises (with less than 10 employees) from most innovation surveys means, however, that we know relatively little about innovation among this group of firms. Here, using new survey data on a thousand micro-enterprises we explore the determinants of new-to-the-market innovation, the basis for the Schumpeterian creative destruction (CD) process. Our results provide strong support for the interactive nature of micro-enterprise innovation and suggest the potential value of developing a model of interactive creative destruction (ICD). Our results also suggest that family-owned firms are more likely to introduce new-to-the-market innovations and therefore play an important role in the ICD process. In organisational terms, our analysis emphasises the range of technical and co-ordination capabilities required by micro-enterprises to innovate successfully. Policy implications relate to promoting awareness among micro-firms of the support available for innovation to reduce the impact of financial and risk constraints.

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KEYWORDS

Innovation, micro-enterprise, creative destruction

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O32, L1, O38; Q34; L26

CONTENTS

INTRODUCTION

Schumpeterian arguments related to creative destruction place small, entrepreneurial firms at the centre of the innovation process. Here, opportunistic entrepreneurs, invest in new technology and commercialisation and, for a limited time, through innovation, achieve a position of market leadership. In reality such processes are hard to observe systematically both due to the dynamic nature and potential rapidity of the process of creative destruction itself but also due to practical difficulties associated with identifying the firms involved. Studies of emergent clusters or industries (Diaz Perez, Alarcon Ozuna, and Ayala Arriaga 2011; Sydow, Lerch, and Staber 2010) and those focused on start-ups probably come closest (Ganotakis and Love 2011) although, even here, the creative destruction process tends to be observed as historical rather than current phenomena. More generally, innovation studies, many of which are based on data sets such as the EU Community Innovation Survey, have largely turned their backs on micro-enterprises with less than 10 employees excluding them from EU surveys.

While a focus on larger firms may be regarded as a pragmatic decision it means we have very little robust evidence on the drivers of innovation in micro-firms. Only two recent studies based on bespoke surveys – and relatively small samples c. 150 firms - examine the impact of internal factors on innovation in Spanish micro-enterprises (Benito-Hernandez, Platero-Jaime, and Rodriguez-Duarte 2012) and of supply chain cooperation in Chinese night markets (Tu, Hwang, and Wong 2014). Here, we add to this very limited evidence base using data from a large-scale survey of 1,000 micro-businesses in Northern Ireland (Department of Enterprise 2014). This data is interesting for three main reasons. First, it seems unique in providing detailed information on the innovative activities of a large group of micro-firms and may therefore provide new insights into the creative destruction (CD) process. What proportion of micro-enterprises, for example, are introducing new-to-the-market innovations of the type envisaged in the creative destruction model? Second, the survey

includes a range of innovation metrics in common with the EU Community Innovation Surveys allowing comparisons to be made with other data for larger firms. For example, is new-to-the-market innovation more common among micro-enterprises than larger firms as the CD model might suggest? And, thirdly, the survey includes a range of variables focused on the leadership and ownership of the firm providing potential insights into which type of micro-enterprises are likely to take the lead in any creative destruction process. For example, prior studies have suggested that family-owned firms may be more risk averse in their investment and growth strategies and therefore perhaps less likely to introduce more risky new-to-the-market innovations (Kellermanns et al. 2012; Kotlar et al. 2014; Kraus, Pohjola, and Koponen 2012).

Central to our analysis is the idea of the entrepreneurial firm, characterised by growth ambition, flexibility and common ownership and control structures (Vossen 1998). Firms strive to make new-to-the-market innovations to achieve competitive advantage. In this sense our perspective on ambition and agency shares much with the traditional CD model. Our view of the nature of the innovation process, however, differs markedly to that originally envisaged by Schumpeter. In the original CD model the process of technological change and innovation is seen as atomistic, undertaken by individual firms, where innovation is based primarily on firms' internal capabilities. This 'closed', and essentially linear, view of innovation today seems rather naïve. Instead, we increasingly understand innovation as an interactive or social process, shaped strongly by firms' interactions and external linkages (Metcalfe 1997). These may be interactive – partnerships or formal R&D collaborations – or non-interactive – involving copying, reverse engineering or imitation (Glückler 2013). Either way, the evidence from studies of innovation in small and medium enterprises (SMEs) emphasises the importance of external knowledge in contributing to firms' innovation success (Vahter, Love, and Roper 2013)[1].

[1] Little is known about the role of external connectivity in shaping innovation in micro-enterprises, however, although see (Tu, Hwang, and Wong 2014).

This emphasises the role of absorptive capacity and firms' capabilities in integrating external and internal knowledge in successful innovation.

Building on this interactive CD (or ICD) model our empirical focus here is on new-to-the-market innovation in micro firms, and the factors which influence such innovation. Section 2 outlines our conceptual perspective on new-to-the-market innovation and its drivers. We briefly review what is known about the impact of firm ownership and leadership characteristics on SME innovation and outline our hypotheses in Section 3. Data sources are described in Section 4 which also profiles our estimation approach. Our analysis makes use of a standard innovation production function approach which relates innovative outputs to knowledge inputs and resources from within the firm and the firms' acquisition of external knowledge (Leiponen and Byma 2009; Roper, Du, and Love 2008). Within this framework we are also able to test for the impact of firms' ownership characteristics. Section 5 describes our main empirical results.

CONCEPTUAL FOUNDATIONS – TOWARDS AN INTERACTIVE CD MODEL

In creative destruction 'the creation is usually accomplished by invaders – new firms or entrants from other industries – while the destruction is suffered by the incumbents'[2]. Two types of destructive impacts have been identified: competence destroying innovations which undermine or eliminate the value of the assets or technology of incumbents within an existing market paradigm; and, disruptive innovations which change the market paradigm itself (Bergek et al. 2013). Both require innovation which is (at least) new-to-the-market, and both threaten the market position of incumbents which may also be influenced by core-rigidities (Leonard-Barton 1992) and inertia (Lucas and Goh 2009). New entrants may then benefit from 'attackers advantage' and the innovators' potential opportunity

[2] Rosenbloom and Christensen, 1994, p.656 quoted in (Bergek et al. 2013)

to set the ground rules for future competition (Leenders and Voermans 2007; Foster 1986).

Achieving market leading or disruptive innovation, however, requires resources and a willingness to bear risk, both of which may be limited in micro-enterprises. The risk associated with any innovation project will depend on both the technological complexity of the project as well as commercial concerns about sales, profitability and potential competition (Keizer and Halman 2007; Roper, Du, and Love 2008; Cabrales et al. 2008). Technological risks are associated primarily with the potential failure of development projects to achieve the desired technological or performance outcomes, an inability to develop a solution which is cost-effective to manufacture/deliver (Astebro and Michela 2005), or issues around project development time (Menon, Chowdhury, and Lukas 2002; Von Stamm 2003). Each may have implications for innovations' subsequent market success or viability. In terms of development time, for example, it has been suggested that compressed development time may necessitate overly rapid decision making, reducing innovation quality (Zhang, Chen, and Ma 2007) with potentially negative effects on post-innovation returns (Bower and Hout 1988).

Market-related innovation risks have a commercial dimension linked directly to the demand for the innovation but may also involve issues around rivalry or appropriability conditions. Astebro and Michela (2005), for example, emphasise demand instability as one of three main factors linked to reduced innovation survival in their analysis of 37 innovations supported by the Canadian Inventors Assistance Programme[3]. Market rivalry and competitors' responses may also play a critical role in shaping market-related innovation risks. Rivals' new product announcements may reduce returns (Fosfuri and Giarratana 2009), for example, while appropriability conditions may shape firms' ability to benefit from new innovations and

[3] The other predictors of innovation survival identified by (Astebro and Michela 2005) are 'technical product maturity' and 'entry cost and price'.

therefore their appropriate market strategy (Leiponen and Byma 2009). Moreover, as Keizer and Holman (2007) suggest: 'Radical innovation life cycles are longer, more unpredictable, have more stops and starts, are more context-dependent in that strategic considerations can accelerate, retard or terminate progress, and more often include cross-functional and or cross-unit teamwork. Incremental projects are more linear and predictable, with fewer resource uncertainties, including simpler collaboration relationships' (p.30)[4] .

The extent to which individual micro-enterprises are willing to bear innovation risk will relate strongly to the ambitions and attitudes of the leadership team. Family businesses, for example, may be characterised by different patterns of social or relational capital, both inside and across the boundaries of the firm, which may influence their innovation decisions and behaviours (Miller et al. 2015). Miller et al. (2015) identify four types of capabilities which they suggest may endow family firms with superior innovation capabilities: strong emotional commitment to the business; strong stakeholder ties due to patient planning horizons; patient financial capital; and, cost-effective governance mechanisms facilitated by shared values. Conversely, they argue, other family firms may be parochial in outlook, have a preference for stability over risk and for blood-line over talent. 'Family firms confronting such resource disadvantages tend to innovate too little and too late' (Miller et al. 2015, p. 5). Somewhat similar trade-offs have been suggested in terms of the innovation benefits of gender diversity within a firm's leadership team. On the one hand, the 'value in diversity' hypothesis suggests that a leadership team's contrasting backgrounds and experience may increase the ability to generate new ideas. On the other, it has been suggested that increased diversity may lead to conflict and distrust (Diaz-Garcia, Gonzalez-Moreno, and Saez-Martinez 2013).

[4] See also (Leifer et al. 2000)

Innovating through partnering – seeking knowledge and resources outside the firm – may be one way of offsetting innovation risks. For example, Powell (1998) stresses the potential value of openness in reducing risk in the innovation process, accelerating or upgrading the quality of the innovations made, and signaling the quality of firms' innovation activities. External innovation linkages may also increase firms' access to external resources and technology developed elsewhere. Further, having more extensive networks of external relationships, or more different types of relationships, is likely to increase the probability of obtaining useful knowledge from outside of the firm (Leiponen and Helfat 2010). Empirical evidence also points to the conclusion that knowledge gained from alternative sources tends to be complementary and also complementary with firms' internal knowledge in shaping innovation performance (Roper, Du, and Love 2008). However, as Chesbrough (2010) suggests, open innovation poses particular challenges for SMEs because of their relative lack of capacity to both seek and absorb external knowledge.

HYPOTHESES

Small – and particularly micro-enterprises - are commonly thought to have advantages in terms of flexibility but disadvantages in terms of their resource base (Vossen 1998). There is a substantial literature, however, linking the strength and scale of firms' internal resources positively to innovation. R&D capacity and investment for example, has been shown to be important in shaping innovation outcomes in numerous studies (Belderbos, Carree, and Lokshin 2004; Czarnitzki, Ebersberger, and Fier 2007; Graziadio and Zawislak 1997; Harris and Trainor 1995; Hoffman 1998), as well as contributing to firms' absorptive capacity (Griffith, Redding, and Van Reenan 2003; Xia and Roper 2008). Similarly, firms' investments in intangibles such as design (Filipetti 2010; Fridenson 2009; Marion and Meyer 2011; Moultrie and Livesey 2013), advanced manufacturing technologies (Cardoso, de Lima, and Gouvea da Costa 2012; Hewitt-Dundas 2004) and quality improvement (Adam, Flores, and Macias 2001) have also been shown to link strongly to innovation

outcomes. Labour quality and training investment have also been linked to stronger innovation outcomes in small firms (Freel 2005; Leiponen 2005). Public support for R&D and innovation may also create slack within an organisation, allowing greater investments in innovation than would otherwise have been possible (Aerts and Czarnitzki 2006; Ballesteros and Rico 2001; Buiseret, Cameron, and Georgiou 1995; Czarnitzki and Licht 2006). These results all suggest that:

Hypothesis 1: Resources

Micro-enterprises investing more in gathering and creating knowledge are *more likely* to engage in new-to-the-market innovation

In addition to their internal resources, previous studies have suggested the importance of external knowledge and resources for innovation outputs (Oerlemans, Meeus, and Boekema 1998; Love, Roper, and Vahter 2014). And, while it is clear that for micro-firms seeking knowledge outside the firm presents particular problems, recent empirical evidence does suggest that some SMEs do purposively engage in open innovation, and that the prevalence of open innovation among SMEs has increased in recent years (van de Vrande et al. 2009).

At its simplest, the innovation impact of such relationships might depend on a firms' number of connections. In purely statistical terms, since the payoff from any given innovation connection is unknown in advance, the chances of obtaining benefit from any connection in a given distribution of payoffs increases as the number of connections increases (Love et al, 2014). Having more connections increases the probability of obtaining useful external knowledge that can be combined with the firm's internal knowledge to produce innovation (Leiponen and Helfat 2010). The extent or breadth of a firm's portfolio of external connections may also have significant network benefits, reducing the risk of "lock-in" where firms are either less open to knowledge from outside its own region (Boschma 2005), or where firms in a region are highly specialised in certain industries, which

lowers their ability to keep up with new technology and market development (Camagni 1991).

However, the capacity of management to pay attention to and cognitively process many sources of information is not infinite particularly in micro-enterprises, since the span of attention of any individual is limited (Simon 1947). This attention issue means that while the returns to additional connections may at first be positive, eventually the firm will reach a point at which an additional connection actually serves to diminish the innovation returns of external networking. This is reflected in an extensive empirical literature which suggests the value of external connectivity for innovation and an inverted U-shaped relationship between innovation performance and the extent of firms' external networks (Laursen and Salter 2006; Leiponen and Helfat 2010; Grimpe and Sofka 2009; Garriga, von Krogh, and Spaeth 2013). Hence:

Hypothesis 2: Cooperation

Micro-enterprises working with external partners as part of their innovation activity are *more likely* to engage in new-to-the-market innovation although the marginal benefit of each additional external partner will be declining.

Firms' willingness to invest in internal resources for innovation or in building external relationships may be linked to their ownership characteristics. Family-owned firms, in particular, have often been regarded as risk averse, keener on preserving wealth rather than taking undertaking the type of risky investments implicit in new-to-the-market innovation (Kotlar et al. 2014)[5]. Despite arguments about patient capital which might make family firms more innovation friendly this negative relationship has been confirmed by evidence from a range of contexts which suggests that family ownership and control is negatively related to levels of R&D investment –

[5] Although see (Craig et al. 2014) who find no significant differences in the propensity to take risks among a large sample of Finnish family and non-family firms.

(see Matzler et al (2015) for a recent review). Sciascia et al (2015) also find evidence of a negative relationship between family ownership and R&D investment among a group of Italian SMEs. As their study suggests the relationship between family ownership and R&D investment is moderated by other factors related to family wealth and the control of the business. This echoes the early suggestion from Chrisman and Patel (1992), albeit for larger firms, who argued that the negative R&D investment – family ownership relationship may be reversed where the returns being achieved by a family-owned business fell below a desired norm.

Fewer studies have considered the relationship between family ownership and indicators of innovative output, and as far as we are aware none focus specifically on micro-firms. (Craig et al. 2014) is unusual in using survey based measures of innovative sales and finds contrasting relationships between risk propensity and innovation outputs in family and non-family owned firms. Matzler et al (2015) also considers measures of inputs (R&D intensity) and outputs (patent intensity) and suggests that family firms may be more effective innovators given any specific level of innovation inputs[6]. In line with the general evidence on family ownership and R&D investment – itself strongly correlated with innovation output – we suggest that:

Hypothesis 3: Family ownership

Micro-enterprises which are family-owned are *less likely* to engage in new-to-the-market innovation.

Conceptual perspectives on diversity suggest the potential for both positive and negative effects on organisational outcomes as the 'value of diversity' and the potential communication and co-ordination challenges posed by more diverse teams. Evidence on the specific relationship between gender

[6] It is notable that (Matzler et al. 2015) measure innovative output is measured by patent intensity, however, which other studies have suggested is only weakly linked to either new product or service introductions or increased innovative sales (our patents paper).

diversity and innovation performance is relatively limited, although where this has been considered the evidence suggests a positive relationship – i.e. firms with more diverse workforces are more likely to engage in innovation. Ostergard, Timmermans and Kristensen (2011), for example, examined the impact of various dimensions of workforce diversity on innovation in Danish firms and find a strong positive relationship between gender diversity and innovation. More recently, (Diaz-Garcia, Gonzalez-Moreno, and Saez-Martinez 2013) examined the impact of gender diversity of R&D teams within a cross-section of over 4,000 Spanish companies and found a positive link between diversity and the probability that firms undertook new-to-the-market innovation. No such relationship was evident, however, between gender diversity and more incremental product change. As a result we anticipate that:

Hypothesis 4: Diversity

Micro-enterprises which have a diverse leadership team are *more likely* to engage in new-to-the-market innovation.

DATA AND METHODS

Our analysis is based on a survey of innovation among micro-enterprises (with 1-9 employees) conducted in Northern Ireland and relating to firms' innovation activity during the three year period 1st January 2010 to 31st December 2012. The survey closely follows the definitions and questions used in the EU Community Innovation Survey and the UK Innovation Survey but uses a different survey methodology being conducted by telephone rather than post. In each firm the most senior person in the business was the respondent. The survey targeted 1,000 businesses, quota sampled to be representative of the Northern Ireland micro-enterprise population. Northern Ireland itself is the smallest of the devolved territories of the UK with a population of 1.8m in 2012 at the time of the

survey[7]. Linked by a land border with the Irish Republic, Northern Ireland has a long history as a centre for heavy engineering and textile manufacture. However, in common with the rest of the UK, significant industrial restructuring has taken place over recent decades with a loss of manufacturing activity and a growth in creative industries and other services. Around 1:6 of the workforce are now employed in manufacturing, with the economy dominated by micro, small and medium-sized companies. Labour productivity per hour worked has remained around 79-85 per cent of the UK average over the 2000-2010 period and was 17.2 per cent below the UK average in 2012[8].

The proportion of firms introducing either new or significantly improved products/services or processes in Northern Ireland and the UK can be compared using data from the UK Innovation Survey 2013. From 2010-12, 18 per cent of UK firms introduced new products or services compared to 14.6 per cent in Northern Ireland. A more significant difference was evident between the proportion of revenue derived from new-to-the-market innovation in the UK (7.5 per cent) and Northern Ireland (3.2 per cent). Conversely, Northern Ireland firms derived 12.4 per cent of revenues from new-to-the-firm innovations compared to 10.7 per cent in the UK[9]. Product innovators in Northern Ireland (52.1 per cent) were also less likely to be collaborating with other partners than similar firms in the UK (62.7 per cent). Possible explanations for this relatively low level of collaborative innovation activity in Northern Ireland are suggested by previous analyses of Northern Ireland's innovation capabilities. One study of absorptive capacity, for example, places Northern Ireland below the UK average on

[7] Source: Region and Country Profiles – Population and Migration, Office of National Statistics,30 May 2012.

[8] Source: Region and Country Profiles: Economy, Office of National Statistics,30 May 2012. Regional Economic Indicators, July 2014, ONS.

[9] Source: UK Innovation Survey 2010 to 2012: annex. Available at: https://www.gov.uk/government/statistics/uk-innovation-survey-2013-statistical-annex

each of the dimensions measured (NESTA 2008). Another recent on the innovation systems of Northern Ireland and Ireland also suggests that: "Despite numerous agents and supports available to support collaboration and networking, it would appear that the full breadth of the ecosystem is not being fully exploited either a local level or beyond and opportunities exist to increase the relevance of and connections to the other innovation partners". In terms of the ICD framework outlined earlier this suggests the potential for partnership innovation in Northern Ireland may be under-developed at present, perhaps accounting for the lower than average level of new-to-market innovation.

Our analysis is based on the concept of the innovation production function, which relates micro-enterprises' innovation outputs to the knowledge inputs to their innovation process (Griliches, 1995; Love and Roper, 2001; Laursen and Salter, 2006). Adopting the innovation production function also allows us to take into account firm characteristics and other elements of micro-enterprises' innovation strategies – e.g., investments in R&D, design and innovation partnerships – alongside firms' ownership and leadership profile. Furthermore, it enables us to identify any contingent factors, which might be associated with aspects of plants' operating environment (e.g. sector) or other dimensions of firms' innovation activity (e.g. size).

Consistent with the ICD model our interest here is in what shapes micro-enterprises' ability to introduce new-to-the-market products or services. In the micro-enterprise survey this is reflected in a binary indicator of whether or not firms introduced new-to-the-market products or services over the 2010 to 2012 period. While this type of innovation is clearly important in driving the type of competitive process envisaged in the ICD model, three caveats relating to this measure are worth highlighting. First, the measure is subjective in the sense that we are relying on micro-enterprises' own judgment of what is and what is not new-to-the-market innovation. It is difficult to be clear about the scale of any likely bias in this measure but the probability is that this overstates the proportion of innovations described as

new-to-the-market. In this context it is interesting that in the micro-business survey 13.6 per cent of firms reported introducing new-to-the-market innovations in our estimation sample (Table 1) compared to only 7.9 per cent in the UK Innovation Survey which provides representative figures for all UK businesses[10]. Second, the question arises of which market the innovation is new to. For the majority of micro-enterprises in the sample this is the UK and Irish market as only 5.6 per cent of micro-businesses were exporting. Third, the binary indicator provided gives us little idea of the success of the commercial success of the innovation itself. In the UK Innovation Survey, for example, and other EU Community Innovation Surveys firms are asked what proportion of their sales was derived from new-to-the-market innovation, however, this question was not asked in the micro-enterprise survey.

We undertake two analyses. The first reports a series of bivariate probit models focused on the probability that micro-enterprises will make new-to-the-market innovations. For comparison we also report models for the probability of undertaking new-to-the-firm innovation. Second, we report a series of ordered probit models reflecting the progression from no innovation, through new-to-the-firm innovation to new-to-the-market innovation.

(a) Resources

We measure the resources available for micro-enterprises' innovation activity using three indicators. First, we include a binary variable to reflect the engagement of the business in R&D, which is generally associated positively with new product development (Crepon et al., 1998; Loof and

[10] As the original survey report makes clear, however, 'higher [micro-business] innovation rates compared to the UKIS … are a likely consequence of differences in survey methodology. For example, MBIS respondents are the most senior person in the business and therefore more likely both to be aware of, and recall, innovation related activity'.

Heshmati, 2001; Loof and Heshmati, 2002; Roper et al., 2008). Second, we include a scale indicator to reflect micro-enterprises' investment in other types of innovation investment such as design, training for innovation etc[11]. We anticipate this variable having a positive impact on innovation given evidence from other studies that, for example, investments in design and machinery are associated with higher innovation outputs (Marsili and Salter, 2006; Love et al., 2011). Third, we include a variable indicating whether or not the micro-enterprise received public support from either local, national or supranational agencies to support its innovation activity. Such support has been shown in the past to be positively linked to innovation outputs (Smith 1989; Hewitt-Dundas and Roper 2009; Gongora, Garcia, and Madrid 2010).

(b) Innovation co-operation

We measure the extent of micro-enterprises' external cooperation for innovation using a now standard measure of 'breadth' (Laursen and Salter 2006). This relates to the number of partner types with which a firm is engaging whether those partners are local, national or international. In the survey, eight different partner types are identified and this variable therefore takes values 0 to 8[12]. Previous studies have highlighted an

[11] Ten types of innovation investment are identified in the micro-business questionnaire. This variable therefore takes values between 0 and 10. The options were: Advanced machinery and equipment; Computer hardware; Computer software; Purchase of licensing of patents and non-patented inventions, know-how and other types of knowledge from other businesses or organisations; Internal or external training for your personnel, specifically for the development and\or introduction of innovations; Engagement in all design activities, including strategic, for the development or implementation of new or improved goods, services and processes; Changes to product or service design; Market research; Changes to marketing methods; Launch advertising.

[12] These are: Other businesses within your enterprise group? Interviewer note: If respondent queries what is meant by enterprise group, if it is referring to businesses that have multiple units in one group; Suppliers of equipment, materials, services or software; Clients or customers from the private sector; Clients or customers from the public sector; Competitors or other businesses in your industry; Consultants, commercial labs or private R&D institutes; Universities or other higher education institutions; Government or public research institutes.

inverted-U shape relationship between this measure and innovation outputs and we therefore include a square of this variable in all models to capture the potential for this non-linear effect (Vahter, Love, and Roper 2013).

(c) Family ownership

The categorisation of businesses as family-owned and controlled has received substantial attention in the research literature and generated significant debate. In the current context we are limited to a single question in the micro-enterprise survey which directly asked: 'Is the business family-owned?' and required a binary response. Overall, 80.6 per cent of micro-enterprises in our estimation sample indicated that the business was family-owned (Table 1). We have no information on the extent to which a business is family-owned and family-run, however, our information is consistent with previous studies have focussed primarily on the relationship between family-ownership and R&D investment (Matzler et al. 2015).

(d) Gender diversity

In the survey, micro-enterprises were asked how many 'owners, partners and directors were there in day-to-day control of the business' and then 'how many of these owners, partners and directors (OPDs) were female?' On average around a quarter of all OPDs were female (Table 1), a figure strongly consistent with other studies of UK businesses (Martin et al. 2008). In econometric studies two main approaches have been adopted to capturing board diversity. First, a simple proportion of female OPDs is used to capture the impact of diversity, often with a squared term included to allow for any non-linear effect or different bands of gender balance (Ostergaard, Timmermans, and Kristinsson 2011). Other studies have used a Blau index which allows for a non-linear, although symmetric diversity effect on performance (Diaz-Garcia, Gonzalez-Moreno, and Saez-Martinez 2013). Here, we adopt the former approach including in the regression models both the level and square of the proportion of OPDs which are

female.

(e) Control variables

We include six firm-level control variables which previous studies have linked to innovation outputs. First, we include variables related to whether or not the owner-manager of the firm has a science or technology background and whether she or he is a graduate. Both we anticipate will be positively related to innovation. Employment in the firm is also included which again we expect to be positively related to innovation. The independence of the firm is included to reflect any potential resource advantage accruing to firms which are group members (Choi, Il Park, and Hong 2012). Firm age is also included to capture any resource advantages which accumulate as firms age (Balasubramanian and Lee 2008). Finally, we include an exporting variable to capture any benefit which firms derive from selling in international markets (Love and Roper 2015).

EMPIRICAL RESULTS

We report probit models for the probability that firms will undertake new-to-the-firm innovation in Table 2. In addition to the variables of interest and controls, all models include sectoral dummies at the two digit level. In each case the reference group is the group of non-innovating firms, i.e. the models for new-to-the-market innovation exclude those firms doing only new-to-the-firm innovation. Models (2) and (4) relate to new-to-the-market innovation and, for comparison, models (1) and (3) relate to new-to-the-firm innovation in products or services.

Hypothesis 1 suggests a positive link between firms' resources and their probability of undertaking new-to-the-market innovation. This is supported in the case of R&D activity and innovation investment but, contrary to other studies of larger firms, we find no evidence that public support for innovation has any positive output effect. Indeed, R&D itself only has a significant association with new-to-the-market innovation but no significant

link to new-to-the-firm innovation. This may reflect the nature of new-to-the-firm and new-to-the-market innovation, with both requiring investment but the latter with its higher degree of novelty also requiring some in-house R&D activity. This perhaps also suggests the greater resource requirements of undertaking new-to-the-market innovation with its greater technical and commercial challenges.

Central to the notion of the ICD model is inter-organisational cooperation and Hypothesis 2 argues that cooperation will be important for new-to-the-market innovation. This is strongly supported by our estimation with cooperation important for both new-to-the-market and new-to-the-firm innovation. In both cases we see the anticipated inverted-U shape relationship between the breadth of micro-enterprises' external connections and innovation output, although the two relationships differ somewhat in shape and configuration (Figure 1).

Our third hypothesis relates to the potentially negative effect of family ownership on new-to-the-market innovation due to risk aversion. In fact our results contradict this expectation with family-owned firms 8.2-8.3 per cent more likely to introduce new-to-the-market innovations than non-family owned firms. In this sense it seems as if the potential benefits of patient capital which may be innovation friendly (Rogoff and Heck, 2003) outweigh any risk aversion (Matzler et al. 2015; Sciascia et al. 2015). Interestingly this effect is only evident for new-to-the-market innovation with no significant family effect for more incremental product or service change.

Our final hypothesis relates to gender diversity and here we find few significant results (Table 2). Our data therefore provides no support for either the value in diversity or co-ordination difficulties perspective in terms of innovation. This may perhaps reflect the nature of micro-enterprises where communication is often intensive and informal given the size of the working group.

In Table 3 partly as a robustness check we report ordered probit models estimated across the whole group of non-innovators, new-to-the-firm and new-to-the-market innovators. These largely re-emphasise the earlier findings: R&D and innovation investment are important as is external co-operation. Evidence for the importance of family ownership and diversity within the leadership team is, however, less consistent.

DISCUSSION

Our conceptual discussion focuses on the potential role of cooperation or interaction in driving new-to-the-market innovation – and hence a creative destruction process – among micro-enterprises. We find strong support for this central proposition and for the important role of other types of innovation investment and R&D in shaping the probability of new-to-the-market innovation (Table 2). These inputs to the innovation process may be playing complementary roles, with firms' in-house R&D capabilities or activities helping to identify and perhaps absorb externally acquired knowledge (Cohen and Levinthal 1989). Innovation investments may also be playing a complementary role, providing an alternative to co-operation for accessing externally available knowledge. We also find some evidence that family businesses may be more likely to introduce new-to-the-market innovation, although our results suggest little support for any clear link between gender diversity in micro-enterprises' leadership team and innovation.

How does the importance of innovation co-operation suggested by our empirical analysis, and the role of firms' internal complementary knowledge assets, change the competitive dynamics of the CD model among micro-enterprises? In the rather specific context of pharmaceuticals, for example, Rothaermel (2001) shows that incumbents derive performance benefits from developing alliances with new technology providers in a process which is mutually beneficial: through alliance formation the incumbent

neutralises any competitive threat from the new entrant at the cost of internalising any commercial or technical risk; the new entrant benefits from the resource advantages and market legitimacy of the incumbent. Where industries are more atomistic, these strategic advantages to both parties – incumbents and new entrants - will be less pronounced, and motivations for alliance or partnership may instead emphasise resource acquisition and/or risk mitigation. This may influence both firms' alliance portfolios and strategy in terms of each individual partnership. There is mounting evidence, for example, that for smaller firms the breadth of firms' alliance portfolios contributes both to innovative outputs and organisational performance albeit with a declining marginal benefit for each added partner type (Beck and Schenker-Wicki 2014; Vahter, Love, and Roper 2013). Alongside the technological leadership capabilities required for success in the traditional CD model, the need for small firms to carefully select partners also emphasises the importance of firms' organisational capabilities around partner search, partnership management and learning capabilities (Love, Roper, and Vahter 2014; Zhu 2006). This links into on-going debates about ambidexterity in innovation, and firms' ability to effectively explore and develop new technologies through partnerships and then effectively exploit the innovations developed (Chang and Hughes 2012).

The implication is that to be successful in the ICD model micro-enterprises require a rather different – and broader - profile of internal capabilities than in a more traditional CD setting. In the CD model, internal innovation dominates and the emphasis is on firms' internal ambidexterity – their ability to develop and effectively exploit technological innovation based on their internal resources. In the ICD model the picture is more complex with firms needing to achieve partnership ambidexterity – developing relationships which effectively combine internal and external resources to achieve technological leadership (Tiwana 2008).

The importance of co-operation in driving new-to-the-market innovation in micro-enterprises may also contradict to some extent the fluid competitive

dynamics of the CD model with its emphasis on the temporary technological leadership of individual firms. Instead as (Rahman and Korn 2014) p. 257 suggest 'many promising alliances fail to produce satisfactory results because of their inadequate longevity … greater longevity may translate to more time to work on the alliance to yield satisfactory results'. On the other hand, alliances of longer duration may allow the development of deeper, more complementary, relationships between firms yielding more positive outcomes (Pangarkar 2003). In the ICD model this suggests two possible innovation strategies for micro-enterprises seeking to introduce new-to-the-market innovation – that of closed or solo innovation and that of open or partnered innovation. Interestingly, in our sample of micro-enterprises the latter strategy predominates with 74.8 per cent of new-to-the-market innovators collaborating with (often multiple) external partners and only 25.2 per cent being solo innovators. Moreover, new-to-the-market innovators were typically working with 2.8 types of partner compared to 0.99 among all firms in the estimation sample.

Alongside collaboration our analysis also highlights the positive role of family ownership on micro- enterprises' introduction of new-to-the-market innovation (Table 2). On first sight this result appears to contradict the majority of existing evidence which suggests a negative relationship between family ownership and R&D investment (Matzler et al. 2015; Sciascia et al. 2015), although our results are similar to those of a recent German study linking family ownership positively to innovation outputs (Matzler et al. 2015). One possibility consistent with both this wider evidence and our analysis would be that family firms have higher levels of external collaboration and are therefore able to economise on internal R&D expenditure. In our sample, however, among new-to-the-market innovators levels of external collaboration are actually lower among family-owned firms (an average of 2.57 external partner types) than among non-family owned firms (3.9 partner types on average). This is consistent with evidence from other studies which suggests that in order to preserve control over their innovation activities family-owned firms are reluctant to engage in innovation partnerships (Kotlar et al. 2014). More persuasive

therefore are arguments which suggest that all else being equal family-owned firms may be more effective innovators due to deeply embedded knowledge of the company and its operation, close relations between family members and a shared business objectives (Chrisman et al. 2012). It may also be the case that these attributes reduce the search costs of external relationships and enhance the contribution of such relationships to family-owned firms' innovation outputs.

In managerial terms our study emphasises the range of capabilities necessary for micro-enterprises to undertake new-to-the-market innovation and so contribute to the CD process. Resource co-ordination and partnering skills may be equally important as more technological competencies, although our results do suggest that new-to-the-market innovation is more likely where the owner-manager of a firm has a science or technical background (Table 2). In policy terms it is perhaps of interest to consider the barriers to innovation cited by those micro-enterprises which were making new-to-the-market innovations. Factors which were said to be 'very influential constraints' on innovation were: excessive economic risk, 45.4 per cent of firms; availability of finance, 42.7 per cent; costs of finance, 36.9 per cent and direct innovation costs too high, 35.9 per cent of firms. Other factors like regulatory issues (24.2 per cent), a lack of information about partners (19.4 per cent) and uncertain demand (21.4 per cent) were less commonly cited factors. The dominance of risk and finance related constraints on innovation here is common to most innovation surveys. However, perhaps less common is the finding that 33.9 per cent of new-to-the-market innovators felt that a major constraint was a lack of information on the potential support available for innovation. Indeed, only 16.5 per cent of new-to-the-market innovators actually received any public support for their innovative activity. Ensuring micro-enterprises are aware of potential innovation support seems an obvious and cost-effective policy response.

CONCLUSIONS

Relatively little is known about the nature of innovation among micro-enterprises with less than 10 employees due to their exclusion from the majority of innovation surveys. Here, we draw on a regional survey explicitly targeted on micro-enterprises to consider the drivers of new-to-the-market innovation the related process of creative destruction. We find strong support for the interactive nature of new-to-the-market innovation activity among micro-enterprises suggesting the need for a re-definition of the Schumpeterian creative destruction model. The fundamental impetus remains - competition drives innovation – but the process through which innovation and market leadership emerge is interactive rather than atomistic, and socially-embedded rather than acontextual. Alongside micro-enterprises' internal capabilities, innovation co-operation plays a key role in firms' ability to develop new-to-the-market innovations. Family ownership matters too, increasing the probability that firms will engage in new-to-the-market innovation and drive a CD process.

While, we believe, providing some new insights into micro-enterprise innovation our study has a number of significant weaknesses. First, it is based on a cross-sectional survey from a single UK region, Northern Ireland. Both factors limit the generalisability and causal interpretation of the results. Replication with data with broader geographical coverage and a stronger temporal dimension would be valuable. Second, although combining some novel leadership and innovation measures our study remains limited by its econometric and reductionist methodology. Complementary case-study evidence would be a valuable and insightful addition. Finally, while our study does suggest some of the direct influences of factors such as family-ownership and co-operation on innovation outputs we have yet to consider the potential interactions between these influences. Our data shows, for example, that in general

family-owned firms have fewer external innovation partnerships, but it may be that the longer time horizons of family-owned firms allow more complementary partnerships to develop increasing their innovation value. This is for future work.

Table 1: Sample Descriptives

	Obs	Mean	Std. Dev.
Innovation measures			
New-to-the-firm innovation (% firms)	762	0.370	0.483
New-to-the-market innovation (% firms)	759	0.136	0.343
Innovation sophistication (avg. scale)	762	0.505	0.722
Resources			
R&D active firm (% firms)	762	0.227	0.419
Types of innovation investment (avg. scale)	751	2.322	1.610
Public support for innovation (% firms)	762	0.067	0.250
Co-operation			
Breadth of cooperation (avg. number)	762	0.999	1.738
Family ownership			
Family business (% firms)	762	0.806	0.396
Diversity			
Share female directors (% firms)	751	25.099	37.726
Control variables			
O-M has STEM background (%)	762	0.262	0.440
O-M is graduate (%)	762	0.488	0.500
Employment in firm (2010)	756	3.898	2.134
Independent business (% firms)	762	0.907	0.291
Age of business (years)	762	20.283	18.754
Selling outside UK and Ireland (% firms)	762	0.056	0.231

Source: Survey of micro-businesses in Northern Ireland, 2014.

Table 2: The probability of new-to-the-market and new-to-the-firm innovation: probit models

	New-to-the-firm	New-to-the-market	New-to-the-firm	New-to-the-market
	Model (1)	Model (2)	Model (3)	Model (4)
R&D active firm	0.046	0.073**	0.057	0.077***
	(0.040)	(0.029)	(0.039)	(0.029)
Types of innovation investment	0.052***	0.024**	0.051***	0.024**
	(0.011)	(0.010)	(0.011)	(0.009)
Public support for innovation	-0.117	0.046	-0.098	0.051
	(0.073)	(0.047)	(0.071)	(0.047)
Breadth of cooperation	0.197***	0.101***	0.198***	0.101***
	(0.023)	(0.017)	(0.023)	(0.017)
Breadth of cooperation squared	-0.029***	-0.009***	-0.029***	-0.009***
	(0.005)	(0.003)	(0.004)	(0.003)
Family business	0.005	0.083**	0.003	0.082**
	(0.041)	(0.038)	(0.040)	(0.038)
Share female directors	-0.001	0.002	0.000	0.002*
	(0.002)	(0.001)	(0.002)	(0.001)
Share female directors squared	0.002	-0.001	0.002	-0.002
	(0.002)	(0.001)	(0.002)	(0.001)
O-M has STEM background	0.019	0.049*	0.018	0.050*
	(0.037)	(0.028)	(0.036)	(0.028)
O-M is graduate	-0.010	0.008		
	(0.034)	(0.027)		
Employment in firm	0.002	0.006		
	(0.008)	(0.006)		
Independent business	-0.097*	-0.029		
	(0.054)	(0.047)		
Age of business	0.000	-0.001		
	(0.001)	(0.001)		
Selling outside UK and Ireland	-0.072	0.026	-0.071	0.032
	(0.076)	(0.045)	(0.075)	(0.045)
Number of observations	635	547	640	550
Chi-square	176.61	206.79	176.84	205.93
Pseudo R^2	0.237	0.397	0.236	0.395

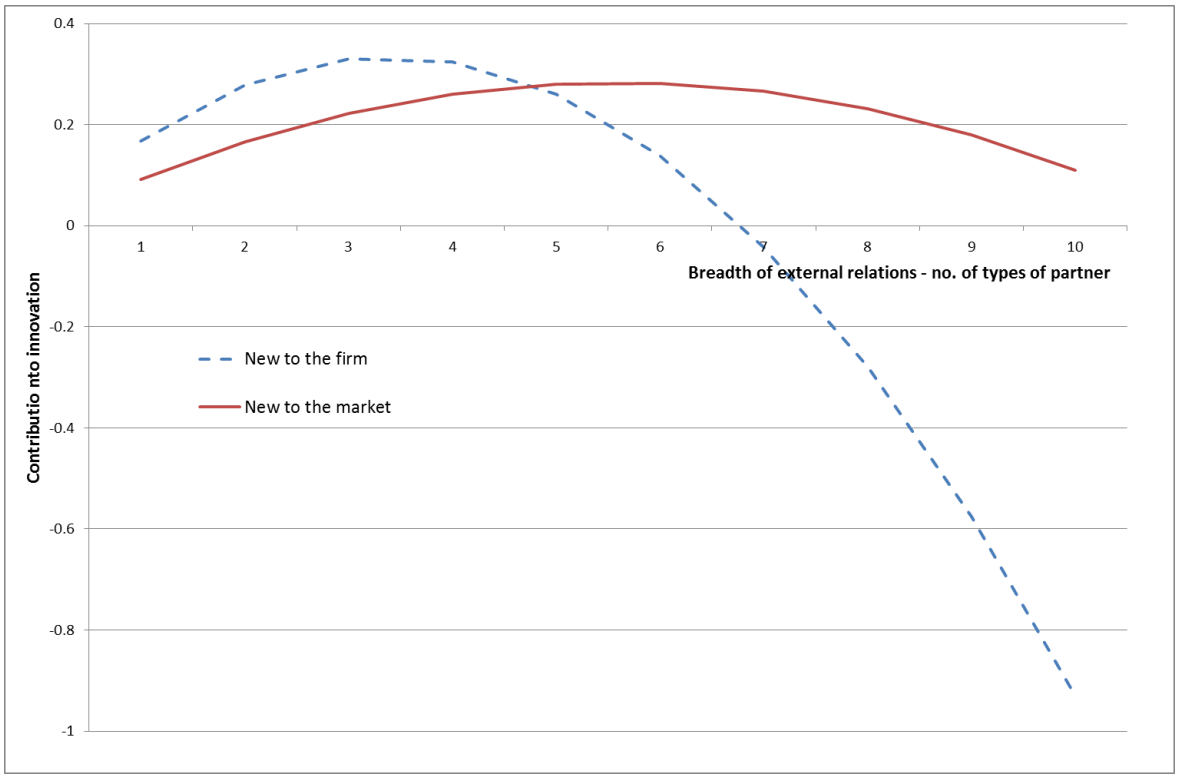
Notes and sources: Values in the table are marginal effects calculated at variable means. Models include sectoral dummies. * denotes p<0.10, ** is p<0.05, and *** is p<0.01. **Source:** Survey of micro-businesses in Northern Ireland, 2014.

Table 3: Modelling the complexity of new goods and services: ordered probit models

	Model 1	Model 2
R&D active firm	0.381***	0.411***
	(0.119)	(0.118)
Types of innovation investment	0.182***	0.183***
	(0.038)	(0.038)
Public support for innovation	0.159	
	(0.204)	
Breadth of cooperation	0.590***	0.594***
	(0.075)	(0.074)
Breadth of cooperation squared	-0.064***	-0.064***
	(0.013)	(0.013)
Family business	0.229*	0.217
	(0.136)	(0.134)
Share female directors	0.006	0.003**
	(0.005)	(0.001)
Share female directors - squared	-0.003	
	(0.005)	
O-M has STEM background	0.130	0.130
	(0.117)	(0.115)
O-M is graduate	-0.04	
	(0.109)	
Employment in firm	0.025	0.023
	(0.025)	(0.024)
Independent business	-0.312*	-0.322*
	(0.179)	(0.178)
Age of business	-0.002	
	(0.003)	
Selling outside UK and Ireland	0.161	
	(0.208)	
Split – no innovation to n-t-f innovation	1.428	1.237
	(0.988)	(0.937)
Split – n-t-f to n-t-m innovation	2.494**	2.299**
	(0.991)	(0.940)
Number of observations	735	735
Chi-square	297.948	295.357
Pseudo R^2	0.224	0.222
bic	1228.523	1198.114

Notes and sources: Models include sectoral dummies. * denotes p<0.10, ** is p<0.05, and *** is p<0.01. **Source:** Survey of micro-businesses in Northern Ireland, 2014.

Figure 1: Contribution of external co-operation to innovation outputs



ANNEX

Annex 1: Correlation Matrix Part1

		1	2	3	4	5	6	7
1	New-to-the-firm innovation	1.000						
2	New-to-the-market innovation	0.520	1.000					
3	Complexity of innovation	0.914	0.822	1.000				
4	R&D active firm	0.309	0.292	0.345	1.000			
5	Types of innovation investment	0.409	0.302	0.416	0.372	1.000		
6	Public support for innovation	0.056	0.148	0.108	0.145	0.118	1.000	
7	Breadth of cooperation	0.458	0.413	0.502	0.349	0.487	0.179	1.000
8	Family business	0.031	0.041	0.040	-0.032	-0.052	-0.135	-0.039
9	Share female directors	0.116	0.049	0.101	0.092	0.049	0.032	0.065
10	O-M has STEM background	0.129	0.129	0.147	0.121	0.116	0.074	0.125
11	O-M is graduate	0.093	0.085	0.102	0.070	0.227	0.080	0.135
12	Employment in firm	0.047	0.028	0.045	0.040	0.141	-0.018	-0.006
13	Independent business	-0.042	-0.012	-0.034	-0.023	0.071	-0.029	0.035
14	Age of business	-0.133	-0.110	-0.141	-0.141	-0.121	-0.094	-0.156
15	Selling outside UK and Ireland	0.110	0.188	0.163	0.228	0.172	0.073	0.150

Source: Survey of micro-businesses in Northern Ireland, 2014.

Annex 1: Correlation Matrix Part2

		8	9	10	11	12	13	14	15
1	New-to-the-firm innovation								
2	New-to-the-market innovation								
3	Complexity of innovation								
4	R&D active firm								
5	Types of innovation investment								
6	Public support for innovation								
7	Breadth of cooperation								
8	Family business	1.000							
9	Share female directors	0.058	1.000						
10	O-M has STEM background	0.071	-0.040	1.000					
11	O-M is graduate	-0.082	0.041	0.140	1.000				
12	Employment in firm	-0.058	0.016	-0.064	0.007	1.000			
13	Independent business	0.052	-0.010	-0.045	0.032	0.016	1.000		
14	Age of business	0.082	-0.051	-0.081	-0.133	0.192	0.047	1.000	
15	Selling outside UK and Ireland	0.017	-0.002	0.060	0.119	0.099	-0.001	-0.068	1.000

Source: Survey of micro-businesses in Northern Ireland, 2014.

REFERENCE

Adam, E.E.; B.E. Flores; and A. Macias. 2001. Quality improvement practices and the effect on manufacturing firm performance: evidence from Mexico and the USA. International Journal of Production Research 39:43-63.

Aerts, K. and D. Czarnitzki. 2006. Title. IWT Study No. 54, No. 54. Brussels.

Astebro, T. and J.L. Michela. 2005. Predictors of the survival of innovations. Journal of Product Innovation Management 22:322-335.

Balasubramanian, N. and J. Lee. 2008. Firm age and innovation. Industrial and Corporate Change 17:1019-1047.

Ballesteros, J.A. and A.M. Rico. 2001. Public financing of co-operative R&D Projects in Spain: The Concerted projects under the national R&D plan. Research Policy 30:625-641.

Beck, M. and A. Schenker-Wicki. 2014. Cooperating with external partners: the importance of diversity for innovation performance. European Journal of International Management 8:548-569.

Belderbos, R.; M. Carree; and B. Lokshin. 2004. Cooperative R&D and firm performance. Research Policy 33:1477-1492.

Benito-Hernandez, S.; M. Platero-Jaime; and A. Rodriguez-Duarte. 2012. Determinants of innovation in Spanish micro-enterprises: The importance of internal factors. Universia Business Review:104-121.

Bergek, A.; C. Berggren; T. Magnusson; and M. Hobday. 2013. Technological discontinuities and the challenge for incumbent firms: Destruction, disruption or creative accumulation? Research Policy 42:1210-1224.

Boschma, R.A. 2005. Proximity and Innovation: A Critical Assessment. Regional Studies 39:61-74.

Bower, J.L. and T.M. Hout. 1988. FAST-CYCLE CAPABILITY FOR COMPETITIVE POWER. Harvard Business Review 66:110-118.

Buiseret, T.; H.M. Cameron; and L. Georgiou. 1995. What differences does it make? Additionality in the public support of R&D in large firms.

International Journal Of Technology Management 10:587-600.

Cabrales, A.L.; C.C. Medina; A.C. Lavado; and R.V. Cabrera. 2008. Managing functional diversity, risk taking and incentives for teams to achieve radical innovations. R & D Management 38:35-50.

Camagni, R. 1991. Local milieu, uncertainty and innovation networks: towards a new dynamic theory of economic space,. In Innovation Networks, Spatial Perspectives, ed. R. Camagni. London, New York Belhaven Press.

Cardoso, R.d.R.; E.P. de Lima; and S.E. Gouvea da Costa. 2012. Identifying organizational requirements for the implementation of Advanced Manufacturing Technologies (AMT). Journal of Manufacturing Systems 31:367-378.

Chang, Y.Y. and M. Hughes. 2012. Drivers of innovation ambidexterity in small- to medium-sized firms. European Management Journal 30:1-17.

Chesborough, H.W. 2010. Open Innovation: A Key to Achieving Socioeconomic Evolution. How Smaller Companies Can Benefit from Open Innovation: Japan Economic Foundation.

Choi, S.B.; B. Il Park; and P. Hong. 2012. Does Ownership Structure Matter for Firm Technological Innovation Performance? The Case of Korean Firms. Corporate Governance-an International Review 20:267-288.

Chrisman, J.J.; J.H. Chua; A.W. Pearson; and T. Barnett. 2012. Family Involvement, Family Influence, and Family-Centered Non-Economic Goals in Small Firms. Entrepreneurship Theory and Practice 36:267-293.

Cohen, W.M. and D.A. Levinthal. 1989. Innovation and Learning: the two faces of R&D. The Economic Journal 99:569-596.

Craig, J.B.; M. Pohjola; S. Kraus; and S.H. Jensen. 2014. Exploring Relationships among Proactiveness, Risk-Taking and Innovation Output in Family and Non-Family Firms. Creativity and Innovation Management 23:199-210.

Czarnitzki, D.; B. Ebersberger; and A. Fier. 2007. The relationship between R&D collaboration, subsidies and R&D performance: Empirical evidence from Finland and Germany. Journal of Applied Econometrics 22:1347-1366.

Czarnitzki, D. and G. Licht. 2006. Additionality of public R&D grants in a transition economy. Economics of Transition 14:101-131.

Department of Enterprise, T.a.I. 2014. Innovation survey of micro-businesses in Northern Ireland, ed. DETI. Belfast.

Diaz-Garcia, C.; A. Gonzalez-Moreno; and F.J. Saez-Martinez. 2013. Gender diversity within R&D teams: Its impact on radicalness of innovation. Innovation-Management Policy & Practice 15:149-160.

Diaz Perez, C.; A. Alarcon Ozuna; and A. Ayala Arriaga. 2011. Clustering and Innovation Capabilities in the Mexican Software Industry. Emj-Engineering Management Journal 23:47-56.

Filipetti, A. 2010. The role of design in firms' innovation activity: A micro level analysis ed. DIME working paper No 92.

Fosfuri, A. and M.S. Giarratana. 2009. Masters of War: Rivals' Product Innovation and New Advertising in Mature Product Markets. Management Science 55:181-191.

Foster, R. 1986. Innovation- the attacker's advantage. London: Macmillan.

Freel, M.S. 2005. Patterns of Innovation and skills in small firms. Technovation 25:123-134.

Fridenson, P. 2009. The process of innovation. Innovative design and business growth. Mouvement Social:165-166.

Ganotakis, P. and J.H. Love. 2011. R&D, product innovation, and exporting: evidence from UK new technology based firms. Oxford Economic Papers-New Series 63:279-306.

Garriga, H.; G. von Krogh; and S. Spaeth. 2013. How constraints and knowledge impact open innovation. Strategic Management Journal 34:1134-1144.

Glückler, J. 2013. Knowledge, Networks and Space: Connectivity and the Problem of Non-Interactive Learning. Regional Studies 47:880-894.

Gongora, G.; D. Garcia; and A. Madrid. 2010. The Effect of Public Support on Innovative Behavior and Performance in SMEs. Revista De Ciencias Sociales 16:400-417.

Graziadio, T. and P.A. Zawislak. 1997. The role of informal R&D activities in the evaluation of the SMEs technological capability - the Mechanics

Industry in Brazil. In Thirtieth Hawaii International Conference on System Sciences, Vol 3 - Information Systems Track - Organizational Systems and Technology, ed. J.F. Nunamaker and R.H. Sprague, 518-526.

Griffith, R.; S. Redding; and J. Van Reenan. 2003. R&D and Absorptive Capacity: Theory and Empirical Evidence. Scandinavian Journal of Economics 105:99-118.

Grimpe, C. and W. Sofka. 2009. Search patterns and absorptive capacity: low- and high-technology sectors in European countries. Research Policy 38:495-506.

Harris, R.I.D. and M. Trainor. 1995. Innovation and R&D in Northern Ireland Manufacturing: A Schumpeterian Approach. Regional Studies 29:593-604.

Hewitt-Dundas, N. 2004. The adoption of AMT and innovation strategy in small firms. International Journal of Innovation and Technology Management 1:17-36.

Hewitt-Dundas, N. and S. Roper. 2009. Output Additionality of Public Support for Innovation: Evidence for Irish Manufacturing Plants. European Planning Studies 18:107-122.

Hoffman, K., Milady, P., Bessant, J., Perren, L 1998. Small firms R&D, technology and innovation in the UK: a literature review. Technovation 18:39-55.

Keizer, J.A. and J.I.M. Halman. 2007. Diagnosing risk in radical innovation projects. Research-Technology Management 50:30-36.

Kellermanns, F.W.; K.A. Eddleston; R. Sarathy; and F. Murphy. 2012. Innovativeness in family firms: a family influence perspective. Small Business Economics 38:85-101.

Kotlar, J.; H. Fang; A. De Massis; and F. Frattini. 2014. Profitability Goals, Control Goals, and the R&D Investment Decisions of Family and Nonfamily Firms. Journal of Product Innovation Management 31:1128-1145.

Kraus, S.; M. Pohjola; and A. Koponen. 2012. Innovation in family firms: an empirical analysis linking organizational and managerial innovation to corporate success. Review of Managerial Science 6:265-286.

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.

Leenders, M. and C.A.M. Voermans. 2007. Beating the odds in the innovation arena: The role of market and technology signals classification and noise. Industrial Marketing Management 36:420-429.

Leifer, R.; C.M. McDermott; o.C.G. C; L.S. Peters; M.P. Rice; and R.W. Veryzer. 2000. Radical innovation; How mature companies can outsmart upstarts. Boston: Harvard Business School Press.

Leiponen, A. 2005. Skills and innovation. International Journal of Industrial Organization 23:303-323.

Leiponen, A. and J. Byma. 2009. If you cannot block, you better run: Small firms, cooperative innovation, and appropriation strategies. Research Policy 38:1478-1488.

Leiponen, A. and C.E. Helfat. 2010. Innovation objectives, knowledge sources, and the benefits of breadth. Strategic Management Journal 31:224-236.

Leonard-Barton, D. 1992. Core capabiliteis and core rigidities: a paradox in managing new product development. Strategic Management Journal 13:111-125.

Love, J.H. and S. Roper. 2015. SME innovation, exporting and growth: A review of existing evidence. International small business journal 33:28-48.

Love, J.H.; S. Roper; and P. Vahter. 2014. LEARNING FROM OPENNESS: THE DYNAMICS OF BREADTH IN EXTERNAL INNOVATION LINKAGES. Strategic Management Journal 35:1703-1716.

Love, J.H.; S. Roper; and P. Vahter. 2014. Learning from openness: the dynamics of breadth in external innovation linkages. Strategic Management Journal, forthcoming.

Lucas, H.C. and J.M. Goh. 2009. Disruptive technology: How Kodak missed the digital photography revolution. Journal of Strategic Information Systems 18:46-55.

Marion, T.J. and M.H. Meyer. 2011. Applying Industrial Design and Cost Engineering to New Product Development in Early-Stage Firms. Journal of Product Innovation Management 28:773-786.

Martin, L.; I. Warren-Smith; J. Scott; and S. Roper. 2008. Boards of

Directors and Gender Diversity in UK Companies. Gender in Management 23:194-208.

Matzler, K.; V. Veider; J. Hautz; and C. Stadler. 2015. The Impact of Family Ownership, Management, and Governance on Innovation. Journal of Product Innovation Management 32:319-333.

Menon, A.; J. Chowdhury; and B.A. Lukas. 2002. Antecedents and outcomes of new product development speed - An interdisciplinary conceptual framework. Industrial Marketing Management 31:317-328.

Metcalfe, S. 1997. Technology Systems and Technology Policy in an Evoluntionary Framework. Cambridge University Press.

Miller, D.; M. Wright; I. Le Breton-Miller; and L. Scholes. 2015. Resources and innovation in family businesses; the Janus-face of family socio-economic preferences. California Management Review Forthcoming.

Moultrie, J. and F. Livesey. 2013. Measuring design investment in firms: conceptual foundations and exploratory UK study. Research Policy Forthcoming.

NESTA. 2008. Innovation by Adoption – Measuring and mapping absorptive capacity in UK nations and regions. In October. London.

Oerlemans, L.; M. Meeus; and F. Boekema. 1998. Do networks matter for innovation? The usefulness of the economic network approach in analysing innovation. Tijdschrift voor Economische en Sociale Gcografie 89:298-309.

Ostergaard, C.R.; B. Timmermans; and K. Kristinsson. 2011. Does a different view create something new? The effect of employee diversity on innovation. Research Policy 40:500-509.

Pangarkar, N. 2003. Determinants of alliance duration in uncertain environments: The case of the biotechnology sector. Long Range Planning 36:269-284.

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

Rahman, N. and H.J. Korn. 2014. Alliance Longevity: Examining Relational and Operational Antecedents. Long Range Planning 47:245-261.

Roper, S.; J. Du; and J.H. Love. 2008. Modelling the Innovation Value

Chain. Research Policy 37:961-977.

Rothaermel, F.T. 2001. Incumbent's advantage through exploiting complementary assets via interfirm cooperation. Strategic Management Journal 22:687-699.

Sciascia, S.; M. Nordqvist; P. Mazzola; and A. De Massis. 2015. Family Ownership and R&D Intensity in Small- and Medium-Sized Firms. Journal of Product Innovation Management 32:349-360.

Simon, H.A. 1947. Administrative Behavior: A Study of Decision-Making Process in Administrative Organization Chicago: Macmillan.

Smith, K. 1989. Public Support for Civil R&D in the UK: Limitations of Recent Policy Debate. Research Policy 18:99-109.

Sydow, J.; F. Lerch; and U. Staber. 2010. Planning for Path Dependence? The Case of a Network in the Berlin-Brandenburg Optics Cluster. Economic Geography 86:173-195.

Tiwana, A. 2008. Do bridging ties complement strong ties? An empirical examination of alliance ambidexterity. Strategic Management Journal 29:251-272.

Tu, C.; S.-N. Hwang; and J.-Y. Wong. 2014. How does cooperation affect innovation in micro-enterprises? Management Decision 52:1390-1409.

Vahter, P.; J.H. Love; and S. Roper. 2013. Openness and innovation performance: are small firms different? Research Paper 12: Enterprise Research Centre.

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.

Von Stamm, B. 2003. Innovation, Creativity and Design Chichester: John Wiley and Sons

Vossen, R.W. 1998. Relative Strengths and Weaknesses of Small Firms in Innovation. International small business journal 16:88-95.

Xia, H. and S. Roper. 2008. From Capability to Connectivity: Absorptive Capacity and Exploratory Alliances in Biopharmaceutical Firms: A US-Europe Comparison. Technovation 28: 776-785

Zhang, X.; R.Q. Chen; and Y.B. Ma. 2007. An empirical examination of

response time, product variety and firm performance. International Journal of Production Research 45:3135-3150.

Zhu, Z.H. 2006. The dynamic balance between explorative and exploitative learning under open innovation. In Proceedings of the Eighth West Lake International Conference on SMB, ed. Z. Henry; P. Read; L. Chen; L. Liu; and C. Zheng, 44-47. Marrickville: Orient Acad Forum.

ERC
Enterprise Research Centre

Centre Manager
Enterprise Research Centre
Warwick Business School
Coventry, CV4 7AL
Enquiries@enterpriseresearch.ac.uk

Centre Manager
Enterprise Research Centre
Aston Business School
Birmingham, B1 7ET
Enquiries@enterpriseresearch.ac.uk