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Measuring the impact of innovative human capital on small firms' propensity to innovate

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ABSTRACT

The ability to identify and evaluate the competitive advantage of employees' transferable and innovative characteristics is of importance to firms and policymakers. This research extends the standard measure of human capital by developing a unique and far reaching concept of Innovative Human Capital and emphasises its effect on small firm innovation and hence growth (jobs, sales and productivity). This new Innovative Human Capital concept encapsulates four elements: education, training, willingness to change in the workplace and job satisfaction to overcome the limitations of measurements used previously. An augmented innovation production function is used to test the hypothesis that small firms who employ managers with Innovative Human Capital are more likely to innovate. There is evidence from the results that Innovative Human Capital may be more valuable to small firms (i.e. less than 50 employees) than larger-sized firms (i.e. more than 50 employees). The research expands innovation theory to include the concept of Innovative Human Capital as a competitive advantage and determinant of small firm innovation; and distinguishes Innovative Human Capital as a significant concept to consider when creating public support programmes for small firms.

1. Introduction

Innovation plays an important role in firms' survival (Cefis and Marsili, 2006) and is generally defined as the commercial application of new knowledge and the implementation of ideas. It has been acknowledged as a key driver of firm growth and productivity (Ganotakis, 2012; Slaper et al., 2011) and a driving force for industrialised economies' international competition (Kuhlmann and Edler, 2003). Competitive advantage lies in part with the firm's capacity to innovate, evaluate and exploit internal and external knowledge (Cohen and Levinthal, 1990). Human capital provides a competitive advantage for firms in terms of skills, expertise and their willingness to work (Hewitt-Dundas, 2006). Human capital is an essential part of innovation (OECD, 2011). The ability to identify and evaluate the competitive advantage of employees' transferable and innovative characteristics is of key strategic importance to firms and policymakers. Firms and policymakers are faced with many constraints in light of the continued economic downturn and reduced budgets, indicating a need to take advantage of existing resources, human capital being one such resource. This research undertakes an evaluation of employee-managers' human capital to create a new concept, *Innovative Human Capital* (IHC). In turn it examines the concept's effect on small firm innovation and assesses the resulting implications for public policy. In this context, this research poses two central research questions. First, does IHC contribute to firm-level innovation? Second, does IHC have differing outcomes in small and larger-sized firms?

There is an abundance of literature pointing to the importance of research and development (R&D) as a major determinant of innovation and include, for example: R&D cooperation strategies (De Marchi, 2012); R&D tax credits (Cappelen et al., 2012); R&D, product innovation, and exporting (Ganotakis and Love, 2011). However, R&D in small firms is constrained by the high costs and risk of undertaking such projects (Hewitt-Dundas, 2006; Rammer et al., 2009). Most small firms do not engage in formal R&D activity (CIS, 2012), which suggests that these firms find alternative ways to innovate (if indeed they innovate at all). Numerous policy initiatives have focused on supporting R&D in the pursuit of innovation but in the current economic climate of severely reduced budgets (European Commission, 2010a; Forfás, 2012) a focus on the internal resources and capabilities of firms is timely.

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The current research explores employee-managers' IHC. The importance of the managers' role in firm-level innovation stems from his/her position in the firm in terms of how the manager makes decisions, allocates resources, sets priorities, controls costs and spending, and filters ideas (Herrmann et al., 2006; Leiva et al., 2011). Such a role emphasises the importance of this group of individuals in the study of IHC. In the current research the managers, in their response to the survey, indicated that they were an employee (not self-employed[1]) and were either involved in senior or middle management, or at a supervisory level in the firm. Many studies have focused on efforts to identify tangible internal and external conditions and attitudes towards innovation related to the individual person. Coronado et al. (2008), for example, find a positive significance of employees' qualifications and firm size in terms of their attitude to innovation. McGuirk and Jordan (2012) find that diversity in nationality and educational attainment in the workforce relates positively to firms' probability to engage in product innovation.

To date, however, there is limited empirical research on the combined tangible and intangible characteristics of employee-managers' human capital and whether these characteristics contribute to firm-level innovation and differ between small and larger-sized firms. In addition, the current research is motivated by the change in the proportion of the labour force with tertiary education. In Ireland, for example, the proportion of the labour force with a third level degree increased from 25% in 1996 to 36.2% in 2006 (CSO, 2012). By mid-2011, 38% of people in Ireland aged 25–64 year held a third level qualification (CSO, 2011). This increase in educational attainment is also evident in the Organisation for Economic Co-operation and Development (OECD) figures for the adult population: in 2005 the OECD average was 26% and 6 years later this had increased to 33% (OECD, 2007, 2013). Having employees with higher levels of education may no longer be a sufficient criterion for competitive advantage in terms of firm-level innovation: in fact, the proportion of skilled workers has increased in the context of developed countries, as the rate of technological change increases, there is an increase in demand for skilled labour (Piva et al., 2005). Furthermore, there is a growing consensus that Europe must develop citizens' knowledge and skills to create an economy where innovation is part of daily economic life (Ederer, 2006). The importance of human capital to innovate is evident in the Irish Government's *Action Plans for Jobs* (DEJI, 2012, 2014) which state that as skills needs change, the education and training system needs to respond and adapt. The plans also state that investment in management skills is vital. Additionally, the Irish government, through the National Development Plan (2007–2013), set out to invest €8.2 billion in initiatives to enhance human capital, physical infrastructure and commercialisation related to science, technology and innovation (Innovation in Ireland, 2008, p. 3).

Against this backdrop, the aim of this research is to extend the traditional measure of human capital by developing the concept of IHC. It builds on the traditional tangible measure of third level education by adding training, as well as the intangible attitudes and characteristics of the employee-manager including willingness to accept change in the workplace and job satisfaction. The research then proceeds to estimate the effect of IHC on small firm innovation and hence growth (jobs, sales and productivity). The empirical analysis is based on a large rich firm-level dataset extracted from the *Irish National Centre for Partnership and Performance (NCPP) 2009 Workplace Survey*.

[1] The National Centre for Partnership and Performance (NCPP) 2009 Workplace survey (employees) includes employees only – not the self-employed. An employed manager would be included but not a business owner.

The remainder of this paper is organised as follows: Section 2 discusses the theoretical framework underpinning the analysis; Section 3 presents the model and variables. Section 4 describes the data used; Section 5 discusses the empirical analysis and is followed by a final discussion on the results and policy implications in Section 6.

2. Theory and hypotheses

From a theoretical and policy perspective, this research is predicated on the case that sustained competitiveness depends upon the innovation-based strengths of the economy and what determines them (Montalvo, 2006; Santos-Rodrigues et al., 2010). The theoretical framework considers: firstly, the concept of innovation, the determinants of innovation and the types of innovation a firm undertakes; secondly, the theory of human capital as a factor of firm-level innovation and finally, the theory underpinning the newly developed IHC is presented.

2.1. Firm-level innovation

The importance of innovation for economic growth is well documented and has long been part of growth theory, beginning with Schumpeter's (1934) seminal work. His definition of innovation is still used in contemporary innovation studies (Fagerberg et al., 2012). Schumpeter highlighted the role of science, technology and human capital in explaining differing growth rates at both microeconomic and macroeconomic levels through entrepreneurial actions. Schumpeter's 'creative destruction' is the engine of growth (Grossman and Helpman, 1994; Romer, 1990). Innovation is the carrying out of new combinations in the form of: a new good; a new method of production; the opening of a new market; a new source of supply of materials or half-manufactured goods; and finally, the new organisation of an industry (Schumpeter, 1934).

The theory of innovation must incorporate explicitly the stochastic nature of innovation and must have room for organisational complexity and diversity (Nelson and Winter, 1977). Stochastic growth assumes that firms grow randomly (Teruel-Carrizosa, 2010). In addition, Nelson and Winter (1977) emphasise that non-trivial change in product or process, without prior experience, is an innovation. Theory also tells us that innovation is an interactive process, a learning process between people and organisations (Schneider et al., 2010). It is an intentional act to improve the performance in a job, organisations or society, where creative ideas play an explicit role (Williams and McGuire, 2010).

Growth in R&D is an important social and economic change in the twentieth century (Freeman and Soete, 1997), though Shipton et al. (2006) argue that innovation often refers to other activities beyond technical specialists such as R&D professionals and involves those with knowledge of the task and technology to ensure effective completion.

2.2. Firm size and innovation

Firm size as a determinant of innovation activity has long been the subject of empirical research (e.g. Acs and Audretsch, 1990; Hall et al., 2009). In the case of small and medium enterprises[2] (SMEs), such firms can survive and grow "if they are flexible, innovative,

[2] The main factors determining whether a firm is an SME are number of employees and either turnover or balance sheet total – Medium-sized <250 employees (≤€50 m turnover or ≤€43 m Balance Sheet), Small <50 (≤€10 m turnover or ≤€10 m Balance Sheet) Micro < 10 (≤€2 m turnover or ≤€2 m Balance Sheet) (European Commission, 2011).

customer focused, and both proactive and reactive in their business strategies" (Lenihan et al., 2010, p. 3).

There is a particular focus on supporting innovation in small firms (less than 50 employees) in both European and Irish enterprise policy (European Commission, 2010a,b; Forfás, 2011). In the case of Ireland, small firms, encompassing all firms employing up to 50 people, employ 45.7% of the total employed in firms (Forfás, 2011). To stimulate growth and accelerate the development of small firms involves becoming more engaged in innovation, so that it becomes a regular activity (Forfás, 2011). The European Commission also views small firms as being crucially important to the European economy as a source of innovation and employment (European Commission, 2011).

There is conflicting evidence of the effect of firm size on innovation. Schumpeter's (1934) theory argues that innovations normally start in the new and smaller firm and those that succeed grow into large firms. Acs and Audretsch (1990) suggest that small firms who implement strategic innovation can compensate for size-related disadvantages. There is also evidence that small firms are more adaptable and have less rigid management structures (Rogers, 2004), thereby allowing them to implement smaller incremental innovations. Modelling the innovation value chain, Roper et al. (2008) find that the size of the firm affects innovation differently; while there is no impact on product innovation, size is significant for process innovation. The Community Innovation Survey (CIS, 2012) 2008–2010 for Ireland, reports that while 77.3% of large firms (with more than 250 employees) innovate, 41.7% of small firms (with less than 50 employees) innovate. Similarly Roper and Hewitt-Dundas (2008) in an examination of innovation persistence in Ireland and Northern Ireland find that larger-sized firms are more able to sustain product and process innovation than smaller firms. Larger-sized firms tend to have economies of scale in technology and learning, and access to finance, referred to as a 'material advantage' whereas, small firms have flexibility and entrepreneurial drive, a 'behavioural advantage' (Hewitt-Dundas, 2006).

2.3. Human capital as a factor driving firm-level innovation

Human capital is a central element of economic growth theory (Storper and Scott, 2009). An economy with a larger total stock of human capital will experience faster growth (Romer, 1990). A firm's growth is positively related to the quality of human capital and the firm's investment in it (Gossling and Rutten, 2007; Santos-Rodrigues et al., 2010). Human Capital is the embodiment of knowledge, in better educated and productive people (Santos-Rodrigues et al., 2010; Storper and Scott, 2009). It is also an enabling factor in innovation (Leiponen, 2005) and as most firm-level innovations are incremental, it points to their role in the generation, adaption and diffusion of technical and organisational change (Toner, 2011). Research has identified middle management's creation of an innovative climate and openness to technological innovation as influences on innovation (Hosseini et al., 2003).

The innovation literature refers to the role played by individuals in innovation and highlights the importance of recognising what they bring to firms' innovation activities (Lundvall, 2009). Theory also suggests that innovation is a process of learning both by individual personnel and by the organisation as a whole (Lloréns Montes et al., 2005; Schneider et al., 2010). This learning comes, through face-to-face communication (Asheim et al., 2007); teamwork (Lloréns Montes et al., 2005); absorptive capacity (Cohen and Levinthal, 1990) and education, occupation and work experience (Schneider et al., 2010).

The new enterprise/business model focuses on a holistic approach to enterprise policy interventions when operating in a knowledge economy that rests on intangible assets, (e.g. technological spillovers, innovation and linkages) (Lenihan, 2011). Schiuma and Lerro (2008) point to the need for an appropriate balance of education types, and Richard (2000) highlights firms' need for a diverse stock of human capital. This is supported by an emerging literature which examines more tacit characteristics including managers' capabilities (Fitjar et al., 2013); the individual's creativity in innovation (Storper and Scott, 2009); founders' human capital (Gimmon and Levie, 2010) and leadership's essential role in developing innovation throughout the organisation especially in SME innovation (McAdam et al., 2010).

2.4. Measuring human capital

There is great interest in the problems of measuring human capital (Soboleva, 2010). The difference between human capital as a physical asset and human capital as an intangible asset is at the root of the difficulty of its measurement (Soboleva, 2010). In his seminal work on human capital, Becker (1993)[3] distinguishes between general and specific human capital; general human capital relates to knowledge and skills that are easily transferable, whereas specific human capital relates to knowledge and skills that are less transferable and have a narrower scope of applicability. Becker (1993) also describes the traditional concept of investing in capital as encompassing expenditures on education, training and medical care, thereby producing human capital rather than financial or physical capital. In this regard, it is important to note that some investments (known as specific investments) in human capital do not affect earnings because the costs and returns may be collected by the firm (Becker, 1993).

Hofheinz (2009) has proposed that educational attainment is an effective means of assessing levels of skills in a workforce, where higher skills indicate tertiary attainment or equivalent and medium skills indicate attainment of secondary or equivalent education. He found that employment, earning potential and prospects of further training are higher in all instances for employees of higher skills than for those of lower skills (Hofheinz, 2009). According to Lundvall and Johnson (1994), higher education impacts on innovation in two ways; firstly, graduates can invent and develop new technologies and, secondly, these higher educated graduates can exploit technological progress. In a study of human capital of firms' founders, Ganotakis (2012) found that specific human capital (in the form of specific education and experience including managerial, commercial and technical experience) provided positive contributions to firms' performance and survival. Similarly, in their study of the human capital of firms' founders, Criaco et al. (2013) found entrepreneurial education positively influenced 'university start-up' survival, whereas industry human capital among firms' founders had a negative effect on survival. In the case of firms in the high technology sectors or "research-based" firms[4] and particularly start-ups, Heirman and Clarysse (2004, p. 252) found that such entrepreneurs had a much higher level of education than the average entrepreneurs. Roberts (1991) also found other similar factors among high technology entrepreneurs such as that on average, they had attained at least a Master's Degree and they had similar family background and managerial work experience.

The European Human Capital Index (Ederer, 2006) measures four elements relating to human capital to account for countries' abilities to improve the quality and quantity of its human capital.

[3] Though first published in 1964 we refer to the 3rd ed. (1993) throughout this paper.

[4] Research-based refers to firms that have their own R&D and develop their own products; following the International Patent Classification system, Heirman and Clarysse (2004) aggregate firms into four main classes: Software, Telecom, medical-related and others.

This measure, though useful at the level of the European Union and member states, does not account for the specific individual elements of human capital which may influence the probability of innovation at firm level. The main focus and contribution of the current study is to introduce the concept of IHC to estimate its effect on small firms' innovation. This is important as IHC has the potential to generate a competitive advantage for small firms' innovation.

2.4.1. Tangible elements – the traditional measure of human capital

There is no widely accepted measure of human capital in the literature, though level of education/years of schooling and training have long been considered good proxies (Cohen and Soto, 2007; Romer, 1990). Other measures include industry experience and learning (Santarelli and Tran, 2013) and general and specific human capital (measured by age, gender, parental background and education) (Ganotakis, 2012; Robson et al., 2012). While acknowledging the complexity and challenge of the task of measuring human capital, Teixeira and Tavares-Lehmann (2014) have captured the intensity of human capital by measuring specific human capital as referring to top-skilled workers and general human capital as relating to top-educated workers. They found that, where a firm is foreign-owned, this factor directly impacts on its general human capital (education) and indirectly influences its specific human capital (skills). Investment in human capital is believed to improve the performance of employees (Bosma et al., 2004). Education is a type of 'credential' that indicates greater productivity (Ucbasaran et al., 2008).

The evidence regarding the impact of education on innovation is mixed. An empirical study of Finnish manufacturing firms found that technical skills are the key to profitable innovations (Leiponen, 2005). Equally, Saridakis et al.'s (2008) study of small firms in England found that business owners' human capital (measured by education) promoted firm survival. However, a study of firms in Germany found that the number of highly skilled employees within and across manufacturing sectors was not necessarily positively related to the firms' ability to innovate (Schneider et al., 2010). Furthermore, Stuart and Abetti (1988) found the number of chief executives of new technical firms with an education beyond a Bachelor's degree to be negatively related to firm performance. However, Blundell et al. (1999) found that highly educated and highly-skilled workers adapted rapidly and efficiently to new tasks, thus providing a direct source of innovation.

To encapsulate both the education element of a new IHC concept and capture firm size, we present two hypotheses[5]: the first hypothesis is formulated for small firms (employing less than 50 employees) and the second is formulated for larger-sized firms (with more than 50 employees), hence:

H1(s). Small firms employing managers who have attained a third level education or higher[6] are more likely to innovate

H1(l). Larger-sized firms employing managers who have attained a third level education or higher are more likely to innovate

There is a strong association between higher levels of education and technical training and an increased demand for the supply of technical and organisational innovation (Toner, 2011). Romer (1990) measured human capital by assessing the cumulative effects of formal education and on-the-job training. While the latter can be limiting, it is easily measured. The OECD (2011) suggest an array of skills required for innovation including basic and digital-age literacy, academic and technical skills; however, education and technical skills remain an important prerequisite to innovation. Becker (1993) examined the consequences of investing in a person's knowledge and skills through education and training. He describes capital as, in the first instance, money in the bank or shares in a company, but he adds that schooling and training courses are also investments in the human or the individual. He differentiates between the types of advantage conferred by on-the-job training in terms of general and specific training. According to Becker, general training increases the productivity of the trainee, while specific training can be defined as "training that has no effect on the productivity of trainees that would be useful in other firms" and leads to greater marginal productivity for the firm providing the training (1993, p. 40). Mincer (1962) points out that formal schooling is not sufficient alone as a method of training the labour force, that is, graduation from schooling does not signify the completion of the training process but, rather, the end of a more general and preparatory stage. In a study of firms in Australia, Rogers (2004) found management training had a positive association with innovation for manufacturing firms employing 5–19 people; there was no significance for the larger-sized firm in the same study. Interestingly, Rogers (2004) found management training to be important for larger-sized firms in the non-manufacturing sector. From this evidence, we formulate our next two hypotheses as follows:

H2(s). Small firms employing managers who participate in training are more likely to innovate

H2(l). Larger-sized firms employing managers who participate in training are more likely to innovate

2.4.2. Intangible elements of human capital

There is increasing awareness and debate about the importance of 'soft' skills for innovation (OECD, 2011). The subjective characteristics of the individual have also emerged in the innovation literature recently where, for example, the relationship between innovation and subjective wellbeing is examined (Dolan and Metcalfe, 2012). In the resource-based view of the firm, the performance differences across firms may be accredited to variations in the firms' resources and capabilities where "intangible resources are more likely than tangible resources to produce a competitive advantage" (Hitt et al., 2001, p. 14). The remainder of this section describes the intangible elements that are core to the introduction of the multi-dimensional IHC concept.

Work is an important part of human life and has a strong effect on a person's happiness or satisfaction with life (Binder and Coad, 2013). Job satisfaction is widely studied in the context of organisational behaviour (Zhou and George, 2001). In a study of aggregate job satisfaction and organisational innovation in UK manufacturing firms, Shipton et al. (2006) found that job satisfaction was a significant predictor of innovation: they suggest that employees who experience job satisfaction will support rather than resist innovation. Zhou and George's (2001) research, part of a larger research project on creativity in organisations, examined conditions under which employee job dissatisfaction might lead to creativity. Their study of 149 office employees from a manufacturing firm found that employees who were dissatisfied with their jobs but committed to remaining in their position for various reasons found that they made improvements in their workplace resulting in increased creativity (Zhou and George, 2001). This creativity was further supported where co-workers' feedback and organisational support was high. From the perspective of the theory presented here, we

[5] Rejection of the first hypothesis, for small firms, does not automatically imply the reverse, and therefore, it is necessary to formally estimate for larger-sized firms. This approach is carried out for the other three elements of IHC and is indicated by (s) for small firms and (l) for larger-sized firms.

[6] For the purpose of the current research and given the data at our disposal, we measure education by third level education or higher. This refers to whether the responding employee manager has attained the award of undergraduate (Bachelors) degree or postgraduate degree/diploma (e.g. Masters, PhD) (NCPP, 2009).

capture the first of the intangible elements of IHC in the next two hypotheses:

H3(s). Small firms employing managers who are satisfied in their job are more likely to innovate.

H3(l). Larger-sized firms employing managers who are satisfied in their job are more likely to innovate.

Change is at the heart of innovation (Montalvo, 2006). Hurt et al. (1977) define individuals' innovativeness as their willingness to change. In addition Wang and Ahmed (2004) find that managers' innovativeness lies in their willingness to change and encourage new ways of doing things. In their study of 231 UK firms with more than 50 employees, Wang and Ahmed (2004) identify lack of management capabilities as an obstacle to strategic change on the part of the individual in organisations, along with executives' hesitation to take risks due to the uncertainty of change. Little is known of the issue of willingness to change in small firms and in particular how this willingness to change in turn impacts on small firms' propensity to innovate. From a report on the findings from the NCPP surveys 2003 and 2009, a marked increase in the willingness of employees to accept change was reported (NCPP, 2009). The type of 'changes' addressed in the current research include willingness to increase the level of technology or computers involved in the employees' work; willingness to accept change in levels of skills necessary to carry out their job, and increased responsibility. Hence we formulate the last of our hypotheses:

H4(s). Small firms employing managers who are willing to change are more likely to innovate.

H4(l). Larger-sized firms employing managers who are willing to change are more likely to innovate.

To summarise the theoretical model underpinning this research, Fig. 1 illustrates the connections between the four elements of IHC, both tangible and intangible, in the development of a new and holistic measure of human capital and demonstrates the value it represents to three types of firm-level innovation. The illustration below also includes the corresponding hypotheses presented earlier in the section, as well as the various internal and external control variables outlined in the next section that may impact on firms' innovation.

3. Model and variables

The methodology is divided into two stages. The first stage encapsulates IHC based on tangible and intangible characteristics of managers employed by private firms in Ireland; the second tests the eight hypotheses

3.1. Measuring innovation

Measuring innovation is an on-going challenge; patents and trademarks are commonly used as proxies (Buesa et al., 2010).

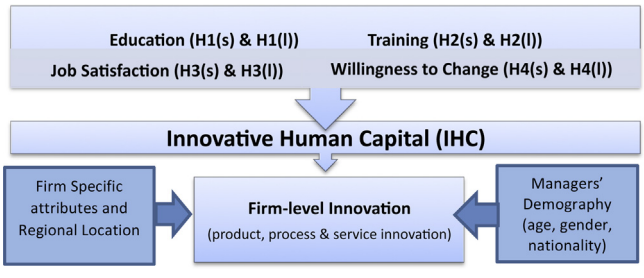

Fig. 1. A framework for the analysis of Innovative Human Capital as a valuable resource and determinant of firm-level innovation.

This type of measurement though easy to quantify is problematic as not all innovations are registered, and not all patents are innovations (OECD, 2011). The survey method of measurement, where respondents are asked about their firm's innovation activity, is increasingly used in research (i.e. Community Innovation Survey (CIS, 2012)). The current research estimates for three types of firm-level innovation. The dataset used in this research provides information on the innovation activity introduced by the firm as follows:

1. Product innovation–introduce a new or significantly improved product
2. Service innovation–introduce a new or significantly improved service
3. Process innovation–introduce innovations in the workplace such as new ideas, processes or behaviours that lead to significant improvements in the way the work is carried out (NCPP, 2009).

3.2. Measuring innovative human capital

IHC builds on the traditional measure of human capital (education and/or training) and adds intangible characteristics including the manager's willingness to accept change and job satisfaction. Appendix provides a detailed list of the survey questions pertaining to each element of IHC. To measure IHC we score each individual manager in each of the four elements. Education is a binary variable (taking a value of one if the manager has a third level education or higher, otherwise zero). Training is also a binary variable: one indicates that the manager availed of training provided by the firm, otherwise zero. The two intangible elements, willingness to accept change and job satisfaction, are an average of the subscale scores.

3.3. Testing the hypotheses

The second stage tests the hypotheses based on an augmented innovation production function, an approach common in the literature (e.g. Love et al., 2011; Roper et al., 2008). The innovation production function to test the eight hypotheses takes the form:

$$\mathbf{Inn_i} = \alpha_{0i} + \alpha_1 \mathbf{Z_i} + \alpha_2 \mathbf{Dem_i} + \alpha_3 \mathbf{RS_i} + \alpha_4 \mathbf{IHC_i} + \mu_i$$

where $\mathbf{Inn_i}$ is the innovation activity of firm_i; the innovation production function estimates for the three types of firm-level innovation; product, service and process innovation. The firm specific variable, **Z**, is a vector of internal firm-specific attributes that may be expected to affect the firms' capacity to innovate. These include sector type (production, financial and other business activities and all other services) and the firm's work practices; the latter controls for the strength of the firm's innovative climate (Johnson, 2011). Creating an innovative firm environment includes the provision of training; ensuring management hierarchy is as unimportant as possible and communicating to employees on innovation activity (Reza Noruzi and Westover, 2010). Firms' work practices used in the current research are captured by a seven question Likert scale with a Cronbachs Alpha of 0.80. This variable includes the firms' willingness to accept risk in order to be innovative and whether the firm encourages employees to work in teams to improve performance (see Appendix for a detailed list of questions for this variable).

The estimation controls for the respondent's age, gender and nationality, denoted as $\mathbf{Dem_i}$. The external effects on firms' innovation are controlled for by the location of the firm $\mathbf{RS_i}$. The research uses the eight NUTS 3 regions of Ireland (nomenclature of territorial units for statistics) with Dublin (Ireland's capital city) as the reference region. Networking and their effects on innovation are more likely to be positive in a capital city or large urban areas as firms in such locations are more likely to innovate as they experience

fewer constraints and lower costs (Forman et al., 2008). The complex combination of resources, industrial structure, specialisation and diversity in capital cities facilitate innovation and productivity growth (De Groot et al., 2007). Agglomeration also enables knowledge creation and spillovers, essential factors for innovation (Pavitt, 2005). Forman et al. (2008) also suggest that the benefits from agglomeration are important among small firms and firms in new industries where specific human capital is still being developed. The main variable for this research is the estimation of Innovative Human Capital $\mathbf{IHC_i}$, on the part of the employee–manager responding to the Irish *National Centre for Partnership and Performance (NCPP)* workplace survey 2009.

A probit estimation regarding the probability of introducing product, service or process innovation is conducted. Probit estimation is appropriate in this instance because the dependent variables are binary, taking a value of one if the firm introduced an innovation during the reference period (2007–2008), otherwise, zero.

4. Data

The empirical analysis is based on the *Irish National Centre for Partnership and Performance (NCPP) 2009 Workplace Survey*. The Workplace Survey dataset provides extensive information on employees' views and experiences in their workplaces as well as firm specific details including innovation activity. In collaboration with Ireland's Economic and Social Research Institute (ESRI) survey unit and Amárach Research,[7] the NCPP conducted two large-scale surveys in 2003 and 2009, compiling data on the perspectives and experiences of a representative sample of employees from the public and private sectors. The 2003 dataset did not contain information on innovation or location and is therefore not used in the current study. The 2009 dataset has in excess of 5000 observations and 200 variables. This sample survey was conducted during March 2009 by telephone. To ensure that all regions of Ireland were represented, the dataset was sorted by area codes; the volume was relative to the area code's representation in the country. The survey was statistically adjusted, in line with all sample surveys prior to analysis. The re-weighted variables included gender by industrial sector, age group and region. The Workplace Survey is not principally concerned with small firm innovation or managers' human capital. However, it offers a large rich variety of information for a representative sample of firms in Ireland.

To obtain our data, we selected only manager/supervisor level employees. This was undertaken by extracting all respondents who best described their job as Senior Management, Middle Management or Supervisor. Leiva et al. (2011) test the innovation implementation model for a similar group (managers and supervisors), as they shape the innovation climate through their supportive actions and attitudes to innovation. For the purpose of the current study, we selected only managers/supervisors from the private sector. This provides us with a dataset of 1129 useable observations. The data is separated to account for small firms (less than 50 employees) and larger-sized firms (greater than 50). These size categories are similar to those used by Hewitt-Dundas (2006) in her study of constraints of innovation for small and larger plants in Ireland. As the theory suggests, firm size impacts on firm level innovation (Hall et al., 2009; Rogers, 2004) and consequently an issue meriting investigation when measuring the impact of IHC on small firm innovation. A description of the data used to test the hypotheses is contained in Table 1.

From the refined NCPP dataset of 1129 observations used to conduct this research, 58% of firms perform product innovations, 57% service innovations; 65% of responding employee-managers indicated that their firms introduced a process innovation during the reference period, 2007–2008. Of the firms who engage in product innovation, 24% employ 5–19 people and 22% employ 100–499 people. The micro-sized firms (1–4 employees as defined by Coronado et al. (2008) and NCPP (2009)) are the least active product innovators at 0.06%, confirming Coronado et al.'s (2008) findings that such firms are too small to undertake R&D and innovation. Process and service innovation showed similar patterns across the firm sizes.

Though the survey asks the participants to describe the main activity of the business where they work, the data provided in the NCPP database use nine groups of *European industrial activity classification* (NACE) codes. For the purpose of this research, firms are grouped into three sectors; production (excluding agricultural related industries) which accounts for 22% of the dataset used; financial and other business activities account for 30% and 'all other services' account for 48%. It should also be noted that a small minority of the total number (7%) of firms are in high technology sectors.[8] The dataset contains 53% of firms with less than 50 employees (small firms). With respect to the small firms, most responding managers are male (60%) and 35% of managers hold a third level qualification or higher; a total of 94% are employed on a permanent basis and 99% as direct employees (1% agency worker). The average age of managers in small firms is 41.5 years with an average of just less than 10 years' service to the firm. In the case of larger-sized firms, 53.1% of managers have attained a third level education or higher and 65.7% availed of training provided by the firm. The majority of larger-sized firms innovate in some form; for example, 58% engage in process innovation, 52% service and 54% product innovation.

With respect to the preparation of the data for the creation of IHC, questions related to job satisfaction and willingness to accept change were extracted. These questions were measured on a Likert scale. Where necessary we reversed scored the items so that higher scores reflect greater levels for all variables. The scales were subjected to both factor analysis and reliability tests. To measure the internal consistency of the scaled questions, a Cronbach's Alpha was used. The Cronbach's Alpha results for job satisfaction was 0.74 (16 questions) and a value of 0.57 (3 questions) for willingness to accept change. Though some may consider the latter below the ideal value of 0.7 (DeVellis, 2003), Schmitt[9] states that there is "no sacred level of acceptable or unacceptable level" (1996, p. 353) and it is common in the literature to find values of below 0.6 (Landry et al., 2001; Song et al., 2011).

The question pertaining to education attainment gives a choice of eight levels of education to capture the respondent's highest level of education completed to date. These scales ranged from none/primary certificate or equivalent (1); some secondary (no exam) (2); Junior/lower second level (3); Leaving certificate/upper second level (4); post leaving course (5); third level (6); postgraduate diploma/degree (7) other (8). To measure the percentage of managers with higher levels of education the question was recoded as a binary variable. This binary variable takes a value of one if the respondent has a third level degree or higher, otherwise zero; training provided by the firm is a binary question in the survey.

[7] Amárach Research are research consultants based in Dublin, Ireland.

[8] High technology refers to an aggregate of NACE Rev2 codes 24, 29–33, similar to Heirman and Clarysse (2004) definition (e.g. medical devices, chemical, and electronics). NACE codes constitute the European industrial activity classification system.

[9] Song et al., (2011, p. 386) cites Schmitt where he states that a "problem in the use of alpha arises from researchers' common presumption that a particular level of alpha (usually 0.70) is desired or adequate... When a measure has other desirable properties, such as meaningful content coverage of some domain and reasonable unidimensionality, this low reliability may not be a major impediment to its use" (1996, pp. 351–352).

Table 1
Descriptive statistics of the data used to estimate the impact of IHC on firms' propensity to innovate.

	Small firm <50 employees $n = 603$ (53%)	Larger firms >50 employees $n = 526$ (47%)
Service innovation (0/1)	51.9%	62.3%
Product innovation (0/1)	54.6%	62.1%
Process innovation (0/1)	58.4%	71.7%
Employee managers with a:		
Second level education or less	35.8%	23.4%
Vocational certificate/diploma	29.1%	23.4%
Third level degree (bachelors degree)	22.4%	32.2%
Postgraduate degree (e.g. masters, PhD)	12.7%	21%
Employee–manager and supervisors' demography		
Average Age	41.5 years	40.5 years
Male respondents	60.5%	67.7%
Irish respondents	82.7%	83%
Average number of years' service to the firm	9.9 years	11.4 years
Sector[a,b]		
Production	15%	31%
All Other Services	60%	34%
Financial and other business activities	25%	35%

Firm size category in the NCPP survey (no. of employees)	NCPP survey
1–4	8%
5–49	45%
50–100	12%
100+	35%

Subscales	Cronbach's alpha
Job satisfaction	0.74 (16 items)
Willingness to change	0.57 (3 items)
Firm work practices	0.80 (8 items)

Source: Data taken from National Centre for Partnership and Performance (NCCP) National Workplace Survey 2009 (Employees).
Data also includes regional dummies.

[a] Of the total number of firms in the dataset (1129 observations), 7% are in high technology sectors. High technology refers to an aggregate by NACE (Rev2) codes 24, 29–33 (e.g. medical devices, chemicals) similar to Heirman and Clarysse (2004).

[b] Broadly based on NACE codes, the NCPP categorises 'Production' by NACE Rev 2C (10–33); 'Financial and other business activities' on NACE codes K–J and 'All other services' includes all other NACE codes (e.g. health, education, mining construction).

5. Empirical results

The results of the probit estimations regarding the probability of firms introducing a service, product or process innovation in small and larger-sized firms are presented in Table 2. The difference between the firm sizes supports Rogers (2004) findings that determinants of innovation may vary between small and larger-sized firms.

5.1. Small firms

The results below reveal that managers in small firms who avail of training provided by the firm have a significantly positive impact on the probability of engaging in all three types of innovation tested. Service and process innovation shows a strong marginal effect of training at the 1% level; the significance of training on product innovation is at the 5% level.

The willingness of the manager to accept change is the other element of IHC to show a significant result: although its effect is not as strong as that of training, willingness to change is found to be positively significant for service innovation (at 10% level), and stronger for product innovation (at 5% level). The benefits small firms gain from managers who partake in training and have a willingness to change may contribute to increased innovative activity.

The control variables are also revealing in the case of product innovation. The managers' age and nationality (being Irish) are both negatively significant at the 5% level. This may suggest that the younger, non-Irish manager in small firms increases the probability of the firm product innovating. The issue of age and firm level innovation has an inverted 'U' shape where a survey of the literature reveals that most inventors are under the age of 40 and older ages' performance gradually level off (Frosch, 2011). On the issue of mobility, the negative significance of being Irish is in line with the findings of McCann and Simonen (2005) that innovation is positively associated with new labour acquired from outside of the sub-region. The location of the small firm as negative marginal effect for firms in the Midlands region of Ireland (at the 10% level) compared to those firms located in Dublin.[10]

There is a mixed result in the case of firm sector. Firms in the services sector reveal a negative significance at the 5% level for product innovation. This negative significance is expected as the services sector by its nature offer services and not physical products, hence the positive significant effect on service innovation at 5% level.[11]

5.2. Larger-sized firms

In the case of larger-sized firms (those with more than 50 employees), the IHC is less significant. Training is positively significant for process innovation (at the 5% level) with all other IHC

[10] As outlined in Section 3.3, the choice of Dublin is based on its status as Ireland's capital city. Additionally, such a location offers agglomeration externalities linked to for example, opportunities for networking, access to research and development centres, business services and large markets (Neffke et al., 2011).

[11] An extra estimation using a dummy variable for firms in high technology sectors reveals similar results to those found for the firm sector control variables. This is expected as high technology firms are captured in the production sector, hence a positive result in the case of product innovation (and a negative one for service innovation. However, as highlighted earlier, it should be borne in mind that high technology firms account for a minority of our observations (7%).

Table 2
Marginal effects on innovation activity for small firms and larger-sized firms (probit model).

Control variables	Small firms < 50 employees		*n* = 603	Larger firms > 50 employees		*n* = 526
	Service innovation	Product innovation	Process innovation	Service innovation	Product innovation	Process innovation
Male	−0.069 (0.043)	0.036 (0.043)	−0.010 (0.043)	−0.018 (0.048)	0.045 (0.048)	−0.014 (0.043)
Age of respondent	−0.0006 (0.001)	−0.006 (0.002)**	−0.003 (0.001)	0.0002 (0.002)	0.001 (0.002)	−0.000 (0.002)
Irish	−0.087 (0.058)	−0.130 (0.058)**	−0.025 (0.057)	−0.001 (0.061)	−0.049 (0.059)	0.001 (0.055)
Firm's work practices	0.167 (0.046)***	0.166 (0.047)***	0.343 (0.049)***	0.204 (0.058)***	0.273 (0.062)***	0.335 (0.055)***
Sector – [production]						
– Services	0.138 (0.067)**	−0.163 (0.067)**	−0.042 (0.065)	0.051 (0.057)	−0.195 (0.060)**	−0.067 (0.056)
– Financial and Business	0.084 (0.073)	−0.087 (0.078)	−0.098 (0.075)	0.060 (0.056)	−0.136 (0.060)**	−0.100 (0.059)*
Regions [Dublin]						
– Boarder	−0.011 (0.079)	0.079 (0.079)	−0.035 (0.081)	−0.195 (0.092)**	−0.157 (0.091)*	−0.017 (0.088)
– Mid-East	−0.060 (0.080)	0.031 (0.083)	−0.044 (0.085)	−0.022 (0.077)	−0.051 (0.076)	−0.035 (0.073)
– Midlands	−0.043 (0.101)	−0.162 (0.095)*	0.003 (0.105)	−0.036 (0.123)	−0.300 (0.126)**	−0.195 (0.140)
– Mid-West	0.011 (0.076)	−0.031 (0.076)	−0.031 (0.078)	0.099 (0.087)	−0.005 (0.086)	−0.128 (0.081)
– South-East	0.040 (0.087)	0.004 (0.088)	−0.136 (0.088)	−0.055 (0.101)	−0.176 (0.099)*	−0.028 (0.093)
– South-West	−0.062 (0.066)	0.070 (0.068)	0.008 (0.065)	−0.684 (0.075)	−0.138 (0.075)*	−0.172 (0.079)**
– West	−0.046 (0.082)	0.057 (0.082)	0.005 (0.085)	−0.025 (0.103)	0.127 (0.097)	0.0712 (0.08)
Four elements of IHC						
Willingness to change	0.069 (0.039)*	0.109 (0.040)**	0.023 (0.040)	−0.031 (0.059)	−0.039 (0.053)	−0.015 (0.044)
Job satisfaction	0.018 (0.082)	−0.024 (0.085)	0.022 (0.082)	−0.073 (0.088)	−0.008 (0.093)	0.005 (0.085)
Third level education	0.011 (0.047)	−0.037 (0.048)	−0.012 (0.048)	0.035 (0.046)	−0.012 (0.047)	0.057 (0.042)
Training	0.199 (0.043)***	0.092 (0.044)**	0.222 (0.043)***	0.080 (0.049)	−0.022 (0.049)	0.104 (0.045)**

The figures are the marginal values with standard errors in brackets. The significance of each marginal effect as noted *** denotes significance at the 99% level, ** 95% level and * at the 90% level.

elements showing no effect on firm-level innovation. Firms in the services sector and financial and other business activities have a negative effect (at the 5% level) in the case of product innovation (where the production sector is the reference). Similar to the case of small firms, larger-sized firms in the services sector offer a variety of services, not physical products, hence the negative significance at the 5% level.[12] The location of the firm, controlled by region, has a more significant effect for larger-sized firms than small firms; four of the eight regions have a negative marginal effect on the probability of product innovation activity. This result may indicate that larger-sized firms in Dublin for instance, are more product innovative than larger-sized firms located in the Border, Midland, South-East and South-West regions of Ireland. Interesting to note, three of these regions, namely, Border, Midland, and South-East regions share a common characteristic of having no university in the region. The proximity to such sources of knowledge spillover and collaboration is important for business innovation (Hewitt-Dundas, 2013). Conversely, McCann and Simonen (2005) found very little support for the argument that cooperation with universities, among other sources of knowledge, plays any role in promoting innovation, in the case of Finland as least.

5.3. *Empirical results common to larger-sized and small firms*[13]

A striking result across all three innovation types is that higher levels of education are insignificant in the estimations. Though striking, considering the emphasis of policy on education for innovation (e.g. European Commission, 2010b), the results from empirical studies are mixed; Schneider et al.'s (2010) research into the skills from a sectoral perspective, based on German micro data, found that educated employees are not necessarily positively related to firms' probability to innovate. Though Romijn and Albaladejo (2002) in their study of small electronics and software firms in southeast England found education, especially higher tertiary education, can contribute to firms' innovative capabilities. Using dummy variables, we estimated the effect of various levels of educational attainment among employee-managers (second level education or less; vocational/non degree type education, and third level degree) and found one minor change; that is, larger-sized firms employing managers with a third level degree only, are more likely to product innovate (although this was a weak significant result – at the 10% level).

The significance of the control variables is dominated by firms' work practices; this variable shows a resoundingly strong positive effect on innovation, regardless of size of firm or type of innovation. This result points to the importance of the firm's innovative work practices and culture in the pursuit of innovation, hence growth (Johnson, 2011).

It should be noted that interaction effects were also explored. Evidence from the literature shows that while the region in which the firm is located impacts on innovation performance (Fitjar and Rodriguez-Pose, 2011), location may also effect innovation inputs (Sternberg and Arndt, 2001). To this end, we examine the interaction between firms' location and the four IHC elements. Similar to Ganter and Hecker (2013) who include interaction effects, we adjust for Ai and Norton's (2003) argument that interactions cannot simply be read using the interaction coefficients. This adjustment entails the calculation of cross derivatives or differences (Ai and Norton, 2003). We include the interaction effect between location and IHC (32 interaction variables in total) in each of the six models, and find that there is no effect across regions. Like regions, firm sector influences the level of innovation performance and may also impact upon innovation inputs (Evangelista and Mastrostefano, 2006). Therefore, we also explore whether there is a sector effect[14] – is there a link between IHC in different sectors and innovation activity? The estimations reveal just one significant interaction effect; the positively significant interaction between training and the services sector may indicate that the likelihood of small services firms to process innovation improves when employee-managers avail of training.

[12] Similar to the estimation for small firms, we conducted an extra estimation using the high technology dummy variable and found no significance to report.

[13] Care was taken to avoid using highly correlated variables in the model. A correlation matrix found very low correlation between variables in the model.

[14] We include the interaction effect between three sectors (production, service and banking and finance) and four IHC elements (12 interaction variables in total) in each of the six models.

6. Discussion

The results of this research contribute to innovation theory and also proffer potentially important policy implications. Firstly, the research adds to innovation theory by introducing the concept of IHC as a competitive advantage for firms and a determinant of innovation, especially for small firm innovation. This is important as the value of individuals' education levels as a competitive advantage may decrease in the future, as the proportion of people with higher education levels increases, particularly across developed economies (CSO, 2012; OECD, 2013). The idea of moving beyond a single measure (usually education and/or training) as a measure of human capital is beginning to appear in the literature (e.g. Fitjar et al., 2013; Ganotakis, 2012; Gimmon and Levie, 2010; Robson et al., 2012; Soboleva, 2010); the results from our research provide additional insights to this debate.

The implication of IHC for public policy generates various issues regarding the introduction of publicly supported innovation programmes and supports, especially in the case of small firms. Creating an enabling environment (both within the firm and the external environment in which the firm operates more broadly) to recognise and embrace IHC as a determinant of small firm innovation is critical. It could be argued that this is particularly the case in the current economic climate where access to finance is increasingly limited (European Commission, 2010a; House of Commons, 2014; Forfás, 2012); most small firms do not conduct R&D (Czarnitzki and Hottenrott, 2011; CIS, 2012) and surviving in business depends on exploiting assets such as knowledge and as a means to increase firms' innovative activities.

The absence of third level education as a significant variable across small and larger-sized firm, and all innovation types in this study has potentially important implications for policy. Though it may make sense, for accountability purposes for example, to invest in tangible and easily measured education programmes to increase human capital, providing more targeted, at times intangible measures such as techniques to increase managers IHC in support of innovation may also be necessary (maybe even more so). This paper follows Ganotakis (2012) call for policymakers and policy-enforcers, especially those responsible for the allocation of financial assistance to firms, to focus beyond high technical skills. The current research suggests policymakers consider incorporating initiatives that encourage the development of IHC intertwined with methods to incentivise and inspire managers to innovate and encourage innovation within the firm.

Current and long standing programmes in support of innovation include innovation vouchers (available in Ireland, UK, Denmark and Netherlands for example), R&D tax credits (available UK and Canada amongst other countries) and programmes in support of networks and collaboration with universities, available in most developed countries. Few innovation focused programmes or policy instruments concentrate on human capital directly, though a number of programmes/frameworks appear to be taking a step in this direction, albeit without focusing sufficiently on the specific intangible elements. Some examples include:

- The UK Government's publicly funded framework, 'Investors in People' is a scheme to improve business through people management (IIP, 2014). Aimed at all firm sizes, the organisation provides guidance, tools and a recognised accreditation to businesses to achieve success through people management.
- The 'Management 4 Growth' programme in Ireland, aims to give management in SMEs the opportunity to develop themselves into highly effective managers who can, through the productivity, innovation and competitiveness of their firm, grow their business internationally (Enterprise Ireland, 2014).
- The European Union's IMP^{3}rove – *European Innovation Management Academy* combines education and research in innovation. With over 450 consultants, the academy provides international benchmarking services, training and certification to SMEs (IMP^{3}rove, 2014).

While Ireland is the focus of this research, the methodological approach adopted and the analysis applied may have a more broad-based application beyond the Irish case by using similar work place surveys. Such surveys have been conducted for example, in Canada, the UK, and are currently in progress in Australia. For example, the Australian workplace survey conducted by the Government's 'Fair Work Commission' (undertaken in 2013–2014) includes themes such as: flexibility arrangements, employee engagement practices, workforce characteristics, communication and consultancy (FWC, 2014), all of which are contained in the NCPP, 2009 survey. The Canadian 'Workplace and Employee Survey' (WES, 2014) conducted annually until 2005, provides information on employees' response to the changing competitive and technological environment using similar topics to the NCPP survey. Meanwhile the UK's 'Workplace Employment Relations Survey' (WERS, 2014) has been undertaken six times since 1980, with the latest 2011 survey completed in June 2012. The key information provided by the surveys includes: family-friendly policies, employment equality, learning and training, and management practices. The 'Employee attitudes in Britain' survey is another UK-based survey producing information on topics such as communication, firms' culture and pay and conditions from over half a million employees (Towers and Watson, 2014). Applying the current study's methodology across different workforces would further advance the development of IHC as a valuable resource for firms' innovation beyond the tangible measures.

The current paper has some limitations that should be acknowledged at this point. The use of secondary data provides us with a large number of usable observations, but provides a limited set of variables. For example, while firm characteristics (e.g. firm sector) are controlled for, due to the limitations of the data available it was not possible to test for the effect of other characteristics, such as firms' age or ownership. Similarly, though the analysis does not include R&D variables (as the data used does not allow for this), the limitations are reduced by the findings of Rammer et al. (2009) that the majority of innovating firms without in-house R&D refrained from R&D activity and have other ways to innovate. In addition, the research does not explore any lagged effects of IHC on firm-level innovation. Prior research shows that the benefits of innovation have a lagged effect (Qi Dong et al., 2012). Using only a single year's data as we do here may not help to fully understand the relationship between innovation and IHC. To fully explore this effect would require longitudinal survey data and corresponding external census data over a similar longer-term period. This would enable an analysis and a tracking of changes of IHC and the effect on firm-level innovation over time. The external census data would allow analysis of the changing regional and national environment and its effect on IHC and innovation.

7. Conclusions

Innovation is a central focus of the growth and recovery of firms and nations (Buesa et al., 2010; European Commission, 2010b; Leiva et al., 2011). Many innovation and human capital studies measure regional and national level innovation activity; for example, the *European Human Capital Index* examines countries' ability to develop and deploy their human capital by measuring

the cost of formal and informal education (Ederer, 2006); and the *Index of Innovation* measures innovation capacity at county and state level in the USA and assesses whether the index measures growth of GDP per worker (Slaper et al., 2011). In the case of firm-level studies, the effect of human capital on firm-level innovation has been limited to a measure of formal education. The current research introduces a new and multi-dimensional concept of IHC to investigate its impact on the probability of firms' innovating. In so doing, we use a large and rich firm-level dataset of employees of firms in Ireland surveyed in 2009. The research extracted data on private firms and respondents at senior and middle management and supervisor level. This yielded a dataset of 1129 usable observations, 53% of which derive from small firms.

The research reveals a variance among firm size and the determinants of firm-level innovation across different firm sizes. There is evidence from the results that IHC may be more valuable to small firms (i.e., less than 50 employees) especially in the case of training and willingness to change. This supports the paper's hypotheses that small firms employing managers who participate in training and are willing to change are more likely to innovate (H2(s) and H4(s)). It also answers the two questions posed by this research namely; does IHC contribute to firm-level innovation and does IHC take effect in small and larger-sized firms differently? We find small firms whose employee-managers have IHC are more likely to engage in service, product and/or process innovation. In the case of larger-sized firms (i.e. more than 50 employees), the findings support hypothesis H2(l), that such firms employing managers who participate in training are more likely to process innovate (in terms of new ideas or behaviours that lead to significant improvements in the way work is carried out).

It should be remembered that the current research introduces a new concept of IHC and will require further empirical research on different types of human capital across all firm sizes (e.g. owner-managers and non-managerial employees in SMEs). Such research would facilitate a more in-depth assessment of the new concept.

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Appendix. Questions from National Centre for Partnership and Performance 2009 Workplace Survey 2009

Education	Which of the following best describes the highest level of education which you have completed to date? 8 options from Primary level to postgraduate and other
Training	Have you received any education or training paid for or provided by your present employer over the last 2 years? Yes/No
Job Satisfaction	Attitudes to work and work issues – (Questions fall into three distinct components JS 1,2 and 3) JS1 in general I am satisfied with my present job I am satisfied with my present job. I am satisfied with my hours of work I am satisfied with my earnings from my current job My Job is secure JS2 I am willing to work harder than I have to in order to help this organisation succeed My values and the organisations values are very similar I am proud to be working for this organisation I would turn down another job with more pay in order to stay with this organisation I feel very little loyalty to the organisation I work for (R) I would take almost any job to keep working for this organisation JS3 My job requires that I work very hard I work under a great deal of pressure I never seem to have enough time to get everything done in my job (R) I often have to work extra time, over and above the formal hours of my job to get through the job or help out (R) My job requires that I keep learning new things
Willingness to Change	Willingness to accept change in workplace over next 2 years – increase in the level of technology or computers involved in your work – increase in the level of skills necessary to carry out your job – increased responsibility for improving how your work is done
Firm's work practices	Statements that might apply to the organisation you work for. – New ideas are readily accepted in my workplace – People in my organisation are always searching for new ways of looking at problems – Customer needs are considered top priority in my organisation – This organisation is prepared to take risks in order to be innovative – This organisation is quick to respond when changes need to be made – My employer encourages employees to collaborate with people in other organisations – This organisation is continually looking for new opportunities in a changing environment – My employer encourages employees to work in teams in order to improve performance

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