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Measuring and Estimating the Impact of *Innovative Human Capital* on Firm Performance: is there a role for public policy?

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1. Introduction

Innovation is a well-recognised determinant of growth in firms, regions and in the economy as a whole, although explaining why (and how) firms innovate remains a challenge for academics and practitioners alike (Montalvo, 2006).

The knowledge-based theory of the firm emphasises the central role of the individual as the source and creator of knowledge (Grant, 1996). Individuals are also key actors in innovation (OECD, 2011; Grossman and Helpman, 1994). Human capital is the aggregation of knowledge and skills (Al-Laham et al., 2011). It promotes growth and development through increased productivity of labour and capital (Mathur, 1999) and is the ‘cement’ that holds “knowledge and innovation systems together” (Soete, 2007, p. 279).

The literature lacks a clear measure of human capital, though education and training have long been used as proxies to measure it (Cohen and Soto, 2007; Romer, 1990). Of late, it has been recognised that the individual’s management capabilities, for example, complement their education attainment (Ganotakis, 2012). There is recent evidence that such capabilities, prior work experience, trust and open-mindedness (in other words, the ‘softer’ elements of human capital) merit examination (e.g. Arvanitis and Stucki, 2012; Ganotakis, 2012; Fitjar and Rodriguez-Pose, 2011).

It is also increasingly apparent that measuring and defining human capital solely in terms of education and training (i.e. its more tangible elements) is too narrow; a more holistic measure and concept of human capital is called for. This novel measure/concept of human capital, which we term *Innovative Human Capital*, includes both traditional (tangible) and the more intangible elements, such as job satisfaction³ and willingness to change⁴. The latter comprise the more innovative aspects of human capital, thus leading to the term *Innovative Human Capital* (IHC).

The prime contributions of this paper can be summarised as follows: firstly, we extend the standard measure of human capital to encapsulate not only tangible but also intangible elements of the individual.

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³ This relates to questions on the respondents’ attitudes to work and work issues, including their satisfaction with their present job, physical working conditions and hours of work

⁴ This relates to the respondents’ willingness to accept changes in their workplace over the next 2 years, including those related to the level of technology or computers involved in their work, increases in the level of skills necessary to carry out their job and increased responsibilities in improving how their job is carried out. This variable is referred to as ‘willingness to change’ throughout the paper.

Such an approach allows us to create a holistic IHC concept. Secondly, we take IHC and estimate its effect on firm-level innovation, as well as identifying the types of firms where IHC currently exists. Thirdly, we use a unique pooled data set to test our eight hypotheses. Finally, the research assesses the implications of our findings regarding the role of public policy. In this regard, our research addresses the questions: Does IHC contribute to firm-level innovation?; What factors affect IHC? and Can public policy promote and support IHC? Our primary concern here is to highlight potential issues and moreover, to stimulate debate on human capital measures and policy options and to promote the debate to explore new directions.

It is important for firms and policy makers to identify the competitive advantage yielded by employees' innovative characteristics as a valuable resource to develop. The role of managers is instrumental in firms' innovation activities; managers make decisions about how to allocate resources, set priorities, and filter ideas (Leiva et al., 2011; Storey and Salaman, 2005). They can also influence workers and encourage and reward innovation and change (Damanpour and Schneider, 2009). Managers are, therefore, key to the study of IHC.

The current paper focuses on Ireland, though we believe that the IHC concept developed, applied and analysed here has broad-based application regardless of country context. That said, we do acknowledge from the outset that as outlined by Fagerberg (2014), due to historical reasons, innovation systems can vary significantly, and that this should be accounted for when designing and implementing policy.

Ireland's present enterprise policy as evidenced *inter-alia*, in the current 'Action Plan for Jobs' focuses on job creation and innovation for growth and recovery (DEJI, 2014). Ireland's innovation performance remains stable with a modest growth rate of 0.7 percent between 2008 and 2012, as recorded in the most recent European Commission's 'Innovation Union Scoreboard' 2013 (European Commission, 2013a). Placed in the 'Innovation followers' group along with Belgium, Austria and UK, Ireland is ranked in the top ten of the EU27 countries with human resources and economic effects (i.e. knowledge-intensive service exports and licence and patent revenues from abroad) being particular relative strengths. In relation to its demography, with a population of 4.58 million (2011), Ireland has a growing proportion of the labour force with a third level degree or higher⁵ (CSO, 2011). From the last population census in 2011, 38 percent of people in Ireland aged between 25-64 years had attained a third level degree or higher, increasing from 25 percent in 1996 (CSO, 2011). This increase in educational attainment is mirrored in other OECD countries; for instance in 2000, the OECD average was 22 percent compared to 33 percent in 2011 (OECD, 2013, p. 38). While PhD graduates represent a small proportion of overall higher education, the rates of PhDs have doubled over the past 15 years (OECD, 2012). This continuous increase in Ireland, supported in part by the availability of free third-level education introduced in the 1990s, may diminish the competitive value of such education in the future; this emphasises the importance of developing IHC.

The remainder of the paper is organised as follows. Section 2 outlines the theoretical framework and provides insights regarding the elements of IHC. In Section 3, external and internal factors driving this novel concept are explained. Section 4 details the data employed in our analysis, explains the stages of our analysis, and concludes with a presentation of our empirical results. Section 5 assesses the

⁵ Third level degree refers to a Bachelors degree or higher. Similar to Bosma et al. (2004) who distinguish between business founders with high education and those less educated, we measure education where employee managers' educational attainment is in terms of a third level/Bachelors degree or higher (and those without). This is similar to what OECD (2013) terms tertiary education, which includes Type A education (largely theory-based programmes including second-degree programmes), and Type B, advanced research programmes (e.g. Ph.D). These categories are equivalent to the International Standard Classification of Education, 1997 (ISCED) Levels 5 and 6)

implications for public policy and answers the question: How useful are existing policy instruments in unleashing the potential of IHC? The section also asks an intrinsically related question: What kinds of changes are necessary in terms of the mix of instruments and policies needed to promote IHC in the future? Section 6 discusses the findings from the research.

2. The theoretical framework – Innovation and Innovative Human Capital

Innovation is of vital importance in developed economies and the links between innovation and growth have long been a topic of research (Kuhlmann, 2001; Simonen and McCann, 2008). Innovation is described as the ‘engine of growth’ in the seminal work of Schumpeter and as the carrying out of new combinations of productive means or ‘creative destruction’ (Schumpeter, 1934). While firms⁶ rely on diverse sources of knowledge including horizontal, backward, forward and in-house linkages for innovation (Roper et al., 2008), the ability to exploit external knowledge is critically important for firm-level innovation (Cohen and Levinthal, 1990). As Grant (1996) suggests, no single multipurpose theory of the firm exists; innovation is “a multi-faceted phenomenon and the translation of theory into actual realization requires an open and flexible structure” (Lambooy, 2005, p. 1146). The theory underpinning the current research rests on a conceptual framework that integrates a diverse set of economic, management and human resource based studies into a single testable model comprising the conditions key to developing IHC as a competitive advantage and determinant of firms’ innovation activity, and hence growth. Such a multidisciplinary approach is warranted in light of the boundary-spanning nature of innovation and, in the context of this paper, the novel concept of IHC.

2.1. Innovative Human Capital

Before conceptualising IHC, we need to look at human capital, the starting point in the creation of the holistic IHC measure. Human capital is shorthand used by economists and other social scientists to refer to skills, knowledge and capabilities embodied in people (Abel and Gabe, 2011); conceptualising such qualities in the workforce of a firm or the population of a country (Blair, 2011) cannot be reduced to a single theory (Blaug, 1976). Classical and neoclassical theorists on economic growth (Schultz, 1961; Teixeira and Fortuna, 2004) paid little attention to the role of human capital as a source of growth. It did not feature strongly in the economic literature until the works of Mincer (1958, 1962), Schultz (1961) and Becker (1964), who developed the concept of human capital as an important input to production and an economic consideration worthy of examination (Burton-Jones and Spender, 2011). Human capital is aptly defined by Rowley, (2001) and Storper and Scott, (2009) as the embodiment of knowledge in terms of the understanding, practices, awareness and creation of tacit knowledge within people. As knowledge increases, so too does the absorptive capacity of both the individual and the firm (Grant, 1996). The 1960s and 1970s saw a growth of interest in investment in human capital which was motivated by the “realization that the growth of physical capital, at least as conventionally measured, explains a relatively small part of the growth of income in most countries” (Becker, 1993, p. 11). Becker’s theory of human capital also distinguishes between firm-specific and general 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 (Ucbasaran et al., 2007). As alluded to earlier, innovation literature traditionally measures human capital using number of years schooling or level of formal education (Cohan and Soto, 2007; Romer, 1990). Authors such as Edquist (2011) outline ten important activities

⁶ For the purposes of this research a firm is defined as a privately owned organisation that produces goods and/or services and employs at least one person.

in innovation systems⁷. These activities include education and training. In the current paper, we also argue (both in terms of our conceptual framework and empirical analysis) that education and training are key elements (tangible) of human capital and in turn determinants of innovation. However, we also argue, that to arrive at a more holistic measure of human capital, there is a need to also add the more intangible elements of human capital (e.g. job satisfaction and willingness to change). It is to these issues that we now turn our attention. As alluded to previously, in line with other studies (e.g. Vinding 2006; Levia et al., 2011), we focus on the employee manager. This cohort of employees are used in several innovation studies: Vinding (2006) selected managers and heads of departments as the most influential in the development process; and Leiva et al. (2011) used managers and supervisors because of their importance for innovation success. Creating, encouraging and maintaining a culture at the level of the firm which promotes innovation is at the core of the arguments we put forward in the current paper.

Though education and training are valuable for innovation, these measures do not capture the intangible elements inherent in the individual. The difficulty of measuring intangible variables is well known (Coronado et al., 2008). This may be part of the reason for the limited empirical analysis (until recently) of human capital beyond education and training. The emerging literature examines more tacit characteristics of human capital: for example, creativity (Storper and Scott, 2008), and work experience (Ganatakis, 2012). Recent literature examining the role of individuals in innovation recognises the importance of what they bring to the firms' innovation activities (Aalbers et al., 2013). Due to the high costs and risk of investment in R&D for growth, firms need to employ their capital to maximum efficiency; this includes human capital already accessible to them (Grossman and Helpman, 1994).

Given the above, we view human capital through a multi-dimensional lens and propose IHC as a valuable input to firms' innovation activity. In developing such a far reaching concept, we draw on the relevant literature to formulate four hypotheses. These hypotheses capture both tangible and intangible elements of the employee-manager. Figure 1 illustrates the combination of the traditional measures of education and training with two more *innovative* elements: the individual's job satisfaction and willingness to change.

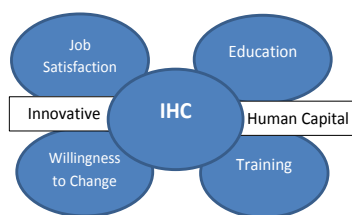


Fig 1: The four elements of the novel *Innovative Human Capital* concept

2.1.1. Formulating the hypotheses related to the creation of IHC

As a starting point in the creation of IHC, the first hypothesis is based on the well-established educational attainment measure of human capital. Formal education, which is the main source of general human capital (Schwerdt and Turunen, 2007), enables a person to acquire the skills necessary to identify business opportunities (Arvanitis and Stucki, 2012) and increases firms' absorptive capacity

⁷ These 10 activities are referred to by Edquist (2011) as the hypothetical determinants of the development and moreover, the diffusion of innovation.

(Goedhuys et al., 2013). Though Stuart and Abetti (1988) found advanced education (i.e. beyond a bachelors degree) amongst chief executives of 52 new technical firms to be negatively related to firm performance, Benhabib and Spiegel (1994) suggest that education as a measure of human capital increases firms' ability to innovate. Becker (1993) considers the concept of investing in capital to include expenditure on education and training to produce human capital as opposed to physical capital. Hence our first hypothesis⁸ is formulated as follows:

H1a: *Firms employing managers with a third level degree or higher in terms of their education attainment are more likely to innovate.*

Investing in (and maintaining) higher levels of human capital is important to firm-level innovation (Al-Laham et al., 2011). Better-trained employees are usually more efficient and develop new skills effectively, an essential part of firm-level innovation (Rennings et al., 2004). Becker (1993) in his seminal work, describes training in two distinct ways: general and specific. The former increases the productivity of the trainee, while specific training is useful only to the firm providing the training. We include the measure of training to capture a second tangible element. Like Gallié and Legros (2012) we measure training financed by the firm for their own employees, thus formulating the second IHC related hypothesis:

H1b: *Firms employing managers who participate in training are more likely to innovate.*

From the resource-based view of the firm, differences in firms' performance may be attributed to variations in their resources and capabilities, and "intangible resources are more likely than tangible resources to produce a competitive advantage" (Hitt et al., 2001, p. 14). One such intangible measure is job satisfaction, or the contentment of an individual with respect to their job (Judge and Kammeyer-Mueller, 2012). The current literature suggests that job satisfaction serves a number of functions for the firm, including aiding knowledge formation and the formulation of strategies for problem solving (Whitman et al., 2010). Whitman et al., (2010) in their meta-analysis, found employee satisfaction to be related to firms' outcomes and, hence, it is important for managers to raise the collective satisfaction levels of employees within the firm. Meanwhile, McKinnon et al., (2003), in their study of manufacturing firms in Taiwan, found that organisational culture, innovation and stability are strongly associated with job satisfaction and information sharing. Shipton et al. (2006) found job satisfaction to be significant for firm-level innovation in that satisfied employees support rather than oppose innovation. Judge and Kammeyer-Mueller (2012) suggest including such measures in any study concerned with the broad topic of job performance. Our third hypothesis is formulated from the above evidence:

H1c: *Firms employing managers who are satisfied in their job are more likely to innovate.*

Change is at the core of innovation (Montalvo, 2006); thus, attitude toward change is an intangible element of interest in creating IHC. Individuals' innovativeness is described as their willingness to

⁸ In order to address firm size, our estimations test for both small (less than 50 employees) and larger-sized firms (50 employees and over). This format is applied equally to the other hypotheses, as is explained in detail in Section 4.

change (Hurt et al., 1977). Managers' positive attitude to change encourages an environment where new ways of doing things are encouraged (Wang and Ahmed 2004; Damanpour 1991). Equally, there is evidence that the level of employees' willingness to change has increased in recent years (NCP Report, 2009). Change, in this context, incorporates various areas, including technology, skills necessary to carry out the job and increasing responsibility. It is assumed that a person's willingness to change influences their adoption or rejection of innovations (Agarwal and Prasad, 1998). Employees' willingness to change routines has a key role for service innovations in particular (Nijssen et al., 2006). These characteristics lead to our fourth hypothesis:

H1d: *Firms employing managers who are willing to change are more likely to innovate.*

While considering the effect of the four elements of IHC on three types of firm-level innovation we examine further the new concept of IHC by identifying the types of firms that employ managers exhibiting elements of IHC. In this regard, we consider the impact of firm and regional factors on IHC.

3. The impact of firm and regional factors on Innovative Human Capital

To further understand the IHC concept, it is necessary to find the conditions where IHC can succeed. Based on the literature, we formulate a further four hypotheses to identify such conditions. These include two regional factors: entrepreneurship activity and workforce diversity; and two internal factors: work practices⁹ and work arrangements¹⁰.

3.1. Factors internal to the firm connected to Innovative Human Capital

The knowledge-based view of the firm describes the firm as an institution that innovates and creates, coordinates and protects knowledge (von Krogh and Wallin, 2011). People, whether individuals or groups, are at the centre of creating a culture to promote innovation. At the level of the firm, the determinants of such organisational culture include: strategies, structures, support mechanisms and behaviours that encourage innovation and communication (Martins and Terblanche, 2003). Published studies on innovation and on human capital identify the absorptive capacity of the individual and of the firm as being of particular importance for innovation (Cohan and Levinthal, 1990). In their seminal work, Cohan and Levinthal (1990) stated that absorptive capacity encompasses not just the sum of the individual contributors but also the capacity of organisations to exploit it. High-involvement firm practices are a growing area of organisational performance literature in the areas of: knowledge sharing and innovation (Camelo-Ordaz et al., 2011) and employee involvement, diversity and innovation (Yang and Konrad, 2011). We capture these employee centred work arrangements to assess, in part, conditions in firms where IHC currently exists. This argument leads us to formulate the following hypothesis:

⁹ Work practices are measured by the extent to which the following statements relate to the organisation where managers are employed: people in the organisation are always searching for new ways of looking at problems; customers' needs are considered top priority; and the organisation is prepared to take risks in order to be innovative (see Appendix 1 for full list of questions).

¹⁰ Work arrangements are measured by, for example, frequency of receiving information from management on plans to introduce new ideas, to change work practices, regarding staff reductions or the use of flexible hours in the workplace, job sharing and regular performance reviews or appraisals (see Appendix 1 for full list of questions).

H2a: *Employee-managers with IHC are more likely to be found in firms with employee centred work arrangements.*

Firms' innovative behaviour (Montalvo, 2006) and attitude to innovation (Coronado et al., 2008) affect employee performance, as well as absorptive capacity and performance of the firm. Based on behavioural science, Montalvo (2006) argues that innovation in firms is attributable to firm-level factors such as entrepreneurial or risk-taking behaviours, organisational learning and capabilities, and institutional arrangements. According to a study by Fitjar et al., (2013) of 1600 firms in Norway, managers with positive attitudes toward innovation and risk-taking were found to be significantly more likely to engage in product innovation. Coupled with firm capabilities such as open-mindedness and collaboration with international markets, these factors promote innovation (Fitjar et al., 2013; Fitjar and Rodriguez-Rose, 2011). The openness of firms to new ideas, teamwork, flexibility and communication are all cited as having a positive effect on innovation (Love et al., 2011; Michie and Sheehan, 2003; Rammer et al., 2009). We use information on firms' innovation-focused work practices to formulate our second hypothesis related to the internal factors connected to IHC:

H2b: *Employee-managers with IHC are more likely to be found in firms with innovation-focused work practices.*

3.2. *External factors connected to Innovative Human Capital*

The spatial context of the firm as a source of knowledge for innovation is a dominant area of study in the empirical literature on innovation, with a focus on, for example, agglomeration (Foreman et al., 2007) and collaboration with firms and organisations outside the region (Fitjar and Rodriguez-Pose, 2011). According to a study of UK service businesses (Love et al., 2011), linkages with alternative types of partners also contribute to different stages of innovation, including knowledge sourcing, knowledge transformation and knowledge exploitation. As noted by Roper and Love (2006), it is important to study the availability of knowledge and the characteristics of the local labour market.

The term 'diversity' refers to differences existing between individuals (Hubbard, 2004). When people think differently, with different perspectives, diverse workforces can improve innovation activity (Bassett-Jones, 2005). Research suggests that diversity in the labour market is associated with greater creativity (Florida, 2002). In the case of local workforce diversity, variations in nationality and education have positive effects on product innovation although educational diversity is negatively significant for process innovation (McGuirk and Jordan, 2012). In terms of providing sources of knowledge, McGuirk and Jordan (2012) also found that greater levels of diversity in the local labour force and greater levels of internal human capital may be substituted for each other. While diversity can create barriers to communication, higher levels of diversity can weaken such barriers (Blau, 1977). Hence, the following hypothesis:

H3a: *Employee-managers with IHC are more likely to be found in firms located in regions with higher workforce diversity.*

Based on knowledge spillover theory, Carree and Thurik (2010) have suggested that the results of entrepreneurship at firm level generally relate to innovation. Hence, a further possible source of

knowledge is entrepreneurship (Silverberg *et al.*, 1988). Furthermore, Audretsch *et al.*, (2010) suggest that entrepreneurs who establish and run new businesses are essential to the economy as they tend to be interactive people who depend on people, resources and opportunities to succeed. Acs and Armington (2004) found that the impact of knowledge externalities from entrepreneurial activity was strongly associated with faster growth of the local economy. Our research captures this possible source of knowledge by measuring the level of regional entrepreneurship activity. From these findings, we formulate our final hypothesis:

H3b: *Employee-managers with IHC are more likely to be found in firms located in regions with higher entrepreneurial activity*

The current model of analysis contains a broad variety of explanatory variables, although it is certainly not an exhaustive list. There are a number of variables not addressed directly in the hypotheses but which may be expected to impact on IHC. These are controlled for in our estimations, which include proxies for R&D¹¹, population density, firm sector and managers’ demography. Population density captures possible agglomeration spillover effects in the region (Simonen and McCann, 2008), while R&D is a measure of innovation input and increases firms’ absorptive capacity (Goedhuys *et al.*, 2013). Firm sector captures whether firms are engaged in production, financial and other business activities, or other services¹².

Figure 2 provides an overview of the conceptual framework of the current research. It illustrates the effect of IHC on firms’ innovation, the internal and external factors promoting IHC and the role for public policy (if any). The framework indicates the two stages of analysis used to test the eight hypotheses tested in this paper.

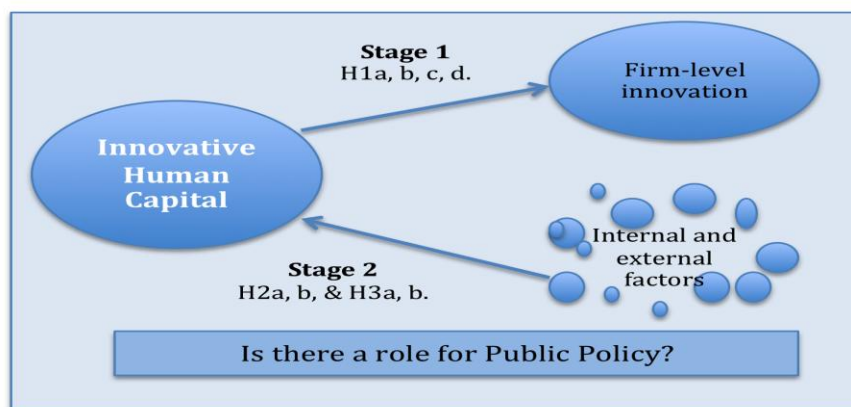


Fig 2: A framework for the study of Innovative Human Capital

¹¹ We use firms’ innovation activity as a proxy for firm-level R&D while, for regional R&D we use the number of firms with R&D activity. We explain these proxies in detail in Section 4.

¹² Production/Manufacturing is categorised by NACE codes C (10-33); ‘Finance and other business’ activities broadly based on NACE codes K-J. and ‘other services’ broadly based on all other NACE codes (e.g. education, health, construction,). NACE codes are the European industrial activity classification (NACE Rev. 2) (CSO, 2014).

4. Estimating the research hypotheses – data, methodology and results

To test the eight hypotheses, our analysis employs a two-stage process: the first stage estimates the impact of IHC on three types of firm-level innovation (product, process and service innovation), which address hypotheses H1a, b, c, d. The second stage of the analysis estimates the internal and external factors associated with IHC which address hypotheses H2a, b and H3a, b.

This section initially describes the four datasets used to create the new pooled dataset which is then discussed in detail. The latter is followed by a discussion of the methodology used to estimate the two stages. Finally, a description of the results for the multiple regressions is provided.

4.1. *Source of data used to create the new pooled dataset*

Four datasets were pooled using the common identifier of the NUTS3¹³ regions: Ireland's National Centre for Partnership and Performance (NCPPI) Workplace Survey 2009¹⁴; Ireland's Central Statistics Office (CSO) *Population Census* data (2006), *Global Entrepreneurship Monitor* (GEM) 2008 National Report (Fitzsimons and O'Gorman, 2009), and the *Irish Innovation Panel* (IIP) dataset (provided by Roper, Hewitt-Dundas and Love).

Source of individual and firm-level variables: The NCPPI is used in this research to provide information on individual employee-managers' working for private firms in Ireland in 2007 and 2008. Although the NCPPI Report (2009) dataset is not principally concerned with firm-level innovation, the survey offers a large and rich variety of information on a nationally representative sample of employees in Ireland. The use of this large dataset provides extensive information on the views and experiences of employees (including job satisfaction, their willingness to change, education and employment status) as well as firm-specific details including innovation activities, work practices and regional location. Constrained by the firm size categories used by NCPPI 2009, the current research divides the data into two firm sizes¹⁵: small firms, with less than fifty employees, and larger-sized firms, employing fifty employees or more.

The current research focuses on private firms in Ireland, since these are the main sources of innovation and job creation (NCPPI Report, 2009; DEJI, 2012). For this reason, in preparing the NCPPI dataset we extracted the data where respondents identified themselves as senior or middle management or supervisor employed in the private sector. The role of managers in the innovation process is an important one. Unlike with physical capital, it is not possible to accumulate and distribute knowledge and expertise to those projects that yield positive outcomes for the firm; instead, this type of capital resides in the minds of individuals in the firm and, therefore, managers promote individuals' levels of expertise and initiative-taking (Bartlett and Ghoshal, 2002). A positive and motivating mindset is required of managers if they are to encourage innovation (Hotho and Champion, 2011). Managers are vitally important as they are the ultimate decision-makers in many features of innovation. In particular, they set the tone of the firm and constitute the gatekeepers who determine the fate of innovation activity in the firm (Storey and Salaman, 2005).

¹³ NUTS3 is the Nomenclature of Territorial Units for Statistics use by the European Commission. Ireland has eight regions at this level.

¹⁴ The NCPPI include employees only – not the self-employed.

¹⁵ The size categories are determined by the available data and are similar to those used by Hewitt-Dundas (2006) in her study of constraints of innovation for small and larger plants in Ireland.

Sources of regional variables: Ireland's Central Statistics Office (CSO) Census of Population 2006 – Sample of Anonymised Records (COPSAR) is a sample of the population census taken for the first half of 2006. A census of the population in Ireland is taken approximately every five years; 2006 was selected as it was the closest to the NCPP 2007-2008 reference years. COPSAR is a five percent sample (212,006 observations and 38 variables) relating to persons within households anonymised by stripping all identifiable information. The census data supplies information on individuals at a county¹⁶ level; due to the supply of firm-level data at the NUTS3 level only, the census data is grouped according to the NCPP regional level, which roughly equated to the NUTS3 level¹⁷. In order to capture the entrepreneurship activity of a particular region in Ireland, this research uses information published in the Global Entrepreneurship Monitor 2008 Country Report for Ireland (Fitzsimons and O’Gorman, 2009, p.42). ‘Entrepreneurship in the Regions’ (at NUTS3 level) provides information for 2004-2008. To present a complete picture of the regional influences that may be connected to IHC, it is necessary to control for R&D. The IIP dataset comprises data from 6 surveys or waves using similar methods and questions, which captured information from manufacturing firms on the island of Ireland from 1991-2008. The current research uses R&D information from waves 3-6 for the Republic of Ireland.

4.2. *Description of the data used in the analysis*

The pooled dataset provides 1070 observations (562 small and 508 larger-sized firms) and reveals that during the reference period 2007-2008, 58 percent of firms performed product innovations, 57 percent service innovations, and 65 percent process innovations. Of the employee-managers, 43.5 percent had a third level degree or higher; the average age of a manager was 41 years. The data contains 65 percent male employee-managers, and 83 percent of respondents indicated that they were Irish born. Approximately 30 percent indicated that they worked for a banking/finance organisation; 22 percent worked for a production firm. Of the total number of observations, 82 (7%) were high technology firms¹⁸. A total of 56 percent availed of training provided by their employing firms, with a further 37 percent indicating that they were satisfied in their jobs. At the level of the firm, 71 percent of firms captured in the dataset provided regular performance reviews or appraisals to employees. This varies across firm size; for instance, 85 percent of larger-sized firms (>50 employees) offered this work arrangement compared to 61 percent in small firms. The frequency of receiving information from management was measured by a 7-item Likert scale with a Cronbach’s Alpha of 0.8, on which nearly 50 percent of respondents indicated that they received information on a ‘regular basis’ with 19 percent ‘hardly ever’. (This question is a component of the measure of firms’ work arrangements.) On statements related to the firm, 89 percent of responding managers indicated that firms encouraged employees to work in teams in order to improve performance. In the 8-item Likert scale (a Cronbach’s Alpha of 0.8), 91 percent of managers indicated that their firm positively considered customers’ needs as top priority (this question is one component of the measure of firms’ work practices). Table 1 presents a description of the data used to test the eight research hypotheses and is described in more detail in the next section.

16 The Republic of Ireland has 26 counties.

17 With the exception of the South East and Mid-West regions; in the NUTS3 the county of North Tipperary North is included in the Mid-West and Tipperary South in the South East regional. NCPP includes both Tipperary North and South in the Mid-West regional. For the purpose of this research, we follow the NCPP regional, referred to as NUTS3.

18 High technology refers to an aggregate of NACE Rev2 codes 24, 29-33, similar to the definition provided by Heirman and Clarysse (2004) (e.g. electronics, medical devices and chemicals). NACE codes constitute the European industrial activity classification system.

Table 1: Summary of variables used to estimate the effect of IHC on firms' innovation and the external and internal factors promoting IHC.

Codes used in equations 1 & 2	Variables	Dimension	Value
<i>Inn</i>	Innovation		
	- Product (1/0)	Firm	58%
	- Process (1/0)		65%
IHC ¹	- Service (1/0)		57%
	Education ² (1/0)	Individual	43%
	Training (1/0)		56%
	Job satisfaction		37%
<i>Ext</i>	Willingness to change		89%
	<i>Explanatory variables</i>		
	Entrepreneurship activity	Regional	Regional Average
	- Informal investment		10%
	- Early stage		8.1%
	- Expected to start		2.8%
			Blau Index
<i>Int</i> ¹	Diversity in nationality	Regional	0.31
	Diversity in education		0.78
	Work arrangements (i)		
	- Provide flexible hours (1/0)	Firm	49%
	- Provide regular reviews/appraisals (1/0)		71%
	Work arrangements (ii)	Firm	Cronbach's Alpha
	- Receiving information		0.8
- Consultation		0.8	
- Pay & conditions		0.6	
C	Work practices	Firm	0.8
	<i>Control variables</i>		
	Managers' ³ age (average)	Individual	41 years
	Managers' ³ nationality (Irish)	Individual	83%
	Managers' ³ gender (male)	Individual	65%
	Sector	Firm	
	- Production		22%
	- Banking/finance & other businesses		30%
	- Other services		48%
	Regional R&D (in-house R&D)	Regional	52%
Firms' R&D (innovation activity)(1/0)	Firm	82%	
Population density	Regional	Regional Average	
		63 per km ²	

Source: NCPP (2009); CSO (2006); Roper, Hewitt-Dundas and Love (2010); Fitzsimons and O'Gorman (2009).

¹See Appendix 1 for questions related to variables. ²Education refers to Bachelors degree and higher. ³ Refers to employee-managers..

4.3. Estimating the effect of Innovative Human Capital on Innovation - Stage 1

Our first estimation addresses the effect of IHC on three types of firm-level innovation (product, service and process innovation) for small and larger-sized firms; hence we estimate a total of six logit models. The equation takes the form of:

$$\mathbf{Inn}_i = \alpha_0 + \alpha_1 \mathbf{Z}_i + \alpha_2 \mathbf{Dem}_i + \alpha_3 \mathbf{RS}_i + \alpha_4 \mathbf{IHC}_i + \boldsymbol{\varepsilon}_i \quad [1]$$

where \mathbf{Inn}_i is the measure of innovation activity of firm $_i$; the firm specific variable, \mathbf{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, business & finance activities, and all other services) and the firms' work practices. \mathbf{Dem}_i controls for the employee-manager's age, gender and nationality, while the external effects on firms' innovation are controlled for by the location¹⁹ of the firm \mathbf{RS}_i . The main variable in this part of the analysis is the estimation of Innovative Human Capital \mathbf{IHC}_i on the part of the employee-manager, a description of which follows.

Description of variables used to create and analyse IHC

As outlined previously, The holistic concept of IHC is composed of four elements: education, training, willingness to change and job satisfaction. Questions related to job satisfaction and willingness to change are measured on a Likert scale in the NCPP survey. Where necessary, we reverse-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 willingness to change had a value of 0.57²⁰ (3 questions). We recode the education variable as a binary variable taking a value of one if the respondent has a third level degree or higher, otherwise zero²¹; training provided by the firm is a binary question in the NCPP survey.

4.4. *Estimating the effect of internal and external factors on Innovative Human Capital – Stage 2*

The second estimation in this research, similar to the methodology used by Rammer et al. (2009) and Ganotakis (2012), uses a series of logit regressions in which IHC of responding managers employed by firms in Ireland is the dependent variable. Four models are estimated for both small and larger-sized firms to capture the effect of the internal and external factors that may influence IHC, giving a total of eight logit models. The equation is given as follows:

$$\mathbf{IHC}_i = \alpha_0 + \alpha_1 \mathbf{Int}_i + \alpha_2 \mathbf{Ext}_i + \alpha_3 \mathbf{C}_i + \boldsymbol{\varepsilon}_i \quad [2]$$

where \mathbf{IHC}_i refers to firm i 's Innovative Human Capital and four different dependent variables denote the four elements of IHC. The use of multiple dependent variables is similar to the methodology employed by Fitjar and Rodriguez-Pose (2011). Model 1 measures level of education; Model 2 measures firm-provided training availed of by employee-managers; Model 3 job satisfaction; and Model 4 willingness to change.. To measure IHC, we score each individual employee-manager in relation to each of the four elements. That is to say, if the employee-manager has a third level degree or higher; has availed of training provided by firm i ; is willing to accept change in the workplace, and has indicated that he/she is satisfied with various aspects of his/her job, all take the value of 1, otherwise 0. The first variable of interest in equation [2] comprises the internal (\mathbf{Int}) factors covering firms' (a) work practices and (b) work arrangements. The second independent variables of interest comprise the external (\mathbf{Ext}) factors that may influence IHC: (a) regional workforce diversity and (b) entrepreneurship activity in the region. The model also includes a vector of controls (\mathbf{C}) that may be expected to affect IHC, a description of which follows.

¹⁹ The effects of regional entrepreneurship and diversity were tested with no statistical significance to report.

²⁰ Though some may consider the latter below the ideal value of 0.7, Schmitt (1996, pp. 351-352) states that there is "no sacred level of acceptable or unacceptable level of alpha". It is common in the literature to find values of below 0.6 (Landry et al., 2001; Song et al., 2011).

²¹ We also estimated (using dummies) the effect of respondents with an undergraduate or Masters degree only and those with a PhD degree, compared to those with no tertiary education, with no significance to report.

Description of variables causally connected with IHC - Internal factors (Int)

Under the broad heading of *work arrangements*, this measure of firms' work arrangements captures: the source and frequency of information received by the responding employee-manager, and whether the firm: adopts flexible working hours; provides a bonus/share scheme as part of pay and conditions; and is involved in regular review and appraisals of employees. The second internal factor measures firms' work practices and includes questions on the firm's readiness to accept new ideas in the workplace. It also captures whether customer needs are considered a top priority and whether an employer encourages employees to work in teams in order to improve performance. Such variables measure the strength of the firm's innovative climate (Johnson, 2001); in this case a 7-item Likert scale was used with a Cronbach's Alpha of 0.8. Appendix 1 provides details of the questions used in the analysis.

Description of variables causally connected with IHC - External factors (Ext)

The first of the external factors captures the diversity of the local workforce. Similar to McGuirk and Jordan (2012), this research uses a Blau Index (Blau, 1977) of heterogeneity to calculate diversity in the local workforce, and is formulated as follows:

$$D = 1 - \sum P_i^2$$

where **D** is diversity and **P_i** is the proportion of the total population from the group *i*, with *i* being the number of labour market-related categories represented in the population. The index measures the probability that two people chosen at random from the sample population will differ vis-à-vis educational attainment and nationality (Blau, 1977). The diversity of educational attainment assesses five levels of education attainment, from primary to postgraduate level. If the entire sample is in one category, (e.g. all have a third level degree or higher) the Blau index will equal 0, whereas, if they are spread evenly across all categories, the Blau will equal 1. Ireland's level of diversity in education ranges from a Blau score of .76 in the Border region of Ireland (its lowest) to a high of .83 in the Mid-East region. The level of diversity of nationality is measured in four groups; results reveal that nationality is less diverse than level of education. This is not surprising in Ireland's case; non-Irish nationals constituted five percent of Ireland's population in 2002, but increased by 143 percent in 11 years to comprise over 12 percent of the population in 2011 (CSO, 2014)²².

The second external factor is entrepreneurship²³ activity in a region, which is measured using information from the Global Entrepreneurship Monitor (GEM) 2008 Report (Fitzsimons and O'Gorman, 2009, p. 42). The GEM's 'Entrepreneurial Activity by Region (2004-2008)' measured at the NUTS3 level, includes details on the percentage of adults expected to start a business in the next three years, total early stage entrepreneurs, and informal investment activity, all three of which are used in the current analysis.

Although stage two of the analysis focuses on the effect of firms' internal and external factors on IHC, it is necessary to control for other factors that can be expected to influence IHC. Empirical research shows that R&D cooperation (Simonen and McCann, 2008) and R&D intensity (Gallié and Legross, 2012) are positively significant for innovation. As alluded to earlier, the current research is constrained by the availability of R&D data; therefore the model relies on the use of proxies. To measure firms' R&D we use innovation activity, and in the case of regional R&D, the level of in-house R&D in

²² The diversity in age and gender of the workforce were also calculated, with minor degrees of diversity found across the eight regions.

²³ Entrepreneurship "tends to be associated with economic development and well-being of society" while entrepreneurs are ambitious, innovative, contribute to productivity and job creation (GEM, 2013, p16).

manufacturing firms in the region. The demography of the employee-manager is also controlled for in the estimations: age, gender (male) and nationality (being Irish) of the manager.

4.5. Results from estimating equations [1] and [2]

Results from multiple logit regressions of equation [1] reveal a difference between small (less than 50 employees) and larger-sized firms (more than 50 employees). *IHC in small firms – training* is positively significant at the 1 percent level for service and process innovation. The intangible element of *willingness to change* is a positively significant factor for product and service innovation. *IHC in larger-sized firms - training* is positively significant for service and process innovation at the 10 and 5 percent levels respectively while education is positively significant (at the 5% level) for process innovation. The results provide evidence that IHC may be more valuable to small firms, especially in relation to training and willingness to change. The absence of a statistically significant result for job satisfaction is unexpected. The results for education is surprising at first glance but adds to the debate in the literature around human capital and education. In relation to the control variables, firms’ work practices have a strongly positive significance on all the three types of innovations, across small and larger-sized firms. The employee-managers’ age and being Irish are both negatively significant (at the 5% level) in the case of product innovation. Being Irish, also has a negative effect on service innovation in small firms, while age has a negative significance in the case of process innovation in small firms. This may suggest that the younger, non-Irish managers employed in small firms increases the likelihood of firms innovating. Table 2 presents a summary of results from equation [1]. A full table of results is presented in Appendix 2.

Table 2: Summary of results from estimating equation [1]

	Small Firms < 50 employees			Larger Firms > 50 employees		
	Service Inn.	Product Inn.	Process Inn.	Service Inn.	Product Inn.	Process Inn.
Job Satisfaction						
Willingness to Change	+	+				
Training	+		+	+		+
Education						+

Note: Positively significant results are indicated by (+), where * at the 0.10 level, ** at the 0.05 level and *** at the 0.01 level.

There are mixed results from the estimations of equation [2], in terms of identifying which type of firms employ managers with the various different elements of IHC. For the purposes of clarity, this section details the results for each of the four models (summary presented in Table 3 and detailed results in Appendices 3a and 3b). **Model 1** – (where education is the dependent variable), the external variables measuring entrepreneurship activity (*informal investment*) was found to be statistically significant at the 5 percent level in the case of those employed in larger-sized firms. In terms of internal factors, both *flexible working hours* and *regular performance reviews or appraisals* were found to be positively significant in both small and larger-sized firms (at the 5% and 10% level respectively). The results for firms’ work arrangements, particularly for level of *consultation* experienced in the workplace, is positively significant at the 10 percent level for larger-sized firms. The logit estimations showed that population density of the region was negative (at the 5% level) compared to Dublin (the capital of Ireland, with the highest population density in the country); this is consistent with the negative or insignificant results in Simonen and McCann’s (2008) study on the impact of mobility of human capital

on innovation. Being Irish also returned a negative result, at the 5 percent level, for both small and larger firms; this result could be likened to the finding of Simonen and McCann (2008, p. 153) that “human capital inputs acquired locally are never positively related to any form of innovation”. The same authors found that labour acquired from other regions with specific experience may be important for particular innovations. In other words, we find that managers with a third level degree or higher are more likely to be employed in firms that provide *flexible working hours and regular reviews*. Meanwhile, larger-sized firms that facilitate *consultation* between management and employees are more likely to employ managers with a third level degree or higher. In addition, employee-managers with such levels of educational attainment are more likely to be employed in larger-sized firms located in regions where *entrepreneurship activity* is present, particularly *informal investment*.

In **Model 2** where training was the dependent variable, the external factors of regional diversity or entrepreneurial activity were found to be insignificant. In the case of internal factors, firms’ *work practices* and provision of *alternative pay and conditions* were both positively significant at the 5 percent level for larger firms; the pay and conditions variable was positively significant for small firms (at the 5% level). The latter variable captures various types of share options, bonus schemes and non-monetary performance incentives as part of pay and conditions. With regard to the control variables, the level of innovation activity of firms (the proxy for firm-level R&D) had a strong positive significance in relation to the likelihood of employee-managers to avail of training in small firms; this result is unique to training (Model 2). To summarise the findings from Model 2, we find managers who avail of training are more likely to be employed in larger-sized firms that provide such *work practices* as measured in the current research. This is also the case for those firms (small and large) that offer *alternative pay and conditions* to employees. The benefits acquired by a firm from providing such *work practices* and *pay and conditions* include the training availed of by employee-managers (an element of IHC), which may, in turn, contribute to increased innovation.

In the case of job satisfaction (**Model 3**), the first intangible element of IHC, the indications are that this element is most affected by firms’ internal factors. For larger-sized firms, *work practices* and *work arrangements* (specifically *consultation* and *pay and conditions*) are positively significant (at the 1%, 1% and 5% levels respectively). The only negatively significant result for internal factors across all eight estimations is found for *frequency of received information* in the case of small firms (at the 5% level). The two other internal factors that are significant in the estimation for small firms are *work practices* and *consultation* (at the 1% and 5% levels respectively). In other words, we find employee-managers who are satisfied in their jobs are highly likely to be employed in firms that provide such *work practices* as measured here and facilitate *consultation* between management and employees. Small firms that offer *frequent information* to their employees are less likely to employ managers who are satisfied in their jobs. Small firms located in regions with *diverse nationality* are more likely to have satisfied employee-managers. Larger-sized firms that provide *alternative pay and conditions* are more likely to employ managers satisfied in their job. These findings indicate that, to ensure job satisfaction among employee-managers, firms should, in most cases, provide innovative *work practices* and certain human capital focused *work arrangements* highlighted here.

In **Model 4**, where willingness to change is the dependent variable, the results show statistical significance for larger-sized firms only. The estimations reveal that diversity in nationality of local workforce and work arrangements (providing regular performance reviews or appraisals) are both positive at the 5 percent level. Therefore, employee-managers who demonstrate willingness to change are more likely to be found in larger-sized firms that offer *regular reviews and appraisals* to employees. Again, larger-sized firms located in regions with *diverse nationality* are more likely to have employee-

managers who are willing to change.

Overall, the findings suggest that firms that provide *work practices* and *work arrangements* such as those addressed in the current research are more likely to employ managers manifesting the different elements of IHC, which is, in itself, a determinant of innovation. In limited cases, a firm's location is also a supporting factor for IHC, particularly for those located in regions with diverse labour forces with respect to nationality, and where informal investment for entrepreneurs occurs. These results could potentially have implications for public policy and hence are explored in the next section.

Table 3: Summary of results from estimating equation [2] to identify the type of firms who employ managers with the different elements of IHC

Selected Variables from Eq [2]	Model 1 Education		Model 2 Training		Model 3 Job Satisfaction		Model 4 Willingness to Change	
	Small	Larger	Small	Larger	Small	Larger	Small	Larger
<i>INT</i> – internal factors								
Work practices				+**	+***	+***		
Work arrangements					- **			
- Frequency of information								
- Consultation		+			+**	+***		
- Flexible hours	+**	+						+**
- Regular review/appraisals	+**	+						
- Pay & conditions			+	+		+**		
<i>EXT</i> – external factors								
Ent'ship activity		+						
- Informal investment		+						
Diversity - Nationality					+**			+**

Note: –Positively significant results are indicated by (+), negatively (-), where * at the 0.10 level, **at the 0.05 level and *** at the 0.01 level.

5. Is there a role for policy in support of Innovative Human Capital?

As aptly summed up by Kuhlmann (2014), innovation is shaped by both institutional contexts and public policy. It is to the public policy aspect that we now turn. Having found that IHC contributes to firm-level innovation, and that internal and to a lesser degree external firm factors influence IHC, this section examines the role of public policy in its promotion and support. We also consider two related questions: how useful are existing policy instruments in unleashing the potential of IHC, and what kinds of changes are necessary to promote IHC in the future? By supporting IHC, firms can unleash a valuable resource available to contribute to their innovation activity. Is there a role for public policy in supporting this holistic determinant of innovation, or should it be a concern for firms alone? Perhaps the optimal solution lies in a combination of both private and public sector interventions. To operationalise and study the IHC concept at a policy level, we use the innovation policy landscape in Ireland as our laboratory, with the view that many of the issues we unravel here have the potential to demonstrate broad-based applicability regardless of country context (bearing in mind the caveat as outlined from the outset of the paper when referring to the work of Fagerberg 2014). Additionally, from the outset when making policy suggestions (as we do below), we do not assume the "...unproblematic and straightforward translation of these into the formulation of innovation policies (Flanagan et al., 2011, p.704).

5.1. Justification for public policy support for innovation

Innovation policy is concerned with the arrangements made by public institutions that influence

innovation activities (Edquist, 2011). Such policies (offered by all OECD countries) are required to address the wide range of complex issues surrounding innovation (Lundvall and Borrás, 2009), and are described as the public intervention supporting the “generation and diffusion of new products, processes or services” (Edler et al., 2013, p. 4).

In a market economy, public policy intervention is necessary where “private organizations must prove to be unwilling or unsuccessful in achieving the objectives formulated; a problem must exist” (Edquist, 2011, p. 1741). In this context, Edquist (2011) defines a ‘problem’ as being, from a policy perspective, the low performance of the innovation system. Where such problems occur, governments fund projects to compensate for market failure and to reduce uncertainty (Gök and Edler, 2011).

In providing public support for innovation, governments correct for the inherent tendency of markets to produce inefficient knowledge and information (Metcalf, 2005). Most market failures reflect a mismatch between private and social benefits (Warwick, 2013); for example, publicly-funded financial assistance for firms is normally justified when markets fail to meet a standard of perfect competition. This failure is referred to as a market failure (Lenihan and Hart, 2004).

Over time, there has been a move in focus from concentrating solely on market failure to also a concern with systemic failure resulting to a large extent in a changed rationale for intervention (e.g. Laranja et al., 2008 and Gustafsson and Autio, 2011). The Systems Innovation (SI) and National Systems of Innovation (NSI) approaches, involve complex and non-linear information exchange mechanisms which determine the success of innovation (Woolthuis et al., 2005; Edquist and Hommen, 2006). Woolthuis *et al.* (2005) argue that in the case of SI, systems failure is synonymous with the rationale for government interventions, although the same authors categorise this type of failure and present a framework that “enables a clear-cut distinction between the different forms of system failures and the actors that should be involved to address these failures” (p. 618). These failures include infrastructural, institutional and capabilities failures (particularly relevant to HC and IHC), while the actors comprise demand entities (consumers and large buyers), firms, knowledge institutes and third parties (banks, venture capitalists, intermediaries and consultants). The systems failure theory views governments as concerned not only with markets but also with “improving the institutional set up and opportunities for constructive non-market interactions that better encourage preferred innovation paths...” (Bleda and del Río, 2013, p. 1040). Warwick (2013) explains systems failure as arising from the interactions between institutions that generate the learning and operating environments for firms. Institutional failure relates to problems with the formal written laws governing an institution; soft institutional failure (most relevant to the study of IHC) refers to problems inherent in the culture and values that shape a firm (Woolthuis et al., 2005). Carlsson and Jacobsson (1997) refer to soft institutional failures as relating to failures of the culture, laws and customs of a country or region. This definition could equally refer to the soft failures of firms: in this context, such ‘soft’ failures can obstruct innovation (Woolthuis et al., 2005).

5.2 *Policy programmes and instruments driving innovation.*

According to Smits and Kuhlmann (2004), policy instruments are increasingly systemic. This would seem like a natural development given that as outlined above, there has overtime been a move away from overcoming market towards overcoming systemic failures. Additionally, there has been a concern with overcoming ‘blocking mechanisms’ in innovation policy analysis and studies (Bergek et al., 2008). Throughout the remainder of the paper, we use the term policy instruments which we take to mean “techniques of governance, which, one way or another, involve the utilization of state resources, or their conscious limitation, in order to achieve policy goals” (Howlett and Rayner, 2007, p. 2).

Table 4 presents a summary of public support for innovation from five developed countries including: Australia, Sweden, Singapore, UK and New Zealand. There is a notable lack of focus on the human capital elements of innovation policy, particularly what we define as the intangible components of IHC. However, Singapore and the UK are of particular interest to this research given their focus on human capital (highlighted in bold italics in Table 4). Singapore develops human capital by promoting productivity and an innovative mindset, while the UK aims to develop complementary non-technical innovations, including intangible assets from human capital (BIS, 2011; NPCE, 2012).

Table 4: Survey of current innovation reports and strategies in five developed countries

Country	Description of public innovation policy/strategies
Australia	Innovation Policy is based mostly on market failure. Types of policies include R&D support schemes, public research, collaboration (university-industry linkages and inter-firm networks) and financial support schemes.
Sweden	The innovation ecosystem is the link between large multinational companies, industrial policy, public organisations and university research. The latter receives the most public funding.
United Kingdom	Funding blue skies research, improving links between HEI and businesses, and delivering a better environment for commercialising research. This includes an emphasis on all industries and services to invest in adapting technologies and develop complementary non-technical innovations, <i>including intangible assets from human capital</i> . Using open innovation – exploiting knowledge and ideas from any area of the UK.
Singapore	New strategy for competitiveness includes the ‘National Productivity and continuing education council’ (NPCE). High priority includes <i>programmes to increase workers’ skills</i> , to lower production costs. <i>The programmes include educational opportunities for working adults particularly lower paid workers. The strategy also aims to promote a productivity and innovative mindset.</i>
New Zealand	Increased investment by Government in innovation programmes include the development of innovation parks, increasing the number of engineering and science students, ensuring that agencies incentivise innovation by researchers, improving intellectual property rights and a focus on innovations to solve national specific issues.

Source: de Rassenfosse et al. (20110); BIS (2011); Miller (2013); NPCE (2012); New Zealand Government (2012).

5.3. Policy programmes and instruments driving innovation in Ireland

In Ireland, the shape and vision of current innovation policy has emerged from several reports and policy documents. With regards to the development and promotion of human capital, the various reports and policy documents have made the following contributions. In 1996, ‘Shaping Our Future’ aimed to establish an economy conducive to enterprise innovation. As part of a longer-term strategy, the report encouraged a major drive to raise people’s skills through education and firm-level investment in training and human resources development. This was followed by ‘Ahead of the Curve’ (2004) which recognised the importance of the improved quality of human capital (education), continual learning, R&D and innovation for a competitive knowledge-based economy. In 2010, ‘Innovation Ireland’ placed innovation at the heart of enterprise policy in Ireland. Its objective was to strengthen the knowledge base by improving human capital through education at all levels, and strengthening the innovation ecosystem to build Ireland’s Smart Economy. The ‘Action Plan for Jobs’ (2012) focused on seven

principal areas, including building competitive advantage by focusing *inter-alia* on innovation and skills. The report identified the need for the education and training system to respond and adapt to changes in new and emerging technologies. The 2013 and 2014 ‘Action Plan for Jobs’ supports the transition to an economy based on innovation, enterprise and export, by building competitive advantage through ‘disruptive reforms’ aligning skills and improving competitiveness. Further details on the various reports used to inform policy in Ireland over the past decade are presented in Table 5 (references to human capital are highlighted in bold italics). The impact of the Irish government’s long-term objective to increase the skills profile of people through education, outlined in the 1996 report ‘Shaping Our Future’ (Forfás, 2013), is evident in today’s increased numbers with third level degree or higher (CSO, 2014). Innovation policy in Ireland recognises education and training as an input to innovation, but tends not to acknowledge the intangible and indeed more innovative elements of human capital.

Table 5: Summary of the reports and strategies used to inform policy programmes in Ireland.

Report title, (author and date)	Aim of the report
Shaping Our Future (Forfás, 1996)	To promote a strategic view of enterprise in Ireland to help the economy and industrial base. Establish an environment conducive to innovation through the <i>longer-term measures of the major drive to raise the skills profile of people.</i>
Enterprise 2010: New Strategy for the Promotion of Enterprise in Ireland in the 21st Century (Forfás, 2000)	Provides a framework for action by public and private sectors to build Ireland’s knowledge-based economy. Place science and technological innovation at the heart of enterprise policy. Improve the financing of innovation.
Building Ireland’s Smart Economy (Government of Ireland, 2008).	Provides a framework to enhance productivity and sustained growth. Create ‘The Innovation Island’. <i>Build innovation or ‘ideas’ component of the economy through using human capital.</i>
Making it Happen: Growing Enterprise for Ireland (Forfás, 2010).	Identifies the actions needed to ensure competitive and sustainable enterprise that will support growth and jobs. Productivity and innovation at the core of Ireland’s enterprises.
Innovation Ireland (Innovation Taskforce, 2010).	Report of the Innovation Taskforce places innovation at the heart of enterprise policy in Ireland by <i>utilising human capital to translate ideas into valuable innovations.</i>
Report of the Research Prioritisation Steering Group (Forfás, 2011).	Provides recommendations to Government for future public investment in science, technology and innovation. Priority areas include: Future Networks and communications, Data Analytics, medical Devices and Diagnostics.
Action Plan for Jobs (Dept. Jobs, Enterprise and Innovation, 2012; 2013; 2014).	These annual plans build on the broader work of the Government to rebuild the economy after the recession. The aim is to increase employment by: supporting indigenous firms; improve performance and access to credit for Small and Medium Enterprises (SMEs). The three (2012, 2013 and 2014) reports highlights the need for <i>alignment between education and training with industry’s needs.</i>

Source: Forfás (2013).

5.4. *Justifying public support for IHC*

The findings from the current research (Section 4.5) provide evidence that policy makers and firms should look beyond the education element of human capital to enhance returns on investments in innovation. More specifically, we argue that policy makers should adopt a more holistic and all-encompassing measure of human capital (which we term IHC) where education is only one of a number of elements. Other elements include training, and most importantly *vis-a-vis* the contribution of the current paper, the new IHC concept emphasises the intangible and more innovative elements/characteristics of the individual such as the individual's job satisfaction and willingness to change (all parts of the culture and mindset inherent in a firm). Central to our argument is that a focus on IHC will create a competitive advantage in an environment of increasing levels of third level degree or higher (OECD, 2012).

To ensure that there is effective policy in place to support IHC, it is necessary to examine the source of the problems the policy (and its associated policy instruments) is proposed to address. The findings from this research, in relation to the contribution of IHC to firm-level innovation and the firm-level work arrangements and practices which support IHC, demonstrate that firm-level systems failure may exist. Innovation policy should be underpinned by an analysis of underlying innovation system dynamics as opposed to focusing on general theories of market failure (Dodgson et al., 2011). Moreover, Bergek et al. (2010) have put forward the view that innovation policy should be concerned with system weaknesses or failures and aim to overcome 'blocking mechanisms' (Bergek et al., 2008) that may exist within that system.

To conceptualise this further, one may reframe Woolthuis *et al.*'s (2005) framework of system failures to include firm-level systems failure, since soft institutional and capabilities failures best explain the combined failures of the actors²⁴ and the rules/system.²⁵ Such firm-level systems failure highlights a potential role for public policy programmes in supporting the novel IHC concept. Public policy can address systems failures in two ways: strengthen and preserve existing systems or create new systems (Carlsson and Jacobsson, 1997). Thus, public programmes could strengthen firms' innovation- and human capital-focused work practices and arrangements where these exist, or create and support these elements in firms where they do not exist. Public policy support for IHC should target both the firm and the individual, as well as promoting a change in culture and mindset amongst the whole workforce and in the firms that currently do not provide employee-focused or innovation-centred working practices (e.g., flexible working conditions and/or performance-related incentives).

A prime example of culture change is the introduction of the concept of 'Health and Safety' at work. Public policy programmes supported firms to adopt health and safety routines in the workplace; this support changed the culture to a point where health and safety is now viewed as the responsibility of every individual (Gray, 2009). In a similar vein, enabling an environment (both internal and external to the firm) which supports IHC should be a high priority for everyone in the firm; management are the conduit to develop and communicate ideas and to promote the positive implications of IHC for innovation. Policy support for such activities will enhance opportunities and capabilities for innovation, according to the systems failure approach (Metcalf, 2005).

The support of the holistic IHC concept may prove a challenge for both policy makers and firms at a number of levels. Direct policy measures are lacking for the intangible elements of IHC and the internal

²⁴ Actors include knowledge institutions, firms and employees.

²⁵ Rules/system include the culture, laws and values of the organisation.

firm factors (as evidenced in Tables 4 and 5), while the tangible elements of education and training attainment are more easily supported; however, this issue should not provide an excuse for avoiding the challenge of supporting IHC. Although our prime concern here is with the factors internal to the firm that support IHC, it should not be overlooked that external firm factors also (admittedly to a lesser extent) showed some significance. Given the relatively weak significance of the external factors in the current paper, coupled with our prime concern on internal firm factors and dynamics, we will not delve too deeply into any explanations or interpretations in this regard here. Suffice to say however, that it should be acknowledged that creating an enabling environment and ecosystem (with a focus on external factors such as entrepreneurship and workforce diversity) which supports IHC is key, and most certainly policy makers have an important role to play in this regard too. As argued by Lenihan (2011), policy makers have a key role to play *vis-a-vis* enabling framework conditions for enterprise start-up/growth and innovation.

It is to this challenge of a new policy offer (series of programmes) focussed on developing and supporting IHC within firms (a review of the international literature has not revealed any similar offers in other countries) that we now focus our discussion here. While programmes based on correcting for market failure use the tax system and the protection of intellectual property (IP) (Laranja et al., 2008), the proposed offer is founded on a knowledge of the types of systems failure that occur and uses a framework programme with some similarities to the *Lean Business Offer*²⁶ programme currently operating (by the development agency Enterprise Ireland) in Ireland (the details of which are outlined in Appendix 4).

5.5. *Towards developing a public policy offer to support Innovative Human Capital – Innovative People 4 Growth (IP4G)*

A sample of existing programmes and instruments in Ireland that support innovation directly and indirectly are presented in Appendix 4. It is immediately evident even from merely looking at the titles, that most instruments are aimed at increasing product-innovation-type activities (e.g. R&D funding, Innovation Vouchers and Innovation Partnerships). Other instruments listed focus mainly on firm strategy in management and improving firms' productivity. Clearly, a study as to the precise nature of the systemic failures and blocking mechanisms that exist with respect to IHC (beyond the realm of the current paper) is an area that merits further investigation and analysis (from both theoretical and practical perspectives).

With respect to programmes offered by other developed economies, most governments support innovation at firm level through the tax system and collaboration with higher education institutes (HEI). Examples of these include the UK's 'Collaborating for Success' support collaboration between firms and HEI for innovation. The Canadian government helps companies bridge the pre-commercialisation gap by procuring and testing late-stage innovative goods and services within the federal government before taking them to market (BCIP, 2013; Business Wales, 2013; BIS, 2013). This widespread provision of subsidies/grants for the creation of knowledge across many countries confirms the generally held view that "governments should facilitate the creation and transfer of knowledge and remove unnecessary impediments to its diffusion" (Jones and Grimshaw, 2012, p. 6). These impediments, in the case of support for IHC, may include the internal factors identified in the current research as work practices and work arrangements.

²⁶ For further details refer to <http://www.enterprise-ireland.com/en/productivity/lean-business-offer/>

Regarding the type of support needed to promote IHC and in agreement with Lenihan (2004), this research does not suggest the need for a complete reconstruction of current innovation support instruments. Rather, it suggests the need to:

1. Recognise the merits of IHC and the related positive significance of firms' work practices and work arrangements and, in certain cases, the external factors of workforce diversity and entrepreneurship activity, in order to sustain IHC as a valuable and competitive resource;
2. Develop an IHC-centred suite/combination of programmes to target both the individual person working within the firm and the firm's wider work practices and arrangements. The notion here is to help the firm to promote an innovation culture within the firm and to create, facilitate and encourage an innovative mindset within its employees. Moreover, there should be a focus in creating a culture where the intangible elements of job satisfaction and employees willingness to change are seen to matter within a firm and become a natural part of the firms culture where innovation is everyone's concern.
3. Introduce a pilot programme. This would be of benefit to policy makers in the first instance; innovation is by its very nature experimental, and so too should be the policy interventions which support it. Following on from a rigorous evaluation of the pilot programme, a more informed decision (important for the process of policy learning) can be made as to whether or not there should be a full roll-out of the programme.

The development and support of IHC and other factors internal to the firm may not be best handled solely by policy makers. Given that firms appear to have lots to gain from IHC, investment by the private and the public sector in partnership (as suggested below *vis-à-vis* the *Innovative People 4 Growth* offer) may be the optimal way forward. As suggested previously, a more in-depth market/system failure analysis is beyond the realm of the current paper, but certainly merits attention in future.

Indirect supports for IHC - In the Irish context, a number of existing programmes stand out as providing indirect support for IHC in firms (for more details see Appendix 4). Enterprise Ireland²⁷ offers a set of management development programmes: *Management 4 Growth* and *Leadership 4 Growth* aim to provide top management with the opportunity to develop and improve their management skills. Additionally, the *Excel for People and Performance* programme and the *Lean Business Offer* suite of programmes are designed to encourage firms to increase performance and competitiveness. The provision of R&D tax credits may also be viewed as an indirect support for IHC. For example, the Netherlands categorises wages related to R&D as eligible R&D expenditure when claiming tax credits (OECD, 2011). This could be extended to IHC-related expenditure, thereby providing an incentive to firms to invest in IHC.

Direct support for IHC - Innovation is a complex process of interactive learning (Chaminade and Edquist, 2005). In this respect, it is worth remembering that IHC is a holistic concept and a valuable resource available to the firm. Support is unlikely to arise from the traditional single instrument method, but rather from a suite of complementary instruments (offer). The *Lean Business Offer* (Appendix 4) is a good example of a suite whose objectives are to increase performance and competitiveness at an individual and firm level.

²⁷ For further details on Ireland's development agency, Enterprise Ireland, refer to <http://www.enterpriseireland.ie/en/>

So as to promote IHC, with the ultimate aim of increasing innovation, we propose a new ‘offer’ in the Irish context which we title *Innovative People 4 Growth*, based on the findings from the current research that IHC contributes to innovation and that certain firm factors (Section 4.5) support this novel concept. Table 6 illustrates the structure and workings of the proposed *Innovative People 4 Growth* offer, which aims to:

- introduce firms to the concept of IHC as a competitive advantage and determinant of firm-level innovation;
- foster a firm environment that recognises and supports IHC; and
- include the concept of IHC in existing and future programmes.

The proposed *Innovative People 4 Growth offer* is in-line with current Irish policy strategies that promote competitiveness, innovation and improved productivity in pursuit of job creation and economic growth.

Innovative People 4 Growth is designed to encourage and incentivise firms to promote IHC as a competitive resource in driving innovation activity in their firm. The suite of instruments, built on a firm-level systems failure approach, is designed to drive innovation activity through improved opportunities, capabilities and efficiencies of employees. Ideally, firms would undertake the *Innovative People 4 Growth* offer in full (all 4 programmes) to ensure maximum benefit. Before undertaking Programmes 2, 3 and 4 (outlined in Table 6), the firm will undergo a one-day consultation with the public agency appointed facilitator to benchmark the level of IHC and assess the current level of IHC focus in the firm. The inclusion of *Lean Start plus IHC* (programme 2) allows firms to understand lean tools and techniques as well as the value of IHC for firms’ innovation activities. Programme 3 of the offer undertakes changes to improve firms’ IHC, creating conditions that develop this valuable resource. This programme will result in lasting promotion of the holistic IHC concept. We propose that the public policy development agency offer a grant to firms to contribute to the cost of implementing necessary changes. Finally, *Innovative People 4 Growth* offers a review to monitor current developments and outline plans for continued promotion of IHC, with the ultimate aim of increasing innovation. It is not expected that *Innovative People 4 Growth* will be restricted to any particular firm size, sector or type of ownership, though the results of the current research reveal that small firms who employ employee-managers with IHC are more likely to innovate. Though *Innovative People 4 Growth* is preferably undertaken in full, each programme is also ‘stand-alone’, so firms can adopt an *à la carte* approach. However, our preference is that the offer be taken in full as it is this interaction between programmes/instruments that has the potential to make for an effective ‘instrument mix’. The issue of interaction between instruments and what makes for an effective ‘policy mix’ in the sphere of IHC certainly deserves investigation in moving forward. The discussion as per Flanagan et al., (2011) would appear to be a good starting point in this regard. Policy complexity is certainly a key issue that needs to be highlighted.

As a result of the economy-wide availability of the programme, it is envisaged that IHC will have an effect on the general workforce, thus in turn strengthening system-wide capabilities. The movement of people between employers will help in developing an innovative workforce and national innovation mindset. The *Innovative People 4 Growth* programme, like any new best-practice policy intervention, will require *ex-ante*, *interim* and *ex-post* evaluations. Such an evaluative approach will be necessary not only to ensure value for money and accountability, but also to ensure policy improvements in moving forward (Lenihan, 2011).

Table 6: Overview of the proposed IHC focused *Innovative People 4 Growth* (IP4G) offer.

<i>Innovative People 4 Growth (IP4G)</i>		
Activities	Objectives/intended Outcomes	Existing/new programme
1. Innovative People 4 Growth Start		
Short in-firm consultancy	» A review to assess the level of existing IHC supports at firm-level ²⁸	New programme
2. Lean Start plus IHC		
7 days input from expert consultant on the principles of Lean Business Offer ²⁹	» Reduce costs and refine process » Introduce lean skills in the firm » Introduce an IHC mindset among all personnel	Existing programme plus: introducing the notion of IHC to management and developing a strategy to implement supports for IHC ³⁰
3. Innovative People 4 Growth Change		
Programme ³¹ to introduce changes to firm's organisational structures	» In tandem with the introduction of Lean principles, promote the merits and value of IHC through supports for employee job satisfaction and willingness to change. » Develop an innovative mindset and change in culture where innovation is everyone's concern	New programme
4. Innovative People 4 Growth Review		
Short in-firm consultancy	» Review to assess the change/benefits of IHC and to identify possible future adjustments needed	New programme

As with most programmes offered by Irish development agencies, a financial commitment by firms will be required. For example, in the case of the *Lean Business Offer*, the cost to firms is generally 50 percent of the overall programme cost, with the government agency paying the other half to a maximum amount. We propose a similar approach in the case of *Innovative People 4 Growth*. It is envisaged that the benefits from improving IHC would outweigh the costs of investment by firms in the form of improved innovation activity.

As outlined from the very outset of this paper, our concern in proposing this new IHC policy offer is not to suggest wholesale emulation of what we propose here. Much more modest and realistic hopes are in order. Our concern here is merely to highlight to policy makers and academics alike the potential benefits that can flow to individuals, firms and moreover, the general enterprise and innovation ecosystem when focus is placed on IHC and measures to promote and support it. More debate is certainly warranted regarding these issues and our hope is that the current paper makes some inroads in terms of stimulating such debate.

6. Discussion and conclusions

The traditional measurement of human capital (tangible elements of education and training) is currently being debated in the literature (Ganatakis, 2012; Fitjar and Rodriguez-Pose, 2011). The results from our research, with a focus on not only the tangible, but also the intangible elements of

²⁸ This review will be conducted by the public agency (e.g Enterprise Ireland) appointed facilitator.

²⁹ Lean Business Offer (LBO) tools and techniques help companies across the globe to address competitiveness issues within their businesses by building the capability of their people to identify problems and improve operations. Refer to Appendix 4 and <http://www.enterprise-ireland.com/en/productivity/lean-business-offer/>

³⁰ Including firms' work practices and work arrangements.

³¹ Programme will vary in size and scope depending on firm but will normally take six months to complete.

human capital, add to this debate and generate potentially interesting insights as to factors necessary to promote the new and holistic *Innovative Human Capital (IHC)* concept which we develop.

Our research promotes IHC as a determinant of firm-level innovation *via* a three-stage process. Firstly, to address the limitations of the traditional measure of human capital, the research develops the novel and multi-dimensional IHC concept. Building on the commonly used, tangible measures of human capital (e.g., education and training), we add the more innovative elements of job satisfaction and willingness to change. With regard to the value of IHC, we estimate its impact on the likelihood of firms innovating. The analysis is based on responses from employee-managers in private firms in Ireland surveyed in 2009. The results reveal a variance among firm size and type of innovation. Our findings suggest that IHC may be more valuable to small firms, especially in the case of training and willingness to change.

In order to fully understand the new IHC concept, it is necessary to identify the conditions where IHC exists. Drawing on management and innovation literatures, the second stage of the research estimates the effect on IHC of factors internal and external to the firm. Overall, the estimations show the statistically significant effect of internal factors on the four elements of IHC; as expected, these effects vary across firm size and across elements of IHC. From the knowledge-based view of the firm, von Krogh and Wallin (2011) describe the firm as an institution that coordinates and protects knowledge; our research supports the notion that knowledge inherent in IHC comes from a variety of firms' organisational structures, such as firms' work arrangements and work practices. Our results are also consistent with the resource-based view of the firm, where firms' management need to maximise the value of existing resource capabilities (Grant, 1996; Spender, 2009). For example, firms' capacity to facilitate regular performance reviews or appraisals, and the provision of alternative forms of pay and conditions, are positive factors in the majority of our estimations, highlighting the conditions where IHC exists and can be supported as a valuable resource. We find limited statistical significance regarding the effects on IHC of diversity of nationality and education in the local labour market. This may be in part related to the low level of diversity in nationality in Ireland, and the homogeneity that exists across regions.

As with most empirical research, this study has limitations, not least the absence of a more accurate measure of regional and firm-level R&D. The majority of studies in the field of innovation, firm growth and survival include R&D as a contributing factor. Another limitation of the research is its capacity to estimate changes over time. Studies reveal that the impact of innovation has a lagged effect (Mansfield, 1991; 1998). A longitudinal study would help to more fully understand the relationship between innovation and IHC. This prompts a suggestion for further research using time series data to advance the understanding of IHC. While Ireland is the setting for this research, the framework could potentially be replicated using similar information to the NCPP workplace survey used here. Such surveys have been conducted in the UK, Canada and the proposed 'Workplace Relations Study' in Australia (FWC, 2014). The Australian survey, for example includes questions on employees' engagement practices, communications and flexibility arrangements in their workplace (FWC, 2014). The UK survey, 'Workplace Employment Relations Survey' provides information on firms family-friendly policies and management practices (WERS, 2014). This is certainly an area ripe for further investigation and exploration.

The results from the current research suggest a potential role for public policy *vis-à-vis* direct and indirect interventions to support IHC. While we acknowledge that training and the increased number of graduates with a third level degree or higher (particularly in Europe) are important, and a good starting point (European Commission, 2011), they represent only one dimension of an individual's capacity to

drive innovation. Yet policy makers tend to focus on such supports to the possible neglect of the more intangible elements of IHC highlighted by our research (Izsak and Grinieca, 2012). In a similar vein to Lenihan (2004), we argue that there is no need for a total overhaul of current innovation or management support programmes; rather, policy should recognise the value of IHC and the importance of firms' innovation-focused work practices and employee-focused work arrangements in sustaining this valuable resource. In justifying public support for IHC, our research finds that market and systemic failures may exist; however, given the benefits to firms from IHC, we suggest a combined investment by firms and policy makers with respect to our proposed *Innovative People 4 Growth* offer. Moreover, we suggest that this offer be tested (introduced) on a pilot basis, and that a rigorous evaluation process be put in place ranging from *ex-ante* to interim to *ex-post* evaluations of the offer. Once robust evaluations have been undertaken, then decisions to have a full-roll out (or not-or a modified version) of the offer can be considered based on the available evidence.

In sum, this research contributes to knowledge by considering a holistic measure of human capital and creates the novel *Innovative Human Capital* concept as a determinant of innovation. In addition, it identifies factors internal and external to the firm which foster this valuable resource. Public policy has a potentially strong role to play in enabling IHC to flourish with the ultimate aim of increasing firms' innovation activity.

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Appendix 1: Questions from *National Centre for Partnership and Performance 2009 Workplace Survey 2009*

Variable	Description/Question
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 – In general, I am satisfied with my present job I am satisfied with my physical working conditions I am satisfied with my hours of work I am satisfied with my earnings from my current job My Job is secure 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 My job requires that I work very hard I feel very little loyalty to the organisation I work for (R) I would take almost any job to keep working for this organisation I work under a great deal of pressure I never seem to have enough time to get everything done in my job I often have to work extra time, over and above the formal hours of my job to get through the job or help out 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
Firms' 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
Firms' work arrangements	Work arrangements - Are flexible hours/flexitime used in your workplace? - Are regular performance reviews or appraisals used in your workplace? How often are you and your colleagues consulted before decisions are taken that affect your work? If changes in your work occur, how often are you given the reason why? If you have an opinion different from your supervisor/manager can you say so? If you are consulted before decisions are made, is any attention paid to your views or opinions? Form part of pay and conditions at work - regular increment - employee share options, profit sharing or gain sharing - bonus scheme

Appendix 2: Logit regression estimation of the effect of IHC on firm-level innovation (Equation 1)

	Small Firms < 50 employees			Larger Firms > 50 employees		
	Service Innovation	Product Innovation	Process Innovation	Service Innovation	Product Innovation	Process Innovation
Male	-0.319 (0.177)**	0.228 (0.175)	-0.009 (0.183)	-0.108 (0.210)	0.231 (0.205)	-0.058 (0.225)
Age of respondent	-0.005 (0.008)	-0.025 (0.008)**	-0.017 (0.008)**	-8.08 (0.011)	0.009 (0.011)	-0.008 (0.012)
Irish	-0.446 (0.238)*	-0.578 (0.239)**	-0.204 (0.35)	-0.075 (0.252)	-0.228 (0.252)	0.078 (0.276)
Firm's work practices	0.658 (0.219)**	0.753 (0.223)**	1.361 (0.244)***	0.954 (0.288)**	1.074 (0.279)***	1.618 (0.332)***
Sector - [production]	0.152 (0.141)	-0.081 (0.138)	-0.143 (0.147)	0.185 (0.117)	-0.188 (0.115)	-0.263 (0.134)*
Regions [Dublin]	0.030 (0.033)	0.005 (0.034)	-0.026 (0.035)	-0.029 (0.038)	-0.036 (0.037)	-0.081 (0.043)
Four elements of IHC						
Willingness to Change	0.295 (0.161)*	0.487 (0.161)**	0.038 (0.154)	-0.101 (0.231)	0.119 (0.216)	0.071 (0.203)
Job Satisfaction	0.033 (0.314)	-0.088 (0.332)	0.207 (0.343)	-0.246 (0.377)	-0.141 (0.380)	0.056 (0.437)
Education	-0.062 (0.184)	-0.124 (0.185)	-0.031 (0.192)	0.196 (0.189)	0.191 (0.188)	0.407 (0.208)**
Training	0.798 (0.174)***	0.282 (0.174)	0.841 (0.181)***	0.328 (0.196)*	-0.014 (0.197)	0.547 (0.211)**

Note: The first number denotes the coefficients with robust Standard Errors in parentheses - Statistically significant * at the 0.10 level, **at the 0.05 level and *** at the 0.01 level.

Appendix 3a: Logit regression of the estimation of the factors supporting IHC (Equation 2)

Firm Size	Model 1 Education		Model 2 Training		Model 3 Job Satisfaction		Model 4 Willingness to Change	
	Small <50	Larger >50	Small <50	Larger >50	Small <50	Larger >50	Small <50	Larger >50
<i>EXT</i> – external factors								
Entrepreneurship Activity	0.376	1.55**	0.258	-1.28	-0.133	-0.637	0.324	-2.062
- Informal investment	(0.725)	(0.786)	(0.664)	(0.826)	(0.690)	(0.954)	(1.010)	(1.818)
- Early Stage Start-up	-0.099	0.092	0.137	0.026	0.194	0.164	0.085	0.337
	(0.136)	(0.146)	(0.127)	(0.158)	(0.138)	(0.167)	(0.183)	(0.345)
- Expected to Start	0.083	-0.029	0.013	-0.128	-0.112	-0.318	0.011	-0.720
	(0.179)	(0.180)	(0.158)	(0.190)	(0.178)	(0.199)	(0.228)	(0.450)
Diversity	1.480	-0.470	3.140	1.377	8.095**	3.751	-2.036	14.721**
- Nationality	(2.971)	(3.117)	(2.916)	(3.378)	(3.347)	(3.890)	(4.050)	(5.573)
- Education	-3.606	-6.14	-1.027	-8.461	1.578	1.134	-4.154	198.948
	(9.609)	(11.721)	(7.877)	(11.548)	(8.707)	(11.171)	(11.856)	.
<i>INT</i> – internal factors								
Work Practices	-0.198	-0.271	0.125	0.8268**	2.784***	2.235***	0.225	-0.342
	(0.224)	(0.267)	(0.218)	(0.285)	(0.315)	(0.347)	(0.306)	(0.467)
Work Arrangements	-0.159	0.166	0.149	-0.015	-0.429**	-0.300	0.217	0.533
- Frequency of Information	(0.159)	(0.207)	(0.157)	(0.210)	(0.1759)	(0.245)	(0.200)	(0.385)
- Consultation	-0.028	0.226*	-0.087	0.056	0.297**	0.906***	-0.007	0.0229
	(0.114)	(0.127)	(0.106)	(0.131)	(0.131)	(0.172)	(0.148)	(0.229)
- Flexible hours	0.278**	0.377*	-0.128	0.234	-0.052	0.161	0.245	0.858**
	(0.195)	(0.196)	(0.185)	(0.203)	(0.211)	(0.237)	(0.270)	(0.373)
- Regular review/appraisals	0.445**	0.610*	0.125	0.367	0.122	0.128	0.176	0.237
	(0.204)	(0.329)	(0.184)	(0.246)	(0.225)	(0.311)	(0.297)	(0.395)
- Pay & conditions	1.143	0.540	1.138**	1.035**	0.554	1.059**	0.217	1.082
	(0.405)	(0.357)	(0.394)	(0.374)	(0.452)	(0.402)	(0.621)	(0.719)

Note: The first number denotes the coefficients with robust Standard Errors in parentheses - Statistically significant * at the 0.10 level, **at the 0.05 level and *** at the 0.01 level.

Appendix 3b: Logit regression of the estimation of the factors supporting IHC (Equation 2 contd.,)

Firm Size	Model 1 Education		Model 2 Training		Model3 Job Satisfaction		Model 4 Willingness to Change	
	Small(<50	Larger>50	Small<50	Larger>50	Small<50	Larger>50	Small<50	Larger>50
C – control variables								
Sector - Bank/Finance	-0.257 (0.270)	-0.357 (0.246)	0.218 (0.265)	-0.164 (0.252)	-0.205 (0.310)	0.218 (0.280)	-0.188 (0.374)	-1.287** (0.538)
Sector - Other Services	0.374 (0.295)	0.294 (0.248)	0.656** (0.293)	-0.173 (0.274)	-0.205 (0.341)	-0.138 (0.287)	0.465 (0.454)	-0.873 (0.545)
Regional - Density	-0.000 (0.001)	-0.001** (0.001)	0.000 (0.001)	0.001** (0.001)	0.000 (0.001)	0.001 (0.001)	-0.000 (0.001)	-0.001 (0.001)
Male	0.261 (0.20)	-0.284 (0.220)	-0.119 (0.189)	0.019 (0.217)	-0.079 (0.224)	-0.273 (0.249)	-0.050 (0.280)	-0.242 (0.405)
Irish	-0.730** (0.239)	-0.828** (0.257)	-0.132 (0.235)	-0.066 (0.265)	-0.012 (0.270)	0.213 (0.321)	0.0788 (0.346)	0.1051 (0.451)
Firm R&D	-0.098 (0.250)	0.243 (0.317)	1.080*** (0.255)	0.420 (0.285)	0.223 (0.297)	-0.247 (0.371)	0.475 (0.295)	0.335 (0.456)
Regional R&D	-0.007 (0.161)	-0.316** (0.156)	-0.006 (0.143)	0.270 (0.166)	-0.021 (0.165)	0.009 (0.190)	-0.080 (0.220)	0.0277 (0.329)

Note: The first number denotes the coefficients with robust Standard Errors in parentheses - Statistically significant * at the 0.10 level, **at the 0.05 level and *** at the 0.01 level.

Appendix 4: Sample of direct and indirect innovation support programmes available to firms in Ireland

Programme Target	Examples of specific programmes
R&D and innovation	Technology centres, Technology gateway, Innovation partnerships, R&D funding, Innovation Vouchers
Collaborate on R&D	Pooled Innovation Vouchers, Enterprise R&D fund, Strategic advice and expertise
Productivity	Best practice Study Visits, Lean Business Offer*
Leadership and Management development	Management4Growth, Strategic Leadership4 Chief Financial Officers, Leadership4Growth, Strategic Consultancy Grant.

* *Lean Business Offer* is designed to encourage firms to adopt Lean business principles to increase performance and competitiveness.

LeanStart - provides an introduction to Lean concepts and allows firms to gain an understanding of what the tools and techniques can do for the firm in a short, focused engagement. Firms can apply for grant support towards the cost of hiring a Lean consultant/trainer to undertake a short in-company assignment which will;

- introduce Lean principles and Agile processes,
- achieve immediate cost reduction targets, and
- lay a foundation for future Lean or productivity improvement projects. The typical cost is €6,300. The firm must pay the first €1,300 and Enterprise Ireland will provide grant funding for the outstanding costs to a maximum of €5,000.

LeanPlus – An assignment is a medium-term business process improvement project which will result in sustained use of Lean techniques and related methodologies by the firm, and will achieve significant measurable gains in capabilities and competitiveness. Assignments may vary in size and scope but will typically be completed within six months and will not exceed a total project cost of €70,000.

LeanTransform is a large scale, extensive and holistic firm transformation programme delivered by an external consultancy team of international reputation. LeanTransform projects should;

- deliver firm-wide transformation in culture and productivity performance,
- embed the competencies necessary for on-going competitiveness result in sustainable improvement in the business and across its supply chain

The maximum level of grant support is up to 50% of eligible costs incurred. The percentage and level of funding will be determined on a case-by-case basis by the Enterprise Ireland Investment Committee.

Source: Enterprise Ireland (2013).