Estimating the impact of Innovative Human Capital on firm-level innovation

by

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ABSTRACT: Innovation is a well-recognised determinant of growth in firms, regions and the economy as a whole. Many studies focus on tangible conditions and factors related to innovation, including human capital. Human capital is an essential part of innovation and is traditionally measured by a uni-dimensional approach: the tangible elements of education and training. Increases in levels of education, especially in developed countries, are causing uncertainty about the competitive advantage afforded by the traditional measure of human capital. From the literature presented in this thesis, it is also evident that such measures of human capital are limited, and a more encompassing measure and concept of human capital is called for. To overcome these limitations and address the lack of a holistic measure of human capital in the literature, this research extends the traditional measure by developing a unique and far-reaching concept of Innovative Human Capital (IHC). The novel and multi-dimensional IHC concept encapsulates four elements of the individual employee-manager: the tangible and standard measures of educational attainment and training, as well as the intangible and more innovative elements of willingness to change in the workplace and job satisfaction.

Using Ireland as a laboratory, the analysis creates a new multi-level dataset from four sources. This rarely-used combination of micro (firm) level data with regional data allows for empirical analyses on the effect of the holistic IHC concept on firms’ innovation activity. In addition, the research examines factors that may be causally connected to IHC at regional and firm level; specifically, regional entrepreneurship activity and workforce diversity, along with firms’ work practices and work arrangements.

The research highlights the importance of extending the measurement of human capital; it finds elements of IHC as significant contributors to firm-level innovation, particularly for small firms (<50 employees). The related estimations also find internal (firm) factors more significant than external (regional) factors in the case of all four elements of IHC, to varying degrees.

From a policy perspective, the research explores current innovation policies and programmes from a number of developed economies to assess the effectiveness of these policies and programmes in promoting IHC. In line with current Irish policy to promote innovation, job creation, and economic growth, and in an attempt to operationalise the valuable concept of IHC in support of innovation, a new policy offer is proposed. The new suite/combination of programmes (offer) is designed to encourage and incentivise firms to promote IHC as a competitive resource and determinant of innovation. The research argues that firms and policy makers who consider human capital through a holistic lens (comprising the tangible and intangible elements of the individual) may enhance return on investments, and likewise support a valuable competitive advantage for innovation.
Declaration of Originality

No portion of the work referred to in this thesis has been submitted in support of an application for another degree or qualification of this or any other university or institute of learning.

I declare that the thesis represents the results of my own work. Following normal academic conventions, I have made due acknowledgements of the work of others. The work has been completed within the specific word limit with 67,228 words, including references and appendices.

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Signed: __________________________
Helen McGuirk
Acknowledgements and Dedication

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I dedicate this thesis to the memory of my beloved husband, Patrick T. Cadogan, and to my wonderful dad, Michael McGuirk
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List of abbreviations

CSO Central Statistics Office
COPSAR Census of Population – Sample of Anonymised Records
DARM Department of Agriculture, Forestry and the Marine
DJEI Department of Job Enterprise and Innovation
EI Enterprise Ireland
EPA Environmental Protection Agency
ESRI Economic and Social Research Institute
EU European Union
GDP Gross Domestic Product
GEM Global Entrepreneurship Monitor
GNP Gross National Product
HEA Higher Education Authority
HEI Higher Education Institutes
HRB Health Research Board
IDA IDA Ireland
ICT Information and communication technology
IIP Irish Innovation Panel
IHC Innovative Human Capital
IP4G Innovative People 4 Growth
IRCHSET Irish Research Council Science Engineering and Technology
IRCHSS Irish Research Council Humanities and Social Science
ISSDA Irish Social Science Data Archive
KMO Kaiser-Meyer-Olkin Measure of Sampling Adequacy
LHS Life and health sciences
QNEC Quarterly National Economic Commentary
NACE Nomenclature generale des Activites economiques dans les Communautes europeennes
NCPP National Centre for Partnership and Performance
NSI National Systems of Innovation
NUTS3 Nomenclature of Territorial Units for Statistics (Level 3)
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>RBV</td>
<td>Resource-based View</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>SFI</td>
<td>Science Foundation Ireland</td>
</tr>
<tr>
<td>SI</td>
<td>Systems Innovation</td>
</tr>
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<td>SME</td>
<td>Small and Medium Enterprises</td>
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<td>SWB</td>
<td>Subjective well-being.</td>
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1 Introduction

1.1 Introduction

The aim of this chapter is to present an overview of the current research as a context for the subsequent chapters. The chapter presents the background to the research, outlines the key concepts and discusses the rationale for the research, states the research objectives and finally highlights the central contributions of the thesis.

Innovation is an intrinsic phenomenon necessary for firms and economies to survive and grow (Fagerberg et al 2013; Cefis and Marsili, 2006; Lambooy 2005; Lundvall 1995: Grossman and Helpman 1994). The relevance of innovation extends far beyond the confines of research laboratories; it permeates all sectors, users, suppliers, and consumers, and exerts its influence across institutions and governments (OECD 2013). It involves the commercialisation of new ideas and constitutes the ‘engine of growth’ for firms, regions, and economies (Grossman and Helpman 1994, p. 32; Roper et al 2010; Romer 1990). Furthermore, industrial/enterprise policymaking in the European Union (EU) continues to focus on innovation as the route for sustained economic growth (European Commission 2010; 2014a). While innovation is not a new phenomenon, interest in the topic has grown in the economic literature since the 1980s (Fagerberg 2005). This interest in innovation is fuelled in part by the dynamic and rapid nature of industries such as information and communication technology (ICT), digital technologies and the life science technologies (Cohen et al 2004) as well as by the broad perspective of environmental issues (Smith et al 2010). Explaining why (and how) firms innovate remains a challenge for academics and practitioners alike (Montalvo 2006).

1 Organisations for Economic Co-operation and Development
Many research studies focus on the determinants of innovation at both micro and macro levels of the economy. At the macro (national/regional) level studies include the determinants of regional innovation (Fritsch and Slavtchev 2011; Fitjar and Rodriguez-Pose 2011) and national innovation systems (Guan and Chen 2012; Filippetti and Archibugi 2011) for example. At the micro (firm) level, studies are dominated by topics such as firm size and research and development (R&D) activity (Raymond and St. Pierre 2010; Ace and Audretsch 1990; Hall et al 2009). More contemporary studies include how firm-level innovation varies over the industry life cycles (Tavassoli 2014); and the implications of the financial crisis on firm innovation (Milberg and Shapiro 2014).

In addition to the above, human capital as a determinant of firm-level innovation is of interest in the literature (Kato et al 2014; Ottaviano et al 2003; Schneider et al 2010). To some economists and social scientists, human capital refers to the skills, knowledge, and capabilities of the workforce of a firm (Coleman 1988; Hsu and Sabherwal 2012; Blair 2011). However, 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; McCann and Simonen 2005). Educational attainment, especially third-level, constitutes a signal of ability, discipline and perseverance in the individual (Toner 2011). Investment in education has long been considered an investment in human capital, and in turn a key input to firms’ growth and productivity (Burton-Jones and Spender 2011; Becker 1964/19932).

This tangible, standardised measure of human capital does not capture the intangible and possibly more innovative elements of the individual. In other words, it takes no account of the holistic view of the individual person. However, recent literature gives evidence of an emerging interest in the area of human capital beyond education and training: for example, studies on: how managers’ capabilities and experience complement their education (Ganotakis 2012). Managers’ capabilities and attitudes (Fitjar et al 2013),

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2 The 1993 (3rd edition) is used throughout this research
prior work experience and motivation (Arvanitis and Stucki 2012) are also topics of debate in the contemporary literature. Despite these developments, there is a lacuna in this area of research perhaps because such intangibles are difficult to measure (Coronado et al 2008).

The purpose and key contribution of the current research, is to address the gap between the use of a single-dimensional measure of human capital (the tangible and easy-to-quantify, education and training) and a multi-dimensional approach. To address this gap the research creates and develops a novel and holistic concept, named here as ‘Innovative Human Capital’. This new concept encapsulates four elements of the individual person: two tangible measures, educational attainment and training provided by the firm; and two intangible elements, willingness to change in the workplace and job satisfaction. More specifically, the current research focuses on Innovative Human Capital of managers³, as research has shown them to be key to innovation (Fitjar et al 2013). Managers control resources, filter ideas and set the atmosphere of discussion and communication in the firm (Storey and Salaman 2005); further details of their function are outlined in the next section and in Chapter 4.

The current study employs econometric analyses to estimate the effect of Innovative Human Capital on firms’ innovation activity⁴, as well as to identify factors that support the novel concept. These supports include factors internal to the firm, such as firms’ work practices and arrangements (e.g., pay and conditions, working in teams and level of consultation with employees); and external factors, which include the level of diversity in the workforce (i.e. education and nationality) and entrepreneurial activity in the region where the firm is located.

Ireland serves as the locale for the current research into the Innovative Human Capital of employee-managers. Thus the question arises, what

³ The research specifically focuses on employee-managers. The rationale for selecting this cohort of employees is further outlined in Chapters 3 and 4.

⁴ Estimations also control for other variables, which may affect innovation (e.g. firm sector, firms specific factors, for example, the level of communications and team work in the firm, and managers’ demography).
makes Ireland a suitable and interesting case study? The next section provides an explanation.

*Ireland: an interesting case study*

Ireland is a small open economy with a population of approximately 4.6 million people in 2011 (this represents an 8% increase over five years) (CSO\(^5\) 2014a). The country has been a member of the European Union since 1973, and part of the Eurozone since its inception in 1999. Ireland’s indigenous enterprise sector consists mainly of service providers and agricultural exports (Enterprise Ireland 2014).

Ireland’s economic indicators since joining the Eurozone reveal sharp contrasts: Gross Domestic Product (GDP) growth in 1997 stood at a high of 11.9 percent, with a low of -5.5 percent in 2009; the unemployment rate\(^6\) was at an all-time low of 3.35 percent in 2002 and currently stands at 11 percent (October 2014) (CSO 2014a). The government surplus/deficit too shows extreme shifts; in 2006 (Q4\(^7\)) the government had a surplus of 10.7 percent compared to a deficit of 39.1 percent in 2010 (Q1), and a deficit of 7.2 percent in 2013 (CSO 2014b; CSO 2013a; 2013b). With respect to the reference period of this study (2007-2008), Ireland was at the end of the so called ‘Celtic Tiger’ boom period and the beginning of a recession (NCPP Report 2009). Current Irish public policy centres primarily on job creation through foreign direct investment, innovation and entrepreneurship (DJEI 2012; 2013; 2014).

In the case of education, the proportion of the labour force with a third-level degree in Ireland increased from 25 percent in 1996 to 36.2 percent in 2006 (CSO 2012). By 2011, 38 percent of people in Ireland aged 25-64 held a third-level qualification or higher (OECD 2013, p. 38). In respect of

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\(^5\) Ireland’s Central Statistics Office (CSO).

\(^6\) Seasonally adjusted rate of unemployment.

\(^7\) Q indicates years’ quarter: Q1 represents an aggregate of figures for January, February and March; Q2 for April, May and June; Q3 for July, August and September; and Q4 for October, November and December.
different age groups, 47 percent of people in Ireland aged 25-34 had a third-level education in 2011, compared to 30 percent in 2005 (OECD 2013, p. 37). This places Ireland well above the OECD average of 39 percent and 26 percent respectively, behind only Canada, Japan and South Korea for the same age group (OECD 2013, p. 33). Overall, countries within the OECD area have also experienced increases: from 2000-2011, the average annual growth rate of number of adults with a tertiary education was 3.3 percent (OECD 2013, p. 38). This has resulted in 32 percent of adults aged between 25-64 years with such an education in 2011 (OECD 2014, p. 37).

Considering also the levels of innovation activity and investment (details provided in Section 1.2), as well as the exponential increase in levels of education amongst its workforce may lead to a decrease in the competitive advantage garnered by employers, all indicate that Ireland serves as an interesting case study when examining the effect of Innovative Human Capital on firm-level innovation.

**Defining key concepts**

As previously outlined, the aim of the current research is to analyse the effect of a holistic concept of Innovative Human Capital on firm-level innovation and to identify factors that support the new concept. In order to understand and contextualise Innovative Human Capital it is necessary to first define a number of key concepts, including the firm, innovation and human capital. These definitions are followed by a brief outline of the elements of Innovative Human Capital and the underlying importance of such a new concept. While this section briefly explains the key concepts, detailed descriptions of each are presented in subsequent chapters of the thesis.

**The firm:** Grant (1996) suggests that no single, multipurpose theory of the firm exists; however, for the purposes of the current research, the firm is defined as *a privately owned organisation with productive resources that*

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OECD (2013) measures tertiary as third-level degree or higher.
produces goods and/or services and employs at least one person. This definition is drawn from the discussion of the theory of the firm and firm growth presented in Chapter 2.

Innovation: Also drawn from the literature review is the definition of innovation. Innovation is a complex issue to define. Like the theory of the firm, innovation may be viewed as “a multi-faceted phenomenon and [therefore] the translation of theory into actual realization requires an open and flexible structure” (Lambooy 2005, p. 1146). Until relatively recently, innovation was described as a set of pre-defined actions by the firm (also known as a linear model) (Trott 2005). This model has for the most part been replaced by evolutionary theory, which considers innovation as a complex system of actions and collaborations between many actors (e.g., researchers, management, public institutions, customers and suppliers) (Rosenberg 1994; Nelson and Winter 1982). For the purpose of defining key concepts here, and based on the literature review outlined in detail in Chapter 2, innovation is the commercialisation of new or significantly improved ideas. These ideas may be in the form of products, process or services; again these are discussed further in Chapters 2 and 4.

Human capital: As alluded to earlier, the innovation literature is dominated by exploration of factors that determine innovation. The current research is based on the notion that human capital is one such determinant. Human capital is a determinant of national innovation activity (Furman et al 2002; Schneider et al 2010) and firm-level innovation (Leiponen 2005; Reichstein et al 2008); it has traditionally been measured primarily by education and training. The knowledge-based theory of the firm emphasises the central role of the individual as the source and creator of knowledge (Grant 1996). Effective human capital promotes growth and development by increasing the productivity of labour and capital (Mathur 1999); it is the cement that holds “knowledge and innovation systems together” (Soete 2007, p. 279). As such, it is considered an important source of sustained competitive
advantage\(^9\) (Coff and Kryscynski 2011). However, as education levels increase and the proportion of the workforce with a third-level education grows, particularly in developed economies, the competitive advantage provided by employees with third-level degrees may decline. Given this potential loss of competitive advantage, there is a need to examine the other elements inherent in the individual; these elements may be more difficult to quantify.

*Innovative Human Capital:* The new concept of Innovative Human Capital captures the important standard elements of education and training, and uniquely adds intangible and perhaps the more innovative elements of the individual. In other words, Innovative Human Capital is concerned not only with whether managers employed by firms in Ireland have attained a third-level degree or higher, but also whether they have availed of training provided by the firm, their willingness to change in the workplace, and their satisfaction in the job.

While the tangible elements of education and training are relatively easy to understand, the two intangible elements require a brief explanation at this juncture (an in-depth discussion is provided in Chapter 4). Willingness to change in the workplace includes for example, willingness to change how work is carried out, willingness to change the level of technology used in the workplace and willingness to work unsociable hours is used. Employee-manager’s job satisfaction is measured using such issues as: whether the employee-manager is satisfied with pay, conditions, the physical working environment, whether the manager feels loyalty to the firm.

Taken together, the four elements comprise a multi-dimensional measure of the employee-manager human capital. Considering the complexity of human capital and understanding that its accumulation is more than the effect of education and training (Gallié and Legros 2012), the current research

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\(^9\) In this context competitive advantage can be described as follows: “an enterprise has a competitive advantage if it is able to create more economic value than the marginal (breakeven) competitor in its product market.” (Peteraf and Barney 2003, p. 314).
departs from previous studies by measuring Innovative Human Capital (adopting a holistic approach). Incorporating such a holistic concept overcomes the limitations of the uni-dimensional (the tangible education and training) measure used previously.

The purpose of this introductory chapter is primarily to provide the rationale for the research (Section 1.2). In this context the contributions of the research are presented in Section 1.3 followed by an outline of the structure of the thesis in Section 1.4. Section 1.5 concludes the first chapter and introduces the review of pertinent literature.

1.2 Rationale for the Research

The rationale for the research is presented in this section followed by its objectives. As briefly discussed earlier, based on a substantial review of the literature, the importance of innovation for firms’ growth and survival is the underlying rationale for the current research coupled with the fact that individuals are a key part of innovation (OECD 2011a).

Most countries have experienced enormous economic and social changes over the past thirty years; these changes are prompted by developments in communications, science and technology, and are generally referred to as the ‘knowledge economy’ (Esposto 2010). Such changes rely on innovations in products, services and organisational processes, and involve a broad range of new knowledge (Toner 2011). The level of innovation activity presented in the most recent available EU-led innovation survey *Innovation Union Scoreboard*\(^{10}\) illustrates the change in the level of innovation in EU member states from 2006-2013 (European Commission 2014a). Figure 1.1 provides information on the growth rates for a selection of member states. Across the EU27\(^{11}\), the average innovation performance growth rate over the period 2006-2013 is 1.7 percent (European Commission 2014a).

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\(^{10}\)The *Innovation Union Scoreboard* (2014) measures eight innovation dimensions and 25 indicators to analyse the performance of the EU innovation system.

\(^{11}\)EU27 refers to 27 member states of the European Union.
Commission 2014, p. 23). Countries described as Innovation Followers, (e.g. Netherlands, Austria, Belgium, Ireland and Estonia) have all experienced increased growth rates. However, Ireland had only a 0.9 percent increase over the same period (2006-2013), well below the EU27 average. Estonia displays the largest growth rate of 3.7 percent (p. 23). It is also interesting to note that Ireland’s ranking in the individual measures employed by the survey indicates relative weakness in Irish firms’ non-R&D innovation investment (p. 50). This is in stark contrast to other countries in the Innovation Follower group, as well as the more advanced Innovation Leader group.

**Figure 1.1** Summary of Innovation Index Growth Rates for selected EU Member States 2006-2013.

![Growth Rate 2006-2013](image)

**Source:** European Commission (2014, p. 92).

As alluded to earlier, the significance of a continuous increase in innovation activity as a source of growth and survival is also an underlying motivation for the current research. Meanwhile, both firms and policy makers are faced with significant constraints in light of the recent economic difficulties and
the associated reduced budgets available to support innovation. In Ireland, support for R&D and innovation has long been supported by public finances (Forfás 2013c). This support has fluctuated between 2003-2012, with an overall decrease of 13 percent between 2009 (when the highest figures occurred) and 2012 (OECD 2014). This trend in government financial support for R&D corresponds broadly with the proportion of public spend in relation to Gross National Product (GNP) (Forfás 2013c). Figure 1.2 illustrates this fluctuation. This decrease in support indicates a need for firms to take advantage of existing resources available to them: human capital is one such valuable resource.

**Figure 1.2** Ireland’s government budget appropriations and outlays on R&D (GBAORD) as a percentage of GNP

![Ireland's GBAORD % GNP 2003-2012](image)

**Source:** Data from *Business Expenditure on Research and Development* Forfás (2013c).

As pointed out earlier, according to Becker (1993) investment in education and training is an important investment in human capital. This supports Mincer’s (1962) finding that formal schooling is not sufficient as a method of training the labour force; rather, it is the end of a more general and preparatory stage. Human capital in turn provides a competitive advantage
for firms (Hewitt-Dundas 2006) and consequently, firms and policy makers can reap strategic benefits by identifying and evaluating the competitive advantage yielded by employees’ human capital.

However, in light of the continuous increase in educational attainment, the competitive advantage garnered from employees’ higher levels of education may no longer be sufficient for firms; this is particularly significant given the importance placed on innovation for firm growth. Hence, measuring and defining human capital only in terms of education and training (i.e., tangible elements) is too narrow a focus. People are not merely a product of their education (Gallié and Legros 2012); a study of human capital from a multi-dimensional perspective is necessary. When these multi-dimensional elements such as job satisfaction and willingness to change in the workplace are understood, firms can support and develop Innovative Human Capital as a valuable resource, in the same way that they invest in education and training to improve productivity (e.g. Becker 1993; Black and Lynch 1996), and in other types of assets such as physical capital (Coleman 1988).

Following from the above discussion on the motivation for the current research, the related research objectives and questions are outlined in the next section.

**Research Objectives**

The current research poses three questions, which in turn inform three research objectives. The theory underpinning each objective is detailed in subsequent chapters of this thesis.

The first question is as follows: Does Innovative Human Capital contribute to firm-level innovation?

This question gives rise to the first research objective:

- To extend the standard measure of human capital by creating a novel concept of Innovative Human Capital and to estimate its effect on firms’ innovation
Given the primary objective above and in order to further understand Innovative Human Capital, a second question arises: What factors support Innovative Human Capital? To this end the second objective is as follows:

- To examine the internal and external firm factors that may be causally connected to Innovative Human Capital, specifically the support offered by the firm and by the region in which the firm is located.

Resulting from the two questions above, a further question emanates from a policy perspective: What are the implications of Innovative Human Capital for innovation policy? From this the third objective is as follows:

- To consider the implications of Innovative Human Capital for innovation policy.

In order to address these questions and objectives, the theoretical framework underpinning the research is presented in Chapters 2 and 3. The review of the literature helps to formulate sixteen hypotheses, which are presented in Chapters 4 and 5. Having presented the objectives and related research questions, the next section outlines contributions to knowledge emanating from the findings of the current research.

### 1.3 Contributions of the Current Research

Using Ireland as a case study, the research builds on the traditional formal education and training to measure human capital as a determinant of innovation. To the best of the author’s knowledge, this research is the first to estimate employee-managers’ Innovative Human Capital as a determinant of innovation. In addressing the three research questions posed above, the research makes a number of contributions to the knowledge base.
Theoretical contributions

- The current research provides a holistic approach to human capital and creates a novel and multi-dimensional concept of Innovative Human Capital as a valuable determinant of innovation.

- Innovative Human Capital encapsulates both the traditional (tangible) elements of the individual employee-manager and the more innovative (intangible) elements of their job satisfaction and willingness to change in the workplace.

- The creation and development of the holistic Innovative Human Capital concept while embracing the traditional measures of education and training contributes to an emerging debate in the innovation literature on measuring human capital beyond education and training (Arvanitis and Stucki 2012; Ganatakis 2012; Fitjar et al 2013).

Methodological contributions

- This research creates a new dataset. This multi-level merged dataset provides information on managers employed by firms located in Ireland, including their age, gender, educational attainment, willingness to change in the workplace and satisfaction with their job. In addition, the 1070 observations provide information on the firms’ work practices and innovation activity, as well as information on the regions where the firms are located (including level of diversity in the workforce, entrepreneurship activity and regional R&D activity).
• While Ireland is used as the case study for the current research, the methodological approach applied and analysed here has the potential to have broad-based application regardless of country context.

• The research considers three types of innovation: product, process, and service innovation. This in itself is not new, but the manner in which the current research uses these multiple types of innovation in the Irish context is rare\textsuperscript{12} and provides insights into whether various types of innovation demand different levels of Innovative Human Capital.

  o Empirical contributions

• Results from the econometric analyses show the effect of Innovative Human Capital on firms’ innovation. These results provide evidence that Innovative Human Capital may be more valuable to small firms\textsuperscript{13}, especially in relation to training and job satisfaction, with a mixed result for willingness to change. For larger-sized firms, Innovative Human Capital is particularly significant with respect to process innovation.

• Further analyses provide evidence that firms that provide work practices and work arrangements (such as alternative pay and conditions and information sharing with employees) are more likely to employ managers displaying the different elements of Innovative Human Capital. In limited cases, firms’ location is also a supporting factor for Innovative Human Capital.

\textsuperscript{12}While most studies estimate product and/or process innovation (e.g., Doran \textit{et al} 2012; Becker and Egger 2013) or service innovations (e.g., Love \textit{et al} 2010; Perks \textit{et al} 2013), to the best of the authors knowledge this is the first to estimate product, process and service innovation in an Irish context.

\textsuperscript{13}Small firms refer to those employing less than 50 employees; larger-sized firms employ more than 50. A full discussion on this issue is presented in Chapter 4.
Practical and policy contributions

- Given the emphasis on innovation in Irish policy (DJEI 2012; 2013; 2014) as well as the central role of innovation in European policy (European Commission 2010), the current research proposes a policy offer (Innovative People 4 Growth) that provides policy makers with an evidence-based programme with which to support the new concept of Innovative Human Capital, thus driving firms’ innovation activity.

- The logic model (adapted from Lenihan (2011)) provides a robust evaluation tool with which policy makers can evaluate (ex-ante) the new offer, Innovative People 4 Growth.

- The transferability of the findings from the research, by way of the proposed policy offer, strengthens the link between academic research, policy makers and firms.

Based on the above discussion, the next section provides a synopsis of the research design followed by an outline of the research structure.

1.4 Research design and structure of the thesis

In order to answer the first two research questions posed earlier, the empirical analysis comprises three stages. The first stage is the creation of the new Innovative Human Capital concept; the second stage focuses on the effect of Innovative Human Capital on firms’ innovation activity. The third stage is concerned with the factors that support firms’ Innovative Human Capital; namely, internal firm work practices and arrangements, as well as supports that may exist outside the firm in the form of regional level entrepreneurship activity and the diversity of the regional workforce. A
unique multi-level merged dataset, created by combining information from four sources using a common identifier, allows the current research to use quantitative analysis. From a policy perspective, and to address the third research question, the research explores current policy and programmes from Ireland, Europe, and beyond to assess the effectiveness of existing direct and indirect programmes, which may support Innovative Human Capital.

Figure 1.3 presents an outline of the framework for the research and the stages of analysis. This framework is discussed in detail in Chapters 4 and 5.

**Figure 1.3 Research Framework**
Structure of the thesis

The theoretical framework underlying this research is grounded in a comprehensive approach to the literature and theory, including economics, management, and human resources. Chapter 2 presents a review of innovation theories, sets out a definition and outlines the determinants of innovation. Chapter 3 provides an in-depth discussion of human capital, including the history of the study of human capital, its various definitions and an explanation of how this resource is treated by the innovation literature.

Chapter 4 presents the first two stages of analysis undertaken by the current research. The chapter explains in detail the creation of the novel concept of Innovative Human Capital, the elements related to the concept, and the rationale for using each element. Most importantly, this chapter poses the question: How does Innovative Human Capital affect firm-level innovation? In order to answer this central research question and estimate the eight research hypotheses, the creation of the unique multi-level merged dataset is explained. The analysis estimates multiple logit regressions, where innovation is the dependent variable; Innovative Human Capital (the variable of particular interest here) is used as an independent variable, along with a number of control variables to account for other possible determinants of innovation at the level of the firm.

Chapter 5 explores the third stage of analysis and the factors that may support Innovative Human Capital. Based on the literature, these include both the external and internal factors outlined earlier. The literature provides information to formulate a further eight hypotheses. Findings from the analyses presented in Chapter 4 and 5 raise possible implications for public policy. Chapter 6 explores such implications. The chapter initially outlines the rationale for government policy in general terms and tracks the changes in justification for public intervention. The chapter then investigates Irish policy that promotes innovation. In addition, the research explores current policies and programmes from a number of developed economies to assess the possible effectiveness of existing direct and indirect programmes, in
promoting Innovative Human Capital. In line with current Irish policy to promote job creation and economic growth, and in an attempt to operationalise the valuable concept of Innovative Human Capital for innovation, a new policy offer is proposed. The new offer is designed to encourage firms to promote Innovative Human Capital as a competitive resource. The research argues that firms and policy makers who view human capital through a holistic lens (considering the value of the tangible as well as the intangible elements of the individual) may enhance returns on investments and support for innovation.

The final chapter provides a summary of the main findings of the research and presents key contributions to both the academic literature and practitioners, including employers and policy makers. It also sets out the limitations of the research and suggests opportunities for future research in the field.

1.5 Conclusion

Despite the plethora of literature on innovation and the large volume of empirical studies on what determines innovation, a holistic measure of human capital as a determinant of innovation is yet to be embraced. This may be as a result of the difficulty of measuring the unknown (Kramer 2008); more specifically, the difficulties in measuring intangibles (Coronado et al 2008). The thesis, in essence, extends the standard measure of human capital by developing a multi-dimensional holistic concept. The novel concept of Innovative Human Capital, while including the traditional measures of education and training moves further to include two more innovative elements: employee-managers’ willingness to change in the workplace and their job satisfaction.

This chapter provided an overview of the key concepts, a rationale for the research and a brief description of Ireland’s economy as the location for the research. In presenting the contribution of the current research, the chapter
also highlighted that the findings not only contribute to the academic literature and provide a valuable addition to the current debate on human capital as an input to firm-level innovation, but also have the potential to inform innovation policy and support firms in their innovation activity. Based on a broad theoretical framework, the next chapter provides a review of innovation-related literature, followed in Chapter 3 by a review of human capital-related literature underpinning the research. Figure 1.4 outlines the complete structure of the seven chapters in this thesis.
**Figure 1.4** Structure of the thesis chapters

- **Chapter 1**
  - Introduction

- **Chapter 2**
  - A survey of the literature on innovation as a source of firm growth

- **Chapter 3**
  - Human capital as a determinant of innovation

- **Chapter 4**
  - Developing the concept of Innovative Human Capital and estimating the effect on firm-level innovation

- **Chapter 5**
  - The impact of firm and regional factors on Innovative Human Capital

- **Chapter 6**
  - Innovative Human Capital: Is there a role for public policy?

- **Chapter 7**
  - Conclusion
2 A survey of the literature on innovation as a source of firm growth

2.1 Introduction

This chapter provides a theoretical framework to underpin the current research by reviewing literature in the context of firm-level innovation. In order to analyse Innovative Human Capital (IHC), it is important to establish the theoretical framework on which it stands. Given the plethora of literature related to innovation, this chapter first traces its origins and considers how history has shaped contemporary understandings of innovation, particularly from the firm’s point of view. Taking a multidisciplinary approach to the literature, results in an appreciation of the importance of innovation for firm growth while deepening an awareness of its complexity.

The word innovation is derived from the Latin word innovat meaning ‘renewed’ or ‘altered’, from the verb innovare, meaning ‘to make new’ (OED 2012). The literature lacks an authoritative definition of innovation; its meaning has evolved from early writings (e.g. Schumpeter 1934) which referred to innovation as technical or scientific progress, to a definition which considers non-technical change to be an innovation (Grupp 1998).

As alluded to in the introductory chapter, the study of innovation is not a new phenomenon; the concept has been a topic of much debate since the 1980s (Fagerberg 2005) and is the focus of many research reports, books, articles, and policy programmes and documents (Leiponen 2005). In fact, it has shaped how today’s world operates (e.g. telecommunications, electricity, or earlier again, the wheel and printing) (Fagerberg 2005). A variety of theoretical fields influence its study, including economics, management, psychology, and science and technology.
A considerable amount of research has been dedicated to macro-level analysis of how innovation can be developed and its contribution to society. Florida (2004), for example, emphasises the links between creativity, innovation and economic growth; McCann and Simonen (2005) stress the role of geography in the promotion of innovation; creative clusters and innovation (Chapain et al 2010), while Lundvall (1995) focuses on national innovation systems and interactive learning. At firm level, the focus is mainly on the exogenous determinants of innovation, for example: workforce diversity (McGuirk and Jordan 2012); firms’ openness and linkages (Love et al 2011) and constraints of resource and capabilities on innovation (Hewitt-Dundas 2006). Firm size as a factor of firms’ innovation has long been a focus in the literature; a topic discussed later in this chapter (see Section 2.5). The examination of other internal determinants of firm-level innovation, which was in its infancy at the beginning of this century, is now a developing debate in the literature (Lockett and Thompson 2001). Leiponen’s (2005) study of skills and innovation, Jones’ (2009) study of knowledge and innovation and employee diversity on innovation (Østergaard et al 2011) all provide examples of contemporary debates.

In the context of the discussion above and to address the research objectives outlined in Chapter 1, the remainder of this chapter is structured as follows: a review of the original theorists in the areas of invention, innovation and technical change as sources of firm growth is presented in Section 2.2. This review provides the foundations of the theoretical framework underpinning the study and highlights how the theory of innovation has evolved over time. In order to emphasise the importance of innovation for firms Section 2.3 considers the theory of the firm, firm growth and the firm’s treatment of innovation. Developing the theoretical framework further, Section 2.4 discusses economic theories in the context of firm-level innovation; these theories include neoclassical and evolutionary theories, as well as the closely related theories of resource-based view and knowledge-based view of the firm. Section 2.5 draws on the literature to provide a definition of innovation in order to establish a clear understanding of the prime concept.
underlying the study. This section also provides a discussion on various determinants of firm-level innovation, so as to highlight the theory motivating the key objective of the current research: to develop IHC as a valuable determinant of firm-level innovation. Section 2.6 concludes the chapter and introduces the next, which reviews the literature related to human capital.

2.2 Early economic and innovation theorists

This section looks at the history of economic theory and its treatment of innovation, and how this treatment contributes to contemporary innovation theory. Tracing the history also highlights the development of innovation as a concept and lends credence to the definition of innovation employed for the purposes of this thesis.

Most textbooks and current literature highlight the works of three authors as central to the development of innovation theory: Adam Smith (1723-1790); Karl Marx (1818-1883); and Joseph Schumpeter (1883-1950) (Grupp 1998; Audretsch and Link 2012; Swann 2009). John Rae (1796-1872), a lesser-known economist of the 19th century, should also be acknowledged as a major contributor to the literature on innovation. The above authors recognised the value of invention and innovation in the creation of wealth and growth. However, not until the publication of Joseph Schumpeter’s work (1934; 1942) did innovation become a key component of economic thought.

The founder of modern economics, Adam Smith, first raised the notion of innovation. In his 1776 classic *The Wealth of Nations*, Smith recognised the centrality of technological invention in economic progress and productivity, specifically in terms of the improvements brought about through developments in machinery (Freeman 1982). Smith also argued that division of labour allows for greater progress, as it permits individuals to become more expert in their own branches of work, thereby facilitating
change and developments in the science related to their fields of expertise (Swann 2009; Grupp 1998; Desrocher 2001).

Karl Marx expanded Smith’s theory by asserting that division of labour increases productivity and the accumulation of capital through scientific advances and technical change, and is therefore the driving force of economic development (Marx 1867/2007; Fagerberg et al 2005; Grupp 1998). John Rae (1796-1872) was the first to argue that invention was a central source of the wealth of nations (Brewer 1998). This nineteenth-century Scottish economist’s main focus was capital. His theory of economic development, involving technological change and capital accumulation, influenced Schumpeter’s work and critiqued Adam Smith’s theory of wealth creation (Hamouda and Mair 1998). Rae saw invention as the primary cause of growth and argued that the growth of economic prosperity must be spurred by adopting new methods of production, and that these must be invented (Hamouda and Mair 1998).

However, Joseph Schumpeter an economist from the Austrian School, is cited as the principal founder of innovation theory (Grupp 1998; Fagerberg et al 2005). Described as the twentieth century’s most radical scholar in the discipline of economics (Rosenberg 1994), Schumpeter focussed attention on the roles of science, technology, and entrepreneurship in explaining the differing growth rates of the economy, at both microeconomic and the macroeconomic levels (Schumpeter 1934). Schumpeter (1934) drew on Marx’s theory that capitalist economic processes involve changes in production following technical change. In his book The Theory of Economic Development (1934), Schumpeter explains the circular flow of the economy and the tendency towards equilibrium. In this context, he explains that all goods find a market and that the circular flow of the economy is closed, in that the sellers are also the buyers. He emphasises, the economy will not change impulsively but as a result of preceding situations (Schumpeter 1934). In addition to the circular flow, he introduces the notion of development leading to growth:
Development in our sense is a distinct phenomenon, entirely foreign to what may be observed in the circular flow or in the tendency towards equilibrium. It is spontaneous and discontinuous change in the channels of the flow, disturbance of equilibrium, which forever alters and displaces the equilibrium state previously existing.

(Schumpeter 1934, p. 64).

These discontinuous changes, which Schumpeter termed ‘new combinations’, is not as a rule carried out by the same people. He uses his own example (“in general it is not the owner of stage-coaches who build railways”) to illustrate his theory that new combinations are inherent to the process by which development build upon preceding situations (Schumpeter 1934, p. 68). Thus, opportunities may create competitive advantage (and growth based on gains) through either the “discovery of cost-reducing innovations or by imitating the industry best practice” (Coad 2009, p. 106). This leads to Schumpeter’s concept of ‘creative destruction’, which has been described as the engine of growth (Grossman and Helpman 1991; 1994; Romer 1990; Aghion and Howitt 1992). The theory of firm growth has developed over decades and has produced many theories on how firms grow and survive; Schumpeter’s ‘creative destruction’ has become the central theme of modern innovation literature.

While Schumpeter’s earlier work (1934) hones in on the merits of small and new firms as sources of innovation, his later work *Capitalism, Socialism, and Democracy* (1942) focuses on the large-sized firm and its competitive advantage over small firms. He cites economies of scale in research and development (R&D), management capabilities, access to finance, and risk spread as giving particular advantages to the larger-sized firm. These advantages allow the larger firm to exploit new technologies and enhance product development. It is clear from the early theorists that change and advancement is necessary for firm growth. To grasp the theoretical framework underpinning the research it is crucial to understand innovation
in the context of firm growth. The next section expands the discussion beyond the key innovation theorists to include firm growth theorists and economic theories of innovation.

2.2.1 The key theories of firm growth

This section examines the theory of the firm (given that the firm is the level of analysis for this research), looking at early economic philosophies before embarking on an examination of two economic theories that address innovation in a broad sense: namely, neoclassical and evolutionary approaches. This theoretical analysis provides the information on the fundamental principles of firms’ objectives and approaches to innovation. This is followed by a review of the alternative theories of the firm: specifically, the resource-based view (RBV) of the firm and the closely related knowledge-based approach, which also contributes to the theory supporting the research.

Traditionally, the firm’s objective was seen simply as “that of acquiring and organizing human and other resources in order profitably to supply goods and services to the market” (Penrose 1995, p. xi). In past decades, the size of the firm was seen as the source of success and growth; it was believed that small firms had a competitive disadvantage compared to larger firms (Bentzen et al 2012). Established economic theories in the early part of the 20th century were based on the ‘Fordism’ style of mass-production, which involved large assembly lines for production and economies of scale (Coad 2009), which became the ‘in’ way of doing business at the time. Currently scholars agree that there is no single, multipurpose theory of the firm; theories of the firm are based on the nature of the business enterprise and are designed to address the characteristics and behaviours of the firm (Grant 1996).

The most seminal discussions on firm behaviour and growth emanate from the works of Alfred Marshall (1895), Coase (1937) and Penrose (1959).

14 First published in 1959 the 1995 edition is used throughout this research.
Coase’s (1937) seminal paper *The Nature of the Firm* changed how people think about firms (Williamson and Vinter 1993). His transaction cost theory centres on the efficiency of authority-based hierarchies and markets (Coase 1937). The theory argues that the firm is a system of organising production, which determines the relationship between the firm and the larger economy. As firms grow there may be diminishing returns to the entrepreneur caused by the “costs of negotiating and concluding a separate contract for each exchange transaction…”; these costs vary across firms (Coase 1937, p. 390). Penrose (1995), an eminent scholar on the theory of firm growth, first published her book *The Theory of the Growth of the Firm* in 1959; this formed the foundation of modern firm growth theory. Firms are a central unit of economic analysis, and the nature of economies is defined by the type, size, and composition of their firms (Penrose 1995). Penrose described growth in a number of ways: growth in output, exports and sales, as well as improvements in quality or increases in size.

The connection between firms’ size and growth is the focus of ongoing debate in the literature. While Gibrat’s Law states that firm growth is independent of firm size, Evans (1987) rejects this. In his analysis of excess of 42,000 US firms operating in 100 manufacturing industries, he found departure from Gibrat’s Law decreases with size; that is to say, firm growth decreases at a diminishing rate as firms get larger. This is of particular significance for the current research in that the empirical analysis addresses both small and larger-sized firms.

The emphasis of early theories on optimal firm size was the basis of what is known as the neoclassical theory of firm growth. It was assumed that big was best, and that once a firm reached its optimal size, it would not grow any more. This notion was superseded by the advent of the computer software and chemical industries; the blanket hypothesis that ‘big wins’ has been undermined by the reality that small new firms can now make outstanding contributions to innovation (Freeman 1982).

The age of the firm, its ownership structure, legal status, capital intensity and management structures are all cited as firm-specific factors associated
with firm growth. The age of the firm appeared in the empirical literature of Fizaine (1968), who studied French firms. She found that age had a negative effect, in that growth decreases with age. Location of the firm has also been cited as a factor relating to firm growth: Audretsch and Dohse (2007), for example, refer to new economic geography and endogenous growth literature suggesting that spatial growth will be greater if knowledge spillovers are higher.

Given the continued debate on firm size and location alluded to above, it is interesting to note that Penrose (1995) rejected the notion that firms develop like living organisms in the natural world, and that human decisions have no place in the process of firm growth. Instead, she highlighted the connection between growth and particular groups of humans performing a task. Her fundamental contribution to the theory of firm growth, as described by Coad (2009, p. 102), was that “internal momentum (is) generated by learning by doing, managers become more productive over time as they become accustomed to their tasks”. The firm described by Penrose is distinguished by its ability to use its resources productively to produce and sell goods and services. Given that human capital is a resource available to the firm, this notion of the firm’s ability to use its resources is particularly relevant to the current research. Penrose (1995) stresses the importance of the idiosyncratic resources possessed by the firm, including brand names, in-house knowledge of technology, skilled personnel, and efficient procedures. Routines are also considered as an organisation-specific resource (Winter 1995). These resources can give the firm an important competitive advantage.

Likewise, the growth of the firm depends on the extent to which it acts upon opportunities, and it is assumed that the firm is “willing to find opportunities and is not hindered in acting on them by ‘abnormally’ incompetent management” (Penrose 1995, p. 32). Coad (2009) identifies two forms of firm growth that can result from acting on such opportunities: sales growth and employment growth. Although there is ample empirical research on the positive effects of innovation on firm growth, the scale of the impact varies. According to Coad (2009), the effect of firm-level innovation on
employment growth is unclear. On the one hand, innovation is associated with improved productivity, which may lead to the need for fewer employees. On the other hand, product innovation may lead to increased demand/sales for the firm, thus potentially resulting in growth in employment (Coad 2009; Grupp 1998). The relationship between innovation and sales growth is a paradox; theories of firm growth emphasise the importance of the role played by innovation for firms that want to expand market share, but few empirical studies identify strong links between innovation and sales growth. One reason for this lack of evidence may be the time lag between innovative acts and their conversion into economic returns for the firm (Coad 2009), an issue discussed further in Chapter 7.

After exploring a number of theories of firm growth, the question remains as to how innovation contributes to this growth? To address this issue it is necessary to expand the focus of this review to examine some broader economic theories and assess their perspectives on innovation. Such a review explains the formation of the hypothesis that innovation contributes to firm growth, as well as highlighting the complexities of innovation.

2.3 Economic theories of innovation

The choice of theory underpinning research will always depend on the question being asked; addressing this question may require a combination of insights derived from a number of theories (Lambooy 2002). Therefore, this section provides a focused review of innovation theory at firm level. Innovation first appeared in the neoclassical literature in the 1960s (Grupp 1998) and it is to this the next section turns, followed by a discussion on evolutionary theory. The latter was developed from the seminal work of Richard Nelson and Sidney Winter’s (1982) An Evolutionary Theory of Economic Change, which describes innovation as complex and involving changes in routine.
2.3.1 The Neoclassical view of innovation

Central to neoclassical economics is the allocation of resources in a static sense; that is, the market is central and constitutes the “sole institution generating the prices upon which individuals and firms base their decisions” (Audretsch and Link 2012, p. 4). Audretsch and Link point out that the neoclassical analysis of the economy is based on mathematical models as opposed to the study of individuals, firms, and regions; therefore, innovation tends to be on the periphery of this approach. Reflecting this static view, early neoclassical ideas of innovation relied on the linear model of technical and scientific invention (Kline and Rosenberg 1986): a well-defined set of stages for conducting research, followed by development, and then by production and marketing. This simplistic linear model was in common use in industrial policy after World War II (Trott 2005).

The theory continued post-war with Arrow’s (1962) contribution to modern innovation theory. Arrow (1962) cites structure as an important issue, considering that full competition (as opposed to a monopolistic position) stimulates innovation. Though he states that a free enterprise economy would under-invest in research, as it is deemed a risk, he points out that knowledge (core to innovation), as a public good is not easily excludable. However, other scholars have taken an opposing view to the non-excludable nature of knowledge, where advancements in the area of intellectual property rights can protect knowledge (Mansfield 1995; Pisano 2006).

Taking a neoclassical approach to innovation, Von Hayek’s (1937) analysis of economic theory and the competitive society investigates the importance of knowledge. He argues that equilibrium is disrupted by interaction between people as they acquire new knowledge. This disruption, over time, may lead to competition and eventually growth; such disruption could be particularly pertinent where innovating firms look for opportunities (Grupp 1998). Contemporary neoclassical models assume that price, production volumes and R&D are important, though the latter is seen essentially as a wild card in terms of accounting for success (Verspagen 2005).
In contrast, Rosenberg (1994) takes issue with the neoclassical assumption that there can be perfect knowledge of the production-possibilities frontier, as well as with the linear model of innovation. Both of these neoclassical concepts run counter to the “recognition that producers and innovators only acquire information through experience, experimentation, and investment” (Rosenberg 1994, p. 6), which is corroborated by the empirical studies presented in his work. Interestingly, Schumpeter (1934) rejected the central principles of neoclassical theory as well as the view, held by the economist Léon Walras (1834-1910), that economic theory is based on general equilibrium, a state in which economic life is essentially passive and adapts itself to natural and social influences (Rosenberg 1994; Schumpeter 1934).

Given the significant advances in technology prompted an increase in the literature on ‘new growth’ theory, particularly with the publication of Romer’s (1986) and Grossman and Helpman’s (1991) models of growth, in which R&D is described as a process of endogenous growth (Verspagen 2005). It is also interesting to note that organisational theory addresses aspects of the firm ignored by neoclassical economics. In particular, by dispelling the notion of the firm as, “a singular decision taker and recognizing the firm as a complex organization encompassing multiple individuals, organization theory analyzes the internal structure of the firm and the relationship between its constituent units and departments” (Grant 1996, p. 109). In relaxing the neoclassical assumptions of perfect competition and decreasing returns to scale, endogenous growth theory describes innovation as the result of learning by doing and the move toward R&D (Laranja et al 2008). When innovation is seen as an endogenous factor in growth, firms have certain levels of incentives to invest in such activities (Laranja et al 2008).

These theories, however, give a somewhat limited understanding of innovation, which invokes a discussion on the aptly named evolutionary theory of growth; this theory captures the complexities of innovation in the context of contemporary economic conditions.
2.3.2 Evolutionary theory of innovation

The evolutionary approach to economics, based on the dynamic theory of competitive advantage, argues that the static, linear neoclassical model of firm growth is inadequate in the rapidly changing world of information technology. The evolutionary approach explores the sources of organisational differences, placing organisational capabilities at the centre of understanding firm behaviour; it examines what is in the ‘black box’ of the firm (Foss et al 1995; Rosenberg 1994). The integration of economics and organisational approaches to the firm has contributed to evolutionary theory of the firm (Grant 1996).

The evolutionary approach, also referred to as the neo-Schumpeterian approach, consists of loosely connected theories based on the importance of innovation, technology and the positive role played by government policy in science and technology (Verspagen 2005). This approach adopts, in part, the notion that the individual person cannot cope fully with the complexities of technology and innovation; individuals must rely on adaptive behavioural rules to make decisions (Verspagen 2005). The theory derives from the Darwinian principle of ‘survival of the fittest’, which emerged in growth theory in light of firms’ struggle for survival in a competitive environment (Dosi and Nelson 1994). Nelson and Winter (1982) highlight that skills, organisational capabilities and behaviours take a central role in explaining change within the firm. For instance, “individual skills are the analogue of organizational routines” and routines play an important role in organisational functioning as well as individual’s behaviour (Nelson and Winter 1982). Skills include individuals’ capabilities: for example, a competent carpenter, or a manager whose judgement is used to hire the correct candidate for a particular job (Nelson and Winter 1982). The same authors follow Marxian economic theory, stressing that, “capitalist organization of production defines a dynamic evolutionary system and that the distribution of firm sizes and profits also must be understood in terms of an evolutionary system” (Nelson and Winter 1982, p. 44).
Evolutionary theory proposes the idea that “innovation is shaped by crisis-driven search programmes by firms” (Mytelka and Smith 2002, p. 1467). Nelson and Winter (1977) describe uncertainty, institutional complexity, and diversity as salient attributes of innovation. They classify change in routine as one of Schumpeter’s ‘new combinations’. When there is an attempt to change a routine it is helpful if the existing routine is fully understood (Nelson and Winter 1982). They also suggest that change requires both trial and error and learning by doing to detect and solve problems, and recommend that new application of an existing routine be as free as possible of operational uncertainties. To clarify this notion of routines and innovation, they point to the fact that success “at the innovative frontier may depend on the quality of the support from the ‘civilized’ regions of established routine” (1982, p. 131). The behaviour of firms is considered to be shaped in part by innovation activities such as “creative problem-solving insights of scientists, engineers, and managers” (Nelson and Winter 1982, p. 135). Such sophisticated problem-solving efforts, coupled with the quasi-routine patterns of the firm, make it difficult for outside observers to identify the foundations of the evolutionary model.

As previously mentioned, skills are considered vitally important in the evolutionary approach to innovation, particularly with respect to organisational routines (Nelson and Winter 1982). Nelson and Winter describe such skills as ‘programmatic’ in that skills involve a sequence of steps, with each successive step triggered by the preceding one. They explain that the knowledge that “underlies a skilful performance is in large measure tacit knowledge – i.e. the performer of the performance finds it difficult or impossible to articulate a full account of the details and the skill often involves making choices” (1982, p. 73).

Evolutionary theory is based on the recognition that innovation involves change in routine, and that its nature is unpredictable. Building on this non-linear model and the value evolutionary theory places on the idiosyncratic resources within firms, the next section explores further the notion that resources are factors in firms’ growth.
2.3.3 The resource-based view of the firm

Firm growth is complex and “has a strong idiosyncratic character and as a result it is difficult to generalize across firms and circumstances” (Coad 2009, p. 110). This provides an explanation of how competitive advantage operates (Peteraf 1993) when resources and capabilities are seen as the foundations of sustained competitive advantage (Hadjimanolis 2000). Penrose’s (1995) notion of a firm’s possessing idiosyncratic resources is the foundation for the resource-based view of the firm. The RBV of a firm’s resources has helped economists “accept the importance of path-dependency in firm evolution” (Locket and Thompson 2001, p. 726). In the context of firms, jobs and growth, typical questions are: ‘Why do firms differ?’ and ‘How does it matter?’ (Lazonick 2005). It is argued that organisations have differing abilities to generate and gain from innovation, and differences in ownership of technologies, for example may be the source of differences across firms (Nelson 1991).

The RBV has evolved since the 1980s to refocus attention on internal sources of competitive advantage (Foss et al 1995) and is based mainly on the work of Penrose (1995), Teece (1980) and Richardson (1972). As noted by Locket and Thompson (2001), each firm’s collection of resources is unique; in an applied sense, RBV could be used to explain the process of determining, exploiting, and developing a firm’s sets of opportunity.

RBV of the firm is not so much a theory of firm structure and behaviour as an attempt to explain why some firms can sustain a competitive advantage and, in so doing, earn superior return (Grant 1996). The RBV perceives the firm as a unique bundle of idiosyncratic resources and capabilities (Coad 2009; Grant 1996; Penrose 1995). These unique bundles should be characterised for the most part by rare, unique, and non-substitutable resources and capabilities (Coad 2009). In addition, as noted by Combs and Ketchen (1999), firms require resources that are not capable of easy imitation by rivals.
In the RBV of the firm, the “primary task of management is to maximize value through the optimal deployment of existing resources and capabilities, while developing the firm’s resource base for the future” (Grant 1996, p. 110). One such resource is the firms’ organisational routines; this highlights the link between evolutionary theory and RBV (Winter 1995). RBV can provide many insights into firm behaviour and firm heterogeneity arising from the past accumulation of resources (Locket and Thompson 2001). The approach tends to see differences in performance across firms as the result of differences in efficiency rather than differences in market power (Foss et al 1995).

Roper et al.’s (2008) work on modelling the innovation value chain relates firms’ innovation output and performance to knowledge sourcing and internal resources. The study uses information on manufacturing firms in Ireland, and is consistent with a resource-based perspective on the growth and development of the firm. Similarly, Hadjimanolis (2000) uses the RBV to explain the determinants of innovativeness in small firms in the small island nation of Cyprus. Centred on the principle that technological innovation is the basis for competitive advantage, Hadjimanolis’s study holds that resources and capabilities develop and sustain competitive advantage. Evidence from this case study reveals that internal “capabilities explain to a considerable extent the differences in innovation behaviour of small firms” (Hadjimanolis 2000, p. 278). These capabilities include the key role of the owner manager, their characteristics (e.g. age, tenure and work experience), technological resources, and innovative capabilities such as machinery adaptation and design capabilities.

RBV emphasises the opaque relationship between resources and competitive advantage; a ‘causal ambiguity’ obstructs an outsider’s ability to analyse the sources of success and thus makes it difficult to measure relevant factors, especially where intangible assets are concerned (i.e. firm culture or capabilities inherent in the firm) (Lockett and Thompson 2001). RBV encounters difficulties when used to analyse the complexities of the firm and to identify successful or valuable resources, since these cannot usually be labelled a success until ex-post (Foss et al 1995). To respond to
these limitations and to further develop a robust view of the theory underpinning the current research, the next section presents the closely related knowledge-based view.

2.3.4 The knowledge-based view of the firm

The theory of knowledge was first introduced by Grant (1996) as a theory of the firm and, according to him, “represents a confluence of long established interests in uncertainty and information with several streams of newer thinking about the firm” (1996, p. 110). Grant’s (1996) knowledge-based theory emphasises knowledge as the most strategically important resource for firms, as it goes beyond strategic management and focuses on innovation in the firm. Building on the RBV theory of the firm, Grant (1996) identifies the need for the transferability of knowledge externally but also, and most importantly, within the firm. The knowledge-based view of the firm “offers a theoretical basis for understanding organizational innovations” (Grant 1996, p. 121). The theory analyses “coordination within the firm and the individual as the primary actor in knowledge creation and the principal repository of knowledge” (Grant 1996, p. 121).

Resources are often defined as tangible and intangible assets; a further distinction can be made between property-based and knowledge-based resources (Hadjimanolis 2000; Miller and Shamsie 1996). The centuries-old question, ‘What is knowledge?’ has been asked by philosophers from Plato to Popper, but there is no clear consensus on the answer (Grant 1996). The knowledge-based theory of firm growth attempts to address this by positing that the purpose of knowledge is to add value, for example, by production (whereby inputs are physically transformed into outputs) or arbitrage (through trade or speculation) (Grant 1996). The transferability of knowledge between firms for the purpose of firm growth is important, but it is even more critical that knowledge transfer occurs within firms. Grant (1996) considers the central role of the firm to be the transformation of knowledge inherent in the individual into goods and/or services.
Knowledge is categorised by Lambooy (2002) into three types: data, information, and knowledge proper; the last exists within the competences of individuals to judge, evaluate, reformulate, and solve problems. The “abilities and organizational routines of individual companies engaged in the same industry… can differ”, which further indicates the value of the unique merits of resources possessed by a firm – specifically, the extent of the available tacit knowledge (Grupp 1998, p. 392). Tacit knowledge is a key source of competitive advantage in the ‘new economy’, that is, knowledge-based economy (Cohen et al 2004). Know-how has always been the key to competitive success, but in the ‘new economy’ knowledge tends to be codified and portable, less controlled by its producers and users than was the case in mass production plants of the past (Cohen et al 2004). Changes in information and communication technology (ICT) may affect the interaction of firms with each other (Cohen et al 2004) and, for the purposes of the current research, the inputs from their workforce.

Central to Michael Polanyi’s (1966, p. 4) thesis regarding tacit knowledge, is the concept that “we know more than we can tell”, comprises conceptual and sensory information: guesses, hunches, and imaginings form part of discovery and creative acts (Smith 2003; Polanyi 1966). Awareness of knowledge, in particular the sources and types of knowledge needed for innovation activity, began to appear in the 1960s in the works of Nelson and Winter (1964) and Polanyi (1966). Nelson and Winter’s (1964) study on a weather forecasting system acknowledged that few studies had explored the economics of information and the coordination of this commodity. Their investigation of the dissemination, use and evaluation of weather forecasting information led them to conclude that prices are not the only consideration for firms; rather, “the cost of generating, sending, and processing information must [also] be considered” (Nelson and Winter 1964, p. 421). This conclusion affirmed Rosenberg’s statement that “acquiring new information is costly” (1994, p. 4). Knowledge and cognitive issues are similarly taken into account by behavioural economics, a branch of economics linked to psychology and game theory (Lambooy 2005). Knowledge in today’s context also brings customers closer and shortens
product cycles; hence the current emphasis on flexibility and ‘lean’ production, which flattens management hierarchies and provides flexibility in relation to innovation (Coad 2009). Although the relationship between flexibility and innovation is complex, positive correlations can be made between flexibility and some types of innovations (Mickie and Sheehan 2003), where flexible firm practices are positively related to innovation (Martinez-Sánchez et al 2011).

In the context of innovation processes, the knowledge-based view can be a useful framework to develop an effective way for firms to innovate (Martin-deCastro et al 2011) while in general terms science and technology innovations involve the resolution of problems (Dosi 1988). Such solutions or discoveries (and their commercialisation) require information from previous experience, formal knowledge, and/or tacit knowledge on the part of the scientist or engineer (Dosi 1988). Whatever the innovative activity, tacit knowledge and the “development and refinement of ’models’ and specific procedures” are required (Dosi 1988, p. 1127). For the most part, firms develop their knowledge of how to do things incrementally through routines and ‘organisational memory’ (Nelson and Winter 1982). In the new economy, firms have learnt to “monitor closely each others’ steps, and search widely for new ideas, inputs and sources of inspiration” (Fagerberg 2005, p. 11). There have been calls for applied research in this area to build an understanding of how knowledge and innovation operates at the organisational level (Fagerberg 2005; Liao et al 2008; Nonaka et al 2006). The current research provides some answers to this call by considering the internal (as well as the external) firm factors causally connected to the new concept of IHC and are presented in Chapter 5.

**National systems of innovation as a determinant of innovation**

While defining innovation and considering its determinants it is worth noting that, innovation does not operate in isolation; rather, it operates
within a system Modern National Systems of Innovation\textsuperscript{15} (NSI) was developed in the 1980s primarily as a result of collaboration between innovation scholars such as Freeman (1987; 2004), Nelson (1993) and Lundvall (1992; 2007). The concept was developed as an alternative analytical framework to include the processes related to innovation and learning (Lundvall 2007). The concept aimed to provide a new economic theory to help integrate innovation and learning into economic policy, as both were important for economic growth and welfare. NSI is defined as the network of public and private institutions “whose activities and interactions initiate, import, and diffuse new technologies” (Freeman 1987, p. 1). Critics have debated whether or not NSI constitutes a theory. Edquist (2005), for example, argues that NSI is not a formal theory; Lundvall (2007) counters this, stating that Edquist’s argument is based on the assumption that social science can be equated to natural science theory\textsuperscript{16}. Lundvall (1992) emphasises knowledge as the most important resource in the economy. NSI captures this resource from the micro to the macro level of the economy: that is, it compares what happens inside the firm; in the interaction among firms; in national education, labour and financial markets internationally; and as a result of specialisation and competitiveness within the innovation system. With regard to the current research, NSI and the empirical research highlight that organisational practices and arrangements such as job rotation, autonomy in work, and investment in training have a major impact on innovation. Sources of knowledge also include inter-firm interaction, inter-sectoral knowledge flows and education systems, and the markets for labour and finance (Lundvall 1995; 2007). NSI provides a holistic and systemic perspective and integrates many innovation-related policies such as enterprise, science, research and regional policies (Fagerberg and Sapprasert 2011). Notwithstanding the debates in the literature as to its legitimacy, NSI is a concept worth considering in relation to the current research, as it helps place the new concept of IHC not only at the level of firms’ innovation activities but beyond.

\textsuperscript{15} Sometimes referred to as the national innovation system.
\textsuperscript{16} The interested reading is referred to Lundvall (2007) for further details on this topic.
The preceding sections of this chapter discuss and analyse the theories and literature that underpin this research. Defining innovation and identifying which factors cause firms to innovate are the next issues of interest.

### 2.4 Definition and determinants of firm-level innovation

Prior to exploring the determinants of innovation, the next section considers how innovation is defined in the literature. Such a review provides the basis for the definition of innovation employed by the current research.

#### 2.4.1 Defining firm-level innovation

Before proceeding with the empirical analysis (presented in Chapters 4 and 5), it is necessary to define innovation. Kuhlmann *et al.* (2010, p. 1) refers to innovation as having “a social, economic and technological character”. The complex nature of innovation is reflected in the various ways it is explained in the literature. Firstly, it is worth noting what innovation is not. Innovation is not the same thing as invention; there is an important distinction between them, which is necessary to clarify (Swann 2009). Invention is the first stage of the innovation process, such as a sketch or model of a new or improved product, process, or system; innovation, on the other hand, refers to the effort to commercialise or the attempt to carry the invention into practice (Lane and Flagg 2010; Fagerberg 2005; Lundvall 1995). Sometimes there may be a difference of decades between an invention and the innovation based on it (Rogers 1995; Mansfield 1991; 1998). Leonardo da Vinci’s advanced ideas for a flying machine is presented by Fagerberg *et al.* (2005) as a classic example of such a time lag; the idea existed, but the lack of skills, materials and sources of power slowed the conversion of the invention into an innovation. This example also illustrates the continuous and incremental nature of innovation; most innovations do not enter the market without changes, improvements, and
occasionally total transformation from the original form (Kline and Rosenberg 1986).

Innovation is described as the “central feature of capitalist reality”, and “the nature of the innovation process, the drastic departure from existing routines, is inherently one that cannot be reduced to mere calculation” (Rosenberg 1994, p. 53). Rosenberg argues that major innovations begin with one innovation that leads to a large number of subsequent innovations, all linked to the original one. These large-framework-type innovations are typically path-dependent activities and extend over several decades creating ‘building blocks’ for new innovations; for example, electric power or machine tools (Dosi 1988; Rosenberg 1994). Dosi (1988, p. 222) focused on the “discovery, experimentation and development, imitation and adoption of new products and production processes”.

Innovation is, by its very nature, a “systemic phenomenon since it results from continuing interaction between different actors and organizations” (Fagerberg et al 2005, p. 4). Similarly, feedback mechanisms are crucial for product and process development (Fischer 2001). Therefore, a static view of innovation performance cannot encompass all the relevant inputs (Brenner and Broekel 2011, p. 8); this finding confirms Nelson and Winter’s (1977) delineation of the stochastic nature of innovation. Coupled with this, reaching a concrete definition of innovation is made increasingly difficult by differences across industries, over time and in different social and organisational contexts (Bruland and Mowery 2005). For instance, it has been defined as the generation and acceptance of new ideas, processes or products (Calantone et al 2002) and as “the commercial application of new knowledge” (Love et al 2010, p 1438). Table 2.1 provides a summary of definitions articulated in the literature and by research organisations such as the Organisation for Economic Co-operation and Development (OECD).

In defining innovation, Lundvall (2007) adopts a broad-based view when it comes to the diffusion and use of innovations, while defining the concept narrowly as technical innovation in hardware and software. The OECD, on the other hand, defines innovation broadly as “the implementation of a new
or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations” (OECD 2005, p. 46). While multiple definitions of innovation are supplied by contemporary literature, it is worth summarising how innovation is described by Schumpeter, the founding father of innovation economics (Audretsch and Link 2012), in order to fully inform future attempts to define the concept.

1. The introduction of a new good – that is, one with which consumers are not yet familiar – or of a new quality of a good;

2. The introduction of a new method of production, that is, one not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new and also exist in a new way of handling a commodity commercially;

3. The opening of a new market, that is, a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before;

4. The conquest of a new source of supply of raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created;

5. The carrying out of the new organisation of any industry, like the creation of a monopoly position (for example through trustification) or the breaking up of a monopoly position.

(Schumpeter 1934, p. 66).

Schumpeter later defined innovation as “…simply the doing of new things or the doing of things that are already being done in a new way” (1947, p. 151). Based on Schumpeter’s description and the contemporary definitions
presented above and in Table 2.1, this research defines innovation as *the commercialisation of new or significantly improved ideas/knowledge relating to a product, service and/or process*. The latter encapsulates such innovations as new marketing, organisational and/or business methods/processes.

**Table 2.1** Examples of how innovation is defined.

<table>
<thead>
<tr>
<th>Publication</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OECD (2010)</strong></td>
<td>Innovation is based on turning ideas into commercial value by means of improving goods, services and processes.</td>
</tr>
<tr>
<td><strong>Schumpeter (1947)</strong></td>
<td>Doing of new things or the doing of things that are already being done in a new way.</td>
</tr>
<tr>
<td><strong>Schumpeter (1934)</strong></td>
<td>The introduction of new good; service; opening of a new market; new source of supply of raw materials; carrying out of the new organisation of any industry.</td>
</tr>
<tr>
<td><strong>Nelson and Winter (1982)</strong></td>
<td>Complex, and involving changes in routine.</td>
</tr>
<tr>
<td><strong>Lundvall (2007)</strong></td>
<td>Adopts a broad-based view when it comes to the diffusion and use of innovations, and narrowly as technical innovation in hardware and software.</td>
</tr>
<tr>
<td><strong>Calantone et al. (2002)</strong></td>
<td>The generation and acceptance of new ideas, processes or products.</td>
</tr>
<tr>
<td><strong>Love et al. (2010)</strong></td>
<td>The commercial application of new knowledge.</td>
</tr>
</tbody>
</table>
For the purposes of this research, it is also necessary to identify the factors that determine innovation, particularly at the level of the firm, given that it is the focus of the current analysis. The following section provides a summary of the key factors identified in classical and contemporary literature as key drivers or determinants of firm-level innovation.

2.4.2 Determinants of firm-level innovation

Many empirical studies have asked such questions as, ‘Why do some firms innovate and others not?’ and ‘Why does one firm innovate more than others?’ No definitive answer exists, but factors which determine innovation include firms’ sector, location, age, size, R&D activity, and human capital (the latter is discussed in detail in Chapter 3). The one certainty about the innovation story is the lack of certainty about innovation activity, a lack of consensus on a single model for understanding innovation (Audretsch and Link 2012). Much innovation literature focuses on the economic/national level (Sears and Baba 2011). The literature tends to be “supported by impersonal analysis of political, economic and/or historical issues” (Sears and Baba 2011, p. 358). The same authors claim that despite calls for a multi-level analysis of innovation, there has been little effort to formulate multi-level models. Hall et al (2009) found that firm size, R&D, and investment in equipment enhance the probability of firms’ innovation in terms of products and processes; however, it is widely accepted that R&D does not capture all aspects of the innovation activity in firms (Hall et al 2009).

While the main focus of this thesis is the contribution of IHC (a resource available to the firm), the analysis includes other factors which may contribute to firms’ innovation activity (e.g., firms’ location, size and sector), and which are described below.
Firm size as a determinant of innovation

As alluded to earlier in the context of firm growth, the size of the firm has long been the subject of empirical research (e.g. Acs and Audretsch 1990; Hall et al 2009). In the case of small and medium enterprises\(^{17}\) (SMEs), such firms can survive and grow “if they are flexible, innovative, and customer focused and both proactive and reactive in their business strategies” (Lenihan et al 2010, p. 3). To stimulate growth and accelerate their development, small firms must become more involved in innovation so that it becomes embedded as part of daily activity (Forfás 2011). The European Commission (Europe 2020 Strategy) focuses on small firms and their crucial importance to the European economy as a source of innovation and employment (European Commission 2010).

However, there is conflicting evidence as to the effect of firm size on innovation. As outlined previously, Schumpeter (1934) argues that innovations normally start in new and smaller firms; those that succeed grow into large firms. Acs and Audretsch (1990) suggest that small firms that implement strategic innovation can compensate for size-related disadvantages. There is also evidence that small firms are more adaptable and have less rigid management structures (Rogers 2004), which allows them to implement smaller incremental innovations. On the contrary, Roper and Hewitt-Dundas (2008), in an examination of innovation persistence in Ireland and Northern Ireland, find that larger firms are more able to sustain product and process innovation than smaller firms. Similarly, Schumpeter’s later work (1942) points to large firms as the source of innovation, which appear in the form of R&D activities, since larger firms have the financial resources to invest in R&D projects. Large firms tend to have economies of scale in technology and learning, and access to finance, referred to as a material advantage; small firms have flexibility and entrepreneurial drive, a behavioural advantage (Hewitt-Dundas 2006; Rodriguez et al 2008).

\(^{17}\) The main factors determining whether a firm is an SME are number of employees and either turnover or balance sheet total: Medium-sized <250 employees (≤€50m turnover or ≤€43m Balance Sheet), Small <50 (≤€10m turnover or ≤€10m Balance Sheet), Micro < 10 (≤€2m turnover or ≤€2m Balance Sheet) (European Commission 2012).
Freeman (1982, p. 126) elaborates on the innovation process by suggesting that in the large firm the innovator must “be high enough in the hierarchy to command resources and get things done” and must also have sufficient knowledge of the way the firm works and how results are achieved within it; in the small firm the innovator may need to be the chief executive or to occupy a position very close to him/her to ensure the necessary efforts are made to accomplish objectives.

**Firms’ location and sector as determinants of innovation**

For the purpose of innovation, the process of learning involves a diverse knowledge base (Simon 1985; Giuliani and Bell 2005) including knowledge from regions within an individual country (Lambooy 2002) and knowledge from outside the local industrial milieu (i.e. global knowledge source) (Asheim and Isaksen 2002). Within a region, a firm may find collaboration partners; it may share resources and human capital through employees involved in different types of social networks and routines, and this may influence its behaviour and stimulate knowledge spin-off processes (Brenner and Broekel 2011).

In the context of firm-level innovation, Vega-Jurado et al. (2008) find that determinants of innovation vary depending on industrial sector. From their empirical research, they find that cooperation with universities and public research institutions has limited effects on firm innovation. However, the importance of face-to-face contacts and the geographical mobility of the labour market were found to foster innovation in the case of Finnish firms (McCann and Simonen 2005). Michie and Sheehan’s (2003) research observes that the increased use of part-time employees and those on fixed-term contracts has a negative correlation to the overall probability of firms innovating. According to Audretsch (2007), innovation is the result of systematic investment by firms to create new knowledge, involving R&D and the enhancement of human capital, the latter being the subject of the next chapter.
Government support as a determinant of innovation

There are mixed views as to whether government should intervene in the economy (Brown and Jackson 1990). Traditionally, public involvement in the economy is justified by market failure and conditions where public goods, externalities, and imperfect information exist (Stiglitz 2000). In the specific case of bolstering innovation activity, governments provide support to nurture ‘knowledge-based’ industries such as information technologies and pharmaceuticals (Romijn and Albaladejo 2002). It is well documented that government support for R&D contributes to firm-level innovation (Lundvall and Borrás 2010). Government support for innovation is a subject of particular interest in the context of innovation and the promotion of the new concept of IHC; therefore, a full discussion on the role of government is reserved for Chapter 6.

This section has presented a usable definition of innovation, and draws scholarly discussion on the determinants of innovation.

2.5 Conclusion

This chapter reviews the literature on the theory of innovation including an account of the early philosophers and a review of the literature informing contemporary innovation theory. The literature presented here provides the foundation for the theoretical framework for the creation and development of IHC as a determinant of firm-level innovation, Section 2.2 provided a wide-ranging review on the history of innovation studies. The section tracked the origins of innovation to the founding father of economics, Adam Smith (1776). The theory of innovation was developed through contributions by many different areas of the literature. Though innovation can be studied at the macro level, as discussed briefly, innovation at the micro (firm) level allows for a concentrated study of the effect of individual employee-manager’s IHC on innovation. Given the focus of this study, Section 2.3 provided a review of the literature of the firm and the theory of firm growth. The latter is founded mainly on the work of Edith Penrose
(1959). Her fundamental contribution to firm growth is the key role played by managers, learning, and the idiosyncratic resources possessed by the firm.

In order to garner an understanding of innovation, various theories were reviewed in Section 2.4. Neoclassical theory provides a starting point for this review of the dramatic evolution in the economic understanding of innovation in recent decades. The neoclassical approach takes a primarily linear model and fails to investigate what Rosenberg (1994) refers to as the ‘black box’ of technical innovation. The review of neoclassical theory however highlighted its lack of focus on the complexity of innovation and evoked a review of the evolutionary, RBV and knowledge-based theories.

The evolutionary theory attempts to ‘unpack’ the complexities of firms’ behaviours and capabilities (Nelson and Winter 1982). This approach recognises the non-linear and complex nature of innovation, and highlights that tacit knowledge and organisational routines yield competitive advantages for the firm. The complex nature of evolutionary theory and the idiosyncratic nature of resources led to focus on the RBV and the closely linked knowledge-based view of the firm. The RBV and knowledge-based views address different issues, though both focus in the broadest sense on the role played by internal resources in firm growth. While RBV address a variety of resources, seeing human capital as one such important resource, the knowledge-based view focuses on the embodiment of knowledge in the individual as a source of innovation in the firm (Grant 1996). Section 2.5 completes this chapter, evaluating various definitions of innovation in order to derive one that allows for a robust understanding of innovation in the context of the current research.

In general, innovation occurs where firms apply either new or pre-existing knowledge to introduce new products, services or business models; thus it creates competitive advantages, giving innovative firms the opportunity to earn higher profits, gain new sales and potentially enter new markets (Roper et al 2010; Slaper et al 2011; Ganotakis 2012). Informed by the literature review presented, this research defines innovation as: the commercialisation
of new or significantly improved ideas/knowledge, including product, service and/or processes.

This definition of innovation prompts questions as to why some firms innovate and others do not. In an attempt to answer these profound questions, Section 2.5 also provides a summary of the vast topic of what determines innovation, which forms part of the analysis presented in Chapters 4 and 5. In order to further capture the theoretical framework underpinning the research and describe the determinant that is of particular interest, a review of the literature on human capital is presented in the chapter that follows.
3 Human capital as a determinant of innovation

3.1 Introduction

Understanding innovation is crucial when considering the fundamental aspects of economics such as growth and productivity; understanding the innovator is equally important, as he or she is at the heart of the innovation process (Jones 2009). Chapter 2 presented a review of the innovation literature, defined innovation, and summarised the factors that determine firms’ innovation activity. This chapter will present a review of the human capital literature, in order to continue building the theoretical framework on which the current research is based.

‘Human capital’ is a term used by economists and other social scientists to refer to the skills, knowledge and capabilities of the workforce of a firm, the population of a country, or simply a network of people who join together to be more innovative and productive (Blair 2011). Human capital is multi-faceted in nature and represents the knowledge and skills, competencies and attributes embodied in individuals within a firm that create economic benefit for the firm (Dimov and Shepherd 2005; OECD 2001). Human capital is the basic input into the discovery process central to innovation; it is the fuel that fires the innovation engine (Romer 2007).

The three theorists who stand out as the founders of the contemporary study of human capital are Mincer (1958; 1962), Schultz (1961) and Becker (196418). These theorists developed the concept of human capital as an important input to production and an economic consideration worthy of examination (Burton-Jones and Spender 2011). During the 1960s and 1970s interest in investment in human capital grew, 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). Human capital is now well-documented as a

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18 The 1993 (3rd edition) is used throughout this research
contributor to economic growth at sector\cite{footnote19} and firm-levels (Arvanitis and Loukis 2009; Barro and Lee 1996; Simonen and McCann 2008).

Becker’s theory (1993) of human capital distinguished between firm-specific and general human capital. Becker also drew a link between investment in human capital and improvements in productivity. The ability to innovate, which is vital to the growth of the firm (as outlined in Chapter 2), depends greatly on the contributions of human capital (Grossman and Helpman 1994). In particular, investment in human capital is believed to improve the performance of the firm’s employees (Bosman et al 2004). However, as alluded in Chapter 2, to date there is limited empirical research into the contribution of human capital to firm-level innovation, and more particularly into the tacit attributes of human capital and the contribution to firm-level innovation. The limited research findings available reveal that organisational support for innovation, the quality of human capital (measured by education), and organisational knowledge accumulation are significantly positively associated with the implementation of green innovations (Lin et al 2008).

Drawing upon the premise that human capital is a resource available to firms, this chapter connects the findings from the literature review presented in Chapter 2 with a review of the human capital literature to provide the theoretical framework underlying the analysis in Chapters 4 and 5.

Human capital theory has received inputs from a diverse range of research fields including economic and management theory, sociology and psychology. For the most part, research in the areas of human capital and innovation has concentrated on human capital in the field of science and technology and reflects a linear view of innovation (Toner 2011). However, the literature reviewed in Chapter 2 indicates that innovation is non-linear and occurs incrementally in firms (Toner 2011; OECD 2011). Such research has prompted greater interest in the topic of human capital as a determinant of innovation; the current research contributes to this debate.

\footnote{While not the focus of the current research, firms’ sector is accounted for throughout the analysis.}
This chapter will present a review of human capital literature through the lens of innovation, building on the information provided in Chapter 2. The next section (3.2) outlines the theories of the earliest philosophers while Section 3.3 presents the contemporary literature on human capital. In Section 3.4, the focus turns to human capital and its contribution to innovation. Section 3.5 presents the characteristics and the changing views of human capital. A discussion on measuring human capital, and the limitation of such measurement, is presented in Section 3.6. Section 3.7 introduces the emerging debate on the contributions of human capital to innovation and growth, while Section 3.8 concludes the chapter.

3.2 The early philosophers of human capital

Human capital cannot be reduced to a single theory (Blaug 1976). The core concept is that people invest (both monetarily and non-monetarily) in themselves for the sake of future returns (Blaug 1976). The study of human capital can be traced back to Sir William Petty (1623-87). An anatomist, professor of music and later industrialist and author, Petty was the first to place a value on the labourer through the labourer’s loss of life in war or through death from other causes (Murphy 2009). A century later, the argument that human beings constitute capital appeared in the writings of Adam Smith (1776), who referred to all the inhabitants of a country as part of its capital (Schultz 1961). Smith (1776) held that an individual’s acquisition of talents was itself capital, fixed and realised in the person (Burton-Jones and Spender 2011). It is interesting to note that Karl Marx (1818-1883), the German philosopher, economist and founder of social science, did not mention human capital as an economic concept (Schultz 1993). As discussed previously (in Chapter 2, Section 2.2), Schumpeter who fostered the theory of innovation refers to human capital in terms of the entrepreneur, describing him (the entrepreneur) as a conduit (of development) between existing resources and business success. Schumpeter refers to development as “aris[ing] by its own initiative, from within” including through the entrepreneur (1934, p. 63). Schumpeter’s
entrepreneur is crucial in recognising the connection between what already exists and what may be converted into a successful business (Schumpeter 1934). In this regard, he states that, “entrepreneurs are a special type, and their behaviour a special problem, the motive power of a great number of significant phenomena” (1934, p. 81). These ‘phenomena’ refer to change or ‘creative destruction’, including innovation.

It is important to clarify the use of the term human capital at this juncture. The use of the word capital as human has a historical context of slavery and servitude; for this reason it has been rejected by many, including: Schumpeter (1954); Bottone and Sene (2011), and Schultz (1961). In the 1960s and 1970s, valuation of a person as an item of capital was the basis of a debate between America and Europe, though the word ‘capital’ is still used to denote the stock of any productive factor including the human kind (Bottone and Sena 2011). Schultz refers to the argument made at the time that investment in human beings is offensive; he says that conversely, “by investing in themselves, people can enlarge the range of choice available to them. It is one way free men can enhance their welfare” (1961, p. 2). This statement highlights that the very term human capital can be viewed as ambiguous, it can refer both to the number of workers and the attributes embodied in the worker that allow them to be more productive (Bottone and Sena 2011).

However, the debate on the role of human capital as a source of growth began in earnest with the works of Jacob Mincer (1958, 1962), Theodore W. Schultz (1961) and Gary S. Becker (1964). Mincer (1958) claimed that investment in human capital and income distribution was based on free choice. He explained that “time spent in training constitutes a postponement of earnings to a later age”; this rational choice means an “equalization of present values of life-earnings at the time the choice is made” (Mincer 1958, p. 301). In his discussion on intra-occupational differences, Mincer described the most important difference between occupations in terms of human capital: “on the whole, increases in productivity with age are more pronounced, and declines are less pronounced, in jobs requiring greater amounts of training” (1962, p. 301). He also pointed out that formal
schooling alone is not sufficient as a method of training the labour force; that is, graduation from schooling does not signify the completion of the training process, but rather the end of a more general and preparatory stage. Schultz, on the other hand, states that, “it has been all too convenient in marginal productivity analysis to treat labor as if it were a unique bundle of innate abilities that are wholly free of capital” (1961, p. 2). The same author highlights that earnings rose as a result of the rapid increase in investment in education from the 1960s onwards, although he points to the deterioration of human capital when idle (e.g. during unemployment the skills acquired by workers are impaired). In a précis of his seminal paper Schultz uses the metaphor of a poor labourer at work in the fields, and describes the economy without growth in human capital with the expression “the man without skills and knowledge leaning terrifyingly against nothing” (1961, p. 16).

The influential work of Gary S. Becker, winner of the 1992 Nobel Prize in economics, is the foundation for much contemporary study of human capital. Becker’s book Human Capital (first published in 1964) examines the consequences of investing in a person’s knowledge and skills through education and training, and builds on the work of Schultz (1961) and Mincer (1958; 1962). Becker (1993) describes capital as, in the first instance, money in the bank or shares in a company, but he adds that schooling and training courses are also investments in the human/individual.

Becker’s work places an emphasis on education; he states that the return on investment in this context means that, “education and training are the most important investments in human capital” (1993, p. 17). This type of investment raises the individual’s level of income and expands scientific and technical knowledge, which in turn increases the productivity of labour (Becker 1993). This means that the earnings of a college-educated people are frequently well above average; the gap is larger in less-developed countries (Becker 1993). He describes the relationship between human capital and economic development in countries that have experienced persistent growth in income and have also seen increases in the education and training of their labour forces. In a study of the causes of increased
human capital in the United States, Becker points out that changes in schooling account for about a quarter of the rise in per capita income during the period 1929-1989. He believes the remainder can be explained by the effects of improved health and by other elements of human capital that cannot be measured.

As alluded to earlier, Becker (1993) makes a distinction between general and specific human capital: general human capital relates to knowledge and skills that are easily transferable (e.g., general literacy and technology skills), whereas, specific human capital relates to knowledge and skills that are less transferable, have a narrower scope of applicability, and are specific to the firm’s operations (Becker 1993; Ucbasaran et al 2007). He describes the traditional concept of investing in capital wherein expenditures are on education, training and medical care; these expenditures produce human capital rather than financial or physical capital. It is important to remember that some investments in human capital (known as specific investments) do not affect earnings as the costs and returns may be collected by the firm (Becker 1993). Although Becker’s (1993) work focused solely on education and training and made no mention of its contribution to innovation per se, his work is the foundation for the contemporary view of human capital and is discussed in the next section in light of the ‘new economy’ as explained in Chapter 2.

3.3 Contemporary approaches to human capital

Human capital has been central to labour economics, macroeconomics, the theory of the firm, and management and strategic planning since the 1960s (Blair 2011). Until recently, debate regarding human capital as a contributing factor of firm-level innovation has been limited; human capital has been reduced to a variable easily measured by education attainment and/or training (Leiponen 2005). This section traces the growth in human capital-related studies, particularly in the context of innovation, so as to
inform the analysis undertaken by the research and clarifies the contribution of the current research in Section 3.8.

The publication of research by Lucas (1988) and Romer (1990), and the ‘new neoclassical theories’, established that, human capital is a critical input to technological development. Human capital theory focuses on formalising individual decisions to acquire knowledge and assessing the consequences of these decisions for productivity (Lucas 1988). Lucas added human capital to the neoclassical model of growth to explain economic development:

By an individual’s ‘human capital’ I will mean, … simply his general skill level, so that a worker with human capital h(t) is the productive equivalent of two workers with ½ h(t) each, or a half-time worker with 2h(t). The theory of human capital focuses on the fact that the way an individual allocates his time over various activities in the current period affects his productivity, or his h (t) level, in the future periods.

(Lucas 1988, p. 17)

Lucas (1988) focuses on how learning-by-doing and public learning from externalities increase the stock of human capital; Romer (1990) addresses the endogenous nature of economic growth, making reference to Lucas’s work. Romer (1990) describes human capital as affecting growth both directly and indirectly. He bases his argument on three premises: first, technical change lies at the heart of economic growth; second, technological change arises from intentional actions by people who respond to market incentives; and third, instructions for working with raw materials are different from those for other economic goods. Romer refers to increasing growth in the stock of human capital that “does not depend on the total size of the labor force or the population” (1990, p. S73). He found that an economy with a larger total stock of human capital would experience faster growth, when human capital is measured as the cumulative effect of formal
education and on-the-job training (Romer 1990); such indicators of human capital are easily measured but limited.

Grossman and Helpman (1994) agree with Romer’s (1986) and Lucas’s (1988) earlier works, that growth can be sustained by the continuous accumulation of inputs that generate positive externalities. Grossman and Helpman, amongst others, developed formal models that “cast industrial innovation as the engine of growth” and found that profit-seeking investments in knowledge play a critical role in long-term growth process (1994, p. 32). Like Romer (1990), these authors see human capital as the accumulation of time spent in schooling and training but recognise that it cannot grow indefinitely. Grossman and Helpman’s (1994) model of growth counters the notion that larger economies always grow faster; they state that a large economy populated mostly by unskilled workers may grow at a slower rate than a smaller population. For instance, one empirical study on the effects of human capital at sectoral level, measured by education, finds that education is considered important in sectors with a high proportion of highly-qualified employees. In a recent study of regions and autonomous communities in Spain, Manca (2012) finds that tertiary education strongly contributed to overall Spanish regional convergence over the period 1960-1997. The same study indicates that, “being closer to the technology frontier implies having to rely on a different and specific combination of human capital inputs in order to bring about growth and catch-up” (2012, p. 1384).

Given the focus of the current research and its concern with a holistic approach to human capital at a micro level the next section revisits the RBV and knowledge-based view of the firm, with special regard to the treatment of human capital.
3.3.1 Human capital in the resource-based view and knowledge-based view of the firm

Further to the discussion presented in Chapter 2, this section reconsiders the RBV and knowledge-based view of the firm and the treatment of human capital. Recall that RBV focuses on the internal resources and capabilities controlled by firms (what neoclassical micro-economists call factors of production) as sources of competitive advantage (Barney and Hesterly 2006; Barney 2001; Locket and Thompson 2001); human capital is one such resource. Individuals in a firm, who learn, solve tasks and collaborate, shape that firm’s environment to create knowledge, which in turn brings competitive advantage (von Krogh and Wallin 2011). RBV theory recognises that knowledge is internally present, generated or obtained externally and that “knowledge is an important resource for innovation” (Gossling and Rutten 2007, p. 257). RBV defines internal resources as tangible and intangible assets that are tied semi-permanently to the firm, form the basis of sustained competitive advantage, and facilitate implementation of the firm’s strategy (Hitt et al 2001; Hadjimanolis 2000).

In the early development of the RBV theory of the firm, Teece (1980) developed Penrose’s (1959) idea that human capital in firms, which is usually not entirely specialised, can be organised to allow firms to diversify into new products and services as well as accessing resources that are commonly available. However, a later strategic management study by Teece et al. (1997) lacks social content and does not ask what types of people are able and willing to make strategic investments that may result in innovation (Fagerberg et al 2005). Taking a critical view of RBV, Krajienbrink (2011) suggests a fundamental limitation of the approach in that it does not recognise the unique character of human capital. However, as explained in Chapter 2, the knowledge-based approach complements the RBV to provide a more refined analysis of knowledge as a valuable resource for the firm. Grant (1996) emphasises knowledge and the individual as the primary agents in knowledge creation, and stresses that the management of knowledge is central in the pursuit of competitive advantage for firms. The
decision-making and learning of individuals allow firms to “create the knowledge assets that bring competitive advantage” (von Krogh and Wallin 2011, p. 261). Strategic management literature that is grounded in the knowledge-based view emphasises the role of human capital in “a firm’s ability to build new capabilities, because human capital provides inimitable, tacit knowledge” (Al-Laham et al 2011, p. 563). Resources facilitate the implementation of a firm’s strategy, and human capital is a vital resource for the implementation of such strategies (Hitt et al 2001). It is clear from both the RBV and knowledge-based views that human capital is a central feature of firm growth, but neither makes an explicit connection between human capital and innovation. This leads to the next section, which provides evidence of the important relationship between human capital and firms’ innovation activity.

3.4 The evidence that human capital is important for innovation

In their study of endogenous growth, Aghion and Howitt (1992) found human capital to be significant for innovation as well as for economic growth. The critical role of the individual in terms of human capital within the innovation process is also acknowledged in the literature (Rothwell et al 1974; Lucas 1988; Ottaviano et al 2003). There is a positive correlation between a country’s technical change and its human capital, using ambiguous aggregate measures, including number of patents or total factor productivity (Schneider et al 2010).

Similar to the other determinants of innovation outlined in Chapter 2, the influences exerted by human capital on innovation are as diverse as the topic of innovation itself. For instance: higher levels of human capital produce greater numbers of patents in the future (Al-Laham et al 2011); human capital inputs acquired from other regions and from the same sector are positively related to product innovations (Simonen and McCann 2008); nationality and education diversity in the local labour market has a positive
association with product innovation, but not for process innovation (McGuirk and Jordan 2012).

Much has been written on the knowledge base of the organisation, which cannot be explained simply by the sum of the individuals within it (Pavitt 1990). At the level of the firm, human capital refers to the employees, owners and managers who contribute to the business; as mentioned earlier, it is a factor of production (Arvanitis and Loukis 2009). The process of knowledge accumulation in the innovative firm is built on tacit knowledge and the methods used to accumulate internal knowledge (Trott 2005). If there is an increase in the explicit/codified knowledge (in the form of formal education for example) within the individual, then the development of unique capabilities and products depends on the creation and use of implicit/uncodified knowledge (Asheim and Gertler 2005). Trott’s model encompasses the discussions (informal and formal) among colleagues, the generation of new associations and linkages by accumulation, and the retention of additional knowledge. In addition, Fagerberg (2005) considers openness to new ideas and solutions to be essential for innovation projects, especially in the early phases. Fagerberg claims that the “greater the variety of these factors within a given system, the greater the scope for them to be combined in different ways, producing new innovations which will be both more complex and more sophisticated” (2005, p. 10). The need for openness is based on the fundamental characteristic of innovation: that is, innovation consists of finding new combinations of existing ideas, capabilities and skills. Openness produces a direct influence not only on talent stock, but also on innovation and regional economic performance (Qian 2010).

The assumption that human capital enhances innovation performance is the basis for the Lisbon Strategy of the European Union (Schneider et al 2010). A briefing paper by the Lisbon Council committee states that, “investing in education always pays, both for society at large as well as for the individual” (Hofheinz 2009, p. 4). However, Hofheinz (2009) argues that Europe can no longer depend on scientific knowledge and education alone to provide a competitive edge; therefore the importance of learning to think
creatively and to respond flexibly to the marketplace is as important as technical ability. Creativity is considered crucially important in keeping knowledge alive to secure the firms’ long-term viability (Chen and Kaufmann 2008). Without such knowledge and skills, firms benefit less from innovation (Leiponen 2005). Furthermore, recent literature has emphasised that it is important to recognise the role of individuals and what strengths they bring to the firm’s innovation activities (Schneider et al 2010; Fitjar et al 2013). These strengths include technical knowledge; skills; and the ability to define problems, develop ideas, and form creative links between people in the firm and externally. Employee engagement too supports innovation, where such enablers as leadership; managers who empower staff; an effective and empowered employee voice; and organisational integrity and sense of trust, are critical (MacLeod and Clarke 2011). To further explore the specific links between human capital and innovation, the next section provides a deeper assessment of the management level of firms’ human capital and the influence of managers on innovation.

3.4.1 The role of the manager in firms’ innovation activities

The role of managers in innovation activities is particularly important due to the position they hold within the firm: they make decisions, allocate resources, set priorities, control costs and spending, and filter ideas (Leiva et al 2011; Hermann et al 2006; Storey and Salaman 2005). Indeed, human capital in terms of managers is frequently among the selection criteria used by venture capitalists (Unger et al 2011). Research has identified the important role of middle management in creating an innovative atmosphere; in particular, their acceptance of technological innovation influences the overall innovation of a firm (Hosseini et al 2003). Grant (1996) considers that the primary task of management is to establish the coordination necessary for knowledge integration between the individual and the production of goods and services. Penrose (1995) also considers managers’
role in the firm and their contribution to growth. She emphasises that as managers gain experience, they reduce administrative tasks; as this happens, their resources and talent can be focused on value-creating growth. As managers acquire experience, the challenge is to take full advantage of their valuable firm-specific knowledge (Coad 2009; Penrose 1995). The discussion above further emphasises the importance of managers for innovation within the firm. Indeed, the central thesis of the current research is the contribution of employee-managers’ IHC to firms’ innovation activity. This cohort of employees is discussed further in Chapter 4.

To further elucidate the link between human capital and innovation, social capital and absorptive capacity are considered to be of value to firms and serve as additional evidence to the key role held by individuals for firms’ innovation activities. Therefore, in the context of this research, knowledge of both these areas highlight and serve to further understand human capital.20

3.4.2 Social capital

Social capital can be defined as the potential value and benefits derived from an individual’s repeated interactions and networks (Santarelli and Tran 2012; Landry et al 2002). Social and human capital are both seen as complementary to each other in sociological literature, just as human and physical capital are treated as complementary in economic literature (Santarelli and Tran 2012). It is assumed in the literature that firms accumulate knowledge from the social capital present within various networks, including business, information and research networks (Landry et al 2002). The networks of relationships that form social capital can lead to resources that are usable for the good of the individual and that may also be shared (Dakhli and De Clercq 2007). Higher levels of human capital

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20 Due to data limitations inclusion of social capital and absorptive capacity in the current analysis was not possible. Absorptive Capacity is discussed further in Chapter 5 (Section 5.2).
enhance social capital, and in so doing support innovation through the individual (OECD 2011). As discussed in Chapter 2, innovation is an interactive process that involves relationships, whether among firms or between firms and education/research institutions (Doh and Acs 2010). Doh and Acs (2010) suggest that the level of social capital existing within a country has a positive influence on overall innovation.

No firm will possess all the skills and know-how necessary to carry out its strategy for growth and greater profits. This reality stems from financial constraints, the temporary nature of the skills needed, or the physical capital required to obtain and sustain these skills (Cohen and Levinthal 1990). As a result, there is an essential need to network and collaborate, increasing the skills to adopt and develop knowledge and integrate it into the firm (Cohen and Levinthal 1990). Hence, the ability to use external knowledge, referred to as absorptive capacity, is explained in the next section.

### 3.4.3 Absorptive capacity

The ability of a firm to utilise external knowledge and relate it to the firm’s prior knowledge and experience is referred to as *absorptive capacity*. Humans are a source of knowledge and absorptive capacity in the firm (Cohen and Levinthal 1990). In their (1990) seminal paper on absorptive capacity, Cohen and Levinthal claim that the ability to exploit external knowledge is critical to innovative capabilities within the firm. According to the authors, in order to recognise the value of new external information and apply it for commercial purposes, a firm “needs prior related knowledge to assimilate and use new knowledge” (1990, p. 129). The prior possession of relevant knowledge and skills gives rise to creativity and enables linkages that may never have been considered before (Cohen and Levinthal 1990). Adopting and adapting existing ideas leads to higher skill levels that increase absorptive capacity and the level of incremental innovation by enabling individuals within the firm to better understand how things work (OECD 2011). Absorptive capacity is generated in a variety of ways,
including diversity of knowledge, prior investment by the organisation, 
education and division of labour (Cohen and Levinthal 1990). The notion of 
absorptive capacity acknowledges that human knowledge is difficult to 
articulate; as alluded to earlier, it re-enforces Polanyi’s (1966, p. 4) view of 
tacit knowledge that, “we know more than we can tell”. Individuals’ 
possession of relevant knowledge and skills leads to greater creativity; 
absorptive capacity and creative capacity share many similarities (Cohen 
and Levinthal 1990), confirming the multi-faceted benefits of human 
capital.

Similar to other types of capital, human capital may decrease in value. The 
next section offers an assessment of literature on human capital 
depreciation. Again, while the current study does not address depreciation, 
it would be remiss of any study of human capital not to acknowledge its 
existence and its potential as a topic for future research.

### 3.4.4 Depreciation of human capital

In discussing human capital it is important to take account of depreciation, 
as one would for other forms of capital. The lack of focus in the 
depreciation of human capital in the literature may be attributed to the 
complex nature of the deterioration of workers over their lifetime, as well as 
deterioration during periods of unemployment and the difficulty of 
measuring human capital depreciation (Arrozola and De Hevia 2004). 
Arrozola and De Hevia (2004) have developed a model for measuring 
depreciation by taking account of post-schooling investment and the 
difference between the potential and observed earnings of individuals. 
Their empirical research in the case of Spain found that “depreciation rates 
of human capital were between one and one and a half percent” (Arrazola

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21 In order to account for depreciation Arrazola and De Hevia (2004) state that information 
on earnings over time are required; likewise, Schultz (1996) elucidates that information on 
employment/unemployment is required. All of this information is unavailable in the data 
employed by the current research.
and De Hevia 2004, p.147). Schultz (1961) points to the fact that human capital deteriorates when idle (during unemployment workers’ acquired skills are impaired). Romer (1990, p. S76) briefly addresses the notion of depreciation of human capital, stating that,

each person has only a finite number of years that can be spent acquiring skills. When this person dies, the skills are lost, but any non-rival good that this person produces – a scientific law; a principle of mechanical, electrical, or chemical engineering… lives on after the person is gone.

In the context of knowledge flow from recruitment and collaboration, Al-Laham et al. acknowledge the decay of knowledge; they assert that the contributions of older knowledge components become less valuable as time passes, but that the rate of decay “depends on both the scope of knowledge that is being transferred and the learning mechanism associated with extracting such knowledge from the knowledge source” (2011, p. 560).

The current chapter aims to develop a deeper understanding of human capital in the context of firm-level innovation. Therefore, the next section discusses the characteristics of human capital within the literature.

### 3.5 The characteristics of human capital

This section provides an overview of the various characteristics used to describe and measure human capital. Human capital is made up of many elements (Arrazola and De Hevia 2007). As discussed previously, in a microeconomics context, the human capital of the individual has traditionally included components such as formal education level and training. However, it is important to recognise that human capital is also made up of factors such as technical knowledge, personal skills, and work experience such as “individual expertise that people develop during
professional life and bring into firms’ innovation activities” (Schneider et al 2010, p. 187).

Schultz, in his study, presents a list of the critical attributes of human capital (1993, p. 14):

- Human capital cannot be separated from the person who has it, unlike physical capital, which can be confiscated. Except in slavery, human capital cannot be bought or sold. It does not exceed the life span of the person who has it;
- Human capital is produced by investing in people;
- It is helpful to think of human capital as encompassing abilities that are either innate (the genes that each person is born with) or that are acquired and can be added to the innate. Human capital is not visible. What is observable is the effect of human capital; and such effects may be internal or external;
- Most of what we know about human capital is gleaned from its observable internal effects; that is, from schooling, on-the-job training, work experience or health, amongst other forms of information, relating to the economic productivity, income and welfare of the individual or the family;
- The external effects of human capital are from spill-over effects and from having a strong human capital environment and a high human capital density.

While the traditional view sees human capital as functioning to improve the productivity of knowledge, the economic growth literature is increasingly interested in human capital due to its “functions as a source of new ideas and innovations and also as a factor facilitating their acceptance and dissemination” (Soboleva 2010, p. 43). Researchers argue that human capital may play a larger role for firms in the future “because of the ever
increasing knowledge-intensive activities of the work environment” (Unger et al 2011, p. 342). As alluded to earlier, there is a growing consensus that the knowledge and skills of individuals must be developed to create an economy in which innovation forms a key part (Ederer 2006). A ‘knowledge-based economy’, a slogan often used in the literature, is based on the intangible assets and investments considered essential elements to creating value in firms (Santos-Rodrigues et al 2010; Forfás 2008). Such intangible assets comprise the heterogeneous knowledge and skills embodied in the firm’s employees (Al-Laham et al 2011).

Schultz (1993), with the benefit of hindsight, acknowledges that advances in technology are man-made, generated by people who possess special skills consisting of the components of human capital. He states that it takes human capital to produce human capital, and stresses that “in making investments, land is overrated, whereas the effort made to increase the quality of human agents is underrated” (Schultz 1993, p. 18). Human capital is, in part, created within the firm by means of on-the-job training, firm specific routines and pre-existing knowledge (Storper and Scott 2009). Overall, it refers to the skills, knowhow, individual abilities and experience of a firm’s owners, employees and managers (Edvinsson 1996). A higher level of human capital encourages innovation by generating new knowledge and developing existing methods, technologies and know-how for the benefit of the firm (OECD 2011).

Table 3.1 provides a summary of how human capital is described in the literature.

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22 In comparison with his seminal work ‘Investment in Human Capital’ (1961).
Table 3.1 A summary of how human capital is described in contemporary literature.

<table>
<thead>
<tr>
<th>Author (publication date)</th>
<th>Contemporary description of human capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>OECD (2001)</td>
<td>The knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being.</td>
</tr>
<tr>
<td>Dimov and Shepherd (2005)</td>
<td>A key component is the possession of knowledge that is specific and not easily appropriable and that yields a competitive advantage.</td>
</tr>
<tr>
<td>Esposto (2010)</td>
<td>Skills are described as a function of experience within an area of work; they are not necessarily stable, but are qualities of the individual that develop gradually. Knowledge is acquired over a lifetime and is used to acquire further knowledge and develop skills/abilities.</td>
</tr>
<tr>
<td>OECD (2010)</td>
<td>Formal - academic and technical skills (from formal education). Informal - soft skills from experience, personal attributes, management, leadership, environmental. Creativity and design. Workplace training is one tool for the development of skills for innovation. Organisational capital or social capital; management and leadership skills may be an important prerequisite for building social skills for innovation, i.e. collaborations within and outside the firm.</td>
</tr>
<tr>
<td>Unger et al. (2011)</td>
<td>Knowledge and skills are acquired through transformation of experience, though experience should not be equated with knowledge because it may or may not lead to an increase in knowledge.</td>
</tr>
<tr>
<td>Gallié and Legros (2012)</td>
<td>The knowledge, skills and other attributes embodied in individuals that are relevant to economic activity – human capital accumulation is complex and is more than the product of schooling.</td>
</tr>
</tbody>
</table>
Advances in knowledge are a decisive factor in economic progress, and these advances have contributed to increases in the quality of physical and human capital (Schultz 1993). Individuals acquire knowledge during their lifetimes; how they use this embodied knowledge to produce goods, services or ideas is of particular concern for firms (OECD 1996). The terms ‘skills’ and ‘knowledge’ are often used interchangeably when discussing the elements of human capital, although Esposto (2010) makes a distinction when discussing the rapidly changing labour market. That is, skills are described as a function of experience within an area of work. Knowledge, however, is acquired over a lifetime and is used to acquire further knowledge and develop skills/abilities usually measured through education and training (Esposto 2010). This topic of measurement is central to the current research; the next section attempts to provide a detailed description of measuring human capital and the limitations.

3.6 Measuring human capital

Unger et al. (2011), amongst others, claim that no official measure of human capital has yet developed. Likewise, Cohen and Soto argue that there is lack of a clear measurement of human capital, and consider “conceptually, there has not been a clear-cut definition on how human capital should be represented” (2007, p. 52). Interestingly, Soboleva’s (2010) account of the paradoxes involved in measuring human capital takes accounts of many definitions; some of these accentuate the market nature of human capital, but contain little on its sources. According to Soboleva (2010), such sources may include the productive skills, talents, and knowledge that permit an individual to earn an income. It is difficult to identify all of the influences on human capital as a complex economic and social phenomenon, whose evolution is marked by both endogenous and exogenous factors (Popescu and Diaconu 2008).
Knowledge and skills form part of the description of human capital: as such, they can be used as methods of measurement. These skills include formal knowledge and general aptitudes acquired either on the job or throughout the individual’s life, often unobserved skills/knowledge (Portela 2001). A measurement of labour quality reflects the skills, know-how and abilities brought by the individual to the organisation (Mostert 2007; Edvinsson 1996; Santos-Rodrigues et al 2010). The OECD (2010) makes the interesting point that linking skills to innovation is difficult; this has led to a lack of clarity in defining and measuring the connections between innovation and human capital. This point is pivotal in the rationale for the current research.

As mentioned earlier, education and training has long been used as a proxy to measure human capital (Cohen and Soto 2007). The level and type of formal education, or number of years of schooling, form the bases of most research assessing return on investment in human capital (e.g. Mincer 1993; 1997; Schiuma and Lerro 2008; Cohan and Soto 2007; McCann and Simonon 2005).

While it is clear from the literature that education plays a key role in relation to human capital, scholars are uncertain about how to measure education in this context (Mulligan and Sala-I-Martin 2000). The average number of years’ schooling is not necessarily a good measure, as it assumes that different levels of education in all categories are standardised for workers, and that time spent in education is proportionate to an individual’s productivity; for example, a person with twenty years’ schooling is twenty times more productive than a person with one years’ education (Mulligan and Sala-I-Martin 2000). Mulligan and Sala-I-Martin suggest that schooling is not a good measure of human capital because “one year of schooling is assumed to deliver the same increase in skill always and everywhere…regardless of the field of study and the quality of the teachers, and the education infrastructure” (2000, p. 216).

Before delving into the emerging debate on human capital (at the micro-level), it is useful to understand how the concept is accounted for at the level
of the whole economy. In studies that measure human capital at the macro level, the use of indices is common. The next section explains two such indices.

3.6.1 Measuring national/regional levels of human capital

For the most part, human capital is measured in aggregate on the national level, for example, the Lisbon Council’s *The European Human Capital Index* (Ederer 2006). Human capital is measured by this means in order to ascertain the level of development of Europe’s overall human capital. The Index ranks 13 countries across the European Union and observes their ability to develop and grow human capital (Ederer 2006). It defines human capital as the cost (in euros) of formal and informal education, multiplied by the number of people living in each country. The Index defines four types of human capital for the participating countries in order to analyse their collective contribution to the wealth of European citizens. The four types of human capital defined are as follows:

- Human capital endowment (the cost of all types of education and training);
- Human capital utilisation (measured by human capital as a proportion of the overall population of a country);
- Human capital productivity (derived by dividing each gross domestic product by all the human capital employed in a country);
- Demography and employment (referring to existing economic, demographic and migration trends in order to estimate employment in the year 2030).

(Ederer 2006)
The 2006 European Human Capital Index report ranks Sweden first, with an overall score of eight, followed by Denmark with a score of 14. Ireland ranked joint seventh with France on a score of 30, indicating a large disparity between countries’ respective human capital.

A similar human capital index has been devised to measure regional innovation performance in the United States at county and state level (Slaper et al 2011). Human capital contributes 30 percent as one of four indicators (the others being economic dynamics 30%, productivity and employment 30%, and economic well-being 10%). The human capital measure assesses the extent to which the population and labour force are able to engage in innovative activities (Slaper et al 2011). Regions displaying higher levels of human capital are those with greater knowledge levels, measured by educational attainment; a larger, younger workforce; and a larger number of innovation-related occupations relative to the overall workforce (technology-based knowledge occupations).

Both of these indices described above, again reiterate the central role played by human capital in innovative activity for growth at a macro level. However, though useful at the regional/economy level, the indices do not address the unique needs of individual firms and the innovative elements of the person. Before addressing the emerging debate in respect to human capital and innovation it is necessary to highlight the contribution of education and training (the traditional measures of human capital).

As outlined previously, human capital is traditionally measured by educational attainment or years of schooling; these can be viewed as a type of credential that indicates a greater innate productivity (Ucbasaran et al 2007). Hofheinz (2009) states that educational attainment is a way of assessing levels of skills in a workforce, ‘higher skills’ meaning tertiary attainment or equivalent, and ‘medium skills’ meaning attainment of secondary or equivalent education; he finds that in all instances, the employment, earning potential and prospects for individuals with further training is are greater than for those with low skills (Hofheinz 2009). Higher education and in-firm training have been found to be positively
related to innovation, and to be the most significant determinant of a firm’s absorptive capability (Rodriguez et al. 2008). However, this finding is contradicted in part by Vinding’s (2006) study of 1544 Danish firms, in which higher education among employees, while positively correlated with ability to innovate was negatively correlated with innovative imitation. Vinding’s (2006) study also found that managers’ work experience was negatively associated with innovation in science-based and ICT type firms. This study confirms in part Schneider et al.’s statement that “highly educated employees are not necessarily positively related to firms’ ability to innovate” (2010, p. 186). Such findings further strengthen the call for a more holistic measure of human capital for which the current research contributes.

According to Lundvall and Johnson (1994), higher education impacts on innovation in two ways: firstly, graduates can invent and develop new technologies; and secondly, more highly educated graduates can exploit technological progress. Interestingly, entrepreneurs’ general human capital (a term discussed earlier) involves the level of education attained by an individual before becoming self-employed, and is considered to be very important for the productivity, profitability and growth of the entrepreneur’s firm (Ganotakis 2012; Bosma et al. 2004). The level of education of the entrepreneur also contributes to their absorptive capacity or learning ability, and to the ability to identify other entrepreneurial opportunities (Ganotakis 2012; Uchasaran et al. 2007). Ganotakis (2012) found that the human capital of a firm’s founders (in the form of specific education and experience including managerial, commercial and technical experience) contributed positively to the firm’s performance and survival.

A national-level analysis of education reveals that developing and developed economies have very different measures of human capital. For example, developing economies aspire to increase the numeracy and literacy skills of their people on a continuous basis (Soboleva 2010). This may explain Romer’s statement about endogenous growth, “that low levels of human capital may help explain why growth is not observed in underdeveloped economies…” (1990, p. S99). Developed economies, on
the other hand, have set ambitious targets, for instance, in Ireland there is a
drive to increase the number of PhD graduates, particularly in the science,
and ICT sectors (Forfás 2009). The number of skilled workers in developed
economies has escalated, and a recently discernible skill bias has been
attributed to this increase (Arvanitis and Loukis 2009)\(^{23}\).

While educational attainment and years of schooling have been highly
developed in the literature as objective tools to measure human capital, the
same cannot be said for the subjective aspects of human capital (e.g., the
tacit elements that differentiate a firm and give rise to competitive
advantage). As indicated by the review of the literature so far, it is
becoming increasingly difficult to ignore the emerging debate on the role of
human capital for firm-level innovation. There is an emerging debate in the
literature on these more innovative elements which are central to the current
research. The penultimate section of this chapter provides details of these
developments.

3.7 An emerging debate on the contributions of human capital to
innovation

Research and “interest in the problem of measuring human capital is now
very high” (Soboleva 2010, p. 65). A move beyond the traditional
measures of human capital has emerged in the literature in recent years;
however, little has been written on the area of innovation and the “quality of
the workers” (Bottone and Sena 2011, p. 405) as a contributor to firms’
innovation activities. The difference between human capital as a physical
asset and human capital as an intangible asset is at the root of the difficulty
of its measurement (Soboleva 2010). Human capital resembles physical
capital in that investment in human capital defers consumption to future

\(^{23}\) Chapter 1 provides statistics on the changes in the level of education amongst the OECD
countries.
expected higher earnings and the improved health, well-being and capabilities of the firm’s workers (Blair 2011).

As pointed out earlier, the new enterprise/business model focuses on a holistic approach recognising that operating in a knowledge economy rests on intangible assets (Lenihan 2011). When referring to human capital as a key determinant of innovation, it has been recognised that human capital is made up not only of technical knowledge acquired by individuals but also of personal skills and individual expertise developed by people during their professional life (Schneider et al 2010). In a similar vein, Page (2007) highlights a firm’s need for a diverse stock of human capital; however, empirical analysis is limited on this. The following section examines the limited studies driving the emerging debate on aspects of quality and tacit elements of human capital at the level of the firm.

In their study of human and social capital, Santarelli and Tran (2012) extend the measure of human capital by considering how both forms of capital shape entrepreneurial performance. Their study assesses human capital in three ways: the professional education of individuals, their start-up experience, and their way of learning. The latter measures take into account the ability of an individual to accumulate knowledge in order to conduct innovation. Using data from approximately 1400 enterprises in Vietnam that have been operating for 1-9 years, the study finds a positive relationship between human capital and new firms. More specifically, the study finds that education, industrial experience, and learning are positively significant in influencing entrepreneurial performance. Similarly, Storper and Scott’s (2009) study on urban growth and geographical distribution of human capital acknowledges the importance of education and training, on-the-job learning and socialisation in the creation of human capital. The same authors highlight the contribution to human capital of interactions between “appropriately matched or complementary individuals” (Storper and Scott 2009, p. 148).

In addition to the literature concerning the general area of human capital, there is an increasing awareness in public policy and in other literature of
the importance of ‘soft’ skills that comprise the subjective elements of the individual (Dolan and Metcalfe 2012; OECD 2011). Dolan and Metcalfe (2012), for example, conducted a representative survey of the British population to examine the relationship between innovation and their subjective well-being (SWB). The authors considered that SWB, which relates to how people think and feel about life and how they evaluate their lives, is associated with originality and imagination. According to the SWB measure, Dolan and Metcalfe (2012) found that having a third-level degree increases life satisfaction by 20 percent; a 33 percent increase in a person’s satisfaction with life is associated with 8 percent greater imagination. In addition, work experience is associated with originality. The study recognises that research into the relationships between innovation and SWB is at an early stage, and suggests that future studies should consider the direction of causality. Such findings may lead to effective ways to increase productivity and economic growth (Dolan and Metcalfe 2012).

A study of 1600 Norwegian firms provides an example of the emerging firm-level innovation debate regarding the importance of a multi-dimensional evaluation of individuals (Fitjar et al 2013). The study explores managerial attitudes and geographical dimensions, and finds that attitudes – or in the broader sense culture, measured by trust, openness, local orientation, staff inclusion and attitudes to risk – significantly shapes the dynamic capabilities of firms and thus their potential to achieve different forms of innovation. In addition, managers’ beliefs and attitudes influence the capabilities of firms and their propensity to collaborate with other regional partners, though less so with national and international partners. The managerial attitude to open-mindedness and risk-taking also affects a firm’s potential to produce innovation (Fitjar et al 2013).

The flexibility of a workforce is another element considered in the literature as well as policy documents (Forfás 2013; BIS 2014; Heery and Salmon 2000). A study by Toner (2011) finds that low levels of labour market regulation and unionisation improve the flexibility of the workforce. However, using a flexible workforce model has a significantly negative
effect on firms’ ability to innovate, partly because firms with higher numbers of casual, part-time workers tend to have lower levels of work-based training (Toner 2011). In Toner’s (2011) study, the skills necessary for human capital with respect to firm-level innovation combine education, training and experience. Toner gathers information on these using an objective measure that takes into account level of schooling, number of years’ experience, and job-related training/lifelong learning (Toner 2011). Such skills are seen as “transcending individual subjects and are argued to be the bases for a ‘flexible’ and ‘multi-skilled’ workforce” (Toner 2011, p. 14). The results presented by Toner, though few in number support the drive to extend the measures used for human capital in the changing world of the firm.

3.8 Conclusion

The role of human capital in innovation activity is the focus of this chapter. Initially, the chapter outlined the perspectives of early philosophers in order to provide a strong theoretical foundation for the research. The literature review moved on to the development of the theory of human capital at the general national level and (for the purpose of the current research) at the level of the firm. The concept of human capital had its origins in the 17th century when the value of labourers was first noted by Petty (1623-1687). However, not until the late 1950s to mid-1960s did human capital emerge as a topic in the economic literature and the publications of Becker (1964/1993). The topic was given scant attention again until the 1980s, when human capital literature developed rapidly following Lucas’s (1988) and Romer’s (1990) studies on ‘new growth theory’.

The theory of human capital spans many literatures and has developed from a number of different theoretical backgrounds, including psychology, sociology, economics and management. The RBV and knowledge-based theories of the firm were reviewed in detail in Chapter 2 but this chapter revisits and highlights the importance of these approaches to the theoretical
framework underpinning the current research. These theories provide evidence that individuals play a key role in firm-level innovation and as an idiosyncratic resource for firms. Section 3.4 also presents a synopsis of social capital and absorptive capacity in order to facilitate a deeper understanding of the links between innovation, the firm and the individual.

Human capital is traditionally measured by level of education or years of schooling and training. Although this is a crude gauge and seems a simplistic measure, it remains a common proxy to measure the skills and knowledge of firms’ employees and indeed the national workforce. The general interest in measuring human capital has emerged recently as a topic of discussion in the literature (Soboleva 2010). Evidence from recent empirical studies using other measures (including flexibility, trust, and networking of human capital) and underlines the need to identify a way to measure the mix of human capital elements necessary to contribute to innovation activity – an activity crucial to the success, sustainability and growth of the firm. Schneider et al.’s (2010) study of innovation and skills also highlights the need for a more holistic measure of human capital. The OECD agrees, stating that “there is a clear need for more empirical work linking measures of skills to innovation indicators” (OECD 2010, p. 11).

Becker, writing in 1960s, believed that although education and training is a major part of human capital, the remainder can be explained by the effects of improved health and by other kinds of human capital that cannot be measured. The notion of ‘other kinds’ of human capital prompts, in part, the current research to identify indicators of human capital that embrace the tangible measures of education and training while adding another dimension, the intangible elements.

The next chapter provides further justification for building on the uni-dimensional (tangible) measure of human capital as a determinant of firms’ innovation activity, to create the holistic concept of IHC, embracing the tangible as well as the intangible elements. In the same way that Kramer (2008, p. 311) used the phrase “making visible what is invisible” in the context of learning how to learn, the current research endeavours to make
visible what is invisible in the context of evaluating the effect of IHC, on firm-level innovation.
4 Developing the concept of Innovative Human Capital and estimating the effect on firm-level innovation

4.1 Introduction

The literature reviewed in the previous chapters highlights the significance of innovation for growth in firms, regions and the economy, and the central role played by individuals as the sources and creators of knowledge (Grant 1996). The review also provides evidence that defining human capital solely in terms of education and training (i.e. its more tangible elements) is limiting, and a more encompassing measure and concept of human capital is called for.

As previously outlined, most empirical studies focus on innovation at the national or regional level; few are conducted at the level of the firm. In addition, there is limited empirical research to date on the combined tangible (e.g., education and training) and intangible (e.g., job satisfaction and willingness to change) characteristics of human capital, whether these characteristics contribute to firm-level innovation, and whether they differ between small and larger-sized firms. The prime aim of this chapter is to extend the standard measure of human capital to encapsulate not only tangible but also intangible elements existing in the individual. The creation of the novel concept of Innovative Human Capital (IHC) is a key contribution of this thesis; it addresses the gap in the literature by moving from defining human capital merely in terms of tangible measures, and developing a holistic multi-dimensional concept, namely IHC. This study is

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24 Much of the material in this chapter is based on a journal article which is in press at Research Policy. McGuirk, H., Lenihan, H. and Hart, M. ‘Measuring the Impact of Innovative Human Capital on Small Firms’ Propensity to Innovate’. 

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predicated on the assumption that the rational firm wants to grow, whether in terms of sales, profit, market share or employment.

This chapter describes the steps taken to construct a unique multi-level merged dataset to operationalise the concept of IHC; that is, to estimate its effect on firm-level innovation. The construction of this dataset makes a methodological contribution to the study of innovation and human capital. In this context, this research poses two central questions at this stage:

- Does IHC contribute to firm-level innovation?
- Do the outcomes of IHC differ between small and larger-sized firms?

The structure of this chapter, based on the first and second stage of the empirical analysis, as explained in Chapter 1, is as follows: Section 4.2 identifies the specific details of the new IHC concept. The section outlines each of the four elements that make up the new multi-dimensional concept, each of which leads to the formulation of eight research hypotheses. The section concludes with Figure 4.2, which illustrates the first and second stages of the research framework. Section 4.3 describes the sources and construction of the rich multi-level dataset used to test the hypotheses. A description of the creation of the new IHC concept is provided in Section 4.4. Section 4.5 outlines the model employed to test the research hypotheses, as well reporting the results of the empirical analysis. In concluding the chapter, Section 4.6 discusses the findings and introduces the third stage of the analysis, which is discussed in Chapter 5.

4.2 Creating a concept of Innovative Human Capital

To fully appreciate the context of the analysis of IHC this section initially identifies the specific firm sizes and individuals on which the current study is based. This is followed in Section 4.2.1 of a description of the elements of IHC and the formation of the first set of hypotheses.
Employee-manager: As alluded to in Chapter 3, the importance of the role of managers in firms’ innovation activity is acknowledged in the literature. This stems from the manager’s position in the firm as one who makes decisions, influence workers, and encourage and reward innovation and change (Damanpour and Schneider 2009). Current studies posit that managers play a critical role in creating, encouraging and maintaining a culture of innovation at the level of the firm. Employee-managers are, therefore, key to the study of IHC.

Firm-size: Likewise, Chapter 2 highlights the significance of firms’ size in the study of innovation. The literature suggests that firms of various sizes have different types of competitive advantages (Hewitt-Dundas 2006). It is interesting to note that micro-sized firms (1-4 employees), as defined by Coronado et al. (2008), were the least active product innovators at 0.06 percent (NCPP Report 2009)\(^{25}\), confirming Coronado et al.’s (2008) findings that such firms are too small to undertake R&D and innovation. Identifying the competitive advantages of IHC for various firm sizes is key to this thesis; therefore, in line with the literature (e.g. Dampanpour and Schneider 2008) and specifically in the Irish context (Hewitt-Dundas 2006), the current research group small firms together; this category includes firms employing less than 50 employees. All other firms are described as larger-sized firms as in Hewitt-Dundas (2006) and Wang and Almed (2004)\(^{26}\).

As previously outlined in Chapters 1 and 3, having employees with higher levels of education may no longer be a sufficient criterion for competitive advantage in terms of firm-level innovation. Furthermore, there is a recent argument in the literature that human capital constitutes more than education and training; various scholars suggest the addition of attributes that affect innovation at various levels; these include, for example, attitudes to risk and trust (Fitjar et al 2013), flexibility (Toner 2011), and the individual’s creativity (Storper and Scott 2009). Interestingly, a large share

\(^{25}\) The NCPP is the source of the firm-level data employed by the current study

\(^{26}\) The firm sizes used by the current analysis are dictated by the size classes used (1-4, 5-19, 20-25, 26-49, 50-99, 100-499, 500+ employees) in the NCPP 2009.
of highly-skilled employees does not substantially increase the probability of a firm being innovative (Schneider et al 2010).

The importance of human capital to innovation is emphasised in the Irish Government’s Action Plans for Jobs reports (DJEI 2012; 2014), which state that the education and training system must respond and adapt to changing needs in terms of skills. The reports also state that investment in management skills is vital. Additionally, through the National Development Plan (2007-2013), the Irish government set out to invest €8.2 billion in initiatives to enhance human capital, physical infrastructure and commercialisation related to science, technology and innovation (Innovation in Ireland 2008, p. 3). This focus is also evident in the UK strategy for growth (BIS 2011), which highlights the value of innovation and research and specifically the benefits of skilled graduates in increasing productivity and innovation.

While an abundance of literature points to R&D as a major determinant of innovation there are constraints; R&D in small firms is constrained by the high costs and risks of undertaking such projects (Hewitt-Dundas 2006; Rammer et al 2009). Most small firms do not engage in formal R&D activity (CIS 2012b; Coronado et al 2008), which may suggest that these firms find alternative ways to innovate, if indeed they innovate at all. Numerous policy initiatives have focused on supporting R&D in the pursuit of innovation, but in the current economic climate of severely reduced budgets (European Commission 2010; Forfás 2012) a focus on firms’ internal resources such as IHC is timely.

4.2.1 Elements of Innovative Human Capital

Having established the importance of the traditional measure of human capital (the tangible dimension of education and training), the emerging literature and the educational statistics presented in Chapter 1 highlight the need for an additional dimension to measure and estimate the effect of employee-managers on firm-level innovation. To this end, the key
contribution of this thesis is the creation and development of a multidimensional IHC concept. Figure 4.1 illustrates the formation of the new concept where the more innovative (intangible) elements of the individual are combined with the traditional and tangible elements.

**Figure 4.1** The elements of the new Innovative Human Capital concept

It would be remiss of any study of human capital to omit the well-tested tangible elements of education and training; the concept of IHC is based on these long-standing tangible measures with the addition of intangible elements of the individual employee-manager that contribute to innovation activity at firm-level\(^27\). There is a strong association between higher levels of education and technical training and an increased demand for technical and organisational innovation (Toner 2011). The OECD (2011) suggest an array of skills required for innovation, including basic and digital-age literacy, academic and technical skills; however, education and technical skills remain an important prerequisite to innovation. As a starting point in the creation of IHC, the first pair of hypotheses are based on educational attainment.

\(^{27}\) As alluded to in Chapter 1, due to data availability this research focuses on the employee-manager as opposed to all employees (an issue discussed further in Chapter 7).
**Education**

To avoid repetition, this section on education provides a short summary of information provided in Chapter 3. The educational attainment of the individual is the conventional measure of human capital (Mincer 1997; Gossling and Rutten 2007; Romer 1990); one reason for this may be that it is easily quantifiable and, for the most part, standardised internationally. For example, the OECD *Education at a Glance* (2013) report uses the *International Standard Classification for Education* (ISCED-97)\(^{28}\) to explain education attainment. The OECD describes the tertiary level of educational attainment as the possession of at least a primary degree from a third-level institution, or what ISCE (1997) refer to as Levels 5 and 6.

To capture both the education element of the new IHC concept and firm size, two hypotheses\(^{29}\) are presented: the first is formulated for small firms (employing less than 50 employees) and the second for larger-sized firms (with more than 50 employees):

**H1a:** Small firms employing managers who have attained a third-level education or higher are more likely to innovate.

**H1aa:** Larger-sized firms employing managers who have attained a third-level education or higher are more likely to innovate.

**Training**

The second tangible element of IHC is training provided or paid for by the firm employing the manager. In the literature, this element is commonly used in combination with education to measure human capital. Mincer (1962) points out that formal schooling is not sufficient alone as a method of training the labour force. Romer (1990), for example, measures human capital in terms of the cumulative effects of formal education and on-the-job

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\(^{28}\)The 1997 standard was revised in 2011 (ISCE 2011) and planned for use in the next OECD report (OECD 2013).

\(^{29}\)Rejection of the first hypothesis, for small firms does not automatically imply the reverse; therefore, it is necessary to formally estimate for larger-sized firms. This approach is carried out for the other three elements of IHC.
training; The *European Human Capital Index* (Ederer 2006), as mentioned in Chapter 3, also considers training in addition to the cost of education. Evidence suggests that expenditure on training increases the likelihood of product and process innovations; hence, training expenditure is a significant variable in explaining the potential for innovation (Reichstein *et al* 2008). Von Krogh and Wallin maintain that, “human capital theory predicts that employers should only pay for employee-specific training, leading to skills that are directly and exclusively applicable to the firm” (2011, p. 267). However, in order to access the human capital of their employees, firms need to invest in on-the-job training as demanded by the employee (Becker 1993; von Krogh and Wallin 2011). Investment by employers in firm-specific training may increase “human capital of the employees’ knowledge and stimulate possible spillovers to other, less able employees during and after training” (von Krogh and Wallin 2011, p. 268). As with education, current public policy strongly emphasises training. Ireland’s *Action Plan for Jobs*, the European Union’s (EU) industrial policy document *Europe 2020* (European Commission 2010), and the UK’s *Strategy for Innovation and Research* (BIS 2011), all promote training and provide support programmes.

As alluded to in Chapter 3, Becker (1993) examined the consequences of investing in a person’s knowledge and skills through education and training. Becker differentiates between the types of advantage conferred by on-the-job training in terms of general and specific training: general training increases the productivity of the trainee, while specific training can be defined as “training that has no effect on the productivity of trainees that would be useful in other firms” and leads to greater marginal productivity for the firm providing the training (1993, p. 40). In a study of firms in Australia, Rogers (2004) found management training had a positive association with innovation for manufacturing firms employing 5-19 people; there was no significance for the larger-sized firm in the same study. Interestingly, Roger (2004) found management training to be important for larger-sized firms in the non-manufacturing sector. From this evidence, the training related hypotheses are as follows:
**H1b:** Small firms employing managers who participate in training are more likely to innovate.

**H1bb:** Larger-sized firms employing managers who participate in training are more likely to innovate.

**Job satisfaction**

The first intangible element of IHC is the job satisfaction an employee-manager experiences in the workplace. According to the RBV 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 element is job satisfaction, or the contentment of an individual with respect to their job (Judge and Kammeyer-Mueller 2012).

Literature suggests that job satisfaction serves a number of functions for the firm, which includes aiding knowledge formation and the formulation of strategies for problem solving (Whitman et al. 2010). In their meta-analysis, Whitman et al. (2010) found employee satisfaction to be related to firms’ outcomes, indicating that 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. Judge and Kammeyer-Mueller (2012) suggest including such measures in any study concerned with the broad topic of job performance. Interestingly, according to Binder and Coad’s research on individual’s characteristics, work is “an important facet of human life and it has strong effects on individuals’ satisfaction with life or happiness” (2012, p. 3). Dolan and Metcalfe’s (2012) study of subjective well-being, (outlined in Chapter 3), considers job satisfaction as a subjective part of a person’s life.

An individual’s level of job satisfaction may contribute to whether they are creative and assertive, or bored and in need of a change to their status quo; a
powerful reason to investigate the aspect of job satisfaction (Zhou and George 2001; Shipton et al 2006). Increased job satisfaction in employees equates to more efficient employee performance; as a consequence, it provides grounds for many theories of management, organisational behaviour and organisational psychology (Morrissey et al 2005; Shipton et al 2006; Zhou and George 2001). Shipton et al.‘s (2006) longitudinal study of 3717 employees from 28 different UK manufacturing organisations measured aggregate-level job satisfaction. This idea captures factors other than those affecting individual performance; in other words, a “shared positive effect may lead to an organizational climate in which creativity, innovation, the search for new products and services, and the support of ideas for new and improved ways of working, are valued by all or most in the organization” (Shipton et al 2006, p. 408). The same study reveals a strong positive relationship between aggregate job satisfaction and innovation in production technology/processes. In contrast Zhou and George (2001), in their study of 149 office employees in a manufacturing plant, found merit in job dissatisfaction. As part of a larger research project on creativity in organisations, Zhou and George found that employees who are dissatisfied with their jobs (but for various reasons are committed to remaining in their positions) make improvements in their workplaces, resulting in increased creativity. Such creativity is further supported where positive reaction from co-workers feedback and organisational support are high. Some studies suggest that, with regard to job dissatisfaction, lack of management capabilities constitutes an obstacle to strategic change, both because it affects the individual in the firm and because executives hesitate to take risks due to the uncertainty inherent in change (Wang and Ahmed 2004).

As indicated by Coronado et al. (2008), the difficulty of measuring intangible variables is well known. As evidence, job satisfaction is rarely included in large-scale surveys such as Europe’s Community Innovation Survey (CIS 2012b) or the Irish Innovation Panel (Roper 2001). As a result, job satisfaction has been an under-researched element of human capital compared to education or training.
From the perspective of the theory and empirical research presented here, the hypotheses based on the first intangible element of IHC are formulated as follows:

**H1c:** Small firms employing managers who are satisfied in their jobs are more likely to innovate.

**H1cc:** Larger-sized firms employing managers who are satisfied in their jobs are more likely to innovate.

**Willingness to change**

The second intangible element included in IHC is the employee-managers’ willingness to change in the workplace. Change is at the heart of innovation (Audretsch 2004; Montalvo 2006). Hurt *et al.* (1977) define individuals’ innovativeness as their willingness to change. However, measuring an individual’s willingness to change is ambiguous and problematic. Wang and Ahmed (2004), in their study of 231 UK larger-sized firms (having over 50 employees), found that the innovativeness of managers lies in their willingness to change and encourage others to develop new ways of doing things. 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 plays a key role in service innovations in particular (Nijssen *et al.* 2006). Interestingly, an increase in employees’ willingness to change in the workplace is reported in the longitudinal study conducted by the *National Centre for Partnership and Performance* (NCPP) (2009) (which is the main source of the data for the current research). The 2009 report captures a greater level of willingness to accept change than that recorded by the same report in 2003. In the report, over 90 percent of employees said that they were willing to accept changes to improve how work is done in their workplace. The survey also found that private sector employees were more willing to accept change than those working in the public sector, specifically in the areas of changes in work pressure and responsibilities (NCPP Report 2009). As will be seen in
greater detail in Section 4.3, the types of change addressed in the study include willingness to increase the level of technology or computers involved in employee-managers’ work; willingness to accept change in levels of skills necessary to carry out their jobs; and increased responsibility. (Section 4.4 provides a detailed description of how these elements are measured.) Hence the last two hypotheses at this stage are formulated as follows:

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

**H1dd:** Larger-sized firms employing managers who are willing to change are more likely to innovate.

To summarise the theoretical model underpinning this research, Figure 4.2 illustrates the connections between the four elements (both tangible and intangible) in the development of a new and holistic IHC concept and shows the first and second stages of the analysis. The figure is expanded in Chapter 5 to include the third stage of the empirical analysis.

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30 The full research framework was presented in Chapter 1.
4.3 Description of the data used to test the hypotheses.

In order to test the hypotheses that firms who employ managers with IHC are more likely to innovate, it is necessary to identify appropriate information on firms, their employees and their innovation activity. This section outlines the process undertaken to identify, acquire and prepare the data needed to test the eight hypotheses. As previously discussed in Chapter 1, the current research uses Ireland as its laboratory, though the research could be adapted to evaluate IHC in any economy by using similar data. Chapter 7 discusses this possibility and identifies similar sources of data to which the methodology used here could be applied.

The empirical analysis undertaken here is based on a unique merged dataset that allows for a comprehensive analysis of the effects of IHC on innovation. The key objective of building a merged dataset was to provide a representative sample of firms and employee-managers from across Ireland. The steps taken to create this new dataset are set out next.
4.3.1 A description of the data from National Centre for Partnership and Performance, Work Place Survey

Ireland’s National Centre for Partnership and Participation Workplace Survey (NCPP) 2009 is the main source of information used by the current research to operationalise the concept of IHC. In late 2011, contact was made by the author and discussions held with a statistician from the Central Statistics Office (CSO) at its Cork office and with the Director of the Irish Social Science Data Archive (ISSDA) at University College Dublin. The dataset from NCPP 2009 workplace survey was identified for use in the research; the right to use the data was given by the ISSDA.

Although the NCPP 2009 dataset is not principally concerned with firm-level innovation or human capital, the survey offers a rich variety of information about a representative sample of firms in Ireland, and on the views and experience of employees during the period 2007-2008. As well as information on their views and experiences as employees, respondents were asked about firm-specific details including innovation activities, sector, number of employees and regional location.

The NCPP collaborated with Ireland’s Economic and Social Research Institute (ESRI) survey unit and Amárach Research31 to conduct two large-scale surveys in 2003 and 200932, compiling data on the perspectives and experiences of a representative sample of employees from the public and private sectors in Ireland. The 2003 dataset did not contain information on firms’ innovation activity or their location; for this reason the 2003 dataset is not used in the current study.

The reference period (2007-2008) is important in the case of Ireland, as it marked the end of the boom period and the beginning of the current economic recession (NCPP report 2009). According to the survey findings,

31 Amárach Research are research consultants based in Dublin, Ireland.
32 The 2009 survey is the most recent survey available for the views of employees. The 2009 survey is one of two conducted that year, one with employees and the other with employers. The latter is unavailable to researchers for confidentially reasons given the small size of the employer pool in Ireland, particularly in the case of large employers.
half of employees reported a reduction in staff numbers in their organisation during this period, and 21 percent reported a decline in hourly pay. The 2009 survey (which targets employees aged fifteen and over) is broadly in line with the 2003 survey, with the addition of questions on work-life balance and diversity in the workplace. Also, the 2009 survey captures for the first time the level of innovation in Irish workplaces and provides information on the location of the firm.

The NCPP report (2009) and its dataset constitute the source of the data description in this section. Following a pilot survey in February 2009, the full survey was conducted from March to June of the same year by Amárach Research, which was contracted to conduct the survey on behalf of the ESRI. The survey was conducted by telephone interview. The telephone numbers were “generated on a stratified random basis from Amárach’s database of landline telephone numbers” (NCPP Report 2009, p. 152). A quota control was implemented on respondents to ensure the sample was representative of the target population. The database was sorted by area code, and a sample was extracted from the groups categorised by area codes to ensure that all regions of Ireland were represented. The telephone interviews with employees within households took, on average, thirty-five minutes. The survey produced 5,110 completed and usable interviews from a total of over 65,000 telephone calls. The majority of these telephone calls (45,880) were not eligible for the survey. Reasons for this ineligibility include: nobody in the household was an employee, ‘out of quota’ where a sufficient number of interviews had been complete in that age and gender category and telephone number was ‘out of service’. In addition, nearly 11,000 telephone calls were of unknown eligibility because it was unclear to the interviewer whether anyone in the household was employed. Therefore in calculating the response rate, the NCPP calculate the completed and usable interviews (5,110) as a percentage of the total estimated eligible interviews (10,186). The non-response outcomes included ‘language barrier of respondent’, ‘outright refusal’, ‘answering machine’ or ‘nobody in employment in the household’. The response rate for the survey was fifty percent; this was calculated on the basis of completed interviews as a
percentage of the total estimated eligible calls (NCPP Report 2009). Reweighting or statistical adjustment of the data was carried out by NCPP to ensure that the dataset included a representative sample of the full population of all employees living in private households in Ireland. This procedure is in line with other sample surveys (Ozgen et al 2011); the variables used for weighting included gender by industrial sector (eleven sectors), gender by region and age group, public or private sector and gender by nationality (four categories). Reweighting used data from the CSO’s *Quarterly National Household Survey* (QNHS) from the first quarter of 2009; the reweighting balance across sectors was “reasonably good (apart from men in construction and women in health)” (NCPP Report 2009, p. 154). The NCPP survey provided information on individuals employed by firms located in Ireland, without providing the firms’ name or a firm identification number. While it is not possible to identify instances of multiple responses from individuals employed by the same firm, this potential limitation is greatly reduced by the robust nature of the data collection process as well as the quota controls and representative nature of the survey in categories such as region, age and gender. The questionnaire has eight sections and includes headings such as ‘Labour Market Details’; ‘Workplace Innovation: The Organisation of Work’; ‘Attitudes to Job and Autonomy’; ‘Change in the Workplace’, and ‘Employer/Employee Relations’.

One of the key reasons for using the NCPP data is that it provides information on the firms’ innovation activity. Measuring innovation is an on-going challenge for researchers; while patents and trademarks are commonly used as proxies (Buesa *et al* 2010; Galasso and Simcoe 2011), such methods have limitations. Though easy to quantify, this type of measure is problematic; not all innovations are registered, and not all patents are innovations (OECD 2011a). The survey method of measurement, which asks respondents about firms’ level of innovation activity, is
increasingly used in research (i.e. Community Innovation Survey\textsuperscript{33}) (CIS 2012a; Roper \textit{et al} 2010). Part of the value of the NCPP 2009 survey lies in the use of this measurement; the survey asks respondents the following:

During the last two years, did your organisation introduce…

- a new or significantly improved product,
- a new or significantly improved service,
- any innovations in the workplace such as new ideas, processes or behaviours that led to significant improvements in the way the work is carried out?

As mentioned earlier, the NCPP database contains in excess of 5,000 observations and 140 variables; not all are suitable for use by the current research, due to the level of response to some questions\textsuperscript{34}. The next section outlines the preparatory work conducted before including the regional information.

\textit{Preparation of the NCPP data for use}

The first step in creating the new merged dataset was to prepare the NCPP dataset, the second step was to add the regional data described in the next section (4.3.2.)

The NCPP dataset acquired from ISSDA was in SPSS\textsuperscript{35} format, while the statistical software Stata\textsuperscript{®} 11 was used to conduct the estimations for the current analysis. Stata®, commonly used in microeconometrics, enables the researcher to utilise various analysis techniques not provided by other software packages. Before transferring the data to Stata®, the author conducted a number of descriptive statistical enquiries; these included summary statistics and reliability tests (details of which are given in Section 4.4). These investigations into the data were carried out to ensure that the

\textsuperscript{33} The Community Innovation Survey (CIS) is based on innovation statistics that are part of the EU science and technology statistics. Surveys are carried out with two years' frequency by EU member states (CIS 2014).

\textsuperscript{34} For example, questions on union membership and salary level. The survey also contained ten questions on family and health-related issues with low response rates.

\textsuperscript{35} Statistical Package for the Social Sciences (SPSS) Version 21 is a computer application that provides statistical analysis of data.

\textsuperscript{36} Stata® is a statistics software package created in 1985 by StataCorp.
data were compatible for use in the current research; for example, questions such as that on union membership received a low response from employee-managers in particular, making it a variable not usable by the research. Chapter 5 describes an issue with respect to gender diversity highlighted by exploring the gender-related weightings used with the NCPP data.

While there is a growing awareness of innovation in the public sector (Parna and von Tunzelmann 2007), the private sector remains the main source of innovation, particularly product innovation and job creation (Parna and von Tunzelmann 2007; NCPP Report 2009; DJEI 2012). For these reasons, the first stage in preparing the NCPP dataset for the purposes of this research was to extract data indicating that respondents were employed in the private sector. The question asked in the survey was, “In which of the following sectors do you work?” The respondents were given three choices: Public, Commercial Semi-State Sector or Private Sector. As expected, focusing on the private sector reduced the data to a total of 3181 observations.

As alluded to earlier in this chapter, the current research explores the IHC of employee-managers (not self-employed\(^37\)). Limiting the analysis to this level of employee helps overcome a limitation of the data. That is, the NCPP data provides information on the firm from a single respondent’s perspective. A bias could be caused by using responses from all levels of employees: in that responses from non-managerial employees capture the views and experience of individuals with no apparent influence over other employees in the firm, or the firm’s budget or strategies. Knowledge of firms’ innovation activity further justified the use of the employee-manager cohort by this research. That is, over twice the number of respondents to the NCPP 2009 survey who indicated their employment status as ‘employee’\(^38\), replied that they did not know whether the firm innovated or not. Hence, extracting employee-manager responses further reduced the NCPP data.

\(^{37}\) The NCPP 2009 Workplace survey (employees) includes employees only – not the self-employed. An employed manager would be included but not a business owner.  
\(^{38}\) Employee opposed to manager or supervisor status.
To capture firm type, the NCPP (2009) survey asks respondents for the main activity of the businesses where they work. The NCPP database uses nine groups of *European industrial activity classification* (NACE) codes: construction; wholesale and retail; hotels and restaurants; transport, storage and communications; financial and other business activities; public administration and defence; education; health; and other services. For the purposes of the current research, and similar to Rammer *et al.* (2009) and Roper *et al.* (2010), firms are grouped into three sectors: production (22%), financial and other business activities (30%) and all other services (48%). (Production includes manufacturing but excludes agriculture-related industries as provided by the NCPP dataset.) This grouping was necessary as the number of private sector employee-managers in such sectors as education and health fell below 10 percent of the total observations.

Preparation of the data also included checking for missing data and assessing the level of answers such as ‘not applicable’ and ‘don’t know’. It was necessary to standardise the information provided by the NCPP in order to enable its combination with regional data. To this end, many of the Likert scale variables were reverse-scored so that higher scores reflect greater levels for all variables. Likewise, binary variables were amended; in most cases NCPP binary scores used the number two to indicate ‘no’ and one to indicate ‘yes’. Finally, to standardise the data, items such as male/female were changed to one if the respondent was male and zero if female. The extensive preparation of the data allowed the author to become familiar with the dataset.

While the NCPP dataset provides rich information at the firm and individual level, it was necessary to supplement it with information on factors external to the firm. This allows for the analysis of IHC beyond a firm level assessment.
4.3.2 Source of the regional information

Despite the merits of the NCPP data (extensive information at the level of the individual’s views and experience in their workplace, and information on the firm employing them), the dataset does not provide any regional data except for the specific region where the firm is located. In order to add equally rich regional level information and address further research questions discussed in Chapter 5, regional data was sought. For this purpose, the author identified:

- Ireland’s Central Statistics Office, population census data;
- Global Entrepreneurship Monitor 2008 National Report;
- Irish Innovation Panel data.

*Census data* - A census of the population in Ireland is taken approximately every five years. 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. 2006 was selected for the purpose of this study, as it was the closest year to the NCPP 2007-2008 reference years. COPSAR is a five percent sample (212,006 observations and 38 variables across 34 administrative areas, including cities and counties) relating to persons within households who are anonymised by stripping out all identifiable information. The COPSAR data provides the current research with information on education levels in each region, detailing the highest levels of education completed to date. The data also provides the individual’s place of birth, (details and use of this particular information is discussed in Chapter 5).

In order to prepare the data for use by this study and to combine with the other three datasets, a number of amendments were necessary. COPSAR provided information on the education attainment under thirteen categories, from having no formal education to primary level and lower second level education. Based on the literature and the data provided by NCPP (2009), these thirteen categories were grouped into five groups, including primary
and third-level degree or higher. The COPSAR data provided information at county/administrative level (34 in total); again, to standardise the data in preparation for merging the data, these were grouped into the eight NUTS3 regions of Ireland. This regional-level of analysis resembles NCPP’s data and hence serves as the common identifier used to merge all four datasets. This is elaborated further in Section 4.3.3.

Global Entrepreneurship Monitor (GEM) - In order to capture the entrepreneurship activity in particular regions in Ireland, this research uses information published in the GEM 2008 Country Report for Ireland (Fitzsimons and O’Gorman 2009). The GEM project is an annual assessment of the entrepreneurial activity of 69 countries; it covers approximately 75 percent of the world’s population and 89 percent of world GDP (GEM 2013). Ireland has participated in GEM since 2000; the 2008 survey uniquely reports the rate of entrepreneurial activity at regional level (specifically at NUTS3 level). Again, details and use of this information are provided in Chapter 5.

The third source of regional information used in the new dataset is the Irish Innovation Panel (IIP). The IIP dataset (version 1.02) comprises data from 6 surveys, or waves, using similar methods and questions across all waves. The surveys captured information from manufacturing firms on the island of Ireland from 1991-2008. The IIP has been used to produce many notable analyses within the broad topic of innovation, including R&D and linkages, for manufacturing and service firms located in both Northern Ireland (UK) and the Republic of Ireland (Roper and Hewitt-Dundas 2008; Roper et al 2008; Woerter and Roper 2010). The current research uses information from waves 3-6 for the Republic of Ireland, which provides information on in-plant R&D, used as a proxy to measure input to innovation activity in the region. In preparing the data for use by this study the county in which the firm was located was used to group the data into the

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39 The rationale for using this information is discussed in Chapter 5.
40 The author is grateful to Stephen Roper (Warwick Business School), Nola Hewitt-Dundas (Queen’s University, Belfast), and Jim Love (Aston Business School) for permission to use the Irish Innovation Panel dataset.
41 Subsequent waves have been carried out but are not yet available for use by third parties.
eight NUTS3 regions. Again, further discussion of this regional-level information is provided in Chapter 5. Having described the four individual datasets, the next section explains the merging process.

### 4.3.3 Merging the four datasets

The regional NUTS3 level (the Nomenclature of Territorial Units for Statistics) is the only common identifier available across all four sources of information (NCPP, GEM, IIP and COPSAR) and is therefore the governing factor in creating the new merged dataset. While the IIP and COPSAR data report information at county level, in combining the four datasets it was necessary to aggregate to NUTS3 level in order to match with the NCPP data. The NCPP NUTS3 ‘version’\(^2\) comprises eight geographical regions in Ireland.

Using the common identifier (NUTS3), information on individual managers, employed by private firms located in Ireland (information from NCPP 2009), is complemented by information pertaining to the region in which these firms are located. Regional characteristics, from the three sources as outlined in Section 4.3.2, is merged with the NCPP data to produce a new dataset containing a total of 1070 usable observations. These observations provide information on individual managers and on the firms employing them as well as information on the region in which the firm is located. To this end, the new dataset makes possible the analysis proposed earlier in this chapter.

\(^2\) With the exception of the South East and Mid-West regions; in the NUTS3 the county of Tipperary North is included in the Mid-West and Tipperary South in the South East region. NCPP includes both Tipperary North and South in the Mid-West region. For the purpose of this research we follow the NCPP regional divisions, referred to as NUTS3, throughout.
4.3.4 Description of the new merged dataset

Overall, the novel dataset provides a representative sample of 1070 employee-managers living in the eight regions of Ireland. Appendix C outlines the alignment with the full NCPP (2009) dataset. The dataset shows that during the reference period (2007-2008) 58 percent of firms performed product innovations and 57 percent undertook service innovations; furthermore, 65 percent introduced a process innovation.

With respect to small firms (562 observations), most employee-managers are male (60%) and 35 percent hold a third-level qualification or higher; a total of 94 percent are employed on a permanent basis, and 99 percent are direct employees (1% agency workers). The average age of employee-managers in small firms is 41.5 years; on average, they have worked just less than ten years in the firm.

The majority of employee-managers in larger-sized firms (508 observations) described themselves as Irish (67.7%); the average age is 40.5 years and the average number of years’ service to the firm is 11.4 years. In the case of larger-sized firms, 53.1 percent of employee-managers have attained a third-level educational qualification or higher and 65.7 percent have availed of training provided by the firm. The majority of larger-sized firms innovate in some form: 58 percent engage in process innovation, 52 percent service innovation and 54 percent product innovation.

With respect to the views and experience of employee-managers, 37 percent indicated that they are satisfied in their jobs. 71 percent of firms captured in the dataset provide regular performance reviews or appraisals to employees, although this varies across firm size: 85 percent of larger-sized firms (>50 employees) offer reviews or appraisals, compared to 61 percent in small firms. Likewise, 89 percent of employee-managers indicated that their firms encourage employees to work in teams in order to improve performance. On the 8-item Likert scale (a Cronbach’s alpha of 0.8), 91 percent of managers responded that their firms positively consider
customers’ needs as a top priority (this was used as part of the measure of firms’ work practices and is discussed in the next section).

In terms of the external or regional variables in the new dataset, the results show that the level of entrepreneurship activity in the regions of Ireland varies; a high of 13 percent of people surveyed in the Mid-West region expect to start a business in the next three years, as compared to a low of 8.6 percent in the South-West region. With regard to regional level in-plant R&D, there is an eight percent difference between regions with a mean of 52.2 percent. Further description of regional variables is provided in Chapter 5.

While Table 4.1 presents a summary of the data used in Stages 1 and 2 of the analysis, outlined earlier in this chapter (see Figure 4.1), a description of the specific measures of the IHC elements are provided in the next section. Likewise, further details of the data used for stage three of the analysis are presented in Chapter 5.
Table 4.1 Summary of variables used to estimate the effect of IHC on firms’ innovation.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Innovation</strong></td>
<td>Firm</td>
<td></td>
</tr>
<tr>
<td>- Product (0/1)</td>
<td>Firm</td>
<td>58%</td>
</tr>
<tr>
<td>- Process (0/1)</td>
<td>Firm</td>
<td>65%</td>
</tr>
<tr>
<td>- Service (0/1)</td>
<td>Firm</td>
<td>57%</td>
</tr>
<tr>
<td><strong>Innovative Human Capital</strong></td>
<td>Individual</td>
<td></td>
</tr>
<tr>
<td>Education&lt;sup&gt;2&lt;/sup&gt; (0/1)</td>
<td>Individual</td>
<td>43%</td>
</tr>
<tr>
<td>Training (0/1)</td>
<td>Individual</td>
<td>56%</td>
</tr>
<tr>
<td>Job satisfaction (Hard)&lt;sup&gt;4&lt;/sup&gt;</td>
<td>82%</td>
<td></td>
</tr>
<tr>
<td>Job satisfaction (Soft)&lt;sup&gt;4&lt;/sup&gt;</td>
<td>66%</td>
<td></td>
</tr>
<tr>
<td>Willingness to change (Hard)&lt;sup&gt;4&lt;/sup&gt;</td>
<td>46%</td>
<td></td>
</tr>
<tr>
<td>Willingness to change (Soft)&lt;sup&gt;4&lt;/sup&gt;</td>
<td>89%</td>
<td></td>
</tr>
<tr>
<td><strong>Control variables</strong></td>
<td>Cronbach’s alpha</td>
<td></td>
</tr>
<tr>
<td>Work practices</td>
<td>Firm</td>
<td>0.8</td>
</tr>
<tr>
<td>Managers&lt;sup&gt;3&lt;/sup&gt; nationality (Irish)</td>
<td>Individual</td>
<td>83%</td>
</tr>
<tr>
<td>Managers&lt;sup&gt;3&lt;/sup&gt; gender (male)</td>
<td>Individual</td>
<td>65%</td>
</tr>
<tr>
<td>Sector</td>
<td>Firm</td>
<td></td>
</tr>
<tr>
<td>- Production</td>
<td>Firm</td>
<td>22%</td>
</tr>
<tr>
<td>- Banking/finance &amp; other</td>
<td>Firm</td>
<td></td>
</tr>
<tr>
<td>businesses</td>
<td>Firm</td>
<td>30%</td>
</tr>
<tr>
<td>- Other services</td>
<td>Firm</td>
<td>48%</td>
</tr>
</tbody>
</table>

Source: NCPP (2009); CSO (2006); Roper, Hewitt-Dundas and Love (IIP dataset v.1.02); Fitzsimons and O’Gorman (2009).

1 See Table 4.2 for questions related to this variable.
2 Education refers to Bachelor’s degree and higher.
3 Refers to employee-managers.
4 A full explanation of the hard and soft measures of job satisfaction and willingness to change is presented in Section 4.4 and Table 4.3.
4.4 Measuring Innovative Human Capital – Stage 1

Having outlined the four elements of IHC as well as the source and description of the data in the previous sections, this section explains the first stage of the methodology: measuring the new IHC concept, which will allow the researcher to operationalise the new concept to estimate the eight research hypotheses formulated earlier.

Education:

As alluded to in Chapter 3, education has been measured in a number of ways including years of schooling and GDP spent on education. The current research follows Hofheinz’ (2009), the NCPP Report (2009) and Leiponen’s (2005) measure of educational attainment. Employee-managers were asked to indicate their highest level of educational attainment, and were given a choice of eight levels including: none/primary certificate or equivalent (1); some secondary education (no exam) (2); Junior/lower second level (3); Leaving Certificate/upper second level (4); post-leaving Certificate course (5); third-level(6); postgraduate diploma/degree (7); and other (8). In order to measure the number of employee-managers with higher levels of education, the question is recoded as a binary variable that takes a value of one if the respondent has a third-level degree or higher (6 and 7), otherwise zero. This binary measure indicates whether the responding employee-manager has attained an undergraduate (Bachelors) degree or postgraduate degree/diploma (e.g. Masters, PhD) (NCPP 2009; OECD 2013) – a common benchmark in the innovation literature (Roper et al 2010; Schneider et al 2010).

Training:

The merged dataset provides information on whether the employee-manager availed of training provided by the firm: ‘yes’ or ‘no’. Consequently, the
research uses a binary measure for training. In order to conform to standard use of binary coding (Long and Freese 2006), this variable was recoded to take the value of one if the respondent availed of training, otherwise zero.

**The intangible elements of IHC:**

In acknowledging the complexities of measuring human capital (Teixeira et al 2014) and to reflect the holistic characteristics of IHC, the current research uses two measures of employee-managers’ willingness to change and an additional two measures to capture their job satisfaction. The purpose of employing two measures is to look deeper into the effects of the intangible elements of IHC on the innovation activities of firms. Because using a crude single measure for each element may lose valuable intangible elements of IHC, what are termed ‘hard’ and ‘soft’ measures are used to capture a more complete picture.

**Job Satisfaction:**

The NCPP data provides a set of questions related to job satisfaction. The use of multi-item scales are anchored from: strongly agree (1), agree (2), disagree (3), strongly disagree (4), refuse (5). The job satisfaction questions include satisfaction with the physical working conditions, hours of work, and whether the employee-manager works under a great deal of pressure (see Table 4.3 for further details).

To assure validity of the scales and reduce them to a workable construct, a factor analysis was conducted. Such an analytic technique is used to evaluate scales and reduce a large number of related variables to a manageable number (Pallant 2010), as was needed in the case of job satisfaction in the current research. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) value was 0.86\(^{43}\). The use of the scatter plot

\(^{43}\) A value of >0.05 indicates suitability for factor analysis. Such a measure is an index for comparing magnitudes of correlation coefficients (Hagedorn and Cloodt 2003).
and factor analysis highlights the loadings of the variables, while the ‘Pattern Matrix’ indicates two factors. The factor analysis also provided the factor scores, which were used in the estimations.

As a result of the analysis explained above, work-focused job satisfaction (e.g. salaries, physical working conditions) captures what the current research terms a ‘hard’ measure of job satisfaction. The ‘soft’ measure of job satisfaction is a composite of a further five questions related to employee-managers’ values, loyalty and pride in working for the firm. Wanous et al. (1997) outline the merits of using such scaled measures of job satisfaction as opposed to a single-item measure.

Following factor analysis and identifying the two components of job satisfaction, a reliability test was conducted. To ensure the internal consistency of the scales (that is, do the scales measure the same underlying constructs?) a Cronbach’s alpha coefficient was employed. The results indicated that the scales are reliable: the Cronbach’s alpha for hard and soft measures of job satisfaction were 0.74 (5 items) and 0.76 (5 items) respectively. Table 4.2 provides a list of the questions related to each of the measures of job satisfaction.

Willingness to change in the workplace:

Two measures of willingness to change are also used in the analysis. A Cronbach’s alpha was conducted using the seven-item scale, with results indicating that the scale was less than reliable; this led the researcher to use a factor analysis similar to the technique employed for job satisfaction. The ‘Pattern Matrix’ indicated one strong component containing three questions, while the other four items returned various values across two factors.

The three-item composite measure of changes to work tasks is employed here to measure the ‘soft’ elements of employee-managers’ willingness to change in the workplace. These soft elements include employee-managers’

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44 The mean score for each of the factors was also used in the estimation with minimal difference in results.
willingness to increase: the level of technology or computers involved in their work, the levels of skills necessary to carry out their job, and levels of responsibility for improving how their work is done. Van den Berg and van der Velde (2006) found that such work tasks reflect employees’ flexibility, which in turn leads to improved work performance. Similar to the job satisfaction measures, the measure of willingness to change was subjected to reliability tests (Cronbach’s alpha had a value of 0.57 (3 questions)). Although some may consider the latter below the ideal value of 0.7 (DeVellis 2003), Schmitt states that there is “no sacred level of acceptable or unacceptable level” (1996, p. 353), and it is common in the literature to find values of below 0.6 (Landry et al 2001; Pallant 2010; Song et al 2011). The ‘hard’ measure, on the other hand, is a single measure, which captures employee-managers’ willingness to work unsociable hours. This question is recoded as a binary variable: willingness to work unsociable hours takes the value of one, otherwise zero.

This completes the first stage of the analysis, a description of the new IHC concept; the second stage is to follow.
### Table 4.2 Summary of variables used to estimate the effect of the external and internal factors on Innovative Human Capital

<table>
<thead>
<tr>
<th>Elements of Innovative Human Capital</th>
<th>Description/Question</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Education</strong></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Training</strong></td>
<td>Have you received any education or training paid for or provided by your present employer over the last 2 years? Yes/No</td>
</tr>
<tr>
<td><strong>Job Satisfaction</strong></td>
<td>Attitudes to work and work issues –</td>
</tr>
</tbody>
</table>
| **Hard**                            | 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 |
| **Soft**                            | My values and the organisations values are very similar  
I am proud to be working for this organisation  
I would turn down another job with more pay in order to stay with this organisation  
I feel very little loyalty to the organisation I work for (R) |
| **Willingness to Change**           | Willingness to accept change in workplace over next 2 years |
| **Hard**                            | - having to work unsocial hours  
- 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. |
| **Soft**                            | - 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 |

**Source:** NCPP Report (2009)
4.5 Estimating the effect of IHC on firms’ Innovative Human Capital – Stage 2

The second stage of the analysis (see Figure 4.1) tests the hypotheses that firms who employ managers with IHC are more likely to innovate. Similar to the methodology used by Rammer et al. (2009) and Ganotakis (2012), this stage tests the eight hypotheses by means of a series of logit regressions in which IHC of managers employed by firms in Ireland is the independent variable, using the following equation:

\[
\text{Inn}_i = \alpha_0 + \alpha_1 Z_i + \alpha_2 \text{Dem}_i + \alpha_3 \text{RS}_i + \alpha_4 \text{IHC}_i + \mu_i \quad [1]
\]

where \( \text{Inn}_i \) is the innovation activity of firm \( i \). Three types of firm-level innovation are estimated for: product, service and process innovation. Until recently, the literature has been limited to product and process innovation (Gordon and McCann 2005); this research incorporates service innovation (details of which were outlined earlier). The firm-specific variable \( Z_i \) is a matrix of internal firm-specific attributes that may be expected to affect a firm’s capacity to innovate. These include sector type (production, financial and other business activities, and all other services) discussed previously, and the firm’s work practices. The latter controls for the strength of the firm’s innovative climate (Johnson 2001); creating an innovative firm environment includes endeavouring to prevent the management hierarchy from becoming a dominant force, and maintaining communication with employees in relation to innovation activity (Reza Noruzi and Westover 2010). This variable includes the firm’s willingness to accept risk in order to be innovative, and the firm’s encouragement of its employees to work in teams to improve performance. Table 4.2 gives a detailed list of questions for this variable.

The estimation also controls for the respondent’s age, gender, and nationality, denoted as \( \text{Dem}_i \). External effects on firms’ innovation are
controlled for by the location of the firm $RS_i$. The research uses the eight NUTS3 regions of Ireland with Dublin (Ireland’s capital city) as the reference region. Networking and the effects on innovation are more likely to be positive in a capital city or in large urban areas; firms in such locations are more likely to innovate, as they experience fewer constraints and lower costs (Forman et al 2007). The complex combination of resources, industrial structure, specialisation and diversity in large cities facilitates innovation and productivity growth (De Groot et al 2007). Agglomeration also enables knowledge creation and spillovers (Puga 2010; Rondé and Hussler 2005), which are essential factors for innovation (Pavitt 2005). However, De Propris et al. (2005) suggest that agglomeration differs across industries. Forman et al. (2007) find that the benefits derived from agglomeration are important among small firms and firms in new industries where specific human capital is still being developed.

The main variable of interest in equation [1] is the Innovative Human Capital $IHC_i$ of the employee-manager. As discussed previously, the four elements are measured as follows; education attainment and participation in training use a binary measure. Likewise a binary measure is employed for the hard measure of willingness to change, while the measures of willingness to change (soft) and job satisfaction (hard and soft) employ a factor score.

Regression models for binary dependent variables explain how the independent variables affect the probability of the event occurring (Long and Freese 2006). The choice of a logit model over a probit model is an issue of concern to researchers in selecting which model to use (Doran et al 2012; Childers 2011; Egger et al 2010). Interestingly, the decision seems to be one of “personal choice” (Childers 2011, p. 51). In her (2011) article in the American Economist, Childer elaborates: “a priori, there does not seem to be a reason to prefer logit over probit or vice versa from theory. Furthermore, the literature does not show a preference for logit or probit.” Childers, does however, experiment with the two models; she finds the probit model better suited her particular data. Following Childers’ (2011) experiment, the current analysis conducted similar trials and found logit to
be a better ‘fit’ to the dataset. Logit estimation is appropriate in this instance because the dependent variables are binary; taking a value of one if the firm introduced a product, process and/or service innovation during the reference period (2007 – 2008), otherwise zero.

4.5.1 Empirical results

Table 4.3 presents the results of the logit estimations regarding the probability of introducing a service, product or process innovation in small and larger-sized firms. Overall, the results from the multiple logit regressions of equation [1] reveal a difference between small (less than 50 employees) and larger-sized firms (more than 50 employees). This result supports in part Rogers’ (2004) findings that determinants of innovation may vary between small and larger-sized firms.

*IHC in small firms* – the results reveal a strong likelihood that small firms engaging in service and process innovation employ managers who avail of *training* (at the 1% level). In an attempt to address the complexities of the intangible elements of IHC mixed results are yielded by the two measures of *willingness to change*: employee-managers who are willing to work unsociable hours (the hard measure) are less likely to be employed in firms that service innovate (at the 5% level), while those firms that product innovate are more likely to employ managers who are willing to change work tasks (the soft measure - significant at the 5% level). In terms of the soft measure of job satisfaction, the results are positively significant for small firms that engage in service and process innovation, at the five percent and ten percent level respectively.

*IHC in larger-sized firms* – the most interesting result in the case of firms employing more than 50 people is that employee-managers who exhibit IHC elements captured by the hard measures of willingness to change (at the 10% level), training (at the 5% level), and education (at the 10% level) are all positively significant for process innovation. This may indicate that IHC is a valuable determinant of process innovation activities in larger-sized
firms. Training is also positively significant for service innovation at the ten percent level. The larger-sized firms that process innovate on the other hand are less likely to employ managers satisfied with such issues as pay, physical working conditions or job security (the hard measure of job satisfaction).

A striking finding, irrespective of firm size and innovation type tested, is that higher levels of education are insignificant except in one case (that of process innovation in larger-sized firms). This finding is important considering the emphasis of policy on education for innovation (e.g. Forfás 2010; BIS 2011; European Commission 2010). The results from various empirical studies have produced mixed results as to the value of education: Schneider et al.’s (2010) research into skills from a sectoral perspective, based on German micro data, found that educated employees are not necessarily positively related to firms’ probability to innovate. However, Romijn and Albaladejo’s (2002) study of small electronics and software firms in southeast England found that education, especially higher tertiary education, can contribute to firms’ innovative capabilities. This policy issue is addressed in Chapter 6.

**Control variables:**

Firms’ work practices is the dominant control variable in terms of significance; this variable shows a resoundingly strong positive effect on innovation, regardless of size of firm or type of innovation. This result points to the importance of a firm’s work practices, a variable which captures the culture in the pursuit of innovation, hence growth (Johnson 2001). This work practice variable forms the focus of Chapter 5.

The other control variables are also revealing in the case of product innovation in small firms. The managers’ age and nationality (being Irish) are both negatively significant (at the 1% and 5% level respectively). The impact of age on firm-level innovation has an inverted ‘U’ shape; a review of the literature reveals that most inventors are under the age of 40 and that
the performance of older employees gradually levels off (Frosch 2011). On the issue of mobility, the negative significance of being Irish is in line with the findings of McCann and Simonen (2005) that innovation is positively associated with new labour acquired from outside the sub-region. The firms’ location reveals no effect on firms’ innovation activity. In the case of sector, there are mixed results for larger-sized firm; as would be expected, being in the services sector has a positive effect on the likelihood of service innovation when compared to the production sector. Larger-sized firms that product and process innovate are less likely to be in the banking and finance sectors (at the 1% and 5% levels of significance). Similar to larger-sized firms, small firms that product innovate are less likely to be in the banking and finance sector. However, small firms in the banking/finance sectors have a positive effect on service innovation.

Summary

The results provide evidence that IHC may be more valuable to small firms, especially in relation to training and the soft measure of job satisfaction, with a mixed result for willingness to change (regardless of whether the hard or soft measure is used). The value of IHC for process innovation is particularly significant for larger-sized firms. The results for education are

It should be noted that interaction effects were also explored. For more on this, the interested reader should refer to: McGuirk, H., Lenihan, H. and Hart, M. ‘Measuring the Impact of Innovative Human Capital on Small Firms’ Propensity to Innovate’ (at the final review process at Research Policy). Evidence from the literature shows that while the region in which the firm is located impacts on innovation performance (Fitjar and Rodriguez-Pose 2011), regional characteristics may also effect innovation inputs (Sternberg and Arndt 2001). To this end, in the above Research Policy paper we examine the interaction between firms’ location and the four IHC elements. Similar to Ganter and Hecker (2013) who include interaction effects, we adjust for Ai and Norton’s (2003) argument that interactions cannot simply be read using the interaction coefficients. We include the interaction effects between location and IHC (32 interaction variables in total) in each of the six models, and find that there is no effect across regions. It is beyond the scope of the current study to delve into this any deeper though interaction effects certainly merit further investigation in terms of taking this research forward.
surprising at first glance, but add 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 three types of innovation, across small and larger-sized firms. Employee-managers’ age and being Irish are both negatively significant in the case of product innovation. This may suggest that firms employing younger, non-Irish managers are more likely to engage in product innovation. The next section concludes this chapter and provides a summary and discussion on the first and second stage of the analysis.
Table 4.3 Logit regression estimation of the effect of IHC on firm-level innovation (Equation 1)

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<tbody>
<tr>
<td></td>
<td>Small Firms &lt; 50 employees</td>
<td>Larger Firms &gt; 50 employees</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Willingness to Change (Hard)</td>
<td>-0.427** (0.187)</td>
<td>-0.304 (0.085)</td>
<td>-0.107(0.194)</td>
<td>0.227(0.201)</td>
<td>-0.032(0.202)</td>
<td>0.442*(0.228)</td>
</tr>
<tr>
<td>Willingness to Change (Soft)</td>
<td>0.128(0.084)</td>
<td>0.213**(0.085)</td>
<td>-0.027(0.084)</td>
<td>-0.051(0.109)</td>
<td>0.009(0.109)</td>
<td>-0.041(0.100)</td>
</tr>
<tr>
<td>Job Satisfaction (Hard)</td>
<td>-0.074(0.106)</td>
<td>-0.304(0.189)</td>
<td>-0.084(0.124)</td>
<td>-0.213(0.137)</td>
<td>-0.175(0.137)</td>
<td>-0.258*(0.145)</td>
</tr>
<tr>
<td>Job Satisfaction (Soft)</td>
<td>0.252**(0.114)</td>
<td>0.115(0.117)</td>
<td>0.214*(0.121)</td>
<td>0.055(0.144)</td>
<td>0.177(0.137)</td>
<td>0.240(0.162)</td>
</tr>
<tr>
<td>Education</td>
<td>0.104(0.196)</td>
<td>-0.128(0.198)</td>
<td>0.059(0.205)</td>
<td>0.212(0.203)</td>
<td>0.087(0.206)</td>
<td>0.399*(0.228)</td>
</tr>
<tr>
<td>Training</td>
<td>0.909*** (0.186)</td>
<td>0.274(0.186)</td>
<td>0.870*** (0.193)</td>
<td>0.363*(0.212)</td>
<td>-0.022(0.214)</td>
<td>0.524**(0.228)</td>
</tr>
<tr>
<td>Control Variables</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Firm’s work practices</td>
<td>0.520** (0.229)</td>
<td>0.730*** (0.238)</td>
<td>1.224*** (0.258)</td>
<td>0.943*** (0.299)</td>
<td>1.019*** (0.301)</td>
<td>1.70*** (0.358)</td>
</tr>
<tr>
<td>Male</td>
<td>-0.023(0.191)</td>
<td>0.116(0.191)</td>
<td>-0.12(0.197)</td>
<td>-0.148(0.223)</td>
<td>0.020(0.218)</td>
<td>-0.127(0.246)</td>
</tr>
<tr>
<td>Irish</td>
<td>-0.409(0.256)</td>
<td>-0.567**(0.258)</td>
<td>-0.090(0.247)</td>
<td>-0.279(0.286)</td>
<td>-0.416(0.296)</td>
<td>0.180(0.312)</td>
</tr>
<tr>
<td>Age</td>
<td>-0.005(0.008)</td>
<td>-0.29**(0.008)</td>
<td>-0.022**(0.008)</td>
<td>0.007(0.011)</td>
<td>0.014(0.012)</td>
<td>-0.013(0.012)</td>
</tr>
<tr>
<td>Region (ref Dublin)</td>
<td>0.026(0.035)</td>
<td>0.002(0.036)</td>
<td>-0.045(0.037)</td>
<td>-0.009(0.041)</td>
<td>-0.026(0.040)</td>
<td>-0.071(0.046)</td>
</tr>
<tr>
<td>Sector – [Production]</td>
<td></td>
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<td></td>
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<tr>
<td>-Banking &amp; Finance</td>
<td>0.504**(0.282)</td>
<td>-0.739**(0.283)</td>
<td>-0.417(0.313)</td>
<td>0.373(0.247)</td>
<td>-0.772*** (0.263)</td>
<td>-0.0603** (0.298)</td>
</tr>
<tr>
<td>- Other Services</td>
<td>0.451(0.306)</td>
<td>-0.226(0.315)</td>
<td>-0.469(0.313)</td>
<td>0.524**(0.247)</td>
<td>-0.026(0.040)</td>
<td>-0.461(0.300)</td>
</tr>
</tbody>
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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.
4.6 Conclusions

Until recently, firm-level studies have been limited to the use of formal education and training as a measure of human capital. The core contribution of this thesis is the introduction of a new and holistic concept of IHC and estimates its impact on the likelihood of firms innovating. In so doing, it uses a new multi-level merged dataset of 1070 managers employed by firms in Ireland. The use of such a multi-level dataset is unusual in itself, and makes a contribution to the innovation literature. Employing the commonly used tangible measure of human capital (e.g., education and training) as a starting point, IHC adds the more innovative elements of job satisfaction and willingness to change to estimate the effect on firms’ innovation activity. The results from the multiple logit regressions reveal variances as to firm size and type of innovation. The findings suggest that IHC may be more valuable to small firms, especially in the case of training, job satisfaction (specifically the soft measure), and willingness to change (hard and soft). These results suggest that policies focusing on increasing willingness to change and/or job satisfaction in firms could have an important impact on firm-level innovation. Again, this policy topic is discussed in detail in Chapter 6.

The results partly support the hypotheses, particularly in the case of small firms, and answer the two questions posed at the beginning of the chapter: does IHC contribute to firm-level innovation, and does IHC take effect in small and larger-sized firms differently? This study finds that small firms whose employee-managers possess the elements of IHC are more likely to engage in service, product and/or process innovation. In the case of larger-sized firms (i.e. more than 50 employees), the findings support the hypotheses for process innovation. In other words, in larger-sized firms employee-managers’ IHC is important for workplace innovations (processes) such as new ideas or behaviours that lead to significant improvements in the way the firm’s work is carried out.
The first and second stages of analysis contribute to the knowledge base as follows:

- Add to the current debate in the literature on human capital measures beyond education and training;
- Generate potentially interesting insights into a valuable resource available to the firm, that is, Innovative Human Capital;
- Create a new and rich multi-level dataset.

Creating a concept of IHC and estimating its effect on innovation leaves questions as to how IHC is supported. Hence, the next stage of the analysis examines the factors which may support the new concept as a determinant of innovation. A review of the literature suggests that firms’ internal factors and the external environment are areas worth assessing; this issue is discussed in the chapter that follows.
5 The impact of firm and regional factors on Innovative Human Capital

5.1 Introduction

The previous chapter concerned itself with Stages 1 and 2 of the analysis: the creation of the new IHC concept and the estimation of its effect on firms’ innovation activity. Continuing directly from this, the third stage of the empirical analysis is presented here (illustrated in Figure 5.1). The focus of this stage is to further understand the novel IHC concept. To do so, it is necessary to identify conditions where IHC can succeed and flourish. In other words, the focus here is on the identification of the factors, both internal and external to the firm that supports IHC. In addition to the literature outlined in Chapters 2 and 3, this chapter reviews a supplementary literature and formulates a further eight hypotheses in order to identify the conditions where IHC can succeed.

As IHC constitutes a valuable determinant of innovation, identifying factors that support it is increasingly important, particularly in light of the current economic climate of austerity as outlined earlier. In addition, the level of R&D intensity in the EU has stagnated over the past ten years (European Union 2011). In this context, the research question posed here is, ‘What factors support IHC?’ This chapter is organised as follows. Section 5.2 presents the rationale for the analysis; the section will provide insights as to external and internal factors related to IHC and the theory underpinning such factors. Section 5.3 outlines the methodology employed in the analysis.

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46 Much of the material in this chapter is based on a conference paper which was presented at the Institute for Small Business and Entrepreneurship (ISBE), Annual Conference, Cardiff, Wales. 12-13th November 2013; McGuirk, H. and Lenihan, H. ‘Innovation and Human Capital: The impact of firm and regional factors on Innovative Human Capital’. This paper won ‘Best Paper in Track’ [http://www.isbe.org.uk/BestPapers#papers13](http://www.isbe.org.uk/BestPapers#papers13)
while Section 5.4 presents the empirical results. Section 5.5 discusses the results from Stage 3 of the analysis while Section 5.6 concludes the chapter.

5.2 The rationale for Stage three of the analysis – internal and external factors connected to IHC

Building on the theoretical underpinnings presented in Chapters 2 and 3, and on the findings of Stages 1 and 2 (detailed in Chapter 4), this section provides a rationale for Stage 3 of the analysis. It is clear from the plethora of literature and empirical studies that firms rely on diverse sources of knowledge: for example, horizontal, backward or forward linkages and interactions for innovation (Roper et al 2008; Doran et al 2012; Nonaka and Takeuchi 1995). It has been acknowledged that the ability to exploit external knowledge is critically important for firm-level innovation (Cohen and Levinthal 1990; Bhide 2008).

Internal factors connected to IHC

As discussed in Chapter 2, a knowledge-based view of the firm is founded on a collection of theories that describe the firm as an institution that innovates, creates, coordinates and protects knowledge (von Krogh and Wallin 2011). People, whether individuals or groups, are central to 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). In relation to innovation and human capital, published studies have identified the absorptive capacity of the individual and of the firm as particularly important for innovation (Cohan and Levinthal 1990). As alluded to in Chapter 3 (Section 3.4), Cohan and Levinthal (1990) stated that absorptive capacity consists not only of the sum of the abilities of individual contributors but also encompasses the capacity of organisations to exploit them. Firms’ innovative behaviour also affects
the absorptive capacity of the firm, as well as employees (Montalvo 2006) and their attitude to innovation (Coronado et al 2008). The exchange of tacit knowledge requires interpersonal contact as well as the creation of collaborative knowledge-sharing processes (Chen and Huang 2009; von Krogh and Wallin 2011). The enabling environment of firms’ tacit and codified knowledge can assist management “to get the most from firms’ knowledge assets” (Teece 2000, p. 35).

The first internal factor considered by the current research is termed work arrangements. The management style adopted can support a firm’s human capital, in that the positive empowerment of employees is associated with their innovativeness (Selvarajan et al 2007). In their study of management teams, Selvarajan et al. (2007) posit the crucial role of a firm’s human capital philosophy in relation to its innovation. Adopting Guest and Peccei’s (2001) measure of human capital philosophy within a firm, the measures developed by Selvarajan et al. (2007) include reward sharing, competency development, feedback from employees, enhancing employees’ employability, and information sharing. Their findings support the importance of a firm’s empowerment-oriented human capital philosophy in fostering innovativeness and performance.

This high-involvement practice is a growing focus 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). In their Canadian study of innovation in 182 large organisations, Yang and Konrad (2011) found a three-way relationship between: employee involvement, variation of this involvement, and ethnic diversity. In other words, high levels of involvement among racio-ethnic groups enhance the innovation effects of employee empowerment systems. In order to measure firms’ support for employee involvement as an enabler of knowledge sharing and innovation, the current research uses work arrangements. This captures the level of consultation between management and employees, the frequency of provision of information from management to employees, alternative pay and conditions, and provision of regular performance reviews/appraisals. Further details are
given in Table 5.1. Identifying the effect of this internal factor on IHC forms the basis for the first two hypotheses in stage three of the analysis.

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

H2b: *Employee-managers with IHC are more likely to be found in larger-sized firms with work arrangements.*

The second internal factor addressed here is firms’ work practices. Capabilities of the firm in terms of open-mindedness and collaboration with international markets have been found to promote the potential to innovate (Fitjar *et al.* 2013; Fitjar and Rodriguez-Pose 2011). In an effort to build innovating capacity, firms need to exploit competencies involved in innovation. These competencies may be created through a highly skilled workforce (Jones and Grimshaw 2012). In addition, as pointed out in Chapter 2, organisational capabilities are central in explaining change in firms (Nelson and Winter 1982), while firms’ openness 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; Chen and Huang 2009; Fitjar *et al.* 2013; Klass *et al.* 2010).

In the context of the innovation value chain, Love *et al.* (2011) found that firms’ external openness was significant at the ‘exploratory stage’, while internal openness, measured by team working, was more significant at the latter stages of the innovation process. Their research, based on UK knowledge-based service firms, also found that internal multi-functional work and working in teams were more important than the quality resources such as graduate skill levels or R&D.

Teamwork was also empirically tested in Rammer *et al.*’s (2009) study on non-R&D-performing firms, which revealed a reliance on management tools among these firms as an alternative to the perceived ‘risky’ activities of in-house R&D; this was especially true for SMEs. The study, based on German data, found that the effective application of management tools such as
teamwork facilitated innovation in such firms. Again, Rammer et al.’s (2009) study moved beyond exploration of the tangible factors related to innovation and highlighted the central role played by management in innovation.

Based on behavioural science, Montalvo (2006) argues that innovation within firms is attributable to factors such as entrepreneurial or risk-taking behaviours, organisational learning and capabilities, and institutional arrangements. Love et al. (2011) also highlight the importance of organisational design for innovation. To measure firms’ innovation work practices, the current research uses information regarding firms’ attitudes toward taking risks as a means of innovation, and the tendency of the organisation to continually look for new opportunities. While a full description of this measure is provided later in the chapter, examples include the firms’ encouragement of employees to work in teams, and firms’ focus on customers’ needs. To capture the effects of work practices addressed by the study (outlined in Table 5.1), the next two hypotheses are:

H3a: Employee-managers with IHC are more likely to be found in small firms with work practices.

H3b: Employee-managers with IHC are more likely to be found in larger-sized firms with work practices.

External factors

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, which focuses on such topics as agglomeration (Foreman et al. 2007), regional networks (Cumbers et al. 2003), clustered firms (De Propris and Driffield 2006), and collaboration with other firms and organisations outside the region (Fitjar and Rodriguez-Pose 2011). As a source of knowledge, the location of the firm (i.e., the external environment in which the firm is physically located) may impact on innovation. As discussed in Chapter 2, the location of the firm is a source of knowledge; thus it may be a support
for IHC as a determinant of firm-level innovation. Linkages with alternative types of partners also contribute to different stages of innovation, according to a study of UK service businesses (Love et al 2011). These stages of the innovation value chain include knowledge sourcing, knowledge transformation, and knowledge exploitation (Love et al 2011). Roper and Love, in a study using experimental data related to UK regional labour market indicators, point to “a contingent relationship between the supply side of the regions’ labour market and their ability to absorb external knowledge for innovation” (2006, p. 445). However, their study highlights the difference in the effect of tertiary education on absorptive capacity in regions located in knowledge-rich countries, in contrast to knowledge-poor countries.

Interestingly, in terms of external factors, Marino et al. (2012) found that diversity in workforce education promotes entrepreneurial behaviour among employees and contributes to an increase in new firm formation. The same study of Danish employees found that “exposure to higher degrees of cultural and educational heterogeneity facilitates knowledge transfer (and sharing), favouring the exploitation of new ideas” (Marino et al 2012, p. 19).

Findings regarding the effects of location on innovation are mixed. Simonen and McCann (2008) investigated the effects of knowledge transferred face-to-face and found such sources to be relatively unimportant for innovation, indicating that location is less likely to make a favourable contribution to innovation than might be expected a priori. Simonen and McCann (2008) also found that high population density within a region is negatively associated with product innovation; it is unrelated to ‘process’ and ‘new to market’ innovations. Interestingly, spatial factors determine the location of human capital, in that regions with a greater number of facilities are associated with a better quality of life and tend to attract talented people (Qian et al 2013). However, bringing together educated, skilled, and creative people in a region is not sufficient in itself to generate innovation (Storper and Scott 2009). Storper and Scott maintain that, “innovation processes are always grounded in a much wider historical and geographic
frame of reference” (2009, p. 156), hence the need to address possible regional effects on IHC.

Arising from the studies outlined above, the level of diversity in a region (with respect to nationality and education) is the first of two external factors. McGuirk and Jordan’s (2012) study of innovation within manufacturing firms in Ireland found that diversity in both nationality and education among the local workforce has a positive effect on product innovation, while diversity in nationality is negatively associated with process innovation. In addition, McGuirk and Jordan (2012) found that greater levels of diversity in the local labour force and greater levels of internal human capital (measured by tertiary education) are mutually substitutable in terms of sources of knowledge. The term ‘diversity’ refers to differences existing between individuals (Hubbard 2004). When people think differently and use 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). Yet the benefits of diversity can be complex (Mulholland et al. 2005); it can create barriers to communication, though higher levels of diversity can weaken such barriers (Blau 1977). Niebuhr’s (2010) study of cultural diversity found that differences in knowledge and capabilities in workers across German regions positively contributed to regional R&D activity. The study also found that the benefits of such diversity outweigh the costs of resulting communication barriers due to language. Alesina and La Ferrara (2005) also highlighted the benefits of diversity when they suggested that innovation involves differences in ability and knowledge, hence cultural diversity constitutes a positive contribution. Such findings prompt the following hypotheses:

H4a: Employee-managers with IHC are more likely to be found in small firms located in regions with higher workforce diversity.

H4b: Employee-managers with IHC are more likely to be found in larger-sized firms located in regions with higher workforce diversity.
Entrepreneurship at regional level has been established as possible source of knowledge contributing to innovation (Silverberg et al 1988). Hence the level of entrepreneurial activity in a region is the second external factor considered here as a possible support for IHC. Entrepreneurs who establish and run new businesses are essential to the economy; they are interactive people who depend on people, resources, and opportunities to succeed (Audretsch et al 2010). Self-employed workers in the Spanish region of Andalusia were found to have a positive effect on innovation (Romero and Martinez-Roman 2012). Based on knowledge spillover theory, Carree and Thurik (2010) suggest that the results of entrepreneurship at firm-level generally relate to innovation. Likewise, entrepreneurship activity is a source of learning; in particular, through feedback mechanisms such as the learning from other employees that is enabled by the competition and selection linked to diversity (Carree and Thurik 2010). Furthermore, Acs and Armington (2004) found that the impact of knowledge externalities from entrepreneurial activity was strongly associated with faster growth in the local economy. Early stage entrepreneurs tend to be more innovative, and entrepreneurs are said to be more alert to opportunities in their environment and less inhibited by failure (Fitzsimon and O’Gorman 2014). The current research captures this possible external source of knowledge by measuring the level of regional entrepreneurship activity, using the final two hypotheses:

H5a: Employee-managers with IHC are more likely to be found in small firms located in regions with higher entrepreneurial activity.

H5b: Employee-managers with IHC are more likely to be found in larger-sized firms located in regions with higher entrepreneurial activity.

The current model of analysis contains a broad variety of possible internal and external factors supporting IHC, though it is certainly not an exhaustive list. One factor posited in the literature as a contributor to innovation and human capital (through education) is public policy (Soete 2007; Audretsch and Link 2012). However, due to the limitations of firm-level identification
in the dataset, it is not possible to determine individual firms’ use of publicly-funded support programmes. In acknowledging public policy as an important factor in promoting economic recovery (as outlined in the Irish government’s Action Plan for Jobs 2013 for example), Chapter 6 discusses the possible implications of the current research in respect of policies aimed at increasing innovation.

To summarise the research framework adopted here, Figure 5.1 provides an overview building on the framework provided in Figure 4.1 in the previous chapter. It illustrates Stage 3 of the analysis and the corresponding eight hypotheses.

**Figure 5.1** A framework for Stage 3 of the analysis – identifying the internal and external factors supporting Innovative Human Capital
5.3 The data and methodology

Similar to Stages 1 and 2, the third stage is based on the new merged dataset described in detail in Chapter 4. This section first outlines the methodology adopted to estimate the effect of internal and external firm factors on IHC, and then describes the variables used in the multiple logit regressions in addition to the descriptive statistics provided in Chapter 4.

5.3.1 The models and estimation methods

Following Rammer et al. (2009), Ganotakis (2012), and Honjo et al. (2013), the current research uses a series of binomial logit regressions where the IHC of responding managers employed by firms in Ireland is the dependent variable. The estimations include a wide range of potentially relevant explanatory variables. A total of six models are estimated for small and larger-sized firms to capture the effect of the internal and external factors that may influence IHC. The regression model is given as:

\[ IHC_i = \alpha_0 + \alpha_1 \text{Ext}_j + \alpha_2 \text{Int}_i + \alpha_3 C_i + \epsilon_i \] \[2\]

where \( IHC_i \) refers to firm i’s Innovative Human Capital and denotes the four different elements of IHC, and hence six different dependent variables\(^{47}\), measuring: the probability that firm i’s manager has a third-level education (Model 1); the probability that the employee-manager has availed of training provided by the firm (Model 2); the probability that the employee-manager is satisfied in their job (Model 3); and the probability that the employee-manager is willing to change in the workplace (Model 4). To measure IHC, each individual employee-manager is scored in relation to each of the four elements: yes takes the value of one, otherwise zero. In

\(^{47}\)The six dependent variables capture education, training, job satisfaction (hard and soft measure) and willingness to change (hard and soft measures).
other words, if the employee-manager has a third-level education or higher\textsuperscript{48}, has availed of training provided by firm \( i \); is willing to change; and has indicated that he/she is satisfied with various aspects of his/her job; all take the value of one, otherwise zero.

The first variables of interest consist of the external (\( Ext \)) factors that may support IHC: (a) regional workforce diversity and (b) entrepreneurship activity in the region where firm \( i \) is located. The second set of independent variables of interest constitutes the internal (\( Int \)) factors supporting IHC, which encompass: (a) work practices and (b) work arrangements. The model also includes a vector of controls (\( C \)) that may be expected to affect IHC. Having presented the different variables used in equation 2, it is now necessary to specify the measures adopted.

\textit{Measuring the dependent variables associated with equation [2]}

The multi-dimensional measure of IHC is composed of four elements: education, training, willingness to change, and job satisfaction of employee-managers. While the two tangible elements of IHC are binary, (as explained in Chapter 4, Section 4.4), it was necessary to create binary variables for the intangible variables (job satisfaction and willingness to change): employee-managers indicating ‘very satisfied/strongly agree’ or ‘satisfied/agree’ to the questions related to their job satisfaction (the hard and soft measures\textsuperscript{49}) were coded one, otherwise zero. Similar adjustments were made for employee-managers’ willingness to change (soft measures) where willingness to change took the value of one, otherwise zero.

\textsuperscript{48} Third-level education or higher refers to the award of an undergraduate degree or a postgraduate degree/diploma (NCPP Report 2009).

\textsuperscript{49} A full description of how job satisfaction and willingness to change are measured is presented in Chapter 4 Section 4.4 and Table 4.2.
Measuring the independent variables causally connected with IHC - internal factors

Under the broad heading of work arrangements, the merged dataset provides information on employee involvement with respect to knowledge and innovation by means of five separate questions. The first relates to provision of flexible working hours or the use of ‘flexitime’ in the workplace; respondents to the NCPP 2009 survey indicated yes or no. The second question relates to the provision of regular performance reviews or appraisals in the workplace (yes or no). The third question relates to ‘frequency of receiving information from management’; this question uses a 6-question Likert scale with a Cronbach’s alpha of 0.827. Employee-managers are asked questions relating to the frequency of receiving information regarding sales profits, introduction of new technology and reorganisation of the company (Table 5.1 contains a detailed list of questions pertaining the internal factors adopted in the current research). The level of consultation experienced by employee-managers is also captured through a 3-question Likert scale with a Cronbach’s alpha of 0.811. In addition to the level of consultation, employee-managers’ views on pay and conditions at work are captured using yes/no questions regarding whether the firm offers regular increments, bonus schemes or merit/performance related pay. Approximately six percent of firms did not offer any such work arrangements, while 12 percent of firms offered all five measures of work arrangements captured by the current research.

The second internal factor measures firms’ work practices and includes questions about the firm’s readiness to accept new ideas in the workplace. With regard to this variable, employee-managers were asked whether the firm they worked for readily accepted new ideas, whether teamwork was encouraged, and whether customers’ needs were considered a top priority. These variables use a seven-question Likert scale with a Cronbach’s alpha of 0.80; as alluded to in Chapter 4 (Section 4.3), this measures the strength of the firm’s innovative climate (Johnson 2001). Creating an innovative

---

50 The reasons for using such a test are outlined in Chapter 4 (Section 4.3).
environment within the firm includes the provision of training, ensuring that management hierarchy is rendered less important and that there is a system of communication for employees in relation to innovation activity (Reza Noruzi and Westover 2010). The following table (Table 5.1) outlines the questions from the new merged dataset used to capture the two internal factors included in equation [2] as detailed in Section 5.3.1.
Table 5.1 Description of the internal variables included in equation [2].

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description/Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firms’ work practices</td>
<td>- new ideas are readily accepted in my workplace</td>
</tr>
<tr>
<td></td>
<td>- People in my organisation are always searching for new ways of looking at problems</td>
</tr>
<tr>
<td></td>
<td>- Customer needs are considered top priority in my organisation</td>
</tr>
<tr>
<td></td>
<td>- This organisation is prepared to take risks in order to be innovative</td>
</tr>
<tr>
<td></td>
<td>- This organisation is quick to respond when changes need to be made</td>
</tr>
<tr>
<td></td>
<td>- My employer encourages employees to collaborate with people in other organisations</td>
</tr>
<tr>
<td></td>
<td>- This organisation is continually looking for new opportunities in a changing environment</td>
</tr>
<tr>
<td></td>
<td>- My employer encourages employees to work in teams in order to improve performance</td>
</tr>
<tr>
<td>Firms’ work arrangements</td>
<td>Work arrangements</td>
</tr>
<tr>
<td></td>
<td>- Are flexible hours/flexitime used in your workplace?</td>
</tr>
<tr>
<td></td>
<td>- Are regular performance reviews or appraisals used in your workplace?</td>
</tr>
<tr>
<td></td>
<td>Frequency of receiving info from management on</td>
</tr>
<tr>
<td></td>
<td>- Level of competition faced by your employer</td>
</tr>
<tr>
<td></td>
<td>- plans to develop new products or services</td>
</tr>
<tr>
<td></td>
<td>- plans to introduce new processes</td>
</tr>
<tr>
<td></td>
<td>- plans to re-organise</td>
</tr>
<tr>
<td></td>
<td>- plans to change work practices (work in terms etc..)</td>
</tr>
<tr>
<td></td>
<td>- plans for staff reduction</td>
</tr>
<tr>
<td></td>
<td>Consultation</td>
</tr>
<tr>
<td></td>
<td>- How often are you and your colleagues consulted before decisions are taken that affect your work?</td>
</tr>
<tr>
<td></td>
<td>- If changes in your work occur, how often are you given the reason why?</td>
</tr>
<tr>
<td></td>
<td>- If you have an opinion different form your supervisor/manager can you say so?</td>
</tr>
<tr>
<td></td>
<td>- If you are consulted before decisions are made, is any attention paid to your views or opinions?</td>
</tr>
<tr>
<td></td>
<td>Form part of pay and conditions at work</td>
</tr>
<tr>
<td></td>
<td>- regular increment</td>
</tr>
<tr>
<td></td>
<td>- employee share options, profit sharing or gain sharing</td>
</tr>
<tr>
<td></td>
<td>- bonus scheme</td>
</tr>
</tbody>
</table>

External factors

As explained in Section 5.2, empirical analyses yield mixed results regarding the contribution of regional factors to innovation and, to a lesser extent, human capital. The first external factor captures the diversity of the local workforce. Similar to Kaiser and Muller (2013), McGuirk and Jordan (2012), Murray (1989), and Richard (2000), this research uses a Blau Index (Blau 1977) of heterogeneity to calculate a local labour market diversity index for two demographic indicators of the local workforce (education and nationality). Blau (1977, p. 9) presents the formula 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 different categories represented in the population to measure the labour market. The index measures the probability of two people, chosen at random from the sample population, being different in educational attainment and nationality (Blau 1977). The measure for diversity of educational attainment assesses five levels (from primary to postgraduate level). The index reveals that if the entire sample is in one category (e.g. all have a third-level education), the Blau index will equal zero, whereas, if they are spread evenly across all categories the Blau rating will equal one. The level of diversity in education reveals a Blau score of .76 in the Border region (lowest) to a high score of .83 in the Mid-East region. The level of diversity in nationality is measured using four groups; results reveal that there is less diversity in nationality than in education. Table 5.2 presents the Blau Index values for educational attainment and nationality for the eight NUTS3 regions of Ireland.
Table 5.2 Blau Index for Ireland’s eight NUTS3 regions.

<table>
<thead>
<tr>
<th>Region</th>
<th>Blau Index</th>
<th>Nationality</th>
<th>Educational Attainment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dublin</td>
<td>0.363</td>
<td>0.780</td>
<td></td>
</tr>
<tr>
<td>Border</td>
<td>0.395</td>
<td>0.763</td>
<td></td>
</tr>
<tr>
<td>Mid-East</td>
<td>0.314</td>
<td>0.770</td>
<td></td>
</tr>
<tr>
<td>Midlands</td>
<td>0.274</td>
<td>0.835</td>
<td></td>
</tr>
<tr>
<td>Mid-West</td>
<td>0.302</td>
<td>0.766</td>
<td></td>
</tr>
<tr>
<td>South-East</td>
<td>0.271</td>
<td>0.769</td>
<td></td>
</tr>
<tr>
<td>South-West</td>
<td>0.315</td>
<td>0.771</td>
<td></td>
</tr>
<tr>
<td>West</td>
<td>0.271</td>
<td>0.779</td>
<td></td>
</tr>
</tbody>
</table>


The second external factor is entrepreneurship activity within a region; this is measured using information from the Global Entrepreneurship Monitor (GEM) 2008 Report (Fitzsimons and O’Gorman 2009). Table 5.3, adopted from the same report, provides information on what GEM describes as the percentage of individuals in a region:

- Expected to start a business in next 3 years;
- Early stage entrepreneurs (which refers to a combination of nascent\(^{51}\) and new firm entrepreneurs);
- Informal investment activity indicates the level of investment by someone other than the entrepreneur, typically family members or friends.

There is a difference across regions in terms of the rate of entrepreneurship; in terms of ‘early stage entrepreneurs’, the results indicate a high of 10.7 percent in the South-East region and a low of 7.2 percent in the three regions of Dublin, the Mid-West and the South-West.

\(^{51}\) Nascent entrepreneurs refer to those actively planning a new venture (Fitzsimons and O’Gorman 2009).
Table 5.3 Entrepreneurial Activity in Ireland, by region (2004-2008).

<table>
<thead>
<tr>
<th>Region</th>
<th>Expected to start a business in next 3 years</th>
<th>Early stage entrepreneurs</th>
<th>Informal investment activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Ireland (2008)</td>
<td>10.0</td>
<td>8.1</td>
<td>2.8</td>
</tr>
<tr>
<td>Dublin</td>
<td>10.5</td>
<td>7.2</td>
<td>2.3</td>
</tr>
<tr>
<td>Border</td>
<td>12.8</td>
<td>7.9</td>
<td>2.0</td>
</tr>
<tr>
<td>Mid-East</td>
<td>11.8</td>
<td>9.5</td>
<td>2.4</td>
</tr>
<tr>
<td>Midlands</td>
<td>10.3</td>
<td>9.1</td>
<td>2.7</td>
</tr>
<tr>
<td>Mid-West</td>
<td>13.0</td>
<td>7.2</td>
<td>1.4</td>
</tr>
<tr>
<td>South East</td>
<td>10.7</td>
<td>10.7</td>
<td>2.0</td>
</tr>
<tr>
<td>South West</td>
<td>8.6</td>
<td>7.2</td>
<td>3.1</td>
</tr>
<tr>
<td>West</td>
<td>10.5</td>
<td>10.0</td>
<td>3.2</td>
</tr>
</tbody>
</table>


Control variables

Although the main focus of this stage of the analysis is the specific internal and external factors influencing IHC, it is necessary to control for other factors that can be expected to affect IHC. As previously highlighted, empirical research shows that R&D cooperation (Simonen and McCann 2008) and R&D intensity (Gallié and Legros 2012) are both positively significant for innovation and possibly IHC. R&D not only creates innovations and new knowledge, but also contributes to a firm’s absorptive capacity (Cohen and Levinthal 1990). The current study is constrained by the availability of data; therefore the model relies on the use of proxies for firms’ R&D in terms of innovation activity. This constitutes a binary variable: firms introducing an innovation during the reference period are indicated by one, otherwise zero. A proxy is also used to capture regional R&D, a binary variable based on information on in-house R&D in manufacturing firms in the region.
Similar to equation [1] in Chapter 4 (Section 4.5), the demographical characteristics of the employee-manager is also controlled for in the estimations, since managers’ age, gender (male) and nationality (being Irish) may make a difference to the dependent variable. A correlation matrix was conducted for the variables in equation [2]. No pair of explanatory variables reported a covariance greater than the ‘rule of thumb’ of +/- 0.8; therefore perfect multicollinearity is not an issue. While this section provides detailed descriptions of the equation and measures adopted by Stage 3, the following table (Table 5.4) provides a summary of the variables used in equation [2].
Table 5.4 Summary of variables used to estimate the external and internal supports for Innovative Human Capital (equation [2]).

<table>
<thead>
<tr>
<th>Equation [2]</th>
<th>Variables</th>
<th>Level</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ext</strong></td>
<td><em>Explanatory variables</em></td>
<td>Regional</td>
<td>Regional Average</td>
</tr>
<tr>
<td></td>
<td>Entrepreneurship activity</td>
<td>Regional</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Informal investment</td>
<td>Regional</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Early stage</td>
<td>Regional</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>- Expected to start</td>
<td>Regional</td>
<td>8.1%</td>
</tr>
<tr>
<td></td>
<td>Diversity in nationality</td>
<td>Regional</td>
<td>2.8%</td>
</tr>
<tr>
<td></td>
<td>Diversity in education</td>
<td>Regional</td>
<td>Blau Index 0.31</td>
</tr>
<tr>
<td><strong>Int</strong></td>
<td>Work arrangements (i)</td>
<td>Firm</td>
<td>49%</td>
</tr>
<tr>
<td></td>
<td>- Provide flexible hours (0/1)</td>
<td>Firm</td>
<td>71%</td>
</tr>
<tr>
<td></td>
<td>- Provide regular reviews/appraisals (0/1)</td>
<td>Firm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Work arrangements (ii)</td>
<td>Firm</td>
<td>Cronbach’s alpha 0.8</td>
</tr>
<tr>
<td></td>
<td>- Receiving information</td>
<td>Firm</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>- Consultation</td>
<td>Firm</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>- Pay &amp; conditions</td>
<td>Firm</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>Work practices</td>
<td>Firm</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>C</strong></td>
<td><em>Control variables</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Managers’ age (average)</td>
<td>Individual</td>
<td>41 years</td>
</tr>
<tr>
<td></td>
<td>Managers’ nationality (Irish)</td>
<td>Individual</td>
<td>83%</td>
</tr>
<tr>
<td></td>
<td>Managers’ gender (male)</td>
<td>Individual</td>
<td>65%</td>
</tr>
<tr>
<td></td>
<td>Sector</td>
<td>Firm</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td>- Production</td>
<td>Firm</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>- Banking/finance &amp; other businesses</td>
<td>Firm</td>
<td>48%</td>
</tr>
<tr>
<td></td>
<td>- Other services</td>
<td>Firm</td>
<td>52%</td>
</tr>
<tr>
<td></td>
<td>Regional R&amp;D (in-house R&amp;D)</td>
<td>Regional</td>
<td>82%</td>
</tr>
<tr>
<td></td>
<td>Firms’ R&amp;D (innovation activity)(1/0)</td>
<td>Firm</td>
<td></td>
</tr>
</tbody>
</table>

Source: NCPP (2009); CSO (2006); Roper, Hewitt-Dundas and Love (IIP dataset); Fitzsimons and O’Gorman (2009). 1See Table 5.1 for questions related to variables. 2 Refers to employee-managers.
5.4 Empirical results

In order to develop a deeper understanding of the new IHC concept, it is necessary to identify factors that may support the concept. Similar to equation [1] detailed in Chapter 4 (see Section 4.5), the dependent variables in equation [2] are binary, a dichotomous outcome for estimation is considered appropriate (Long and Freese 2006). Again, as detailed previously (Chapter 4, Section 4.5) the logit model of estimation is the most appropriate for this dataset; therefore equation [2] is formulated to estimate the likelihood of IHC associated with relevant firm and regional factors in small and larger-sized firms.

Mixed results for equation [2] were produced from the estimations across all the models used. For the purpose of clarity, this section discusses the results for each model. The results are presented in Table 5.5 and continued in Table 5.6; a discussion of the results is provided in the final section of this chapter, and the potential implications for policy are discussed in Chapter 6.
Table 5.5 Results from the logit regressions [equation 2], (Table 1 of 2).

<table>
<thead>
<tr>
<th>Firm Size</th>
<th>Model 1 Education</th>
<th>Model 2 Training</th>
<th>Model 3a &amp;3b Job Satisfaction</th>
<th>Model 4a Willingness to Change (Hard)</th>
<th>Model 4b (soft)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>INT–internal factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work Practices</td>
<td>-0.198</td>
<td>-0.217</td>
<td>0.125</td>
<td>0.826**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.224)</td>
<td>(0.267)</td>
<td>(0.218)</td>
<td>(0.285)</td>
<td></td>
</tr>
<tr>
<td>Work Arrangements</td>
<td>-0.159</td>
<td>0.166</td>
<td>0.149</td>
<td>-0.015**</td>
<td></td>
</tr>
<tr>
<td>- Frequency of Info</td>
<td>(0.159)</td>
<td>(0.207)</td>
<td>(0.157)</td>
<td>(0.210)</td>
<td></td>
</tr>
<tr>
<td>- Consultation</td>
<td>-0.028</td>
<td>0.226*</td>
<td>-0.087</td>
<td>0.056</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.114)</td>
<td>(0.127)</td>
<td>(0.106)</td>
<td>(0.131)</td>
<td></td>
</tr>
<tr>
<td>- Flexible hours</td>
<td>0.278*</td>
<td>0.377*</td>
<td>-0.128</td>
<td>0.234</td>
<td></td>
</tr>
<tr>
<td>-Regular review/appraisals</td>
<td>0.445**</td>
<td>0.610*</td>
<td>0.125</td>
<td>0.367</td>
<td></td>
</tr>
<tr>
<td>- Pay and conditions</td>
<td>1.143</td>
<td>0.540</td>
<td>1.138**</td>
<td>1.035**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.405)</td>
<td>(0.357)</td>
<td>(0.394)</td>
<td>(0.374)</td>
<td></td>
</tr>
<tr>
<td>ENT – external factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entrepreneurship</td>
<td>0.376</td>
<td>1.55**</td>
<td>0.258</td>
<td>-1.28</td>
<td></td>
</tr>
<tr>
<td>- Informal investment</td>
<td>(0.725)</td>
<td>(0.786)</td>
<td>(0.664)</td>
<td>(0.826)</td>
<td></td>
</tr>
<tr>
<td>- Early Stage Startup</td>
<td>-0.099</td>
<td>0.092</td>
<td>0.137</td>
<td>0.026</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.136)</td>
<td>(0.146)</td>
<td>(0.127)</td>
<td>(0.158)</td>
<td></td>
</tr>
<tr>
<td>- Expected to Start</td>
<td>0.083</td>
<td>-0.029</td>
<td>0.013</td>
<td>-0.128**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.179)</td>
<td>(0.180)</td>
<td>(0.158)</td>
<td>(0.190)</td>
<td></td>
</tr>
<tr>
<td>Diversity</td>
<td>1.480</td>
<td>-0.470</td>
<td>3.140</td>
<td>1.377</td>
<td></td>
</tr>
<tr>
<td>- Nationality</td>
<td>(2.971)</td>
<td>(3.117)</td>
<td>(2.916)</td>
<td>(3.378)</td>
<td></td>
</tr>
<tr>
<td>- Education</td>
<td>-3.606</td>
<td>-6.14</td>
<td>-1.027</td>
<td>-8.461**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(9.609)</td>
<td>(11.721)</td>
<td>(7.877)</td>
<td>(11.548)</td>
<td></td>
</tr>
</tbody>
</table>

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. ^Model 3a refers to hard measures of job satisfaction (e.g. salary, physical working conditions) and Model 3b refers to the soft measures of job satisfaction (e.g. loyalty to the organisation and proud of working for the organisation). 2 The hard measure of willingness to change uses a single binary variable (will to work unsociable hours) 3 Willingness to change work tasks such as technology captures a soft measure. Due to a convergence issue, this estimation uses the full complement of observations (while controlling for firm size).
Table 5.6 Results from the logit regressions [equation 2], (Table 2 of 2).

<table>
<thead>
<tr>
<th>Firm Size</th>
<th>Model 1 Education</th>
<th>Model 2 Training</th>
<th>Model 3a &amp;3b Job Satisfaction¹</th>
<th>Model 4a Willingness to Change (Hard)²</th>
<th>Model 4b³</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small &lt; 50</td>
<td>Larger ≥50</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-Control Variables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sector</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Bank/Finance</td>
<td>-0.257 (0.246)</td>
<td>-0.218 (0.252)</td>
<td>-0.254 (0.301)</td>
<td>-0.262 (0.273)</td>
<td>0.274 (0.237)</td>
</tr>
<tr>
<td>- Other Services</td>
<td>0.374 (0.293)</td>
<td>0.656** (0.274)</td>
<td>-0.117 (0.265)</td>
<td>-0.133 (0.033)</td>
<td>-0.375 (-0.198)</td>
</tr>
<tr>
<td>Regional - Density</td>
<td>-0.000 (0.001)</td>
<td>0.000 (0.01)</td>
<td>0.000 (0.00)</td>
<td>0.000 (0.00)</td>
<td>0.000 (0.00)</td>
</tr>
<tr>
<td>Male</td>
<td>-0.261 (-0.220)</td>
<td>-0.119 (0.217)</td>
<td>-0.161 (0.215)</td>
<td>-0.124 (0.226)</td>
<td>0.362* (0.363)*</td>
</tr>
<tr>
<td>Irish</td>
<td>-0.730** (0.257)</td>
<td>0.143 (0.267)</td>
<td>-0.150 (0.481)</td>
<td>0.226 (0.222)</td>
<td>0.133</td>
</tr>
<tr>
<td>Firm R&amp;D</td>
<td>-0.098 (0.243)</td>
<td>0.203 (0.490)</td>
<td>-0.275 (0.032)</td>
<td>-0.439* (0.671)**</td>
<td>0.413*</td>
</tr>
<tr>
<td>Regional R&amp;D</td>
<td>-0.007 (-0.316**)</td>
<td>0.100 (0.274)</td>
<td>0.237 (0.199)</td>
<td>-0.050 (0.273*)</td>
<td>-0.104</td>
</tr>
<tr>
<td>Firm Size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.209</td>
</tr>
</tbody>
</table>

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. ¹Model 3a refers to hard measures of job satisfaction (e.g. salary, physical working conditions) and Model 3b refers to the soft measures of job satisfaction (e.g. loyalty to the organisation and proud of working for the organisation). ² The hard measure of willingness to change uses a single binary variable (will to work unsociable hours). ³ Willingness to change work tasks such as technology captures a soft measure. Due to a convergence issue, this estimation uses the full complement of observations (while controlling for firm size).
With respect to the results of estimating equation [2], the salient points to emerge are as follows:

- **Model 1**, where education is the dependent variable, reveals a positive and significant likelihood that firms providing work arrangements such as flexible working hours and regular reviews are more likely to employ managers with a third-level education and higher (regardless of firm size). Larger-sized firms that consult with employees are also more likely to employ managers with a third-level education and higher (at the 10% level). 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 (particularly informal investment) is present at the five percent level of significance.

- In **Model 2**, where training is the dependent variable, the results reveal that employee-managers who avail of training are more likely to be employed in larger-sized firms that provide work practices as measured in the current research (at the 5% level). This is also the case for those firms (regardless of size) that offer alternative pay and conditions to employees (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. Firms providing such work practices and pay and conditions obtain benefits such as employee-managers who avail of training (an element of IHC); this may in turn contribute to increased innovation.

- **Model 3a and 3b** - To analyse the first intangible element of IHC, two models are used to capture the hard and soft measures of job satisfaction, as discussed earlier (Model 3a captures the hard measure, Model 3b, the soft measure). Perhaps most notable in both models are the strong and consistent results for the internal factors of
work practices and arrangements, specifically consultations (at the 1% level). The analysis finds that irrespective of firm size, employee-managers are more likely to enjoy job satisfaction in firms that provide such work practices as encouraging employees to work in teams, collaborating with other organisations, and making customers top priority for the firm. In addition, firms providing alternative pay and conditions are more likely to employ managers who are satisfied with their physical working conditions (what is termed the hard measure of job satisfaction). Both models, on the other hand, reveal negative significance for frequency of information in the case of small firms, regardless of the type of job satisfaction measure employed. This may indicate that small firms that provide information to employees (e.g. information on new products, changes in work practices, and staff reductions) are less likely to have satisfied managers.

In the case of external factors that may affect job satisfaction, satisfied managers employed in larger-sized firms are less likely to be located in regions with certain types of entrepreneurial activity (related to the informal investment and the level of expected start-ups in a region). The estimations also find that employee-managers with positive soft measures of job satisfaction (e.g. proud to work in the firm, show loyalty to the firm, and have similar values to the firm) are more likely to be found in small and larger-sized firms located in regions with diverse nationalities. These varied results may reflect the findings of Kammeyer-Mueller et al. (2013) of the mixed relationships between job performance and work outcomes such as job satisfaction.

- **Model 4a and 4b**: As explained in Chapter 4, Section 4.4, two measures of employee–managers’ willingness to change in the workplace are adopted in order to unravel the complexity of the intangible elements of IHC. The effect of internal and external factors on IHC is limited. The results reveal that small firms that offer work practices and work arrangements such as consultation and
flexible hours are more likely to employ managers who are willing to work unsociable hours (the hard measure). To analyse the soft measure of employee managers’ willingness to change the full complement of observations is used, due to a convergence issue when estimating separately for firm size. While controlling for firm size, the results show that firms that provide flexible hours are positively significant at the five percent level. In other words, firms that provide flexible work hours are more likely to employ managers willing to change work tasks such as the level of technology they use to carry out their job.

The results of the control variables

As with all estimations, various control variables are included in each of the models. Noteworthy is the lack of consistent results across the models. Nevertheless, the results from Model 1 (education) reveal that being Irish is negatively significant (at the 5% level), irrespective of firm size; 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”. However, labour with specific experience acquired from other regions may be important for particular innovations (Simonen and McCann 2008). In Model 2, the results find that male employee-managers are more likely to be willing to work unsociable hours. R&D (using innovation as a measure) in small firms is positively significant in the case of training, indicating that those employee-managers who avail of training are more likely found in firms who engage in R&D. This control variable is also significantly positive in the case of the two intangible elements; again indicating the potential link between IHC and innovation. The limited significance for regional R&D and regional diversity are expected given the limited significance of the other external factors.

52 A frequent problem in estimating binary logit regression models is a failure of the likelihood maximisation algorithm to converge (Allison 2008). This is due to data patterns; hence the use, by the current research, of a larger number of observations to solve the issue.

53 In addition to estimating the individual firm-level factors that may affect IHC, this research considered the complementarity relationship between the two internal factors,
5.5 Discussion on the results from Stage 3 of the analysis

To develop the concept of IHC further, this chapter asked the question, ‘What factors affect IHC?’ The first section of the chapter outlined such factors based on the literature, before formulating the eight research hypotheses.

Using econometric analysis the multiple logit regressions yield mixed results as to the levels of significance of internal and external factors in support of firms’ IHC. In the main, this stage (Stage 3) of the analysis demonstrates that there is no ‘one size fits all’ formula to support IHC in small or larger-sized firms (at least not in Ireland). This finding confirms Penrose’s (1995) emphasis of the importance of idiosyncratic resources possessed by the firm (the foundation of the resource-based view of the firm). However, emerging from the analysis is the vital role of the employing firm in nurturing IHC. That is, the work practices and arrangements offered by firms to employees are vital in supporting this valuable determinant of firms’ innovation activity. The remainder of this section discusses the results from Stage 3 from the firms’ and employees’ perspective. The potential implications with respect to policy makers are presented in Chapter 6.

The hypotheses posed in this chapter assume that IHC contributes to firms’ innovation as presented in Chapter 4. Overall, the estimations show the statistically significant effects 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; this study supports the notion that knowledge inherent in IHC comes from a variety of organisational structures within the firm, such as work arrangements and work practices. The results are also consistent with the RBV of the firm, where firms’ management need to maximise the value of work practices and work arrangements, with little significance to report. However, where significant, the results are negative for the zero or below average levels of work practices and arrangements and positive for high levels of both.
of existing resource capabilities (Grant 1996; Spender 2009). For example, firms’ capacity to facilitate regular performance reviews or appraisals, and to provide alternative forms of pay and conditions, are positive factors in the majority of the estimations, highlighting conditions that can support IHC as a valuable resource where it exists. Furthermore, the positive externalities garnered by firms offering such work practices and arrangements for other reasons (e.g., union demands or staff retention strategies) may provide support for and nurture IHC. When IHC is developed throughout the firm, employees have the potential to develop innovative characteristic/mindsets capable of contributing to the firm’s innovation activity, where innovation becomes everyone’s concern.

The results from the estimations also offer insights into the relationship between firms’ work practices and arrangements, IHC, and innovation activity. More specifically, they provide evidence that firms’ workplace strategies help promote IHC. This emphasises further that the competitive advantage provided by employees exists at the holistic level, not solely at their level of educational attainment. This addresses the case put forward in Chapter 1: education and training, while important, may on their own no longer provide a competitive advantage to firms. Thus firms, and indeed employee-managers themselves, must think holistically about nurturing inputs to firms’ innovation activity.

At the same time, the analysis finds limited statistical significance regarding the effects of external factors on firms’ IHC. However, diversity of nationality in the local labour market appears significant as a support for job satisfaction; this limited significance may be related to the level of diversity in Ireland and the overall homogeneity across regions. Ireland had a relatively low level of diversity in nationality until recently: figures for non-Irish nationals in Ireland constituted five percent of the population in 2002
but had increased by 143 percent in 11 years, and non-nationals comprise over 12 percent of the population in 2011 (CSO 2012)\textsuperscript{54}.

As suggested by Ganotakis (2012), such insights are important for policy makers and providers of financial assistance (such as banks, governments and venture capitalists), who ought to look beyond education as a key driving force behind human capital. Indeed, the current findings suggest that these stakeholders should ensure the presence of IHC and the supports necessary to develop and sustain this new concept. In view of the current slow growth of the economy (ESRI 2013; Foray \textit{et al} 2012), it is even more imperative that IHC be created and developed as a contributor to innovation.

5.6 Conclusion

In addition to the contributions from Stages 1 and 2 of the study’s empirical analysis outlined in Chapter 4, the third stage of the analysis makes the following contributions to the knowledge base:

- Internal factors in the form of firms’ work practices and work arrangements positively affect the four elements of IHC at various levels.

- To a lesser extent, the regional factors of entrepreneurship activity and diversity affect IHC.

- In addition to identifying supports for the new IHC concept, this research contributes to the on-going debate on developing effective measures and development of human capital (Arvanitis and Stucki 2012; Marrocu \textit{et al} 2012; Fitjar and Rodriguez-Pose 2011; Ganatakis 2012).

\textsuperscript{54} It is worth noting at this juncture that a Blau index was also used to calculate diversity in age and gender of the workforce; minor degrees of diversity were found across the eight regions, and hence were not included in the analysis.
The findings from the research have implications for policies such as innovation and enterprise policy; indeed, for any policy aimed at driving firms’ innovation activity. These implications form the focus of discussion in the next chapter.
6 Innovative human capital: Is there a role for public policy?

6.1 Introduction

The research thus far has focused on the new IHC concept and its contribution to firm-level innovation, and on the factors that influence IHC. This chapter extends the study of the novel concept and examines the role of public policy (if any) in its promotion and support. In so doing, the chapter considers two related questions: first, how useful are existing policy programmes/instruments in unleashing the potential of IHC; and second, what kinds of supports (if any) are necessary to promote IHC in the future?

The findings from this analysis highlight IHC as a valuable resource for firms’ innovation activities, hence the focus on innovation policy in supporting IHC. Innovation policy concerns itself with the arrangements made by public institutions to influence, stimulate and support innovation activities (Edquist 2011; Smart Innovation 2006). Such policies are required to give structure to the complex and wide-ranging issues surrounding innovation (Lundvall and Borrás 2009). This chapter, like Chapters 4 and 5, uses Ireland’s innovation policy landscape as a laboratory to operationalise and study IHC at policy level.

To answer the questions posed above regarding support for IHC, it is necessary to begin by addressing the fundamental meaning of public policy (outlined in Section 6.2), and why it is required (Section 6.3). The remainder of the chapter is organised as follows: In the context of other public policies, Section 6.4 describes first, where innovation policy ‘fits’ and secondly, the types of policy programmes currently on offer to drive

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55 Much of the material in this chapter is based on a conference paper which was presented at the European Forum for Studies of Policies for Research and Innovation (Eu-SPRI) Conference. Manchester Institute of Innovation Research (MIoIR), University of Manchester. 18th-20th June 2014; Lenihan, H. and McGuirk, H. ‘Does Innovative Human Capital drive firm-level innovation? Empirical evidence and implications for public policy’.
innovation. Section 6.5 provides a rationale for the provision of public support for IHC. This is followed by a policy proposal to support and develop IHC in firms. Section 6.6 concludes the chapter.

6.2 What is public policy and how does it support innovation?

Although public policy is a wide-ranging concept and exerts its influence on many diverse issues, its underlying common aim is to achieve a desired goal considered to be in the best interests of the target population. In this regard, it may be defined as a deliberate decision to provide guidance to achieve selected objectives (Torjman 2005).

In considering the role of government in driving innovation, Romer (2008, p. 347) suggests that:

The standard dichotomy in economic policy debates - market exchange versus government intervention - does not capture the complexity of the kinds of social institution already used to achieve common goals. The government is a mechanism for explicitly coordinating the actions of all people.

Support for innovation through public spending on R&D is well documented and monitored (e.g. OECD 2014; EuroStat 2014). While a range of supports are available to government for the purpose of driving innovation, funding R&D activities is by far the most widely used instrument. To provide an example of this direct support for innovation and demonstrate the level of government commitment to increasing innovation, the next section reviews R&D investment from both international and Irish perspectives.

6.2.1 Investment in R&D and innovation

There is no doubt that governments and firms recognise and support R&D as a direct input to innovation for growth and survival\(^56\) (Lundvall and

\(^{56}\)This topic was discussed in Chapter 2.
Borrás 2010). The latest OECD (2014) estimates confirm a recovery of gross domestic expenditure on R&D across the OECD area in 2012; overall government spending is up one percent, and higher educational institutions’ expenditure on R&D is also up (1.1%, 2011 - 2012). According to the latest Government Budget Appropriations and Outlays on R&D (GBAORD) report (Forfás 2013b), Finland reported the highest level of GBAORD as a percentage of GDP, at 1.07 percent in 2011, while Ireland (0.50% of GDP) is ranked below the average EU 27 (0.63%) and above Australia (0.46%). From an international perspective, investment by governments in innovation and R&D was maintained in 2012 (Forfás 2013b). Figure 6.1 illustrates the rates of government spending on R&D for a selection of economies for 2004 and 2011, a period which captures the years referred to in the current study (2007-2008).

**Figure 6.1** Government budget appropriations and outlays on R&D as a percentage of economic activity 2004 and 2011

![Bar graph showing government budget appropriations and outlays on R&D as a percentage of economic activity for various countries in 2004 and 2011.](image)

*Source:* State investment in Research and Development (Forfás 2013b)

In Ireland, support for R&D and innovation (specifically through R&D) has long been supported by public finances (Forfás 2013c; 2014). This support

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57 Civil GBAORD is a good metric for international comparisons as it does not include the defence portion of the R&D budget, for which Ireland does not allocate any sum of money (Forfás 2013b).

58 Economic activity refers to GDP except in the case of Ireland which refers to GNP (Forfás 2013b).
has fluctuated between 2003 and 2012, with an overall decrease of 13 percent since the highest figures in 2009 (OECD 2014). This trend in the government budget on R&D corresponds broadly with the proportion of public spend in relation to GNP, illustrated in Figure 6.2.

**Figure 6.2** Ireland’s government budget appropriations and outlays on R&D (GBAORD) as a percentage of GNP

![Figure 6.2](image)

^2012 based on estimates  
**Source:** Business Expenditure on Research and Development (Forfás 2013c)

While this section has highlighted the more macro-level rates of innovation and R&D investment, it is necessary to assess the level of investment on R&D and innovation by firms (the focus of the current research). Ireland’s current business expenditure on R&D (BERD) (when taken as a percentage of GNP) is 1.46 percent, well above the EU-27 average of 1.20 percent (Forfás 2013b; 2013c). The proportion of gross domestic expenditure on R&D financed by industry in the OECD area is down from a high of 64 percent in 2000 to 59 percent in 2011 (OECD 2014). This decrease is reflected in Ireland, where gross domestic expenditure on R&D, financed by industry, decreased from a rate of 66 percent to 50 percent, 2000-2012 (OECD 2014). With respect to the reference period analysed by this study,
Ireland’s gross domestic expenditure on R&D was 49.55 percent in 2008, far below the OECD average of 63.67 percent for the same year.

**Figure 6.3** Comparing business and government spending on R&D in Ireland 2003-2012

![Graph showing business and government spending on R&D](image)

**Source:** State investment in Research and Development (Forfás (2013b) and Business Expenditure on Research and Development (BERD) (Forfás 2013c).

The statistics above indicate a recovery from the 2008 financial crisis and continued commitment by public and private sector to R&D and innovation, albeit at a reduced level. This raises questions as to why governments invest in innovation even during financial crises, and how governments support innovation other than through R&D expenditure. The next section endeavours to answer these questions and provides a rationale for such intervention. This will enable the author to begin to establish whether or not there is a role for innovation policy in the support of IHC. Such a potential role is discussed in Section 6.5.
6.3 Why do governments support innovation?

As aptly summed up by Kuhlmann (2014), innovation is shaped by both institutional contexts and public policy. Innovation policies are described as the public intervention supporting the “generation and diffusion of new products, processes or services” (Edler et al 2013, p. 4). It is crucial to establish a clear justification for publicly funded interventions, as the opportunity cost of public expenditure is high (Lynch et al 2009; Greene 2009).

In a market economy, public policy intervention is necessary only 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).

All OECD countries offer policies to support and strengthen firms’ innovation activities (OECD 2011a). In providing public support for innovation, governments correct for the inherent tendency of markets to produce inefficient knowledge and information (Metcalf 2005). Knowledge is to some extent excludable, and can thus be considered an impure public good (Stiglitz 1999). Business advice and assistance provided by public money is regarded as such (Hill 2004). The debate continues as to how best to develop and distribute knowledge and intellectual property rights, a crucial issue with respect to some types of innovation (Swann 2009). The term, ‘public goods’ refers to goods or services that are non-rival and non-excludable. Private investment by firms in pure public goods is viewed as a poor investment; hence there are reasons for public support (Alfranca and Huffman 2003).

The rationale for government intervention varies across different economic theories and schools of thought (Laranja et al 2008). The rationale for many
programmes is often not explained in the relevant policies; this can lead to vague and disputed expectations (Edler et al 2013). The majority of the literature focuses on the neoclassical and evolutionary approaches\(^{59}\) (Bleda and del Río 2013; Nill and Kemp 2009; Laranja et al 2008), although neo-Marshallian\(^{60}\) and endogenous growth theories\(^{61}\) (Laranja et al 2008) are also discussed in the context of government intervention and government failure (Warwick 2013). To fully understand why governments intervene it is important to explain the various rationales used, hence the remainder of this section explains the traditional market failure approach, followed by failures that have been cited as more reflective of the complex nature of innovation.

6.3.1 Market failure

Policy should be an improvement on the initial market failure case, “so a policy is successful only if it creates input and/or output additionality” (Gök and Edler 2011, p. 5)\(^{62}\). Examples of why markets may fail to reach the abstract condition of perfect competition include the issue of public goods (alluded to earlier); asymmetric information; and economies of scale. As discussed in Chapter 2, the latter refers to the fact that the larger producer will always be in a position to undercut the smaller producer, or the larger firm will have more resources to invest in R&D than the smaller firm (Hewitt-Dundas 2006); a role exists for government in supporting the smaller firm in this instance. The issue of asymmetric information involves situations where one party has information over another (a competitive

\(^{59}\) In addition to details provided in Chapter 2, the neoclassical approach to policy intervention is dominated by the view that government intervention is justified only where markets fail to allocate resources to enhance social welfare; the evolutionary approach moves beyond this linear model (Laranja et al 2008).

\(^{60}\) The neo-Marshallian approach is based on lessons learned from industrial districts that experience success, or ‘learning regions’ (Asheim 1996).

\(^{61}\) The endogenous approach relaxes the earlier neoclassical view of perfect competition to capture innovation as a result of learning by doing and of increasing returns to investment in R&D (Laranja et al 2008).

\(^{62}\) Where government interventions reduce uncertainty, substitute failing markets, and devise ways to overcome inappropriability (Gök and Edler 2011).
advantage or in some cases an inefficiency) (Swann 2009; Lambrecht and Pirnay 2005); market failure due to asymmetric information could emerge if in the context of the current research for example, some firms lack knowledge about the benefits of developing IHC as a valuable resource for innovation activity (discussed later in this chapter).

Most market failures reflect a mismatch between private and social benefits (Warwick 2013). Where such problems occur, governments might fund projects to compensate for market failure and to reduce uncertainty (Gök and Edler 2011), although it has been emphasised that “governments should intervene only when there is clear evidence that the benefits of the actions outweigh the costs” (Tokila 2011, p. 39).

According to the neoclassical view of innovation, markets coordinate information and allocate resources “for the production and distribution of new knowledge”; a failure in this function prompts government intervention (Bleda and del Rio 2013, p. 1048). The fact, that “knowledge and information are not normal economic commodities but possess attributes that do not make them natural candidates for market exchange” suggests market failure as the traditional rationale for innovation policy (Metcalfe 2005, p. 54). In providing public support for innovation, governments correct for the inherent tendency of markets to produce inefficient knowledge and information (Metcalfe 2005). Interestingly, most innovation policy programmes in the UK for example, are based on market failures on the supply side, where information and other resources are constrained (Edler et al 2013). Having reviewed the literature the same could be said about policy programmes in Ireland. Interventions as a result of market failures tend to focus on allocation, diffusion and transfer of knowledge through subsidies, tax systems and the protection of intellectual property (IP) rights (Laranja et al 2008). Hence policy programmes are usually introduced to overcome the results of such market failures, which generally arise due to a lack of incentives by private firms to invest in conditions of uncertainty (riskiness of return on investments).
Arnold (2004) has developed a neoclassical notion of market failure in the context of innovation policy that includes capability failures, failures in institutions, network failures and framework failures. These failures “justify state intervention not only through the funding of basic science, but more widely in ensuring that the innovation system performs as a whole – always provided that the state is actually capable of reducing failure” (Arnold and Boekholt 2002, p. 10). Evolutionary theory, on the other hand (as introduced in Chapter 2), is concerned with changes in market structure and Schumpeter’s notion of ‘creative destruction’ (Bleda and del Río 2013). The focus of innovation policy in the evolutionary approach is to tackle problems or failures in the management and growth of knowledge and novelty (Bleda and del Río 2013). In addition, from the evolutionary perspective, government intervention should focus on the limitations of agents’ capabilities and their capacity to generate, adopt and retain new knowledge and to increase the potential for experimental behaviour (Metcalfe 1995; Laranja et al 2008; Bleda and del Río 2013). This type of knowledge is a mixture of tacit and tangible knowledge; consequently, a dynamic approach to learning and cognitive capacity must be the focus of attention (Laranja et al 2008).

Innovation policy directed at private firms based solely on market failure misinterprets the role of competition in modern society “through its failure to realize that capitalism and equilibrium are incompatible concepts and that innovation and enterprise preclude equilibrium” (Metcalfe 2005, p. 55). Furthermore, in modern societies, markets are fast moving with short product lifecycles, and innovation depends on dynamic systems and the “generation of unquantifiable uncertainty and asymmetries in information” (Metcalfe 2005, p. 58); such conditions highlight the limits of market failure. While market failure is considered a valid rationale for government intervention, it is argued that it is insufficient justification for innovation policy in light of the non-market stakeholders involved (Bleda and del Río 2013). Therefore, in order to establish whether or not a credible rationale for public support exists for IHC, there must be an understanding of evolutionary theory, systems failure and government failure which takes
account of the uncertainties of innovation and pursuit of competitive advantage of firms. Such an understanding is developed in the next section.

6.3.2 Beyond the traditional rationale for public intervention

The idea of market failure compares the ‘real world’ with the ideal, where failure indicates that there is an optimal point (Chaminade and Equist 2005). However, innovation is complex and path-dependent over time, and innovation systems never achieve equilibrium; thus “market failure loses its meaning and applicability” (Chaminade and Equist 2005, p. 9). According to Smits and Kuhlmann (2004), policy instruments are increasingly systemic. This would seem like a natural development, given that (as outlined above) over time there has been a move away from overcoming market failure towards overcoming systemic failures.

Moreover, over time, the change in focus from market failure to systemic failure has resulted in a new rationale for intervention (e.g. Laranja et al 2008; Gustafsson and Autio 2011). The Systems Innovation (SI) and National Systems of Innovation (NSI) approaches (outlined in Chapter 2) involve complex and non-linear information exchange mechanisms which determine the success of innovation (Woolthuis et al 2005; Edquist and Hommen 2006). 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 Rio 2013, p. 1040). Warwick (2013) explains systems failure as arising from the interactions between institutions that generate the learning and operating environments for firms. 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). Such failures include infrastructural, institutional and
capabilities failures (particularly relevant to IHC), while the actors comprise demand entities (consumers and large buyers), firms, knowledge institutes and third parties (banks, venture capitalists, intermediaries and consultants). Chaminade and Edquist (2005) reiterate the importance of understanding the complexity of innovation in implementing policy, as it affects the focus of the programmes and the rationale for public policy. This confirms Aghion et al.’s (2009) argument that due to the complexity of innovation and the network of agents and institutions through which it operates, a rationale based on systems failure is more appropriate and contemporary.

More specifically, and closely related to systems failure, institutional failure refers 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) define 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). However, market and systems failures may not be enough to justify government intervention (Warwick 2013). The case where governments do not act to alleviate such market or systems failures is known as government failure; there currently exists a debate as to whether market or government failures underpin the rationale for public intervention (Xun and Remesh 2013).

Government failure may include the political systems and institutions of the country (Warwick 2013). ‘Passive government failure’ describes situations where governments do not intervene to achieve Pareto outcomes63, as opposed to ‘active government failure’ where government interventions lead to more inefficient allocation of resources than before the interventions (Weimer and Vining 2014). In the context of justifying public support for

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63 Pareto efficiency refers to “Resource allocations that have the property that no one can be made better off without someone being made worse off are said to be Pareto efficient” (Stiglitz 2000, p. 57).
innovation, it is important to bear in mind the interrelated nature of the different types of failures and to recognise that they are not mutually exclusive; indeed, they frequently overlap (Hollanders 2008). For example, the market failure rationale leads to programmes that offer firms tax incentives and grants, whereas, the systems failure approach provides programmes that “enhance innovation opportunities and capabilities” (Metcalfé 2005, p. 68), a point of interest in supporting IHC as a determinant of innovation and one discussed further in Section 6.5.

Understanding why governments intervene to drive innovation is discussed further in Section 6.5, in the context of IHC. But in order to fully appreciate the source of innovation focused government strategy, it is necessary to understand where innovation policies fit into the overall policy landscape.

6.4 Policies and programmes driving innovation

As highlighted throughout the previous chapters, innovation is a complex phenomenon. Similarly, innovation policy operates in complex social systems rather than in a simple controlled laboratory (Guy 2002). Innovation policy does not emerge from the ether, but evolves from various policies including enterprise, industrial, science and technology (Lundvall and Borrás 2010; Guy 2002; Europa 2014).

Such broad-based and widespread governmental responsibility causes problems for policy makers in terms of where innovation policy ‘fits’ (Smart Innovation 2006). In the case of Ireland and the EU, policy support for innovation is addressed, for the most part, under the broad ‘umbrella’ of industrial/enterprise policy (European Commission 2014).

It is well established that industrial policy affects and supports numerous other policies in a changing economic environment (Cimoli et al 2009). Budd (2007) proposes that industrial policy is the fulcrum between competitiveness, enterprise and cohesion policies in the EU.
This is reflected in rise of globalisation which has introduced new competitors, such as China and India, into the marketplace; and to the interaction of multinational firms beyond the national state. Consequently, industrial policy has become an increasingly complex web of different components (Bianchi and Labory 2006; 2011). Interestingly, Vorley and Nelles (2010) suggest that innovation policy is the future-orientated form of industrial policy.

6.4.1 Policy programmes driving innovation

While government policy provides strategic approaches to desired objectives, such objectives and strategies are operationalised through programmes, or “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). The term programme refers to a set of resources and activities directed toward one or more common goals, typically under the direction of a manager or team (Wholey et al 2010). Innovation policy programmes are described as measures, schemes or initiatives funded by government in order to promote, support or stimulate innovation and innovation-related activities; these may operate directly or indirectly (Smart Innovation 2006). Programmes address ‘shortages’, ‘problems’, or ‘failures’ in the market (Dasgupta and David 1994). As outlined previously, these failures may include market, government, or systems failures. While it is commonly recognised that innovation is the ‘engine of growth’, it is important to note that innovation policy programmes should be concerned with more than the number of product innovations introduced during a given period (Smart Innovation 2006). In other words, innovation support is more than R&D funding (Lundvall and Borrás 2010).

Scholars are aware that innovation can seldom be attributed to a single project or action; rather, it is the result of a multitude of strategies, links, and interactions (Bræin et al 2002; Kline and Rosenberg 1986). Within the
firm, for instance, innovation activity can take place anywhere (Kline and Rosenberg 1986); it does not happen in isolation, and depends on continuous interactions among many actors (Chaminade and Edquist 2005). Based on these realities, a non-linear, evolutionary approach to programmes driving innovation is outlined below, first in a European context, then by examples from individual industrial economies. Such an approach can inform decisions as to whether or not a new policy programme or indeed policy offer is required to support firms in developing IHC as a valuable determinant of innovation.

**Driving innovation in Europe**

In order to establish a full understanding of innovation-focused policy programmes (particularly with respect to human capital), it is useful to review the use of public support for innovation in other economies. Such a review illuminates an array of supports for innovation and provides lessons in developing effective supports for IHC.

Current EU policy is dominated by *Europe 2020*, which sets out the agenda for Europe in the next decade (Camagni and Capello 2013). Launched in October 2010, the *Innovation Union* initiative (one of the pillars of *Europe 2020*) puts research and innovation at the centre of the EU’s policies to increase growth and jobs. *Horizon 2020* is the funding instrument implementing *Innovation Union*; it runs from 2014 to 2020, with an €80 billion budget (European Commission 2013a). The rationale for such supports is based on addressing the challenges facing European society (European Commission 2014). The key element of Horizon 2020 is that the private sector should work with member states through public-private partnerships in order to achieve better outcomes than could be achieved by either sector operating alone (European Commission 2013d).

The programme will combine all research and innovation funding available from the EU (2014-2020), and will fundamentally aim to:

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64 These issues are discussed in Chapter 2.
• Strengthen the EU’s position in science by providing a dedicated budget of €24.5 billion;65

• Strengthen industrial leadership in innovation by investing in key technologies, improving access to capital and providing support for SMEs (€17.9 billion);

• Help address climate change, sustainable transport, renewable energy and the challenge of coping with an ageing population (€31.7 billion).

(European Commission 2013a; 2013b)

The European Commission (2009) sets out the rationale for the programme in the publication Reinvent Europe through innovation: From a knowledge society to an innovation society (containing recommendations made by a business panel on future EU innovation policy), which proposes:

…to base EU action around compelling social challenges, to finance social innovation funds, to incentivise large scale community level innovations, to transform the public sector with a budgetary innovation target and to engage the young and the old in new types of partnerships.

(European Commission 2009, p 3).

The Innovation Union goes beyond the funding of R&D; for example, in the European Institution of Innovation and Technology, education has been added to the research-business partnership. This focus on human capital includes the provision of educational programmes at Masters and PhD levels to promote entrepreneurship, and a trans-disciplinary approach to education and knowledge sharing with society at large (Europa 2014). While such provisions are welcome, there is an absence of focus on the intangible elements resident in individuals.

65 Central to the funding of Excellent Science is the support of the most talented scientists, fostering collaborative research, training and career development of researchers, and ensuring world-class research infrastructures.
The strategy pursued by developed economies beyond the European Union also acknowledges the benefits from supporting innovation (Europa 2014). It is to this issue the next section turns.

**Driving innovation in developed economies**

With respect to programmes offered by developed economies, most governments support innovation at firm-level through the tax system and through collaboration with higher education institutes (HEI). Examples include the UK’s ‘Collaborating for Success’ support for collaboration between firms and HEI’s for innovation. The Canadian government supports companies to ‘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). Table 6.1 provides information on five countries, including Australia, Sweden, Singapore, UK and New Zealand. Innovation in Sweden for instance, emphasises the ecosystem between stakeholders, with the university sector in receipt of the most public funding; the New Zealand government have provided support to develop innovation parks and incentivised innovation by researchers and improved IP rights, and similar to most economies Australia supports R&D schemes and linkages with universities and industry as well as inter-firm networks.

There is a notable lack of focus on the human capital elements of innovation policy, particularly intangible components similar to those of IHC. However, it is worth noting that Singapore and the UK tend to focus more on human capital when compared to their other developed country counterparts. The policy strategies of both these countries focus strongly on increasing human capital (this focus is highlighted in bold italics in Table 6.1). 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).

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66 These developed countries are chosen for study as a result of the information available to the author in the English language.
Table 6.1 Survey of current innovation policies in Australia, Sweden, United Kingdom, Singapore and New Zealand

<table>
<thead>
<tr>
<th>Country</th>
<th>Description of public innovation policy/strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>Innovation Policy is based mostly on market failure. Types of policies include R&amp;D support schemes, public research, collaboration (university-industry linkages and inter-firm networks) and financial support schemes.</td>
</tr>
<tr>
<td>Sweden</td>
<td>The innovation ecosystem is the link between large multinational companies, industrial policy, public organisations and university research. The latter receives the most public funding.</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>Funding blue skies research, improving links between HEI and businesses, and delivering a better environment for commercialising research. These include an emphasis on all industries and services to invest in adapting technologies and develop complementary non-technical innovations, including intangible assets from human capital. Using open innovation – exploiting knowledge and ideas from any area of the UK.</td>
</tr>
<tr>
<td>Singapore</td>
<td>New strategy for competitiveness includes the ‘National Productivity and continuing education council’ (NPCE). High priority includes programmes to increase workers’ skills, to lower production costs. The programmes include educational opportunities for working adults, particularly lower paid workers. The strategy also aims to promote a productivity and innovative mindset.</td>
</tr>
<tr>
<td>New Zealand</td>
<td>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.</td>
</tr>
</tbody>
</table>

Source: de Rassenfosse et al. (20110); BIS (2011); Miller (2013); NPCE (2012); New Zealand Government (2012). Refer to Appendix A for details of programmes from these and other developed economies. Note: references to human capital are highlighted in bold italics.
Driving innovation in Ireland

As a member of the European Union, Ireland is well positioned to benefit from the EU’s Horizon 2020 in terms of the projected increase in innovation activity (Enterprise Ireland 2014). However, the shape and vision of Ireland’s current innovation policy (with respect specifically to human capital - the lens through which innovation policy is studied given the focus of the current research) has emerged from several reports and policy documents in the past two decades. In 1996, *Shaping Our Future* (Forfás 1996) 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. The impact of the government’s long-term objective to increase the skills profile of people through education, outlined in *Shaping Our Future* is evident in today’s increased numbers with third-level degree or higher (CSO 2014) (see Chapter 1 for an earlier discussion). In addition, the *Expert Group on Future Skills Needs* (EGFSN), established in 1997, provides the Irish Government with strategic advice on subjects such as skills foresight and benchmarking, building skills through education and training, and monitoring implementation (EGFSN 2014). Although the central focus of the group’s advice is to ensure that labour market needs for skilled workers are anticipated and met (EGFSN 2014), the advice contains no mention of the more innovative elements of the individual person highlighted in the current research (e.g., willingness to change and job satisfaction). The EGFSN was followed by *Ahead of the Curve* (Forfás 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 increase the knowledge base by improving human capital through education at all levels, and strengthening the innovation ecosystem to build Ireland’s Smart Economy. The most recent policy documents, *Action Plan for Jobs* (DJEI 2012; 2013; 2014) focus on seven principal areas, including building competitive advantage by
focusing *inter-alia* on innovation and skills. The report identified the need for Ireland’s education and training system to respond and adapt to changes in new and emerging technologies. The 2013 and 2014 *Action Plan for Jobs* support the transition to an economy based on innovation, enterprise and export, by building competitive advantage through ‘disruptive reforms’ to align skills and improve competitiveness. Table 6.2 presents various reports used to inform innovation and enterprise/industrial-related policies in Ireland (references to human capital are highlighted in bold italics).
<table>
<thead>
<tr>
<th>Report (author &amp; date)</th>
<th>Aim of the report</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shaping Our Future</strong> <em>(Forfás 1996)</em></td>
<td>To promote a strategic view of enterprise in Ireland to help the economy and industrial base. Establish an environment conducive to innovation through the <em>longer-term measures of the major drive to raise the skills profile of people.</em></td>
</tr>
<tr>
<td><strong>Enterprise 2010: New Strategy for the Promotion of Enterprise in Ireland in the 21st Century</strong> <em>(Forfás 2000)</em></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Ahead of the Curve</strong> <em>(Forfás 2004)</em></td>
<td>Points to the opportunities in internationally-traded services will play a significant role in Ireland’s economy. Recommendations include; an R&amp;D and innovation co-ordination structure; increase applied R&amp;D funding and continue funding for SFI and HEA.</td>
</tr>
<tr>
<td><strong>Building Ireland’s Smart Economy</strong> <em>(Government of Ireland 2008)</em></td>
<td>Provides a framework to enhance productivity and sustained growth. Create ‘The Innovation Island’. <em>Build innovation or ‘ideas’ component of the economy through using human capital.</em></td>
</tr>
<tr>
<td><strong>Making it Happen: Growing Enterprise for Ireland</strong> <em>(Forfás 2010)</em></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Innovation Ireland</strong> <em>(Innovation Taskforce, 2010)</em></td>
<td>Report of the Innovation Taskforce places innovation at the heart of enterprise policy in Ireland by <em>utilising human capital to translate ideas into valuable innovations.</em></td>
</tr>
<tr>
<td><strong>Report of the Research Prioritisation Steering Group</strong> <em>(Forfás 2011)</em></td>
<td>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.</td>
</tr>
<tr>
<td><strong>Action Plan for Jobs</strong> <em>(DJEI</em> 2012; 2013; 2014)*</td>
<td>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 highlight the need for <em>alignment between education and training with industry’s needs.</em></td>
</tr>
</tbody>
</table>

**Source:** Forfás (2014). *DJEI or Department of Jobs, Enterprise and Innovation. Note: references to human capital are highlighted in bold italics.*
The innovation-related policies outlined in Table 6.2 have been activated through the provision of approximately 70 programmes (Enterprise Ireland 2014; Forfás 2014). Table 6.3 outlines a selection of innovation-focused programmes with further details presented in Appendix B. The *Innovation Partnership* programme, for example, is designed to promote collaborative projects between companies and research teams in higher education institutions (HEI), with up to €25,000 available per project. The R&D Fund promotes collaboration on R&D projects between pairs of companies, with a 15 percent bonus available as grants for in-house R&D projects (€150,000 for small projects and up to €650,000 for standard projects). Under Enterprise Ireland’s leadership and management development headings, programmes on offer include *Management 4 Growth; Strategic Leadership 4 Chief Financial Officers* and the *Strategic Consultancy* grant. These programmes promote the development of world-class, highly competent and confident management teams to operate in world markets. Enterprise Ireland subsidises such programmes, while the *Mentor Network* programme provides tailored advice and support to accelerate growth and build management capabilities. *Lean Business Offer* is designed to encourage firms to adopt *Lean* business principles to increase performance and competitiveness. Its three stages include: *LeanStart*, which provides an introduction to *Lean* concepts; *LeanPlus*, a medium-term business process improvement; and *LeanTransform*, a large-scale, extensive and holistic firm transformation programme (Enterprise Ireland 2013). Further discussion on the Lean Business Offer is presented in Section 6.5 and in Appendix B.

As indicated by the titles of innovation support programmes on offer in Ireland, most programmes are aimed at increasing product-innovation-type activities (e.g. R&D funding, innovation vouchers, innovation partnerships and technology gateway programmes). Other programmes focus mainly on firms’ strategies for managing and improving productivity.

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67 Enterprise Ireland (EI) is the government organisation responsible for the development and growth of Irish enterprises. EI partners with Irish enterprises, assisting them to start, grow, innovate and win export sales on global markets. Available online: [http://www.enterprise-ireland.ie/ResearchDatabases/Search.aspx](http://www.enterprise-ireland.ie/ResearchDatabases/Search.aspx)
Table 6.3 Summary of current enterprise- and innovation-focused programmes available to firms in Ireland

<table>
<thead>
<tr>
<th>Programme name</th>
<th>Impact at level of</th>
<th>Focus of the programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology centres</td>
<td>Firm</td>
<td>Innovation</td>
</tr>
<tr>
<td>Technology gateway programme</td>
<td>Firm</td>
<td>Innovation</td>
</tr>
<tr>
<td>Innovation Partnerships</td>
<td>Firm &amp; HEI</td>
<td>Innovation</td>
</tr>
<tr>
<td>R&amp;D Funding</td>
<td>Firm</td>
<td>Innovation</td>
</tr>
<tr>
<td>Technical feasibility grants</td>
<td>Firm</td>
<td>Innovation</td>
</tr>
<tr>
<td>Innovation Vouchers</td>
<td>Firm</td>
<td>Innovation</td>
</tr>
<tr>
<td>Pooled Innovation Vouchers</td>
<td>Firm</td>
<td>Innovation</td>
</tr>
<tr>
<td>Enterprise Ireland R&amp;D Fund:</td>
<td>Firm</td>
<td>Innovation</td>
</tr>
<tr>
<td>Access strategic advice and expertise</td>
<td>Firm</td>
<td>Develop and implement firms’ development plans</td>
</tr>
<tr>
<td>Best Practice Study Visits</td>
<td>Firm &amp; Management</td>
<td>Productivity</td>
</tr>
<tr>
<td>Lean Business Offer</td>
<td>Firm, management and individual employee</td>
<td>Productivity, innovation, firm strategy</td>
</tr>
<tr>
<td>Management 4 Growth</td>
<td>Firm &amp; Management</td>
<td>Firm strategy, management training</td>
</tr>
<tr>
<td>Strategic Leadership 4 Chief Financial Officers (SLACFO)</td>
<td>Firm &amp; Management</td>
<td>Firm strategy, management training</td>
</tr>
<tr>
<td>Leadership 4 Growth Programme</td>
<td>Firm &amp; Management</td>
<td>Firm strategy, management training</td>
</tr>
<tr>
<td>Overview of Enterprise Ireland Key Manager Support</td>
<td>Firm &amp; Management</td>
<td>Firm strategy, management training</td>
</tr>
<tr>
<td>Enterprise Ireland Mentor Network The Enterprise Ireland</td>
<td>Firm &amp; Management</td>
<td>Firm strategy, management training</td>
</tr>
</tbody>
</table>

Source: Enterprise Ireland 2014; Forfás 2014. Refer to Appendix B for details on these programmes.
In summary, by highlighting that government support for IHC originates in the area of innovation policy, the chapter so far, has provided an overview of innovation policy and where it ‘fits’ in the general policy landscape, and has considered the level of investment in R&D and innovation by governments in Europe, Ireland and other developed economies. This review has highlighted the paucity of human capital-focused innovation policy supports, especially those which focus on the intangible elements of human capital as a determinant of innovation. In light of the continuing government interest in driving innovation, the lack of support for the multi-dimensional qualities of the individual as a driver of innovation leads this research to focus on possible supports for IHC.

6.5 Justifying public support for IHC

The findings from the current research (Chapters 4 and 5) indicate that policy makers and firms should look beyond the traditionally studied tangible elements of human capital namely education and training to enhance returns on investments in innovation. More specifically, this research argues that policy makers should adopt a more holistic measure of human capital (termed IHC), of which education is only one of a number of elements. Other elements include training and, most importantly vis-a-vis the contribution of the current research, intangible innovative elements/characteristics of the individual such as job satisfaction and willingness to change. Central to the argument is that a focus on IHC will create competitive advantage in an environment where more and more employees possess a third-level degree or higher.

To ensure that there is effective policy in place to support IHC, it is necessary to examine the source of the issues that the concept of IHC attempts to address. In relation to the contribution of IHC to firm-level innovation, and to the firm-level work arrangements and practices, which support IHC, the study’s findings demonstrate that firm-level systems failure may exist. As pointed out in Section 6.3, innovation policy should be
underpinned by analysis of underlying innovation system dynamics rather than a sole focus 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 actors68 and the rules/system69. Such firm-level systems failures highlight a potential role for public policy programmes in supporting the novel IHC concept.

Public policy can address systems failures in two ways: by strengthening and preserving existing systems, or by creating new systems (Carlsson and Jacobsson 1997). Thus, in respect to the current research, public programmes could strengthen firms’ work practices and arrangements where these exist, and create and support these elements in firms where they do not exist. Public policy support for IHC should target the firm and the individual, as well as promoting a change in culture and mindset within firms supported by work arrangements and practices (e.g., flexible working conditions and/or performance-related incentives).

A prime example of public support of a 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, creating an enabling an environment, which supports IHC, should be a high priority for everyone in the firm; in such an environment, management are the conduit to develop and communicate ideas and to promote the

68 Actors include knowledge institutions, firms and employees
69 Rules/system include the culture, laws and values of the organisation.
positive implications of IHC for innovation. Policy support for such activities will enhance opportunities and capabilities for innovation, according to the systems failure approach discussed earlier.

However, supporting the holistic IHC concept may prove a challenge for both policy makers and firms at a number of levels. While the tangible elements of education and training attainment are more easily supported, direct policy measures are lacking for the intangible elements of IHC. As alluded to earlier, there is an increasing awareness in public policy and in other literature of the importance of ‘soft’ skills that encompass the subjective elements of the individual (Dolan and Metcalfe 2012; OECD 2011).

As evident from a review of the current programmes (Table 6.2), this awareness has yet to appear clearly in policy programmes. However, this lack of awareness should not provide an excuse for avoiding the challenge of supporting IHC.

Although the current research is concerned primarily with factors internal to the firm that support IHC, it should not be overlooked that external firm factors also had some significance in terms of driving firm-level innovation (see Section 4.5 for discussion on this topic). Given the relatively weak significance of the external factors in the analysis, the research will not delve too deeply into explanations or interpretations of external factors from a policy perspective. However, 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; policy makers can have a significant influence in this regard. 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.

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70 This approach is undertaken in the belief that all potential policy suggestions should be evidenced based. Clearly an area for future research is to explore and test the degree to which external factors are relevant in different settings and over varying time periods, the current research is merely the first step in this type of analysis.
It is clear from the review of the policy landscape presented here that there is merit in exploring the possible introduction of a new policy programme in support for IHC. The next section discusses the challenge of a new policy programme focused on developing and supporting IHC within firms, as outlined earlier.

Thus far in the thesis, there is a nascent recognition, in both the literature and innovation policy, of an intangible element to human capital. However, to date no policy programmes support the intangible elements resident in individuals. This study has demonstrated that the multi-dimensional concept of IHC is a valuable determinant of firm-level innovation; to further develop this finding, a framework to support IHC is discussed in the next section.

6.6 Framework to support IHC

This section proposes a policy framework for promoting IHC as a determinant of innovation, comprising both indirect support and a programme to directly support the novel IHC concept.

There is widespread provision across many countries of subsidies and grants for the creation of knowledge; this 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. 2). However, as Jones and Grimshaw (2012) also point out, growing economic uncertainty, fast-changing technologies, short product life-cycles and intense global competition make formulating policy a complex task.

Regarding the type of support needed to promote IHC, this study agrees with Lenihan (2004) in that it does not suggest a complete reconstruction of current innovation support programmes is necessary. Rather, it suggests the need to:
• 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;

• Develop an IHC-centred suite/combination of programmes or offer 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 on creating a culture where the intangible elements of job satisfaction and willingness to change are seen to matter within a firm; these elements should become a natural part of the firm’s culture where innovation is everyone’s concern;

• Introduce a pilot offer. 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 phase, 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 new offer.

The underlying question posed by this chapter is whether there is a role for innovation policy in supporting IHC as a holistic determinant of innovation, or whether it is a concern for firms alone? Perhaps the optimal solution lies in a combination of both private and public sector interventions. Given that firms appear to have lots to gain from IHC, investment by the private and the public sector in partnership (as suggested below) may be the optimal way forward. In justifying government intervention in support of IHC, it is acknowledged that firms too must play a role in the strengthening,
preserving and/or creating such systems. It is key that policy makers and firms recognise the value and merit of these systems in order to nurture IHC as a competitive advantage. As referred to earlier, institutional failure relates to problems with the formal written laws governing an institution; soft institutional failure refers to problems inherent in the culture and values that shape a firm (Woolthuis et al 2005; Carlsson and Jacobsson 1997). Support for IHC may emerge either through direct intervention or indirectly; the following discussion focuses on both indirect and direct supports for IHC.

**Indirect supports for IHC**

In the Irish context, a number of existing programmes stand out as possible indirect support for IHC in firms (although clearly they are not currently labelled as such). Enterprise Ireland offers a set of management development programmes as outlined in Table 6.3 and Appendix B: *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. Such programmes, with some additions could promote the merits of IHC as an input to firms’ innovation activity.

The provision of R&D tax credits (with some amendments) 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. However, as evident in the earlier example of changes in health and safety in the workplace (Gray 2009), a direct support may be more effective at the initial stage.
6.6.1 Direct support for IHC – the proposed, *Innovative People for Growth*

To promote IHC with the ultimate aim of increasing innovation, the current research proposes a new policy offer in the Irish context entitled *Innovative People 4 Growth*, based on the findings from this thesis, that IHC contributes to innovation and that certain firm factors support this novel concept. *Innovative People 4 Growth* is in alignment with current Irish policy strategies that promote competitiveness, innovation and improved productivity in pursuit of job creation and economic growth (DJEI 2014).

Given the multi-dimensional nature of IHC, support is unlikely to arise from the traditional single-programme method, but rather from an offer of complementary programmes. The Lean Business Offer provided by Enterprise Ireland (refer to Table 6.3 and Appendix B for details) is a good example of such an offer, which aims to increase performance and competitiveness at both individual and firm level. The proposed offer uses a framework with some similarities to the Lean Business Offer, which recently received a positive evaluation. The evaluation reports that while the programme gave rise to immediate productivity improvements, it did not result in lost jobs. The report also highlighted that the three stages of the Lean Business Offer allowed firms to engage at the stage most relevant to their skills and experiences (DJEI forthcoming). This positive evaluation indicates that the design and structure of the offer is both efficient and effective; hence it provides a template worth adopting in designing the *Innovative People 4 Growth* offer, in order to save time and finances during both the design and the implementation stages.

Adopting a similar format to the afore-mentioned programmes (e.g., Lean Business Offer and Managements 4 Growth), promotes familiarity for users and policy makers and cost savings in relation to branding and design. Furthermore, the approach proposed here is in line with current government strategy to promote effective targeting and packaging of supports by sequencing/bundling programmes (DJEI 2014a).
Table 6.4 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
- Facilitate the inclusion of the concept of IHC in existing and future innovation support programmes.
Table 6.4 Overview of the proposed *Innovative People 4 Growth* offer

<table>
<thead>
<tr>
<th>Programme name</th>
<th>Activities</th>
<th>Objectives/intended Outcomes</th>
<th>Existing/new programme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. <em>Innovative People 4 Growth Start</em></td>
<td>Short in-firm consultancy</td>
<td>» A review to assess the level of existing IHC supports at firm-level&lt;sup&gt;1&lt;/sup&gt;</td>
<td>New programme</td>
</tr>
<tr>
<td>2. <em>Lean Start plus IHC</em></td>
<td>7 days input from expert consultant on the principles of LBO&lt;sup&gt;2&lt;/sup&gt;</td>
<td>» Reduce costs and refine process&lt;br&gt;» Introduce lean skills in the firm&lt;br&gt;» Introduce an IHC mindset among all personnel</td>
<td>Existing programme plus: introducing the IHC to management &amp; developing a strategy to supports for IHC&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>3. <em>Innovative People 4 Growth Change</em></td>
<td>Programme&lt;sup&gt;4&lt;/sup&gt; to introduce changes to firm’s organisational structures</td>
<td>» 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.&lt;br&gt;» Develop an innovative mindset and change in culture where innovation is everyone’s concern</td>
<td>New programme</td>
</tr>
<tr>
<td>4. <em>Innovative People 4 Growth Review</em></td>
<td>Short in-firm consultancy</td>
<td>» Review to assess the change/benefits of IHC and to identify possible future adjustments needed</td>
<td>New programme</td>
</tr>
</tbody>
</table>

<sup>1</sup>This review will be conducted by the public agency (e.g. Enterprise Ireland) appointed facilitator.

<sup>2</sup>*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 B.

<sup>3</sup>Including firms’ work practices and work arrangements.

<sup>4</sup>Programme will vary in size and scope depending on firm but will normally take six months to complete.
The new offer has potential to develop a resource available to the firm as an additional input to their innovation output (specifically, the capabilities and efficiencies of employees to drive innovation) without major financial investment. Ideally, firms would undertake the *Innovative People 4 Growth* offer in full (all 4 programmes) to ensure maximum benefit. To this end, the offer (illustrated in Table 6.4) is detailed as follows:

- The first programme, *Innovative People 4 Growth Start*, involves the firm undergoing a one-day consultation with the public agency (e.g., Enterprise Ireland) 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 three, *Innovative People 4 Growth Change*, 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. It is proposed that the public policy development agency (e.g. Enterprise Ireland) provide a grant to firms to contribute to the cost of implementing necessary changes (similar to that offered by 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. It is envisaged that the benefits from improving IHC would outweigh the costs of investment by firms in the form of improved innovation activity.

- Finally, programme four, *Innovative People 4 Growth Review*, offers a review to monitor current developments and outline plans for continued promotion of IHC, with the ultimate aim of increasing innovation.
As alluded to earlier, 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. 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. As a result of the economy-wide availability of the offer, 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.

As outlined from the very outset, the goal in proposing the new IHC policy offer is not to suggest wholesale emulation of what is proposed here. Much more modest and realistic hopes are in order. The concern here is to highlight to policy makers and academics alike the potential benefits that can flow to individuals, firms, and the general enterprise and innovation ecosystem when focus is placed on IHC and measures that promote and support it. More debate is certainly warranted regarding these issues, and it is hoped that the current research stimulates and makes a meaningful contribution to such a debate. In fostering a translational element (real practice/policy impact) to the research, presentations were made to both Irish\(^{71}\) and European\(^{72}\) policy makers in 2014 regarding the proposed *Innovative People 4 Growth* policy offer; these presentations garnered overall positive judgments from the audiences (this issue is expanded upon in Section 6.7 and Chapter 7).

The *Innovative People 4 Growth* offer, like any new policy intervention best practice, requires evaluation. Such an evaluative approach will be necessary

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not only to ensure value for money and accountability, but also to ensure policy improvements in the future (Lenihan 2011). It is to this topic that the next section turns.

6.7 Evaluating Innovative People 4 Growth

Having proposed the new offer to support and develop IHC, it is necessary to be aware that no programme or policy is perfect; there is always room for improvement (Smart Innovation 2006). The shortage of funding, and the public desire for transparency and value for money in the current economic climate, has led to an increased spotlight on the evaluation of publicly funded schemes (Lenihan 2011; Sridharan and Nakaima 2011). The purpose of evaluation is to provide a basis for judging the merit of public policy or interventions, whether such evaluation tests the validity of key assumptions for specific programmes (Hart et al 2008), the extent of behavioural additionality (Bakhshi et al 2011), or the effect of a programme (Cornet et al 2006). Such assessment improves government efficiency, learning, accountability, and effectiveness (Sridharan and Nakaima 2011; Smart Innovation 2006). Programmes should also take into account the knowledge acquired by all stakeholders involved in the programme, and the behaviour of these stakeholders in relation to the impact of the intervention (Smart Innovation 2006). These motivations for evaluation equally apply to any programme or policy offer that promotes IHC in order to drive innovation activity in firms.

Though evaluation may be costly in terms of finance and time, a worthwhile evaluation should establish “what works best under what set of circumstances” (Lenihan 2011, p. 325). As suggested by Lynch et al. (2009), the evaluation of any future programme allows governments to find out what happens (or does not happen) in the absence of the programme.

There is no ‘one size fits all’ framework or method of evaluation. A ‘tailored fit’, though usually desirable may be impractical for reasons of
financial and time constraints (Smart Innovation 2006). In evaluating the Prince’s Trust\textsuperscript{73}, Greene (2009) for example, found that “simple monitoring approaches produced different results from those of more sophisticated evaluations” and that the use of simple monitoring over sophisticated evaluations depends on the objective of the funders. Monitoring exercises serve funders if they are concerned with the consistency and performance of the programme; if the aim is to consider a wider economic impact (e.g. job creation), more sophisticated evaluations are needed (Greene 2009).

In advocating the merits of evaluating programmes, the development of a logic model is “fundamental to program evaluation and a core skill required by evaluators” (2002, p. 494). A Logic Model goes beyond a simple monitoring exercise, it is a graphic display or map (Kaplan and Garrett 2005), that, provides policy makers with a credible model of how a programme will work under certain situations, and presents a “convincing story of the program’s expected performance” (McLaughlin and Jordan 1999, p. 65). It is “a tool to guide programme design” (Fielden \textit{et al} 2007, p. 8). Such an \textit{ex-ante} evaluation approach makes it possible to design and implement the optimal programme before it is fully available (Todd and Wolpin 2008). Furthermore, McLaughlin and Jordan (1999) suggest that using a logic model:

- Establishes a common understanding of the programme and expectations;
- Is helpful for programme design or improvement;
- Communicates the place of a programme in the firm;
- Points to a balanced set of key performance measures.

Lenihan’s (2011) logic model framework assists policy makers by clarifying the chains of cause and effect between the inputs, outputs, problems and impacts on programme. Evaluation should be undertaken not only when

\textsuperscript{73} Set up in 1976 in the UK to support youth enterprises (Greene 2009).
designing policy programmes, but also before the implementation of a new programme at multiple levels; policy evaluation is not purely an accountability/value for money exercise, but is overall a way to improve future programmes (Lenihan and Hart 2004).

When programme evaluation follows best practice, evaluation should provide an opportunity to learn lessons and provide valuable insights into the value of programmes being evaluated (Smart Innovation 2006). To this end the current research adapts Lenihan’s (2011, p. 329) logic model (Figure 6.5) so as to provide in the first instance an ex-ante framework to policy makers should they decide to introduce (even on a pilot basis) the Innovative People 4 Growth policy offer. The same logic model could also be used in tandem with other methodologies to measure ex-post the impact of the policy intervention.

The logic model for the proposed Innovative People 4 Growth policy offer has four inputs or resources needed to implement Innovative People 4 Growth: time; personnel (employee-managers and other individuals engaged by the firm); the commitment of top-level management/owners; and public and private funding. The commitment of all stakeholders is important, especially when issues arise as a result of changes in firms’ priorities (Smart Innovation 2006). The activities indicate internal factors of interest: audits and benchmarks, work arrangements and practices, and communication. The outcomes (short and medium term) include a change in mindset, increased knowledge, and possible adverse effects of the offer. The risk of sharing information about new ideas is an issue for certain types of innovation. If managed efficiently, unproductive time-wasting by non-technical individuals should not prove a major issue affecting a firm’s innovation strategy. The longer-term outcomes or ‘solutions’ of the offer include societal benefits in the form of an innovation-focused workforce ultimately leading to a competitive economy.

Given that this research advocates an ex-ante evaluation of Innovative People 4 Growth, an interim and ex-post evaluation is also recommended if a full roll-out of the offer occurs. It is beyond the scope of the current study
to provide any further commentary regarding likely interim or \textit{ex-post} evaluations of the \textit{Innovative People 4 Growth} policy offer. However, should policy makers decide to go down the route of introducing such an offer, then there is certainly need for detailed engagement between the relevant stakeholders (e.g. researchers, firms and policy makers) and these issues so as to ensure that any evaluations follow best-practice available evaluation methodologies. As alluded to in Section 6.6.1, following feedback arising from a presentation to a Forfás Steering Committee on May 2014 of the proposed offer, it would appear that there is a high level of interest among policy makers in exploring its possible introduction or at the very least engaging in further discussions with the researchers regarding the role that public policy can play in terms of promoting and supporting IHC. Discussions with the relevant policy makers and the researchers are currently on going.
Figure 6.4 Innovative People 4 Growth Logic model (Chain of cause and effect)
6.8 Discussion and conclusion

This chapter is predicated on the findings outlined in previous chapters: specifically, that IHC is a valuable determinant of firms’ innovation activity and that, firms’ work practices and arrangements are key to the support of this valuable resource. Therefore, as an input to firms’ innovation activity, innovation policy is the focus of potential government support for the holistic IHC concept.

As well as asking whether there is a role for public support for IHC, this chapter poses two related questions: first, how useful are existing policy programmes in unleashing the potential of IHC; and secondly, what kinds of programme changes are necessary to promote IHC in the future?

The results from the research suggest a potential role for innovation policy vis-à-vis direct and indirect interventions to support IHC. Training and the increased number of graduates with a third-level degree or higher (particularly in Europe) are important, and represent a good starting point (European Commission 2011); however, these represent only one dimension of an individual’s capacity to drive innovation. While policy makers tend to focus on supports for education and training, there is a lack of evidence that the more intangible elements receive support (Izsak and Griniece 2012). The current research concurs with Lenihan (2004) that there is no need for a total overhaul of current support programmes; rather, policy should recognise the value of IHC and the importance of firms’ work practices and work arrangements in sustaining this valuable resource. In addition, government must “learn to be experimental and adaptive too, just like the firms and other organizations whose innovative efforts they seek to jointly stimulate” (Metcalfe 2005, p. 72) Metcalfe, though acknowledging the requirement for public investment in R&D to underpin innovation, argues that it is insufficient and requires “complementary investments in skills, productive capacity and markets are also required” (p. 48).
The review of relevant innovation-focused policies (presented in this chapter) makes clear that the individual person remains vital for innovation. Ireland’s *Action Plan for Jobs* (DJEI 2012; 2013; 2014) endorses previous calls made for improved human capital through increased skills (Forfás 2010); this indicates that a change could be introduced by policy makers to recognise human capital through the multi-dimensional lens of IHC. Acknowledgement of the intangible and an innovative mindset within human capital is evident in recent policy strategies of the UK and Singapore, though it is not yet evident in policy programmes. When it comes to human capital, current programmes tend to recognise only tangible, measurable and standard elements (education and training); this ties into the notion that while the literature and policy documents have begun to move towards acknowledging the intangible aspects of the individual person, current policy programmes have not yet reflected this shift. The current research reinforces the need for change at the programmatic level and proposes such an offer of programmes.

Much like ‘Health and Safety’ in the workplace (Gray 2000), developing IHC and innovation should become a concern for everyone in the firm. Public policy has a potentially strong role to play in enabling IHC to flourish, with the ultimate aim of increasing firms’ innovation activity. In justifying public support for IHC, the current research finds that market and systemic failures may exist; hence suggesting a role for government. However, given the benefits of IHC for firms, it is suggested that a combined investment by firms and government may be required with respect to the proposed *Innovative People 4 Growth* offer. This offer is a suite of four programmes based broadly on the structure of the Lean Business Offer, which recently received a positive interim evaluation (DJEI *forthcoming*), thus suggesting that the design and structure adopted is efficient and effective. If Irish policy makers decide to go down the route of the new *Innovative People 4 Growth* offer, then it should be tested (introduced) on a pilot basis, and a rigorous *ex-ante* evaluation process should be put in place. To this end, this research adapts Lenihan’s (2011) *ex-ante* logic model to support evaluation of the new offer. Once robust
evaluations have been undertaken, policy makers can decide whether or not to have a full-roll out (or a modified version) of the offer based on the available evidence. It is also recommended that the offer be further evaluated mid-term (interim) and at its end (ex-post).

In sum, in addition to the contributions of the previous chapters, this chapter adds to knowledge by proposing a new public policy offer of programmes in support of the novel IHC concept as a determinant of innovation. In addition, it crafts a logic model in order to evaluate ex-ante the new offer so as to assess whether the offer is effective and efficient. The next chapter summaries the findings from the entire study and highlights the contribution to existing knowledge about innovation, human capital and innovation policy. In addition, the chapter clarifies the limitations of the research and proposes topics for future research.
7 Conclusion

7.1 Introduction

This chapter presents a summary of the theoretical and empirical research undertaken in this thesis. In addition, it reflects on the contributions of the research to the knowledge base from a theoretical, empirical, methodological and policy perspective. Finally, the chapter reviews the limitations of the research and outlines suggestions for future research.

The main objective of this study was to examine human capital as a determinant of firm-level innovation. A boundary-spanning approach to the literature, drawing from evolutionary theory and theory of the firm, revealed an important link between innovation and human capital, but highlighted the lack of focus on a multi-dimensional measure of human capital (measuring the tangible and intangible elements) as a determinant of firm-level innovation. To address this gap the research created and developed a new concept, named here as Innovative Human Capital (IHC), and estimated its effect on the innovation activity of firms located in Ireland during the period 2007-2008.

The initial motivation for the research originates from the recognition, that increasing levels of educational attainment may decrease the competitive advantage garnered by firms employing highly educated people. Together with the strong emphasis in the literature regarding the importance of innovation for firm growth as well as the central role played by people in creating and commercialising new ideas (innovation), this recognition ignited the desire to use a holistic lens to investigate human capital as a determinant of innovation.

Firms’ employee-managers were the focus of the research; managers are considered key to innovation as they screen ideas, support the firm’s
innovation culture and communications. This research, to the best of the author’s knowledge, is the first to create and develop the holistic concept of Innovative Human Capital as a determinant of innovation. This novel concept makes an important contribution in addressing the limitation of the uni-dimensional measure (the tangible measure of education and training) used previously, as highlighted by the literature. The development of such a holistic concept also contributes to the debate on the determinants of firm-level innovation. Furthermore, the research provides firms and policy makers with potentially valuable holistic insights into the contributions of employee-managers to firms’ innovation activity. This prompted three key research questions to emerge:

1. Does Innovative Human Capital contribute to firm-level innovation?
2. What factors support Innovative Human Capital?
3. What are the implications of Innovative Human Capital for public policy?

Based on the theoretical and empirical evidence presented in the research, 16 hypotheses were formulated and presented in Chapters 4 and 5 and summarised in Table 7.1. The first eight relate to the creation of IHC while the other eight are related to the factors that support the new concept.

In order to answer the three research questions and test the corresponding 16 research hypotheses, econometric analysis using a new dataset was undertaken. This new dataset was created by merging information from four sources; the information on the firm and employee-manager was provided by a survey carried out by National Centre for Partnership and Performance (NCPP) in 2009. Regional data was obtained from three sources: the CSO’s 2006 census data, the Irish Innovation Panel data and the GEM 2008 Country report. Using a common identifier to merge the data, the dataset provided the research with rich multi-level information on 1070 firms located in Ireland.

To summarise the findings from the analysis and provide insights into the novel IHC concept, this chapter brings together the main findings (in Section 7.2), and discusses the contributions of the research from the
theoretical, methodological, empirical and policy perspectives (Section 7.3). Section 7.4 details the limitations of the research, while suggestions for future research are discussed in Section 7.5. Section 7.6 provides a final conclusion.

7.2 **Summary and discussions of the main findings**

Based on the theoretical review provided in Chapter 2, there is clear evidence that innovation is a crucial activity for firms’ growth and survival. Innovation theory can be examined with reference to neoclassical and evolutionary theories of growth. The neoclassical approach is based on the allocation of resources and analyses the economy based on mathematical models (Audretsch and Link 2012). This approach to innovation relies on a linear model of technical and scientific invention followed by production and marketing (Kline and Rosenberg 1986). Such a linear, well-defined set of stages was challenged by Romer (1986) and Grossman and Helpman (1991); their development of the theory of innovation highlight the complex combination of stages and the need for feedback from various stages of the innovation process. The evolutionary theory of growth, on the other hand, was developed from Nelson and Winter’s (1982) work; it describes innovation as complex, and as comprising changes in routine. Such changes within firms can be explained by the skills of the individuals in the organisation, as well as the capabilities and behaviours of the organisation itself.

Building upon theories of innovation including Schumpeter (1934), and based broadly on contemporary literature (e.g. Love *et al* 2010; Lundvall 2007) and research by groups such as OECD (2013) and EU (2014), this research defines innovation as the commercialisation of new or significantly improved ideas, which include products, services or processes. In order to explore further why and how firms innovate, the resource-based view (RBV) of the firm and the closely related knowledge-based theory are reviewed. These approaches have evolved since the 1980s and focus on
internal sources of competitive advantage (Foss et al 1995). Grant (1996) emphasises knowledge and the individual as the primary agents in knowledge creation, and stresses that the repository of this knowledge is central in the pursuit of competitive advantage for firms.

With this in mind, and having outlined various determinants of firm innovation, Chapter 3 reviews the literature related to human capital, where it is argued that the ability to innovate depends greatly on the contribution of human capital (Grossman and Helpman 1994), and that investment in human capital improves the performance of the firm’s employees (Bosman et al 2004). Mincer (1958; 1962), Schultz (1961) and Becker (1964) first developed the concept of human capital as an important input to production and to firms’ innovation activity. More specifically, the role of managers in innovation activities is important and stems from the position they hold within the firm where they make decisions, assign resources, prioritise projects/activities, control budgets as well as filter ideas (Leiva et al 2011; Hermann et al 2006; Storey and Salaman 2005). To this end, the managerial cohort of employees is the key group analysed by the current research.

The theoretical review revealed that the multifaceted and random nature of innovation has led to a lack of consensus on a single model to understand innovation (Audretsch and Link 2012). What is agreed, however, is that the application of knowledge and human capital play central roles in the innovation process (Slaper et al 2011; Ganotakis 2012). Recent literature highlights the importance of learning to think creatively, and developing flexibility and openness in the workforce (e.g. Schneider et al 2010; Qian 2010; Hofheinz 2009; Chen and Kaufmann 2008). However, human capital for the most part continues to be measured using a uni-dimensional approach; the tangible education and training.

To complement this emerging debate on human capital and to overcome the limitations of previously-used measurements, this research extends the measure of human capital to incorporate a holistic approach by building on the long standing and well-studied tangible elements and adding the new
intangible elements of willingness to change in the workplace and job satisfaction. In developing the unique and far-reaching concept of IHC, the analysis estimates its effect on firms’ innovation. Chapter 4 undertakes the first two stages of the empirical analysis to estimate the first eight research hypotheses. This chapter also describes the new dataset created and employed by the study; this unique multi-level dataset from four sources listed earlier, involved several robustness tests, including reliability tests (Cronbach’s alpha) and factor analysis as well as the creation of a Blau index (1977) of diversity.

Using multiple logit regressions, the econometric analysis suggests that IHC may be more valuable to small firms, especially in the case of training, job satisfaction (specifically the soft measure), and willingness to change (hard and soft measures). The analysis finds that small firms whose employee-managers possess the elements of IHC are more likely to engage in service, product and/or process innovation. In the case of larger-sized firms (more than 50 employees), employee-managers’ IHC is important for process innovations such as developing new ideas or changing behaviours in the workplace, which lead to significant improvements in the way the firm’s work is carried out.

To further understand the new IHC concept, Chapter 5 presents the results of additional econometric analysis on the effect of regional and firm-level factors on IHC (Stage 3 of the analysis). Again using the new merged dataset, multiple logit regressions were employed to test a further eight hypotheses. Overall, the estimations show the statistically significant effects of internal factors on the four elements of IHC, as well as the limited statistical significance of the effects of external factors on firms’ IHC. Building on the knowledge–based view of the firm, where the firm as an institution coordinates and protects knowledge (von Krogh and Wallin 2011), the current research supports the notion that knowledge inherent in IHC is supported by a variety of organisational structures within the firm, such as work arrangements and work practices. For example, regular performance reviews/appraisals, as well as alternative forms of pay and conditions offered by firms, are positive factors in the majority of the
estimations; this highlights conditions that can support IHC as a valuable resource. Diversity of nationality within the local labour market appears significant as a support for job satisfaction; its limited significance may be related to the level of diversity in Ireland and the overall homogeneity across regions.

From a policy perspective, the current research provides important policy insights regarding the development and support of IHC as a driver of firms’ innovation activity. In addressing the third research question, Chapter 6 investigates the usefulness of existing policy programmes in unleashing the potential of IHC, and asks what kinds of policy programmes are needed to support and develop IHC. The chapter finds strong support for innovation in the public policy landscape of Ireland, as well as in the European Union and other developed economies reviewed. In general, this support is in the form of R&D and innovation grants, and tax breaks. With respect to support for human capital, funding is provided for formal education and training (tangibles); however, there is limited recognition of the value of the intangible side of human capital.

In line with current Irish policy strategies to promote competitiveness, innovation and improved productivity in pursuit of job creation and economic growth, the current research proposes a new policy offer (Innovative People 4 Growth) which aims to:

- Introduce the novel concept of IHC as a competitive advantage for firms;
- Foster a firm environment where IHC is recognised, supported and developed;
- Enable future policy programmes to recognise the value of IHC in terms of the tangible as well as the intangible elements.

While there is no perfect programme or policy, there is always an opportunity for improvement (Smart Innovation 2006). To this end, and in acknowledgement of the public desire for transparency and value for money
(Lenihan 2011; Sridharan and Nakaima 2011), the current research adapts Lenihan’s (2011) logic model as a tool to evaluate ex-ante the proposed *Innovative People 4 Growth* offer. The model evaluates the cause-and-effect chain of inputs, activities and outcomes over the short, medium and longer term. It is proposed that the new offer if introduced by policy makers be piloted using the logic model as an ex-ante evaluation tool to ensure that issues are highlighted and necessary changes are made before exploring the possibility of extending the new offer to all firms.

### 7.3 Contributions of the current research

The current research contributes to the study of the determinants of firm-level innovation (specifically in respect of the contribution of employee-managers) from both academic and policy making perspective. This section examines each of these contributions in turn.

Firstly, from a theoretical perspective, the research adds to innovation theory by introducing and developing a holistic concept of IHC as a competitive resource for firms and a driver of innovation. This novel IHC concept builds on the traditional and tangible measures of human capital, and complements them with two new intangible elements of the individual. This is important, as individuals’ education levels may become less valuable as a competitive advantage in the future; the proportion of people with higher education levels continues to increase, particularly across developed economies (CSO 2012; OECD 2014). The idea of extending the measure human capital is beginning to appear in the literature (e.g. Fitjar *et al* 2013; Ganotakis 2012; Gimmon and Levie 2010; Robson *et al* 2012; Soboleva 2012).

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74 A presentation was made to a Forfás (formally Ireland’s policy advisory board for enterprise trade, science, technology and innovation, now integrated with the Department of Jobs, Enterprise and Innovation) steering committee on the 16th May 2014: Lenihan, H. and McGuirk, H. ‘Innovative Human Capital as a driver of firm level innovation: the role and challenges for policy’. The presentation received a positive response to the proposed policy offer. At the time of writing, discussions are on going with policy makers from the relevant development agencies regarding exploring the possible introduction of the *Innovative People 4 Growth* policy offer.
the results from the current research provide additional insights and move this debate forward. Likewise, in developing the new concept, identifying the significance of internal and external supporting factors for IHC is of importance, both for firms themselves and for potential public policy interventions.

Secondly, from a methodological perspective, the research creates a unique merged dataset. The new dataset provides information on 1070 individual managers employed by firms operating in Ireland, as well as regional information including levels of local workforce diversity, R&D, and entrepreneurship activity. This dataset is a useful resource for further study in various areas at multiple levels of the economy: for example, a study of employees’ education attainment at a regional levels, a sectoral level study of diversity in the workplace or the examination of the effect of regional educational attainment on entrepreneurial activity could all benefit from the use of this new dataset.

A focus on three types of innovation, (product, process, and service) innovation in the Irish context is rare and provides insights into whether various types of innovation demand different levels of IHC. The research makes an additional methodological contribution in that, while Ireland is the location for the current research, the methodological approach applied and analysed has widespread application regardless of country context.

The third major contribution of this research is of a policy nature. As reflected in the literature, the value of human capital for firms’ innovation is seldom measured other than by using education and training. Measuring the value of human capital beyond education and training is equally limited when it comes to public policy. The proposed new policy offer, Innovative People 4 Growth, is designed to allow firms to participate, in all four programmes (the ideal) or to choose single programmes in support of IHC. Additionally, the Logic Model provides policy makers with a valuable tool to evaluate IHC from an ex-ante perspective.

As outlined in Chapter 6, UK and Singapore policy strategies offer some recognition of the merits of intangible elements of the individual, but as yet no programme offers support for such elements.
The final contribution of the current research is from the firm’s perspective. The empirical analysis has implications for firms striving to improve their level of innovation activity; those who support IHC can develop a valuable resource, and create a competitive advantage. Participation in the proposed Innovative People 4 Growth offer represents a good start for firms to become ‘IHC aware’.

While this section outlines the contribution of this thesis to the knowledge base, there are a number of limitations to the research which require attention; it is to these issues that the next section turns.

7.4 Limitations

While the design of the current research is based on solid theoretical underpinnings and robust econometric analysis, it is not without limitations; these limitations are outlined in this section.

The first limitation relates to the new merged dataset. While using such data provides the researcher with a large number of usable observations at multiple levels, there are limitations to the set of variables at the researcher’s disposal. These limitations (at the level of the firm) include not least the absence of:

- A firm identifier and a more specific description of firm sector;
- Multiple responses from each firm;
- Information on R&D;
- An indication of the firm’s age;
- Details on firm ownership.

With respect to the regional information in the new dataset, the absence of a more accurate measure of R&D is a limitation. Equally, an aggregate regional level of analysis may reveal more specific spatial differences at

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76 Such analysis would develop the IHC concept further and examine the contribution of all employees’ IHC for innovation.
lower levels than that of the eight NUTS3 regions currently used (information at the Irish county level for example, may be useful 77).

Limitations also exist in relation to the creation of the new IHC concept. The available data necessitated the use of a binary measure for education and training. There is much in the literature on specific versus general training (Becker 1993) and types of educational qualification (e.g. Arts degree, Science, ICT); the use of a more in-depth measure would provide further understanding of IHC.

The capacity to estimate changes over time is a limitation regarding innovation research. Previous studies reveal that the impact of innovation has a lagged effect (Mansfield 1991; 1998); thus a longitudinal study would help to further understand the relationship between innovation and IHC, however, due to data availability this was not possible in this study.

Finally, the analysis is based on a sample of managers employed by firms located in Ireland and cannot claim to be fully representative of all managers, not to mention all employees.

Notwithstanding the limitations presented above, the creation and subsequent analysis of the novel and holistic IHC concept has contributed to the current debate in the literature regarding innovation inputs. The analysis also constitutes a strong starting point for policy makers, employers and employee-managers to recognise and support IHC as a valuable determinant of innovation. These points give rise to a number of suggestions for further research as discussed below.

7.5 Suggestions for future research

Given the findings of the research and their contributions to knowledge, and keeping in mind the limitations listed above, this section highlights a number of opportunities for future research.

77 There are 26 counties in Ireland.
While Ireland is the setting for this research, the framework could potentially be applied in other countries using similar information contained in the NCPP workplace survey (the source of information on employee-managers and firm data in the new merged dataset). Such surveys have been conducted in the UK (WERS 2014) and Canada (NRCC 2013), and in Australia’s proposed Workplace Relations Study (FWC 2014). The Australian survey, for example, includes questions on employees’ engagement practices, as well as communications and flexibility arrangements in the workplace (FWC 2014). The UK’s Workplace Employment Relations Survey provides information on firms’ family-friendly policies and management practices (WERS 2014). Applying the methodological framework of this study to other economies would allow for comparative studies.

Based on the suggestion above and the possible availability of time series data in the future, a longitudinal study of the effect of IHC over time would further advance the understanding of the concept, and would help to inform employers and public policy makers as to its further potential. Coupled with this, estimating the effect of all employees’ IHC on innovation would provide addition insights into the study of IHC. Such a study, as alluded to in the previous section, is not possible here due to the non-availability of such data.

Additionally, while controlling for certain firm specific factors (e.g. sector and work practices) the non-availability of information on firms’ ownership, age and work teams leaves a number of unexplored questions including: How does firm ownership and sector affect IHC as an input to innovation? Does teams’ collective IHC affect various types of innovation differently? The use of an extended dataset similar to the ones listed earlier may provide such information and offers a topic for future research.

A comprehensive evaluation of the proposed Innovative People 4 Growth offer would provide evidence-based insights into the value of the new offer.

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78 The Australian study is currently at the data collection stage.
Conducting *ex-ante*, interim and *ex-post* evaluations (the latter would be relevant should the offer be employed by policy makers) follows best practice policy making, and allows an opportunity to ‘fine tune’ the proposed new offer.

### 7.6 Conclusion

In concluding this research, this chapter reflected on the key objectives and the corresponding research questions and highlighted the research findings and contributions to knowledge.

From the extensive review of the innovation related literature the research identified a dearth of evidence regarding a holistic approach to measuring human capital as a determinant of firms’ innovation activity. This gap led to the creation and development of a multi-dimensional concept of IHC as a valuable input for innovation. Employing a new merged dataset provided the research with multi-level information on 1070 firms located in Ireland. The results of the econometric analyses confirm that the effect of the novel IHC concept, along with other determinants analysed, contributes to firms’ innovation activity, and that firms’ work practices and arrangements support IHC as a valuable resource. To this end, a new policy offer was proposed (as well as an evaluation tool); this offer supports the idea that human capital is a multi-dimensional concept, where the traditional tangible elements of education and training, and the more innovative intangible elements such as the employee-managers’ willingness to change in the workplace and their job satisfaction contributes to firm-level innovation. Thus, the encouragement and support of IHC creates a competitive advantage for firms’ innovation activities.
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Appendices
**Appendix A:** Summary of current policy and programmes available to firms in UK, Singapore, Australia and Canada, the level of impact and focus of the programme.

<table>
<thead>
<tr>
<th>Programme name</th>
<th>Impact at level of</th>
<th>Focus of the policy &amp; programme</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UK</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business Mentoring</td>
<td>Individual</td>
<td>Develop and grow small firms</td>
</tr>
<tr>
<td>Business Innovation</td>
<td>Firm</td>
<td>Improving competitiveness and driving success through innovation,</td>
</tr>
<tr>
<td>Collaborating for Success</td>
<td>Firm and HEIs</td>
<td>Collaboration for innovation</td>
</tr>
<tr>
<td><strong>Singapore</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SMART(^1) Innovation Grant programmes</td>
<td>Individual and HEI researchers</td>
<td>Programmes include Explorer grants, ‘Catalyst Program’ (nurture and mentor entrepreneurs) and Educational programmes</td>
</tr>
<tr>
<td>Productivity and Innovation credit (2013-2015)</td>
<td>Firms</td>
<td>Tax deductions/allowances and pay-outs for investment in innovation and productivity improvements</td>
</tr>
<tr>
<td><strong>Australia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Innovation Development Scheme</td>
<td>Firms HEIs</td>
<td>Programmes include “Innovation Vouchers”, “Industry Facilitation and Support Program”, ‘Innovation Promotion Program’</td>
</tr>
<tr>
<td><strong>Canada</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Build in Canada Innovation Program (BCIP)</td>
<td>Firm</td>
<td>Helps companies bridge the pre-commercialization gap by procuring and testing late stage innovative goods and services within the federal government before taking them to market</td>
</tr>
<tr>
<td>Financial Assistance</td>
<td>Firm</td>
<td>Provides financial support to qualified small and medium-sized enterprises in Canada to help them undertake technology innovation.</td>
</tr>
</tbody>
</table>

\(^1\) SMART - Singapore MIT Alliance for Research and Technology (SMART 2013)

Appendix B: Details of programmes available to firms in Ireland

<table>
<thead>
<tr>
<th>Programme name</th>
<th>Description of the programme</th>
<th>Funding/cost</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>R&amp;D and innovation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology centres –</td>
<td>Industry-led research in emerging technology sectors</td>
<td>A successful centre would operate with State funding of the order of €1M per year over a five year period.</td>
</tr>
<tr>
<td>Technology gateway Programme –</td>
<td>Nation-wide network of industry focused gateways delivering technology solutions for industry through collaborative industrial projects</td>
<td>The programme represents an €23.0M investment by Enterprise Ireland over the 5 years from January 2013 to December 2017.</td>
</tr>
<tr>
<td>Innovation partnerships –</td>
<td>For collaborative projects between companies and research teams in Higher Education Institutions</td>
<td>up to €25,000 available</td>
</tr>
<tr>
<td><strong>R&amp;D Funding –</strong></td>
<td>Grants for in-house R&amp;D projects, small and standard, and collaboration bonuses for company-to-company collaboration</td>
<td></td>
</tr>
<tr>
<td>Technical feasibility grants –</td>
<td>Grant support for undertaking a technical feasibility project into product, technology or process developments or to support cost of preparing a project proposal for FP7</td>
<td>Maximum 50% of eligible expenditures to a maximum grant of up to €35,000</td>
</tr>
<tr>
<td>Innovation Vouchers -</td>
<td>For small companies to get innovative solutions to technical and business challenges</td>
<td>€5,000 (Companies may make use of a maximum of three vouchers)</td>
</tr>
<tr>
<td><strong>Collaborate on R&amp;D</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pooled Innovation Vouchers</td>
<td>Allows up to ten small companies to put their €5,000 innovation vouchers together to explore a common research project</td>
<td>€5,000 x 10 vouchers</td>
</tr>
<tr>
<td>Enterprise Ireland R&amp;D Fund:</td>
<td>A collaboration bonus where there is collaboration between two companies on an R&amp;D project.</td>
<td>Bonus of up to 15%</td>
</tr>
<tr>
<td>Access strategic advice and expertise –</td>
<td>EI can provide advice, specialist expertise and connections to develop and implement company’s development plan.</td>
<td></td>
</tr>
<tr>
<td>Productivity - Company Health Check - Benchmarking Company Competitiveness – Measure of a business’ ability to survive in the market place</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Best Practice Study Visits</strong></td>
<td>Designed to show Irish companies examples of world-class operations implementing Lean best practices and provide solid and practical examples that they can apply to their own business in Ireland.</td>
<td></td>
</tr>
<tr>
<td><strong>Lean Business Offer</strong></td>
<td>Offer is designed to encourage clients to adopt <em>Lean</em> business principles in their organisation to increase performance and competitiveness.</td>
<td></td>
</tr>
<tr>
<td>LeanStart</td>
<td>LeanStart - provides an introduction to Lean concepts and allows you to gain an understanding of what the tools and techniques can do for your company in a short, focused engagement. Companies 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 company must pay the first €1,300 and Enterprise Ireland will provide grant funding for the outstanding costs to a maximum of €5,000.</td>
<td></td>
</tr>
<tr>
<td>LeanPlus</td>
<td>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 company, 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.</td>
<td></td>
</tr>
<tr>
<td>LeanTransform</td>
<td>LeanTransform is a large scale, extensive and holistic company transformation programme delivered by an external consultancy team of international reputation. LeanTransform projects should; deliver company-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.</td>
<td></td>
</tr>
<tr>
<td>Leadership and management development</td>
<td>Customised management development programmes;</td>
<td></td>
</tr>
<tr>
<td>Management 4 Growth</td>
<td>Develop a cohort of world-class, highly competent and confident management teams who can, through the development of the productivity, innovation and competitiveness of their firm grow their businesses. Total programme cost €20k for CEO+1 Manager (subsidised fee payable by company circa €10k)</td>
<td></td>
</tr>
</tbody>
</table>
For SME management teams further develop their strategy, operations and people management practices to drive sales and export growth.

**Strategic Leadership 4 Chief Financial Officers (SL4CFO)**

The Strategic Leadership 4 Chief Financial Officers is aimed at developing a cohort of world-class strategic CFOs with the financial leadership and strategic insight to drive growth in their organisations.

Enterprise Ireland will fund 50-70% of the programme participation depending on the size of the company.

**Leadership 4 Growth Programme**

Combines world-class faculty, exposure to and engagement with highly successful entrepreneurs, a unique coaching and mentoring approach and practical strategy execution support that will provide inspiration, knowledge and skills tailored to the specific business.

Enterprise Ireland will fund 50-70% of the programme participation depending on the size of the company.

**Overview of Enterprise Ireland Key Manager Support**

The aim of this initiative is to provide partial funding towards the cost of recruiting a Key Manager with skills that are critical to the future growth of the client.

1 year's Salary costs up to a maximum salary of €80,000.

**Overview of the Strategic Consultancy Grant**

The SME Strategic Consultancy grant can support the cost of hiring Strategic Consultants to assist in the development and/or implementation of strategic initiatives in the SME.

Up to 50% of the costs incurred in hiring a consultant to a maximum grant amount of €35,000.

**Enterprise Ireland Mentor Network The Enterprise Ireland**

Mentor Network was established to help companies identify and overcome obstacles to growth. Mentors in our network can provide tailored advice, guidance and support, to help you accelerate growth and build management capability.

Grant support toward costs of mentor for up to 10 sessions; maximum eligible cost of €175 per visit (total €1,750).

**Source:** Enterprise Ireland (2014)
Appendix C: Representativeness of the new merged dataset compared to the original NCPP (2009) dataset.

<table>
<thead>
<tr>
<th>REGIONS</th>
<th>NEW MERGED DATASET</th>
<th>ORIGINAL NCPP DATA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PERCENT</td>
<td>CUMULATIVE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PERCENT</td>
</tr>
<tr>
<td>BORDER</td>
<td>9.3</td>
<td>9.3</td>
</tr>
<tr>
<td>DUBLIN</td>
<td>37.7</td>
<td>47.1</td>
</tr>
<tr>
<td>MID-EAST</td>
<td>10.3</td>
<td>57.4</td>
</tr>
<tr>
<td>MIDLANDS</td>
<td>4.4</td>
<td>61.8</td>
</tr>
<tr>
<td>MID-WEST (INCL TIPP. N&amp;S)</td>
<td>10.0</td>
<td>71.9</td>
</tr>
<tr>
<td>SOUTH-EAST (MINUS TIPP. S)</td>
<td>6.6</td>
<td>78.5</td>
</tr>
<tr>
<td>SOUTH-WEST</td>
<td>14.4</td>
<td>92.9</td>
</tr>
<tr>
<td>WEST</td>
<td>7.1</td>
<td>100.0</td>
</tr>
<tr>
<td>MISSING/UNKNOWN</td>
<td>.1</td>
<td>.1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Appendix D: Summary of the sixteen research hypotheses related to the creation and development of IHC (formulated in Chapters 4 and 5)

Eight hypotheses related to the creation of IHC

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1a:</td>
<td>Small firms employing managers who have attained a third-level education or high are more likely to innovate.</td>
</tr>
<tr>
<td>H1aa:</td>
<td>Larger-sized firms employing managers who have attained a third-level education or higher are more likely to innovate.</td>
</tr>
<tr>
<td>H1b:</td>
<td>Small firms employing managers who participate in training are more likely to innovate.</td>
</tr>
<tr>
<td>H1bb:</td>
<td>Larger-sized firms employing managers who participate in training are more likely to innovate.</td>
</tr>
<tr>
<td>H1c:</td>
<td>Small firms employing managers who are satisfied in their jobs are more likely to innovate.</td>
</tr>
<tr>
<td>H1cc:</td>
<td>Larger-sized firms employing managers who are satisfied in their jobs are more likely to innovate.</td>
</tr>
<tr>
<td>H1d:</td>
<td>Small firms employing managers who are willing to change are more likely to innovate.</td>
</tr>
<tr>
<td>H1dd:</td>
<td>Larger-sized firms employing managers who are willing to change are more likely to innovate.</td>
</tr>
</tbody>
</table>

Eight hypotheses related to the factors that support the novel IHC

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2a:</td>
<td>Employee-managers with IHC are more likely to be found in small firms with work arrangements.</td>
</tr>
<tr>
<td>H2b:</td>
<td>Employee-managers with IHC are more likely to be found in larger-sized firms with work arrangements.</td>
</tr>
<tr>
<td>H3a:</td>
<td>Employee-managers with IHC are more likely to be found in small firms with work practices.</td>
</tr>
<tr>
<td>H3b:</td>
<td>Employee-managers with IHC are more likely to be found in larger-sized firms with work practices.</td>
</tr>
<tr>
<td>H4a:</td>
<td>Employee-managers with IHC are more likely to be found in small firms located in regions with higher workforce diversity.</td>
</tr>
<tr>
<td>H4b:</td>
<td>Employee-managers with IHC are more likely to be found in larger-sized firms located in regions with higher workforce diversity.</td>
</tr>
<tr>
<td>H5a:</td>
<td>Employee-managers with IHC are more likely to be found in small firms located in regions with higher entrepreneurial activity.</td>
</tr>
<tr>
<td>H5b:</td>
<td>Employee-managers with IHC are more likely to be found in larger-sized firms located in regions with higher entrepreneurial activity.</td>
</tr>
</tbody>
</table>