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The Effect of Human Capital and Competition on Entrepreneurial Innovation

An Empirical Study on Entrepreneurship in the United Kingdom between 2003 and 2005

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In remembrance of my mother

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Abstract

This study examines how innovation is affected by competition levels and human capital. It expands on previous literature by focussing on early-stage entrepreneurs. The relationship between competition and innovation has been a key issue of discussion in economics and ambiguity exists regarding this relationship both in terms of theoretical reasoning and empirical results (i.e. Arrow's (1962) positive effect, Schumpeter's (1934) negative effect and Aghion el al.'s (2005) inverted-u relationship between competition on innovation), whereas the relationship between human capital and innovation has rather explicit results (i.e. a positive effect of human capital on innovation (Dakhli and De Clercq, 2004; Marvel and Lumpkin, 2007)). The results of this paper expand on this discussion. In the analyses, a distinction is made between product and process innovation. The analyses are performed on a sample of 2,432 early-stage entrepreneurs in the United Kingdom between 2003 and 2005. Empirical support is found for positive relations between education and previous business ownership on the product innovativeness of early-stage entrepreneurs. The mark-up – which captures the economic rents on the industry – measures the competition level on industrial level. Support is found for a positive relation on entrepreneurial product innovation, which is in accordance to Arrow's (1962) replacement effect and Kirzner's (1997) logical deduction. However, none of these relations are supported concerning entrepreneurial process innovation, which is probably due to the measure itself. Yet, in order to stimulate product innovation among early-stage entrepreneurs, policy makers should focus on increasing competition, enhancing education and allow for easy exit barriers, as individuals can gain business ownership experience.

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1. Introduction

Innovation – as in the creation of new or better products, services and processes – is considered a key element in the study of entrepreneurship, as it is of great importance for economic welfare (Schumpeter, 1934; Grossman and Helpman, 1994; Acs and Audretsch, 2003; Hopman and Rojas-Romagosa, 2010). According to Baumol (2002), innovation is not only a key aspect to economic welfare, but also for the individual entrepreneurs. For them, it is one of the main instruments to remain competitive on the market. Several studies claim that human capital is an important predictor for innovation (Dakhli and De Clercq, 2004; Marvel and Lumpkin, 2007; Chi and Qian, 2010), whereas others argue that innovation originates from the competition levels on the market (Schumpeter, 1934; Arrow, 1962; Aghion et al., 2005). This study tends to explore how innovation among new venture entrepreneurs is influenced by the human capital of the entrepreneur and the competition level of the market in the United Kingdom between 2003 and 2005.

This section contains a brief introduction to the main concepts, which lead to the research question. Then, a short overview of the methods is provided, followed by an outline of the structure of this paper.

Human capital involves the accumulation of skills and knowledge that resides within individuals (Becker, 1964). The OECD (1998) defined it as “the knowledge, skills, competences and other attributes embodied in individuals that are relevant to economic activity”. This would suggest that productiveness and efficiency of an individual increases as his relevant knowledge, skills and experience increases (Schultz, 1959; Mincer, 1974). Empirical studies suggest that human capital – in terms of education and work experience – is positively related with the probability of becoming an entrepreneur (Davidsson and Honig, 2003; Bates, 1995; Kim et al., 2006). Furthermore, several studies show these same indicators have significant effects on the successfulness of an entrepreneur, as in survivability (Bates, 1990; Robinson and Sexton, 1994; Gimeno et al., 1997).

Shane and Venkataraman (2000) suggest that entrepreneurship starts with the discovery of entrepreneurial opportunities. It is likely that human capital increases the probability of discovering these opportunities (Shane, 2000; Shepherd and DeTienne, 2005). Consequently, this might lead to the previously mentioned positive relations with the probability of becoming an entrepreneur and their successfulness. However, in these studies, the authors did not account for the quality of the discoveries. High quality discoveries are products, processes and services that are either new or better than previous versions. In other words, innovations are high quality opportunity discoveries.

Marvel and Lumpkin (2007) studied the effect of human capital on radical innovations where they made a division between general human capital and specific human capital. Specific human capital is the level of one's technical or industry related knowledge or skills (Cooper et al., 1994). Consequently, specific human capital is only useable for a single environment, and cannot easily be transferred for other uses. General human capital is useful to all environments. According to Becker (1964), education and experience are the most important facets of general human capital. In the study by Marvel and Lumpkin (2007), especially general human capital was found to be significantly related to radical innovations. Education showed to be most influential to innovation, followed by experience.

In this study, the expectation is that specific human capital indicators show less strong relations with product and process innovation of entrepreneurs, compared to general human capital indicators. The general human capital indicators included in this study are education level and whether the entrepreneur has had previous business ownership experience in the past twelve months. The specific human capital indicator concerns the start-up skills of the entrepreneur, which measures whether the entrepreneur considers his skills sufficient to start a new business. All three of the mentioned human capital indicators are considered individual specific, i.e. these factors are not easily transferrable to other individuals.

Competition is another major factor that might influence innovation, which is why it is also incorporated in this study. However, previous studies on the relationship between competition and innovation are ambiguous. The four main concepts in this paper are developed by Schumpeter (1934), Arrow (1962), Aghion et al. (2005) and Kirzner (1997).

Schumpeter (1934) suggests that incentives to innovate are less for small firms when there are high levels of competition on the market and vice versa. He argues that prospective innovators face lower monopoly rents on highly competitive markets when they innovate, as the competition will catch up to the same technological level. The innovative firm does disrupt the market with their invention – which is known as 'creative destruction'. But as the market is highly competitive, the other firms will imitate quickly and move the market back to an equilibrium in which no firm earns any profit. Moreover, according to Schumpeter (1934), monopolistic firms are more capable to carry the risk of innovating. Also, highly competitive industries provide entry barriers, which in turn discourages new firms from entering and innovating (Dixit and Stiglitz, 1977). These effects imply a negative relation between competition and innovation – also known as the 'Schumpeterian effect'.

In contrast, Arrow (1962) insinuates a positive effect between competition levels and innovation. He argues that innovating on a competitive market earns the firm monopoly profits, as the innovating firm steals the profits away from its competitors. Even though the results of the studies on the relationship between innovation and competition are ambiguous, the authors use the same argumentation to draw their conclusions; a firm's incentive is determined by the potential profits from an innovation minus its costs. In Arrow's (1962) case, the potential rewards for innovating are higher than the costs at higher competition levels, whereas in Schumpeter's (1934) case, the potential rewards for innovating are lower than the costs in highly competitive markets.

There are researchers that argue for an inverted-U shape relation between competition and innovation (Aghion et al., 2005). The results in the paper of Aghion et al. (2005) imply a combination of the previously mentioned theories by Arrow (1962) and Schumpeter (1934). They speak of leveled and unleveled markets[1]. The former is a market which contains firms that acquired the same size, profits and technological level, whereas the latter is a market which contains firms with a lag between size, profits and technological levels. Their results imply that in case of a leveled industry, increasing competition leads to higher incentives to innovate, in order to 'escape competition' – thus following the concept of Arrow (1962). Vice versa, in case of an unleveled market, incentives to innovate decreases for the

[1] This distinction is not made in this paper, as this information is only obtainable when examining on market level, whereas this study focuses on industry level. Furthermore, panel data is needed in order to confirm whether a market is increasing or decreasing in its competition levels. Without the distinction and panel data it is unlikely to find an inverted-U shape relationship between entrepreneurial innovation and competition.

laggard firm as competition increases, due to the reduced economic rents that are captured when ‘catching up’ with the leading firm – thus following the concept of Schumpeter (1934).

Kirzner (1997) argues for a different relation between competition and innovation. According to him, there actually are no innovations on the market, only opportunities. Whereas the previously mentioned authors all argue that opportunities and innovations are created, Kirzner (1997) argues that they are already out there, and the entrepreneur has to be alert to notice them. He claims that on a market with perfect competition (i.e. a market in which all opportunities are already exploited), every player on the market does exactly the same thing as everyone else and it is futile to attempt to become better than the rest. Actually, in such a market it should not even be necessary to keep track of the competitors. This view suggests that as long as the market is not in equilibrium, market participants will attempt to become better than the competition. In other words, as long as the market has not reached an equilibrium, competition increases incentives to innovate, as entrepreneurs gain incentives to be ‘alert’.

Hence, the innovativeness of an entrepreneur could be influenced by both the competition level and human capital indicators. This study tends to extend on the previous literature, by examining how human capital affects the innovativeness of new venture entrepreneurs, and by adding the competition level of the market to this relation. Furthermore, a distinction is made between product and process innovation, in order to examine whether these types are affected similarly .

Product innovation means that the innovator brings a new product on the market. Process innovations contain inventions that increase the efficiency of the company. Making a distinction between these two types of innovation allows for a broader view, in which the effects of human capital and competition on product and process innovation can be compared. According to Aghion and Howitt (1996) increasing competition takes away resources from process innovation to product innovation. Increasing the efficiency of existing products becomes less profitable as competition increases. In other words, they argue for a tradeoff between improving efficiency or bringing new products into the market as competition increases.

This study is probably one of the first which accounts for both human capital and competition level factors on entrepreneurial product and process innovation. Consequently, the research question is:

> *What are the effects of different human capital indicators – education, experience and skills – and competition level on the product and process innovation among new ventures?*

The data on entrepreneurial level is obtained from the Global Entrepreneurship Monitor (GEM) for the United Kingdom. The GEM is a population-based survey on entrepreneurial activity conducted in over 50 countries, which is obtained through door-to-door or telephone surveys. Only individuals who are either involved in setting up their own firm (nascent entrepreneurs) or individuals who are the owner/manager of young business (businesses that exists for less than 42 months) are included in the sample. This dataset contains information for the innovativeness (i.e. *newness of the product*, measuring the entrepreneurial product innovation; and *newness of the technology*, measuring the entrepreneurial process innovation), human capital (i.e. *education level*; *start-up skills*; and *previous business experience*, showing whether the entrepreneur has owned and shut-down a business in the last 12 months), age and the corresponding industry of the entrepreneur.

Industry level data is obtained from the Structural Analysis (STAN) database provided by the Organisation for Economic Co-operation and Development (OECD) [2]. This data is used to calculate the *mark-up* – a competition measure following the methods of Griffith et al. (2006), i.e. economic rents measured as value-added as share of labour and capital costs.

This paper examines entrepreneurs living in the United Kingdom. This country is chosen as it has the most observations spread across consecutive years in the dataset. Also, the collection methods of the data for computing the industry competition levels varies greatly among countries. Consequently, comparison between countries becomes obsolete. In this study, a country is chosen which fairly represents most other markets. Appendix A indicates that the United Kingdom's data

[2] The Organisation for Economic Co-operation and Development (OECD) is an international organisation of 34 countries founded to stimulate economic progress and world trade.

shows close similarities with the total sample of the GEM data[3] – which includes 63 countries. The averages in the United Kingdom do not exceed differences of more than 5% compared to the total sample – with the exception of education level (i.e. 41% of the entrepreneurs in the UK has a high education level, whereas 52% on average in the total sample. Consequently, the United Kingdom shows to be a good representative of an average market for the analyses. The analyses are performed for entrepreneurs between 2002 and 2005, as these are the years with sufficient observations (i.e. at least 400 observations per year). The year 2007 also meets the requirements, but is not included as it is not consecutive with the other years.

Both innovation measures (i.e. *newness of the product* and *newness of technology*) are used as dependent variables in several binary probit models. Developing separate models for each of these measures allows for a distinction between product and process innovation (Leiponen, 2005). For both models, the independent variables of interest are the human capital indicators (i.e. *education level*; *start-up skills*; and *previous business experience*) and competition (i.e. *mark-up).* In addition, the age of the entrepreneur and year are included to serve as control variables. The relation between product innovation and competition is endogenous. Consequently, the *mark-up* is instrumented by *Other Taxes less Subsidies on production* (OTXS) to take into account the endogenous relation including reverse causality. However, the relation between entrepreneurial process innovation and the *mark-up* was found to be exogenous. This might be due to the ability of firms to buy or outsource their processes, instead of developing process innovations themselves. These models are therefore not instrumented. First, a model is generated only including the human capital indicators and the control variables. The same is done for the individual effect of competition on the innovativeness of the entrepreneur. Finally, the complete model is developed including both the human capital indicators and competition levels.

Additional analysis are included, where either the competition measure is replaced or the innovation measure is replaced. Both these analysis have different purposes. The first additional analysis contains models with a different competition measure, which are included in order to check the robustness of the model. The second additional analysis replaces the dependent variables for *R&D intensity*. In addition to the

[3] Only including the individuals who are either involved in setting up their own firm (nascent entrepreneurs) or individuals who are the owner/manager of young business (businesses that exists for less than 42 months).

product and process innovation measures on entrepreneurial level, *R&D intensity* presents the innovativeness on industry level. It might be interesting to see how human capital indicators of entrepreneurs, and competition levels of the market affect the input for innovation on the total industry.

The results of this study are of critical importance for policy makers, since it has been widely recognized that innovation – be it from new ventures or incumbent firms – is of great influence for economic growth and development (Schumpeter, 1934; Acs and Audretsch, 2003; Hopman and Rojas-Romagosa, 2010; Grossman and Helpman, 1994). According to Audretsch and Keilbach (2004), this is due to knowledge spillovers, increased competition and increased diversity. Governments have the ability to influence both the human capital as the competition levels of a market. Having a better understanding of how human capital factors and competition influence the innovativeness of entrepreneurs, can improve policies as these can be targeted more directly on the aspects that have the greatest impact on innovation. Additionaly, this study can provide a guideline for future research.

To summarize, this study focuses on the innovativeness of entrepreneurs in the United Kingdom and how this is affected by human capital indicators and the competition level in the corresponding industry. Data is used for the period between 2003 and 2005. First, it is examined how human capital and competition are individually related to both process and product innovation of entrepreneurs. Second, it is examined how the innovativeness of entrepreneurs – in terms of both product (i.e. *newness of the product*) and process (i.e. *newness of technology*) innovation – is affected when including both human capital indicators and the competition level in the industry. Third, additional analysis are included that either add to the robustness of the main model, or explain further interesting relations.

This study is divided into eight sections. This first section is a brief introduction, which contains an overview of the main concepts and stated the purpose of this research. The next section is the literature review which provides detailed frameworks on the relationship between both human capital and competition on innovation from the perspective of existing literature. The third section contains a description of the data. In the fourth section the methods are explained, which are used to answer the research question. The fifth section contains the results of the study. Sixth, is the discussion, in which the results are analysed. The seventh section covers the conclusion of the research, which includes an overall summary of the study, research implications, future research directions and limitations. Finally, the references are presented.

2. Literature Review

The goal of this review is to give a comprehensive outline of previous studies associated with innovation, human capital and competition, and to derive some hypothesis. The first section discusses the main concepts (i.e. innovation, human capital and competition) in general. The second section summarises literature concerning the possible interactions between human capital and innovation, whereas the final section describes literature about the possible relations between competition and innovation.

2.1. Main topics

This section introduces the main topics, which is divided in three parts. The first part concerns innovation. The second, involves human capital, whereas the final part introduces competition.

2.1.1. Innovation

The central topic in this paper is innovation and how it is influenced. Innovation is an abstract concept, which can be used and interpreted in several ways. The European Commission provided a definition for it, to make the concept more tacit: “innovation is the successful production, assimilation and exploitation of novelty in the economic and social spheres” (European Commission, 1995, p. 9). Rogers (1998) further emphasizes that innovations can only be developed by human skills, experience and knowledge, i.e. human capital.

As stated in the introduction, innovation is one of the main contributors to economic welfare (Schumpeter, 1934; ; Grossman and Helpman, 1994; Acs and Audretsch, 2003; Hopman and Rojas-Romagosa, 2010). Its importance becomes especially clear in the Solow model, where growth per capita is driven by Total-Factor Productivity[4] (TFP) (Solow, 1953). Innovation is one of the key drivers of TFP. Even though there are many other factors (e.g. education and trade) that influence economic growth, without improving technologies there probably is no sustainable TFP growth (Hopman and Rojas-Romagosa, 2010). This does not necessarily mean that there should only be invested in innovation, as there is a trade-off between

[4] Total-Factor Productivity (also known as the ‘Solow residual) accounts for the effects in output that are not caused by inputs (i.e. capital and labour).

investing in innovation and other economic growth factors that influence, e.g. consumption and investment (Hopman and Rojas-Romagosa, 2010). However, the Solow model does present a great example to point out how innovation influences economic growth.

Innovation has both direct and indirect effects on economic growth. Investments in Research and Development (R&D) are considered an input for innovations. These investments are a direct effect on economic growth, as more money is in circulation. An interesting aspect of these investments are the substantial knowledge spillovers (Coe and Helpman, 1995; Coe et al., 2009). Consequently, R&D expenditures from a single company might benefit the whole market. As not only the inventor benefits from the investments in innovation, innovation shows an indirect relationship with economic growth. Firms can imitate the innovation or use certain elements or knowledge of it, according to the firm's absorptive capabilities (Cohen, 1990). Therefore, innovations further stimulate the development in new products and services.

Entrepreneurs have a distinct role when it comes to innovation and economic growth. According to Acs et al. (2009), entrepreneurs are a transmission mechanism for knowledge spillovers. They argue that this is due to the commercialization of individual knowledge. In turn, these spillovers are used by entrepreneurs to identify and exploit opportunities. Audretsch and Keilbach (2004) claim that entrepreneurs contribute to economic growth in three ways. The first is the knowledge spillovers. Second, the increased competition due to new entrants. Third is the increased variety of products and services on the market. Furthermore, Hessels and Van Stel (2011) have found empirical support for a positive relation between entrepreneurship in general and economic growth. They also found that export-driven new ventures in higher-income countries (i.e. as classified by the World Bank) have stronger relations with economic growth.

One of the main aspects where previous literature studying relations with innovation differ, is how they measure it. Before further discussing literature concerning the relationships with innovation, it is important to understand how innovation can be measured. Whereas human capital is more straight forward to measure (e.g. education level, age, previous experience, etc.), innovation offers more of a challenge. R&D expenditures is one of the most commonly used measures for innovation (Yang and Huang, 2005; Yasuda, 2005). As stated earlier, investments in R&D are considered the input for innovations. These data are widely available, making R&D expenditures an obvious choice for measuring innovation. However, Hansen (1992) is not satisfied with this measure, as it only measures inputs. The output of innovation is of interest, but these data are much harder to obtain, i.e. new products and services on the market, the amount of patents and newly obtained knowledge (Hansen, 1992; Love and Ashcroft, 1999).

A distinction can be made between product and process innovation. The OECD defined product innovation as the introduction on the market of "a product whose technological characteristics or intended uses differ significantly from those of previously produced products" or "an existing product whose performance has been significantly enhanced or upgraded". Furthermore, they defined process innovation as "the adoption of technologically new or significantly improved production methods"[5]. This distinction is also made for the analyses in this paper.

2.1.2. Human capital

The next main topic is human capital, which is an important aspect within the field of economics, as it allows for observing how human beings act within economies. Furthermore, it is considered a crucial factor that may cause innovation, which is discussed in section 2.2 (Dakhli and De Clercq, 2004; Marvel and Lumpkin, 2007; Chi and Qian, 2010). As Coleman (1988) described, human capital concerns knowledge and skills from individuals that allow for changes in action and economic growth. Human capital can be developed through formal training and education.

Human capital theory was initially developed by Schultz (1959). Subsequently, Becker (1964) expends on this literature by focusing on the rise in productivity of workers through education or training. According to Becker (1964), education and training generates increased and more efficient use of knowledge and skills, followed by an increase in future wages. These higher future wages not only benefit the workers' motivation, but also the economy itself, as these individuals have acquired more resources to consume. Accordingly, human capital effects the economy in

[5] OECD (2005). Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data. *OECD, Paris*, p.32.

multiple ways. In this study, the point of interest is how human capital influences innovation among early-stage entrepreneurs.

There are several types of human capital to distinguish, i.e. firm-specific, industry-specific and individual-specific human capital (Dakhli and De Clercq, 2003). Although this study mainly focuses on individual-specific human capital, it is important to know the reasons for not including the other human capital types, which are described below.

Firm-specific human capital are those skills and knowledge only useable within a specific firm. According to governance theory, this does increase incentives of loyalty between the employer and the employee as they become bilateral dependent. The employee is less susceptible to work for the competition as he cannot use his firm-specific knowledge and skills outside the company. On the other side, the employer does not have high incentives to abuse these employees, as they have specific knowledge and skills that are not found elsewhere. If these employees would leave the firm, the employer has to train new people to reach the same productivity level again. But it is not only the employees that are less transferable. All firm-specific knowledge within a firm is not transferable, which might give the firms an advantage (Grant, 1996). As its knowledge distribution is limited, firm-specific human capital is not relevant concerning analyses of the innovativeness of entrepreneurs. Firm-specific knowledge obtained in previous work experience may provide limited relevance in a new venture.

Industry-specific human capital are the skills and knowledge only useable within a specific industry. Transactions are far simpler concerning industry-specific human capital compared to firm-specific human capital. Bianchi (2001) suggests that innovations can be generated more efficient when main players on the market exchange their industry-specific human capital. In long-term intimate relationships with other companies on the market, the development of innovation will even further increase, as firms have learned how to communicate efficiently with each other (Bianchi, 2001). Often, industry-specific knowledge is only understandable for specialists in the same industry. Consequently, industry-specific human capital decreases the need for an appropriability mechanism such as patenting, as the knowledge becomes less susceptible to imitation outside the industry (David, 1975).

According to Maskell and Malmberg (1999), a mutual understanding of the knowledge is an absolute requisite for a knowledge transaction. However, as industry-specific human capital is hard to measure, it is not accounted for in the analyses. Yet, it is not unlikely that entrepreneurs with industry-specific human capital are more innovative if their new venture is in that same industry.

The focus of this research lies on individual-specific human capital, which is the last type. Human capital of this type is widely applicable to industries and firms. It contains a wide arrange of indicators that reflect an individual's knowledge, skill and experience, which is not easily transferable among individuals. For instance, Pennings et al. (1998) reckon the skills to start up a new venture to individual-specific human capital, whereas Hinz and Jungbauer-Gans (1999) also point out education and training as individual-specific human capital. Prior research also show a positive relationship between individual-specific human capital and the successfulness of entrepreneurs in terms of earnings after starting up a business (Bates, 1990; Robinson and Sexton, 1994; Gimeno et al., 1997; Kilkenny et al., 1999).

2.1.3. Competition

The third main concept of this research is competition. This concept might be the simplest of the three in general, but it is the relationship with innovation (i.e. discussed in section 2.3) which proves to be complex.

Smith (1776) was one of the pioneers in describing the importance of competition for economic growth. Thereafter, many scholars studied the concept of competition, which led to the distinction between perfect competition and imperfect competition, where the former has the most efficient allocation of resources (Arrow, 1962). However, trying to obtain perfectly competitive markets might not be efficient, as competition also influences innovation (Schumpeter, 1934; Arrow, 1962; Aghion et al., 2005). Increasing competition might give firms incentives to reduce slack and to innovate in order to remain competitive (Hart, 1983; Schmidt, 1997). When there are no opportunities left for the market participants to become better than the competition, a perfectly competitive market is reached. Nevertheless, high levels of competition might also discourage firms to innovate or to enter the market, which is more commonly known as the "Schumpeterian effect".

2.2. *The relation between human capital and innovation*

There are many studies that examine the relation between human capital and the successfulness of entrepreneurs (Bates, 1990; Robinson and Sexton, 1994; Gimeno et al., 1997). Moreover, Engelbrecht (1997) and Temple (2001) found a positive link between human capital – measured by education – and productivity growth, which is in accordance with the human capital theory, i.e. an increase in human capital leads to increased successfulness of firms and an increased productivity growth. However, the relation of interest here is that between human capital and innovation. This section discusses several implications made by previous literature, and what data they used to find these relations.

Marvel and Lumpkin (2007) belong to the few studies that examined the effect of human capital on the innovativeness of entrepreneurs. They measured innovation using their own constructed survey, containing seven questions. A group of 145 technology entrepreneurs (i.e. individuals who recognize and exploit opportunities by leveraging technology and experience to create new value through the venture creation process) from the United States participated. The survey's goal was not only to measure the innovativeness of the entrepreneur, but also to enable the researchers to make a distinction between radical and incremental innovations.

To take things even further, Marvel and Lumpkin (2007) also made a distinction between general human capital[6] and specific human capital[7], i.e. specific human capital contains knowledge, experience and skills only useable in a single environment, whereas general human capital is useable in all environments. Results showed all human capital coefficients to be positively related with both types of innovation, except for *prior knowledge to serve markets*. However, only the general human capital variable *education* and *depth of experience* were significant. Of the specific human capital variables, only *prior knowledge of technology* was positive and significantly related to innovation, while *prior knowledge to serve markets* showed a negative significant relationship. Consequently, a similar distinction is made in this paper between general and specific human capital.

[6] General human capital measures: formal education; depth of experience; breadth of experience (the amount of previous employers worked for).

[7] Specific human capital measures: prior knowledge of ways to serve markets, customer problems, markets and technology.

Subramaniam and Youndt (2005) examine the effect of a firm's human capital and social capital[8] on their innovativeness. They obtained data from a combination of questionnaires and third party sources. In the final sample there were 93 public firms with a single business unit that have over 100 employees in the United States covering the years 1998 and 2001. Since they use longitudinal data, they account for unobserved heterogeneity. Three items of the questionnaire where used to asses a firm's ability to extend and reinforce its current expertise and products or services, i.e. incremental innovation. Another three items assess the firm's ability to make current products or services obsolete, i.e. radical innovation. The researchers only included general individual-specific human capital in their analysis, i.e. the overall expertise, skill and knowledge level of the firm's employees.

The results of Subramaniam and Youndt (2005) are contrary to most studies on the relation between human capital and innovation. A significant negative relation is found between human capital and radical innovations, where others find a positive relation. This might be due to an included interaction between human capital and social capital, which actually had a significantly positive relationship with radical innovation. In other words, this implies that human capital only leads to radical innovation if accompanied by social capital. According to Subramaniam and Youndt (2005), this finding might also originate from a lack of communication by individuals with high human capital levels. When they do not communicate their ideas with colleagues, it is counterproductive for the firm's innovative capabilities. Thus, it is likely that social capital influences how human capital affects innovation. However, these results are based on firms with over 100 employees. It might well be the case that cooperation with colleagues in new and small firms is of less importance concerning the firm's innovativeness. New and small firms hardly have any employees at all, which might make the human capital of the entrepreneur himself a more important predictor for innovation. Consequently, the importance of social capital is not represented in the analyses, as this analyses focusses on early-stage entrepreneur, who are unlikely to have many employees.

There are also those who studied how human capital and innovation relate on a macro economical level (Dakhili and De Clercq, 2004; Chi and Qian, 2010). Dakhili

[8] Social capital is defined as the resources embedded in one's relationships with others (Dakhli and De Clercq, 2003).

and De Clercq (2004) examined the effects of both human capital and social capital on innovation at the country level. They used data from the World Development Report and the World Values Survey to test their hypotheses across 59 countries. For their human capital indicators they use the educational attainment, average income and life expectancy of the citizens. Social capital is measured by generalized trust, institutional trust, associational activity and norms of civic behaviour. Dakhili and De Clercq (2004) use a combination of three indicators – R&D expenditures, the number of registered patents for each country for a particular year, and the amount of high technology exports – to measure innovation. Their results imply a strong positive relation between human capital and all three of the innovation measures.

Chi and Qian (2010) examined the role of education in regional innovation activities using Chinese provincial data from 1997 to 2006. They only focus on education as human capital indicator and use the amount of invention patent applications to measure innovation. All of their analysis imply a strong relation between human capital and innovation. Higher education contributes more to innovation than lower levels of education, which also supports human capital theory.

Hence, previous literature often show strong support for a positive relation between human capital and innovation. Human capital has multiple indicators, which make it interesting to examine how they affect innovation when numerous variables are included in the model. It might also indicate which one affects the innovativeness of entrepreneurs the strongest. The previous literature mainly used education, experience, skills and age as human capital indicators.

Dakhili and De Clercq (2004), Marvel and Lumpkin (2007) and Chi and Qian (2010) all found education to be positively associated with innovation. They argue that education increases knowledge, produces new ideas and augments knowledge spillovers. Higher education increases the probability to discover economic opportunities.

Marvel and Lumpkin (2007) show a positive relation between experience (i.e. measured by the amount of jobs the entrepreneur has had) and innovation. This is in accordance with Becker (1964) who argues that education and experience are the most important human capital factors. As the focus lies on entrepreneurs, it is expected that experience in business ownership experience affects the innovativeness of the entrepreneur.

Both Marvel and Lumkin (2007) as Subramamiam and Youndt (2005) found that skills positively affect innovation. They argue that these skills are necessary to successfully implement an innovation. In other words, skills probably help in successfully introducing the new product or process on the market. Skills lower the entry barriers for the entrepreneur, as he is more likely to successfully put innovations into practice. Thus, entrepreneurial skills might affect whether an individual innovates or not.

These three human capital indicators should be positively related for both product and process innovation. Both types of innovation require knowledge and experience to discover the opportunity. Additionally, it requires the right skills to implement the product and process innovations. Thus, both product as process innovations should be positively influenced by the entrepreneur's human capital.

These three main human capital indicators lead to the following hypotheses:

Hypothesis 1: Human capital – in terms of education level, previous business ownership experience and start-up skills – is positively related to the innovativeness of early-stage entrepreneurs measured by newness of the product (i.e. product innovation).

Hypothesis 2: Human capital – in terms of education level, previous business ownership experience and start-up skills – is positively related to the innovativeness of early-stage entrepreneurs measured by newness of technology (i.e. process innovation).

2.3. The relation between competition and innovation

The second relationship of interest in this study is the one between competition and innovation. In the literature, there is still no agreement whether this relationship is positive or negative. Schumpeter (1934) argues the relation should be negative, Arrow (1962) claims it to be positive, whereas Aghion et al. (2005) found an inverted-U shape. Furthermore, Kirzner (1997) suggests a positive relation as long as the market has not yet reached an equilibrium. First, these main concepts are discussed in more detail, followed by some additional empirical research on this topic.

Schumpeter (1934) contends the relation between competition and innovation to be negative, i.e. the Schumpeterian effect. In other words, higher levels of competition decrease innovative outputs and technological progress. According to Schumpeter (1934), this is due to simple economic decisions, where decisions are made based on the cost-benefit analysis. As long as the potential benefits are higher than the costs of investment, the investment is made. However, when the costs are higher than the benefits, the investment is mostly not worth it. Schumpeter (1934) uses the same reasoning, where laggard firms on highly competitive markets have no incentives to invest in innovation, as the reward is catching up with the leading firm or maybe surpass it. In this short period, the laggard firm might generate some profits due to the innovation. However, since it is on a highly competitive market, other firms will quickly imitate the innovation and cut in on the profits, with a much smaller initial investment. Consequently, profits of the innovator will drop once again. Moreover, Schumpeter (1934) argues that monopolistic firms are more capable to deal with the risks of innovating. However, the latter might not apply for early-stage entrepreneurs, as entering the market contains risks already. Whether this entry is with innovations or with existing products, services and technologies might not relatively matter.

In Schumpeter's (1934) eyes, a firm's innovation on a highly competitive market might generate exceptional profits, but only for a short period of time. In other words, the innovation does not generate sustainable profits. As long as these short-term profits are lower than the initial investment of the innovation, the high competition levels decreases the incentives to innovate. On the other hand, when competition levels are low, especially the larger firms benefit longer from an innovation, as they are not chased as much by the competition, have the resources to innovate and are able to profit from scale economies (Galbraith, 1956). In that case, the smaller companies do not have the resources to follow.

Arrow (1962) argues for the opposite relation between competition and innovation, i.e. higher competition levels foster incentives to innovate. His arguments follow the same principles as Schumpeter (1934), where firms act on simple potential benefits versus costs decisions. However, Arrow (1962) claims monopolists (i.e. markets with low competition levels) have weak incentives to innovate, as they already earn monopoly profits. The incremental gains of an innovation are substantially low, decreasing the incentive to innovate.

In contrast, firms in high competition markets would want to innovate, as they can escape the competition (Arrow, 1962). This effect is also called the replacement effect, where the old product is replaced with a new innovation, which creates a (temporary) niche market for the innovator. In this case, the innovation steals away profits from the competition. Therefore, this effect most likely to be strongest when the innovations are very radical (i.e. as the competition is not able to simply imitate and follow) and when there is no threat of new entrants on the newly created niche market.

Arrow (1962) does point out an exception to his theory, when the monopolist faces the threat of new entrants. Initially an investment in a new innovation might not be the first choice in a cost – benefit analysis, as the potential profits are not per se higher than the current technology. However, when facing the threat of new entrants, innovating could be the better choice. If not, entrants would simply cut in on the monopolist's profits. Investing in the new innovation poses new entry barriers, reducing the threat of new entrants. The loss in profits of when the monopolist has to share its profits due to a new entrant may be higher than the loss in profits of innovating. This is also called the efficiency effect.

Another main view on the relationship between competition and innovation is that of Aghion et al. (2005). In their research, they find that the relationship is not linear but has the form of an inverted-U shape. On a market with unbalanced firms (e.g. some companies are larger and make more profit), the laggard firm has incentives to innovate when competition levels are low. The potential profits of 'catching-up' with the leading firm are substantially high, that investing in innovation is worth it. However, when competition levels increase, these potential profits decrease. For instance, suppose there is an unbalanced market where only two firms participate (low competition level). The laggard firm can 'catch-up' or even surpass the leading firm when innovating. It will gain a larger share of the profits. However, suppose there is an unbalanced market with a laggard firm and multiple leading firms (high competition level), incentives for the laggard firm to innovate decrease, as the share of profits is low even after innovating. Therefore, on an unbalanced market, competition is negatively related to innovate for the laggard firm, similar to the Schumpeterian effect.

On a balanced market (i.e. firms that are equal in size, profit and technology), an increase in competition has a positive effect on innovation. Investing in innovation might enable the innovating firm to 'escape the competition' – similar to Arrow's (1962) replacement effect. Aghion et al. (2005) claims that whenever the opportunity to gain a larger share of the profits increases, incentives to innovate increases as well. How these opportunities are affected by competition, depends on whether the market is balanced or unbalanced. To summarize, on an unbalanced market, incentives to innovate decrease as competition increases, whereas on a balanced market, incentives to innovate increase as competition increases.

The final main view on this topic is that of Kirzner (1997). He supports the Austrian school of economics, which mainly differs in methodology compared to mainstream economics. The Austrian school discards empirical statistical methods, as humans should be too complex for these analyses. Instead, they rely on logical deductions. Kirzner (1997) argues that there actually is no competition in case of perfect competition. An equilibrium is reached as there is perfect knowledge, in which everyone knows what the best offer is. In this equilibrium everyone is doing exactly the same and deviating from this behaviour is not efficient. Therefore, firms do not need to worry about competition or new entrants.

On a market with imperfect competition, firms do have incentives to innovate in order to outcompete the other firms (Kirzner, 1997). This implies a positive relation between competition and innovation. However, Kirzner (1997) argues that innovations are actually opportunities seized by entrepreneurs. According to him, the opportunities are already out there on the market waiting for an alert entrepreneur to utilize them. Innovations are considered a product of seizing these opportunities. This is in contrast to mainstream economics, in which opportunities are created.

It is surprising that empirical literature on the relation between competition and innovation finds support for both Schumpeter's (1934) view (Acs and Audretsch, 1987; Blundell et all., 1999) and support for Arrow's (1962) view (Nickell, 1996; Hopman and Rojas-Romagosa, 2010). However, there have been little to none empirical studies that found a similar relation as Aghion et al. (2005), probably because this concept is still fairly new. As the view by Kirzner (1997) originates from the Austrian school of economics in which researchers do not rely on statistical methods, empirical literature rarely investigate Kirzner's (1997) viewpoint.

Acs and Audretsch (1987) tested the hypotheses of Schumpeter (1934), where innovation is promoted by large firms and imperfect competition. Furthermore, they tested whether the difference between large- and small-firm innovations is attributable to the competition levels in the market. For this reason they measure innovation differently than other studies. Since their interest is the difference between small- and large-firms' innovations, their measure indicates the difference between large firm and small firm innovation rates (i.e. measured by the number of innovations per thousand employees). Firms with more than 500 employees are considered large firms. Competition is measured by the capital intensity, the percentage of employees in the industry covered by collective bargaining, the four-firm concentration ratio, and the advertising-to-sales ratio. More interestingly, this study also included a simple human capital factor in their model, i.e. the percentage of professional and kindred workers of the total employment. However, they found this variable to be insignificant, arguing that this is due to their sample – where virtually all employees are highly skilled. In general, their results imply that indeed in some extend, the difference in the innovativeness of small and large firms is explained by the competition levels. However, this does not apply for all industries.

Hopman and Rojas-Romagosa (2010) analyse the empirical relation between competition and innovation by using OECD panel data for 23 countries between 1987 and 2007. Competition is measured by the Lerner index, whereas innovation is indicated by R&D intensity. Even though looking for it, they did not find a similar inverted-U shape relationship as in Aghion et al. (2005). They did find a linear positive relation between competition levels on innovation efforts. This supports the concept of Arrow (1962).

A British panel study on this relationship is done by Blundell et al. (1999). They used panel data of 340 manufacturing firms that are listed on the London International Stock Exchange for the period 1972 to 1982. They measured competition through a company's market share. Innovation is measured by the count of major technological innovations and patents. In contrast to Hopman and Rojas Romagosa (2010), they find a significant negative relation between competition and innovation and argue that their results are consistent with previous literature where high market share firms have incentives to pre-emptively innovate.

Griffith et al. (2006) uses the *mark-up*[9] as a measure for competition, which is also used in the current study. They focus their empirical analysis on the manufacturing sector, as they argue this is where the most R&D expenditures and patenting activity is. They focus on EU countries and industries. Innovative activity is measured by Business Enterprise R&D expenditures and patents taken out at the European Patents Office. They find that increased competition increases R&D investments in the manufacturing industries.

To summarize, the empirical findings on the relation between competition and innovation are ambiguous. The previous literature does not give any expectations for the results in the current study, except that the relationship might be positive, negative or even an inverted-U relationship. The least probable relation to find in this study is the inverted-U relationship, as the industries need to be evaluated over a longer period of time in order to determine whether competition is increasing or decreasing. Aghion et al. (2005) used panel data concerning the period between 1973 and 1994 in order to achieve this. Furthermore, it is not possible to make a distinction between balanced and unbalanced industries, as the scope is to broad. Thus, competition is expected to be either positively-, negatively- or even non-related to innovation.

For the hypotheses, the positive relation of Arrow (1962) is chosen, as the Austrian school of economics argue for a similar positive relation using logical deduction. Though the empirical results are ambiguous, it seems more intuitively that high competition relates to incentives to become better than the rest. Consequently, the same relation is expected for both product as process innovation, as both types are designed to improve upon competitors.

Hypothesis 3: Competition is significantly positively related to the innovativeness of entrepreneurs measured by newness of the product (i.e. product innovation).

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[9] Explained in detail in Section 4.2.

Hypothesis 4: Competition is significantly positively related to the innovativeness of entrepreneurs measured by newness of technology (i.e. process innovation).

3. Data

This section discusses the data that is used for the analysis. It is divided in three parts. The first part concerns the data and sample in general, and how the data was collected. The second part contains a description of the variables. Finally, some descriptive statistics of the sample are provided.

3.1. Data and sample

This study makes use of data on the individual level, provided by the Global Entrepreneurship Monitor (GEM), and data on industry level, provided by the Structural Analysis (STAN) database of the OECD for the United Kingdom. The Global Entrepreneurship Monitor is a population-based survey on entrepreneurial activity conducted in over 50 countries, which is obtained through door-to-door and telephone surveys. Of the GEM data, only the individuals who are either actively involved in starting up a business (nascent entrepreneurs) or own a young business for less than 42 months – combined also known as total early-stage entrepreneurial activity – are included in this study.

STAN provides annual measures for analyzing industrial performance across countries. They make use of a standard industry list, based on the International Standard Classification of all economic activities (ISIC, Rev.3). The nine main industries – agriculture, hunting, forestry and fishing; mining and quarrying; manufacturing; electricity, gas and water supply; construction; wholesale, retail trade, hotels and restaurants; transport, storage and communications; finance, insurance, real estate and business services; community, social and personal services (from now on referred to as 'the nine main industries') – are used, which are included in the competition variable.

In the GEM database, the United Kingdom has the most observations in three consecutive years. However, the United Kingdom only covers enough observations[10] from 2003 to 2005 and 2007. For the sake of the model, only sequential years are included, resulting in a sample size of 2,432 early-stage entrepreneurs between the age of 18 and 65 in the period 2003-2005. The year 2003 contains a sample of 993

[10] Since there need to be enough observations for each of the nine main industries (minimum of 14 observations with the exception of the mining and quarrying, and the electricity, gas and water supply industries), 400 observations for total early-stage entrepreneurship per year is considered the minimum.

entrepreneurs, 2004 contains 969 observations, and 2005 contains 470 observations (see Appendix A).

3.2. Variables

This section discusses the dependent and independent variables used in the analysis. In the first section, the two dependent variables are explained. The second section discusses the human capital indicators, whereas the third section contains the competition level indicator. The final section goes into the additional control variables.

3.2.1. Dependent variables: Innovation

A wide range of measures have been used in previous studies, such as patent count, R&D expenditures and the amount of new products or services introduced into the market, in order to capture innovation (Aghion et al., 2005; Yusada, 2005; Hansen, 1992). However, this study uses different measures. Before explaining the dependent variables, it is important to understand the reasons for not choosing the previously mentioned measures, which have been used numerous times in the literature. For the main model, R&D expenditures is not used as this is considered to be an input for innovation instead of an output (Hansen, 1992). Furthermore, even if it did measure output, it is unlikely that the new ventures have already invested in R&D within the first months. Innovation is also not measured by patent count, as it is unlikely that entrepreneurs already have granted patents – the average time from filing an application to receiving a granted patent is approximately three and a half years with high variations (Machlup, 1962). Consequently, patent count is not a good measure for the innovativeness of entrepreneurs. Therefore, an entrepreneur's innovativeness will be measured with newness of product or service and newness of technology, which are obtained from the GEM dataset, which is similar to Atuahene-Gima's (1996) method to measure innovation:

Newness of products and services (Entrepreneurial Product Innovation)

This variable measures whether (potential) customers consider the product or service new as perceived by the entrepreneur. This dummy variable is coded 1 if the product or service is new to all or some customers, and takes the value 0 if the product is already familiar to all customers. This indicator is obtained through the following item in the GEM's survey: "How many (potential) customers consider the product new/unfamiliar". Originally this variable consisted out of three categories, i.e. many, few and none. For interpretation purposes the categories have been recoded to two categories – new to some or all; new to none. This measure is used as dependent variable for controlling hypothesis 1 and 3.

Newness of technology (Entrepreneurial Process Innovation)

This variable measures whether the entrepreneur uses technology that has been available for less than a year as perceived by the entrepreneur. It takes on the value 1 if new technology is used, and 0 if otherwise. This variable originates out of two questions. The first has only been asked in the period between 2002 and 2004, whereas from 2005 on worth they switched to the second question. In principle, these questions in the GEM's survey are the same: "were the technologies or procedures available more than a year ago?". However, between 2002 and 2004, prospect were only allowed to choose either yes or no, whereas later on (2005+) they had more options – the entrepreneur uses: the very latest technology (less than 1 year available); new technology (1 to 5 years available); or old technology (longer than 5 years available). These questions have been combined to a binary variable which indicates whether the entrepreneur has used technologies or procedures that were not available a year ago.

3.2.2. Independent variables: Human capital

The following independent variables are used to capture the human capital levels of the entrepreneurs. All of the human capital indicators are considered to be individual-specific, and therefore not easily transferable across individuals:

High education

This binary variable measures the highest educational attainment of the entrepreneur. When the entrepreneur has attained a post-secondary or/and a graduate experience, this variable takes the value 1. It takes the value 0 if otherwise. According to Becker (1964), education is the most important human capital indicator that increases productivity and efficiency of workers. He argues that education increases knowledge, which in turn creates makes individuals more likely to detect economic opportunities. Moreover, this increase in knowledge is also a necessity to be able to exploit these opportunities. It is highly expected that this variable is positively related with both *newness of product or service* and *newness of technology*, as previous literature also found a positive relation with innovation (Dakhli and De Clercq, 2004; Marvel and Lumpkin, 2007; Chi and Qian, 2010). Following Marvel and Lumpkin's (2007) distinction between general and specific human capital, this variable is considered as a general human capital.

Start-up skills

Start-up skills measures whether the entrepreneur considers himself to have sufficient knowledge, skill and experience to start a new business. This dummy variable is coded 1 if the entrepreneur considers his start-up skills to be sufficient, and 0 if otherwise. Yap and Souder (1994) found that individuals with higher start-up skills are more likely to successfully start up a new firm. These skills therefore lower entry barriers for the entrepreneur, which allows them to take the risk of starting their own company. There might be individuals that have come up with great ideas, but do not dare to take the risk of implementing them as they lack the skills. Consequently, it is expected that start-up skills is positively related to both *newness of products and services* and *newness of technology.* However, the expectations for the relationship with *newness of technology* are a bit lower. Early-stage entrepreneurs often do not have the resources to use the latest technology. However, they do have the advantage to be very versatile and are therefore able to implement new technology far easier than incumbent firms. According to Marvel and Lumpkin (2007), start-up skills are considered as specific human capital.

Previous business ownership experience

This variable measures whether the entrepreneur has owned and shut down a business in the past 12 months. If so, this variable takes on the value 1. If the prospect did not own and shut down a previous business in the past year, the variables takes the value 0. Experienced individuals are more likely to discover new market opportunities (Becker, 1994; Marvel and Lumpkin, 2007). The interest here is whether or not business ownership experiences influences the innovativeness of the entrepreneurs. However, it might depend on whether the ownership experience was positive or negative, which is not controlled for. Negative experiences might diminish incentives to take a risk by innovating, whereas a positive experience might increase the risk taking behavior of the entrepreneur. This variable is considered as general human capital.

3.2.3. Independent variables: Competition

Competition is measured using the *mark-up* according to Griffith et al. (2006). A short explanation of the variable is described here, whereas a more detailed explanation of how this variable actually does measure competition is discussed in section 4.1.

Mark-up

This continuous variable measures the economic rents of each of the nine main industries. These economic rents are measured using the *mark-up* developed by Griffith et al. (2006). Their measure of economic rents is the value-added as a share of labour and capital costs, where all variables are in nominal prices found in the STAN database. A higher *mark-up* means more economic rents. As stated in the literature review (see section 2.3.), economic rent is considered a crucial factor in deciding whether to innovate (Arrow, 1962; Schumpeter, 1934; Aghion et al., 2005). A higher *mark-up* (i.e. higher economic rents) means less competition on the main industry, whereas a lower *mark-up* (i.e. lower economic rents) means more competition on the main industry. For more intuitive interpretation purposes, the *mark-up* is included in the model by subtracting it from the value 1. In other words, it becomes '*one-minus-the-mark-up'* where a higher value presents higher competition levels. Vice versa, lower values would mean lower product competition levels on the market.

3.2.4. Control variables

Age

These categorical variables indicate the age of the entrepreneur. An older individual has had more time and experience to discover opportunities and develop an innovative product or service (Marvel and Lumpkin, 2007). However, there are those that find a negative relationship between age and innovation, which is argued by a decrease in motivation and risk-taking as well as by difficulties to keep up with technological change (Dalton and Thompson, 1971). The age categories are divided as follows: 17-24; 25-34; 35-44; 45-54; 55-64. There were not enough observations for entrepreneurs below the age of 17 and above the age of 64, which is why these are not accounted for. In the model, the category between the age of 17 and 24 is used as reference group.

There are reasons to believe that *age* would affect the innovativeness of the entrepreneur in a non-linear manner. A way to utilize this in a model is to use a continues measure for age, and then include a separate quadratic variable of *age.* This is not done in this study, as the turning point of age is above the age of 65. Such a turning point is not useable, and therefore *age* categories are included.

Year

To control for time-specific effects, year dummies for 2003 until 2005 are added. The year 2003 is used as the reference year in the analyses.

3.3. *<u>Descriptive analyses</u>*

This section contains some descriptive analyses of the data, in order to give a more comprehensive overview of the data.

Table 1 – Product innovation performance – in terms of newness of the product or service (as perceived by the entrepreneur) – of early-stage entrepreneurs among different education levels in the United Kingdom for 2003-2005

	United Kingdom (n=2,432)	
	Low/medium education	*High education*
<u>Newness of product/ service:</u>		
New to some/ all consumers	*418 (34.95%)*	*559 (45.23%)*
Not new to any consumers	*778 (65.05%)*	*677 (54.77%)*

Source: Adult Population Survey, Global Entrepreneurship Monitor 2001 - 2008.

In addition, Pearson Chi-squared tests of independence show that there is significant evidence that education and product innovation are not independent of each other (X_2=26.71,p<0.01).

Table 1 shows an overview of the newness of products and services (i.e. product innovation) among different education levels concerning the sample. The sample contains 1,236 highly educated early-stage entrepreneurs, of which 559 (i.e. 45.23%) considers his products or services new to some or all consumers. The remaining 1,196 early-stage entrepreneurs have obtained a low or medium education level, of which 418 (i.e. 34.95%) considers his products or services new to some or all consumers. This shows that highly educated early-stage entrepreneurs consider their products or services new to some or all consumers relatively more often than low and medium educated entrepreneurs in this sample. Furthermore, Pearson's Chi-squared test shows significant evidence that education and are not independent of each other.

However, Table 2 shows a different pattern concerning the newness of technology (i.e. process innovation) among different education levels. It shows that of the 1,236 highly educated entrepreneurs, only 171 (i.e. 13,83%) use technology that has not been available more than 12 months ago. Correspondingly, 146 (i.e. 12,21%) of the 1,196 low and medium educated entrepreneurs use new technology. In this sample, low (and medium) and highly educated entrepreneurs have relatively the same probability of using new technology. Moreover, the Pearson Chi-squared test shows no significant evidence of dependency between education level and newness of technology.

Table 2 – Process innovation performance – in terms of newness of technology used (as perceived by the entrepreneur) – of early-stage entrepreneurs among different education levels in the United Kingdom for 2003-2005

	United Kingdom (n=2,432)	
	Low/medium education	*High education*
Newness of technology		
Technology exists less than 1 year (new technology)	*146 (12.21%)*	*171 (13.83%)*
Technology exists more than 1 year (old technology)	*1,050 (87.79%)*	*1,065 (86.17%)*

Source: Adult Population Survey, Global Entrepreneurship Monitor 2001 - 2008.

In addition, Pearson Chi-squared tests of independence show that there is no significant evidence that education and process innovation are dependent of each other (X_2=1.42,p>0.10).

Table 3 shows the newness of products or services among early-stage entrepreneurs in the United Kingdom who perceive their own start-up skills as sufficient to start their own business. Remarkable is that only 297 of the 2,432 included early-stage entrepreneurs find their start-up skills insufficient. Of these entrepreneurs, only 110 (i.e. 37.04%) perceive their products or services as new to some or all consumers. Likewise, only 867 (i.e. 40,61%) of the remaining 2,135 entrepreneurs who did consider their start-up skills to be sufficient, perceives their products or services new to some or all consumers. The relative difference between the product innovation of the entrepreneurs that find their start-up skills to be insufficient and that of entrepreneurs that find their start-up skills to be sufficient is small. According to

Pearson's Chi-squared test, there is no significant evidence that start-up skills and product innovation are dependent of each other.

Table 3 – Product innovation performance – in terms of newness of the product or service (as perceived by the entrepreneur) – of early-stage entrepreneurs among different start-up skills levels in the United Kingdom for 2003-2005

	United Kingdom (n=2,432)	
	Insufficient start-up skills	*Sufficient start-up skills*
Newness of product/ service:		
New to some/ all consumers	*110 (37.04%)*	*867 (40.61%)*
Not new to any consumers	*187 (62.96%)*	*1,268 (59.39%)*

Source: Adult Population Survey, Global Entrepreneurship Monitor 2001 - 2008.

In addition, Pearson Chi-squared tests of independence show that there is no significant evidence that start-up skills and product innovation are dependent of each other (X_2=1.38,p>0.10).

Table 4 – Process innovation performance – in terms of newness of technology used (as perceived by the entrepreneur) – of early-stage entrepreneurs among different start-up skills levels in the United Kingdom for 2003-2005

	United Kingdom (n=2,432)	
	Insufficient start-up skills	*Sufficient start-up skills*
Newness of technology		
Technology exists less than 1 year (new technology)	*44 (14.81%)*	*273 (12.79%)*
Technology exists more than 1 year (old technology)	*253 (85.19%)*	*1,862 (87.21%)*

Source: Adult Population Survey, Global Entrepreneurship Monitor 2001 - 2008.

In addition, Pearson Chi-squared tests of independence show that there is no significant evidence that start-up skills and process innovation are dependent of each other (X_2=0.95,p>0.10).

Similarly, Table 4 shows the process innovation among the different levels of start-up skills. Of the 2,135 entrepreneurs with sufficient start-up skills, only 273 (i.e.12.79%) use new technology. Only 44 (i.e. 14.81%) of the 297 entrepreneurs who consider their start-up skills as insufficient, use new technology. Again, the relative differences between the two groups of entrepreneurs are minor. The Pearson Chi-squared test shows that there is no significant evidence of dependency between start-up skills and process innovation.

The product innovation performance among entrepreneurs who either have previous business ownership experience in the past 12 months, and the entrepreneurs who did not, is presented in Table 5. Of the total sample (i.e. 2,432 entrepreneurs), only 163 entrepreneurs had previous business ownership in the past 12 months. However, of these early-stage entrepreneurs, 74 (i.e. 45.40%) entrepreneurs consider their products or services new to all or some consumers. Of the 2,269 remaining entrepreneurs without previous business ownership in the past 12 months, 903 (i.e. 39.80%) perceive their products or services new to some or all consumers. The relative difference between the two groups of entrepreneurs is 5.6%. However, the Pearson Chi-squared test does not provide significant evidence that previous business ownership experience in the past 12 months is dependent on the newness of the product or service.

Table 5 – Product innovation performance – in terms of newness of the product or service (as perceived by the entrepreneur) – of early-stage entrepreneurs among different experience levels (in terms of previous business ownership experience in the past 12 months) in the United Kingdom for 2003-2005

	United Kingdom (n=2,432)	
	No previous business ownership experience in the past 12 months	*Previous business ownership experience in the past 12 months*
Newness of product/ service:		
New to some/ all consumers	*903 (39.80%)*	*74 (45.40%)*
Not new to any consumers	*1,366 (60.20%)*	*89 (54.60%)*

Source: Adult Population Survey, Global Entrepreneurship Monitor 2001 - 2008.

In addition, Pearson Chi-squared tests of independence show that there is no significant evidence that previous business ownership in the past 12 months and product innovation are dependent of each other (X_2=1.99,p>0.10).

Table 6 presents process innovation performance among entrepreneurs who have had previous business ownership in the past 12 months, and the entrepreneurs who did not. Of the 163 early-stage entrepreneurs with previous business experience, only 25 (i.e. 15.34%) uses new technology. Similarly, 292 (i.e. 12.87%) entrepreneurs of the 2,269 entrepreneurs without previous ownership experience, use new technology. The Pearson Chi-squared test shows no significant evidence of dependency between newness of technology and previous business ownership experience in the past 12 months.

Further descriptive tables are included in Appendix A and B.

Table 6 – Process innovation performance – in terms of newness of technology used (as perceived by the entrepreneur) –of early-stage entrepreneurs among different experience levels (in terms of previous business ownership experience in the past 12 months) in the United Kingdom for 2003-2005

	United Kingdom (n=2,432)	
	No previous business ownership experience in the past 12 months	*Previous business ownership experience in the past 12 months*
Newness of technology		
Technology exists less than 1 year (new technology)	*292 (12.87%)*	*25 (15.34%)*
Technology exists more than 1 year (old technology)	*1,977 (87.13%)*	*138 (84.66%)*

Source: Adult Population Survey, Global Entrepreneurship Monitor 2001 - 2008.

In addition, Pearson Chi-squared tests of independence show that there is no significant evidence that previous business ownership in the past 12 months and process innovation are dependent of each other (X_2=0.82,p>0.10).

4. Method

This section discusses the methods that are used to examine the relationship between human capital and competition with the innovativeness of the entrepreneur. The first section explains how the *mark-up* (i.e. the measure for competition) is calculated. The second section contains a description of the models that examine the individual effects of human capital and competition on innovation. The third section contains the main model for the analysis, which has both human capital and competition included. The final section discusses some models that add to the robustness of the model and check whether the assumptions made in previous literature holds. The results of the models are provided in section 5.

4.1. <u>The mark-up</u>

For this study, a measure is constructed following Griffith et al. (2006), which presents the economic rents for each of the nine main industries and each of the included years (i.e. 2003-2005). This measure is the *mark-up*, which is preferred above other often used competition measures, i.e. market share; market concentration (Boone, 2008). According to Boone (2008), a measure like the *mark-up* is theoretically more robust than the previously mentioned competition measures. Moreover, the data needed to calculate the *mark-up* are widely available across countries.

This measure of economic rents is generated by using the STAN database by calculating the value-added as a share of labour and capital costs:

$$markup = \frac{ValueAdded}{LabourCosts + CapitalCosts} \qquad (1)$$

Roeger (1995) used the same measure, where he pointed out that this measure contains an assumption of constant returns to scale. In other words, the marginal costs are always equal to the average costs. Otherwise, this measure is biased upwards or downwards compared to the 'true' *mark-up*, depending on whether it has decreasing or increasing returns to scale.

There is another downside to the *mark-up.* A limitation of this measure is that it is not only affected by competition, but factors such as cost and demand shocks could also greatly affect the *mark-up.* Especially since only a short period is included in the analysis (i.e. 2003-2005), these shocks can alter the *mark-up* unnoticed, which is why further examination on the *mark-up* in the United Kingdom is conducted. In this study, the assumption is made that the *mark-up* is only affected by competition.

The average *mark-up* for the nine main industries in the United Kingdom and their total economy for the period between 2000 and 2007 is presented in Table 7.

The first thing to notice is the relatively high *mark-up* score for mining and quarrying, i.e. a *mark-up* of 3.296. A higher *mark-up* score stands for less competition. As the mining and quarrying industry is not large in the United Kingdom (which is also reflected in the sample (see Appendix A)), it was expected that this industry received a high *mark-up* score. It indicates that either the labour and capital costs in this industry are relatively low, or the value added in production is relatively high. Low capital and labour expenditures in an industry means that the firms in total do not often invest in expensive machinery, knowledge and other technologies.

Table 7 – Average industry mark-up in the United Kingdom (2000-2007)

Industry	Mark-up
agriculture, hunting, forestry and fishing	*1.469*
mining and quarrying	*3.296*
manufacturing	*1.232*
electricity, gas and water supply	*1.719*
Construction	*1.830*
wholesale, retail trade, hotels and restaurants	*1.283*
transport, storage and communications	*1.014*
finance, insurance, real estate and business services	*1.445*
community, social and personal services	*1.049*
total economy	*1.593*

Source: STAN database 2000-2007 provided by the OECD

Furthermore, the community, social and personal services industry show the lowest scores, i.e. a *mark-up* of 1.049. This is most likely due to the nature of this industry, which is non-profit. Economic rents are not often obtained in non-profit organisations, as this is not their objective. The transport, storage and communications industry have the lowest *mark-up* with 1.049. In contrast to the community, social and personal services industry, this industry actually does have obtaining high profits as one of their main objectives. In this case, the low *mark-up* score does indicate a very aggressive competitive market, in which the economic rents are rather low.

Figure 1 – mark-up trends for the nine main industries in the United Kingdom between 2000 – 2007.

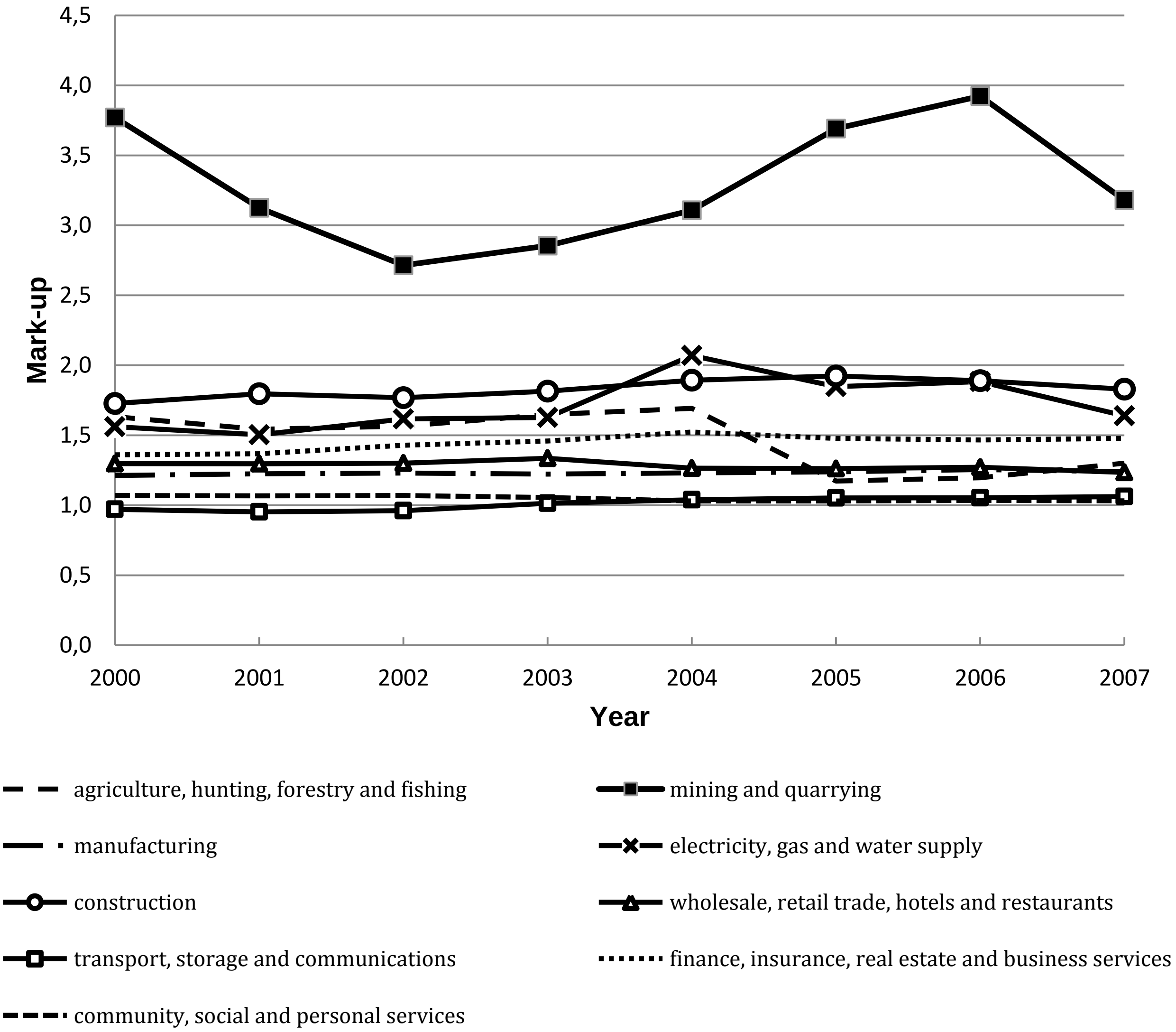

Figure 1 shows the trends of the *mark-up's* for the nine main industries in the United Kingdom between 2000 and 2007. All industries show to be relatively stable, with the exception of the mining and quarrying industry. Since the industry is not large in the United Kingdom, every entrant might drastically change economic rents in the industry, which is shown in the strong decline between 2000 and 2002 and the strong increase between 2003 and 2006. Furthermore, as the figure shows that the rest of the industries remain stable, the *mark-up* might not be susceptible to major demand shocks. Demand shocks in this period would probably have caused much more fluctuation in the *mark-up*.

4.2. *Individual effects of human capital and competition on innovation*

The individual effects – i.e. human capital on innovation and competition on innovation – are examined using separate models. This in order to confirm the findings of previous studies and to control what the effects are when excluding competition or human capital. The results of these models are included in section 5.1.

4.2.1. *Human capital on the entrepreneurial product/process innovation*

The following logit model examines the effect of human capital of entrepreneurs on their innovativeness. More specific, this model explains the innovativeness of the entrepreneurs - measured by both process innovation as product innovation (see section 3.2.1) – only by including the human capital indicators (see section 3.2.2) and the control variables (see section 3.2.4). All included variables in these models are obtained exclusively from the GEM database. The probit models are specified as follows:

$$\Pr(EPI_i = 1) = F(\beta_0 + \beta_1 heduc_i + \beta_2 sus_i + \beta_3 pboe_i + \beta_4 age25t34_i + \beta_5 age35t44_i + \beta_6 age45t54_i + \beta_7 age55t64_i + \beta_8 2004_i + \beta_9 2005_i) \tag{2}$$

$$\Pr(EPrsI_i = 1) = F(\beta_0 + \beta_1 heduc_i + \beta_2 sus_i + \beta_3 pboe_i + \beta_4 age25t34_i + \beta_5 age35t44_i + \beta_6 age45t54_i + \beta_7 age55t64_i + \beta_8 2004_i + \beta_9 2005_i) \tag{3}$$

In these regressions *EPI* stands for entrepreneurial product innovation (equation 2), *EPrsI* for entrepreneurial process innovation (equation 3), *heduc* for high education and *pboe* for previous business ownership experience. *Age25t34, age35t44, age45t54, age55t64* are the age dummies which indicate the age category of the entrepreneur, with the age category between 17 and 24 used as the reference group. Year dummies are also included, with 2003 as the reference year. β_0 indicates the constant. The *i* stands for individual. These regressions allow for examination of only the individual effects of human capital, of which the results are presented in section 5.1.

4.2.2. *Competition on the entrepreneurial product/process innovation*

For competition, similar models are developed as in the previous section in order to control whether the claims of previous literature apply for this dataset and to check what the effect is under these circumstances.

The main challenge in this model is to incorporate the effect of competition. The first challenge is to find a solid measure that presents the amount of competition in an industry (see section 4.1). However, the main problem lies with finding a suitable instrumental variable for it. Competition is endogenous due to reverse causality with innovation. As discussed in section 2.3, competition can affect innovation. However, the effect can also be the other way around, i.e. innovation influences the competition level on the market. Without going into too much detail, it is not unlikely that companies will compete more aggressively when products are similar, due to lack off innovation. Furthermore, markets might also become more competitive as the firms innovate. Without controlling for endogeneity (including reverse causality), the estimated coefficients are biased. Interpreting the results becomes impossible when not including an exogenous instrument.

The instrument needs to be correlated with competition levels, but uncorrelated with the independent variables. *Other Taxes less Subsidies on production (OTXS)* is used to instrument the competition measure - the *mark-up* (see section 4.1). Tax policies in an industry are known to affect the competition levels in an industry as governments use it as an instrument to modify market shares. Moreover, a relation with tax policy and the innovation of entrepreneurs is unlikely. Consequently, *OTXS* is considered a solid instrument. The data is obtained from the STAN database, which contains *OTXS* for each of the nine main industries between 2000 and 2007.

However, reverse causality is more likely to occur between entrepreneurial product innovation and the industry product competition level, than between entrepreneurial process innovation and the industry product competition level. Bringing new innovative products and services on a market can influence complete market structures, including the competition levels on industrial level. Using new technologies does increase one's efficiency. On market level, a process innovation would affect the competition level. However, as this study examines on a broader scope (i.e. industry level), the effect is unlikely. Moreover, new technologies might have either been developed by the entrepreneur, but more likely they bought it from the market. These technologies are therefore available for the whole industry, making reverse causality less likely. Therefore, competition is only instrumented in the product innovation regression. The probit models are defined as follows:

$$\Pr(EPI_i = 1) = F(\beta_0 + \beta_1(1-\hat{u})_i + \beta_2\, age25t34_i + \beta_3 age35t44_i + \beta_4 age45t54_i + \beta_5 age55t64_i + \beta_6 2004_i + \beta_7 2005_i) \quad (4)$$

$$\Pr(EPrsI_i = 1) = F(\beta_0 + \beta_1(1-u)_i + \beta_2\, age25t34_i + \beta_3 age35t44_i + \beta_4 age45t54_i + \beta_5 age55t64_i + \beta_6 2004_i + \beta_7 2005_i) \quad (5)$$

Where *EPI* stands for entrepreneurial product innovation – in terms of newness of product or service – and *EPrsI* for entrepreneurial process innovation – in terms of newness of technology (see section 3.2.1). The *i* presents the individual. The *mark-up* of the corresponding industry instrumented by *OTXS* is presented by *û*, whereas the non-instrumented *mark-up* is presented by *u*. For interpretation purposes, the *mark-up* is included as 'one-minus-the-mark-up'. The age variables – *age25t34, age35t44, age45t54, age55t64* – indicate in what age category the entrepreneur belongs to. The age category 17-24 is used as reference. 2004 and 2005 are year dummies, with 2003 as reference. β_0 indicates the constant.

4.3. The main model

This study intends to understand the dynamics between human capital and competition with entrepreneurial innovation. For this analysis two models are developed, which contain both the effects of human capital and competition on the innovativeness of the entrepreneur – the first model with product innovation of the entrepreneur as independent variable, the second with process innovation of the entrepreneur.

Both the product innovation and the process innovation measure have individual probit regression models, as described below:

$$\Pr(EPI_i = 1) = F(\beta_0 + \beta_1 heduc_i + \beta_2 sus_i + \beta_3 pboe_i + \beta_4 (1 - \hat{u})_i + \beta_5\, age25t34_i + \beta_6 age35t44_i + \beta_7 age45t54_i + \beta_8 age55t64_i + \beta_9 2004_i\ + \beta_{10} 2005_i) \quad (6)$$

$$\Pr(EPrsI_i = 1) = F(\beta_0 + \beta_1 heduc_i + \beta_2 sus_i + \beta_3 pboe_i + \beta_4 (1 - u)_i + \beta_5\, age25t34_i + \beta_6 age35t44_i + \beta_7 age45t54_i + \beta_8 age55t64_i + \beta_9 2004_i\ + \beta_{10} 2005_i) \quad (7)$$

Where *EPI* stands for entrepreneurial product innovation, *EPrsI* for entrepre process innovation (see section 3.2.1), *heduc* for high education and *pboe* for previous business ownership experience (see section 3.2.2). The *mark-up* of the corresponding industry instrumented by *OTXS* is presented by *û*, whereas the non-instrumented *mark-up* is presented by *u*. Since a higher *mark-up* means less competition, it is implemented in the model as *one-minus-the-mark-up*, i.e. 1 – û and 1 – *u*. In this case, a higher value for *one-minus-the-mark-up* stands for higher competition levels. The age variables – *age25t34, age35t44, age45t54, age55t64* – indicate in what age category the entrepreneur belongs to. The age category 17-24 is used as reference. β_0 indicates the constant. The regressions cover the years between 2003 until 2005. In the equations, this is shown by the variables 2004 and 2005, where the year 2003 serves as the reference year. The subscript *i* stands for the individual.

The model presented in equation (6) is used to test hypothesis 1 and 3, whereas the model of equation (7) is used to test hypothesis 2 and 4.

These models contain multiple levels, as there are observations on the individual entrepreneurial level and observations on industry level. One could argue that this analysis should be performed using a multilevel model. However, since there are only 9 observations on level 2 for each year, the multilevel model might not be accurate. A multilevel model has been included in this study in Appendix C.

For all models that include competition, the data is managed in such a way, that for each entrepreneur the *mark-up* is included for his industry. This makes it possible to include both levels, even though it is not totally accurate. There is a downside to this method. Since all entrepreneurs in the same industry have the same value for their *mark-up*, we are actually counting multiple observations for the *mark-up,* while there actually is only one for each industry. This leads to somewhat inaccurate analyses as the computed degrees of freedom do not correspond to the actual amount of *mark-up* observation.

In order to interpret the magnitude of the effects of the probit models, the marginal effects are calculated. The coefficients of the main model only show the sign and significance of the effects, but do not present the magnitude. The marginal effects do present this.

4.4. Supportive models

This section provides extra analyses that contribute to the robustness of the main model and provides different insights to the topic. In the first supportive model, this is done by replacing the *mark-up* with a different competition measure, namely the expected competition level as perceived by the entrepreneur. The second, examines the effect of both human capital and competition on total industry R&D intensity. Results are presented in section 5.3.

4.4.1. *Replacing the competition measure*

In order to check for the robustness of the *mark-up*, a probit model is developed with the *mark-up* replaced with the competition expectancy of the individual entrepreneurs. A limitation of this measure is that is a subjective measure, which depends heavily on the insights of the individual. However, as is shown in section 5, the results remain relatively similar. Therefore, the models in this section add to the robustness of the main model, as the same effects are found while using different measures.

The models with the replaced competition measure are specified as follows:

$$\Pr(EPI_i = 1) = F(\beta_0 + \beta_1 heduc_i + \beta_2 sus_i + \beta_3 pboe_i + \beta_4 c\hat{o}mp_i + \beta_5 age25t34_i + \beta_6 age35t44_i + \beta_7 age45t54_i + \beta_8 age55t64_i + \beta_9 2004_i + \beta_{10} 2005_i) \quad (8)$$

$$\Pr(EPrsI_i = 1) = F(\beta_0 + \beta_1 heduc_i + \beta_2 sus_i + \beta_3 pboe_i + \beta_4 comp_i + \beta_5 age25t34_i + \beta_6 age35t44_i + \beta_7 age45t54_i + \beta_8 age55t64_i + \beta_9 2004_i + \beta_{10} 2005_i) \quad (9)$$

These equations are similar to equations (6) and (7), with the exception of the *mark-up* (û). In this case, competition is measured using the expectancy of the entrepreneur. In equations (8) and (9) this variable is represented by *comp*, which is instrumented by total amount of employees. In the main model, only equation (6) is instrumented. However, the competition measure is on entrepreneurial level for equation (8) and (9), whereas it is on industrial level for equations (6) and (7). Just like on industrial level, the newness of a product or service of an entrepreneur can influence the expected competition. Moreover, the same now also goes for process innovation. Using a new technology is more likely to affect the entrepreneur's expectancy of innovation, than it is to affect the economic rents of the entire industry. Consequently, reverse causality is likely in equation (9), whereas it was not in equation (7). To avoid reverse causality, expected completion is instrumented.

The data for equations (8) and (9) are all available in the GEM database, as the STAN database is only used to provide industry level data.

4.4.2. Human capital and competition on R&D intensity

This section describes an OLS model in which the effects of human capital and competition are tested on a completely different measure for innovation – R&D intensity. Whereas the main model contains a subjective measure of the entrepreneur's innovativeness, the model including R&D intensity objectively measures the innovativeness of the complete industry. RDI is defined in a similar fashion as Hopman and Rojas-Romagosa (2010), where it is measured as the R&D expenditure divided by the value added:

$$RDI = \frac{R\&D\ expenditures}{ValueAdded} \quad (10)$$

The data used to calculate R&D intensity (i.e. equation (10)) are obtained from the STAN database. Consequently, the effects of human capital indicators from the GEM database on the R&D intensity obtained from the STAN database is examined:

$$
\begin{aligned}
RDI_i = \ & \beta_0 + \beta_1 heduc_i + \beta_2 sus_i + \beta_3 pboe_i + \ \beta_4(1 - \hat{u})_i + \beta_5 \, age25t34_i \\
& + \beta_6 age35t44_i + \beta_7 age45t54_i + \beta_8 age55t64_i + \beta_9 2004_i \\
& + \beta_{10} 2005_i + \in_i
\end{aligned} \tag{11}
$$

RDI stands for R&D intensity, *heduc* for high education, *sus* for start-up skills, *pboe* for previous business ownership experience, *age25t34, age35t44, age45t54, age55t62* are the categorical variables for the age of the entrepreneur (with the age category 17-24 as reference group), and *2004* and *2005* for year dummies (with 2003 as reference year). The *mark-up* instrumented by *OTXS* is presented by û. Furthermore, β_0 includes the constant, whereas $\in_i$ accounts for all other shocks on RDI that are not accounted for.

This model does not add much to the robustness of the main model, as R&D intensity does not measure the same thing as the main model. The main models measure innovation on among new entrepreneurs, whereas R&D industry incorporates the entire industry. Furthermore, R&D intensity is considered an input, whereas newness of product or services is considered an output (Hansen, 1992). However, it does provide information about how human capital indicators of new entrepreneurs and competition level affect the entire innovation level on the industry. In other words, this model allows for comparison between innovativeness on the individual level and on industry level.

5. Results

This section describes the results of the models described in section 4. First, the results of the individual effects of human capital and competition are presented (equations (2), (3), (4) and (5)). In the second part, the results of the main models are described (equations (6) and (7)). The final part presents the results of the models that add to the robustness (equations (8), (9) and (11)).

5.1. Results of the individual effects of human capital and competition

Table 8 shows the regression results presented by equation (2) and (3). It concerns the relationship of human capital on product and process innovation individually.

Table 8 – Human capital on entrepreneurial product (measured by newness of products and services) and process (measured by newness of technology) innovation in the United Kingdom between 2003 and 2005.

VARIABLES	(2) Probit EPI	(2) Average marginal effects	(3) Probit EPrsI	(3) Average marginal effects
higheduc	0.274***	0.106***	0.094	0.020
	(0.052)		(0.065)	
suskill	0.093	0.036	-0.074	-0.015
	(0.080)		(0.096)	
pboe	0.160	0.062	0.129	0.027
	(0.102)		(0.124)	
age25t34	-0.142	-0.055	-0.151	-0.031
	(0.112)		(0.133)	
age35t44	-0.107	-0.041	-0.237*	-0.049*
	(0.109)		(0.129)	
age45t54	-0.269**	-0.104*	-0.365***	-0.076***
	(0.114)		(0.138)	
age55t64	-0.333***	-0.129**	-0.184	-0.038
	(0.125)		(0.149)	
2004	-0.009	-0.003	0.084	0.019
	(0.058)		(0.071)	
2005	0.001	0.000	-0.245**	-0.045**
	(0.071)		(0.096)	
Constant	-0.309**		-0.896***	
	(0.125)		(0.148)	
Observations	2,432		2,432	

Standard errors in parentheses
Age17t24 is the reference age category
2003 is the reference year
*** p<0.01, ** p<0.05, * p<0.1

Only education level shows to be significantly positively related to product innovation. The marginal effects show that an average entrepreneur with a high education, is 10.6% more likely to have new products or services compared to an average entrepreneur with medium or low educational attainment. Yet, none of the human capital indicators show to be significantly associated with process innovation. Furthermore, the table shows that the probability of producing new products or services is significantly less for early-stage entrepreneurs in the age categories 45-54 and 55-64 compared to those in the category between 17 and 24. The probability of using new technology is significantly less for early-stage entrepreneurs in the age categories 35-44 and 45-54 compared to the reference group. Furthermore, the probability for using new technology is significantly lower in 2005 compared to 2003.

Table 9 – Competition on entrepreneurial product (measured by newness of products and services) and process (measured by newness of technology) innovation in the United Kingdom between 2003 and 2005.

VARIABLES	(4) Probit EPI	(4) Average marginal effects	(5) Probit EPrsI	(5) Average marginal effects
1-û	1.061**	0.414**		
	(0.422)			
1-u			-0.010	-0.002
			(0.104)	
age25t34	-0.141	-0.055	-0.148	-0.031
	(0.112)		(0.132)	
age35t44	-0.101	-0.039	-0.235*	-0.049*
	(0.109)		(0.129)	
age45t54	-0.229**	-0.087**	-0.357***	-0.075***
	(0.114)		(0.137)	
age55t64	-0.280**	-0.106**	-0.174	-0.036*
	(0.125)		(0.148)	
2004	-0.044		0.083	0.018
	(0.058)		(0.071)	
2005	-0.062		-0.244**	-0.045***
	(0.077)		(0.096)	
Constant	0.337*		-0.910***	
	(0.202)		(0.129)	
Observations	2,432		2,432	

Standard errors in parentheses
Wald test of exogeneity: chi2(1) = 2.87 Prob > chi2 = 0.091
Instrumented: 1-û
Age17t24 is the reference age category
2003 is the reference year
*** p<0.01, ** p<0.05, * p<0.1

Table 9 shows the regression results when only including competition and the control variables, such as stated in equation (4) and (5). Important to mention is that in the regression on product innovation *one-minus-the-mark-up* is instrumented by *OTXS*, whereas it is not in the model on process innovation. However, the Wald test of exogeneity is only marginally significant in case of product innovation, meaning that there is no statistical evidence for endogeneity. Still, the instrument is still included as reverse causality is often present making the relation between product competition and product innovation endogenous.

The results show a strong positive relation between *one-minus-the-mark-up* and product innovation – measured by the newness of products and services, whereas no significant relation is found with process innovation – measured by the newness of technology. According to the marginal effects, a 0.1 unit increase in *one-minus-the-mark-up* for an industry, increases the probability for an early-stage entrepreneur in that same industry by 4.14%.

As both human capital as competition is individually insignificantly related to process innovation, it is likely that the same happens in the main model. Also noticeable is that in the results of both equation (2) and (4), the results show that both age category 45-54 and age category 55-64 are significantly negatively related to newness of products or services. Consequently, this is likely to happen as well in the main model. Furthermore, the results of equation (3) and (5) show significant negative relations for the age categories 34-44 and 45-54, which is likely to occur in the main model as well.

5.2. Results of the main model

Table 10 shows the results of the model described in equation (6). The dependent variable is entrepreneurial product innovation measured by *the newness of products and services* (see section 3.2.1). Especially the effects of *high education, start-up skills, previous business ownership experience* and *one-minus-the-mark-up* are of interest. Of the human capital indicators, only *high education* and *previous business ownership experience* display significant relationships with product innovation. Compared to Table 8, *previous business ownership experience* has become significant in the main model. Both *high education* and *previous business ownership* *experience* show positive relationships with product innovation. However, while *start-up skills* does show a positive association with the newness of the product or service, it is not significant.

Table 10 – Human capital and competition on entrepreneurial product innovation (measured by newness of products and services) in the United Kingdom between 2003 and 2005.

VARIABLES	(6) Probit EPI	(6) Average marginal effects
Higheduc	0.240***	0.093***
	(0.054)	
Suskill	0.103	0.040
	(0.080)	
Pboe	0.209**	0.083**
	(0.102)	
1-û	1.176***	0.459***
	(0.411)	
age25t34	-0.169	-0.065
	(0.113)	
age35t44	-0.117	-0.045
	(0.110)	
age45t54	-0.256**	-0.098**
	(0.115)	
age55t64	-0.317**	-0.119**
	(0.127)	
2004	-0.034	
	(0.058)	
2005	-0.083	
	(0.076)	
Constant	0.176	
	(0.214)	
Observations	2,432	

Standard errors in parentheses
Wald test of exogeneity: chi2(1) = 4.02 Prob > chi2 = 0.045
Instrumented: 1-û
Age17t24 is the reference age category
2003 is the reference year
*** p<0.01, ** p<0.05, * p<0.1

In this model, *one minus the mark-up* is instrumented by *OTXS.* The Wald test in Table 10 shows that the competition measure is indeed endogenous, and an instrumental variable is needed. In Table 9, where the human capital indicators were not included in the model, the Wald test was only marginally significant.

The results fully support hypothesis (3), where *one-minus-the-mark-up* is positively related with entrepreneurial product innovation. However, hypothesis (1) is only partially supported. All individual-specific human capital indicators are positively related to the *newness of products and services.* Yet, *start-up skills* does not show to be significantly related to product innovation.

There are some significant differences with the age categories and their reference category (i.e. 17 till 24), just like in Table 8 and Table9. Both, the category of 45 till 54 as the category with ages between 55 and 64 are significant. Both of them show negative relations with the newness of product or services. This means that compared to the reference category – ages between 17 and 24 – entrepreneurs older than 45 are less likely to produce new products or services, while all other factors are held constant. In these results, there are no significant differences between 2003, 2004 and 2005.

The marginal effects show that for an average individual, being highly educated increases the probability to develop new products or services with 9.3% compared to an average entrepreneur with a low or medium education level. Furthermore, an average entrepreneur that has shut down a business within the past 12 months (*pboe*) is 8.3% more likely to have innovative products and services, compared to an average entrepreneur who did not shut down a business in the past 12 months.

For competition it might not be not as easy to just simply say that a one unit increase in *one-minus-the-mark-up* increases the probability for an average entrepreneur to be innovative with products and services by 45.9%. This because it is a continues variable, which is non-linear. Therefore, the marginal effect for this variable only counts for small unit increases. For instance, a 0.1 unit increase in *one-minus-the-mark-up* increases the probability to develop new products and services by 4.59% (i.e. 0.1*0.459) for average entrepreneurs.

As mentioned earlier, the age categories 45-54 and 55-64 are the only age categories that significantly differ on product innovation compared to the reference category, i.e. 17-24. According to the marginal effects, it is 9.8% less probable that an average entrepreneur in the age category of 45-54 develops a new product or service, compared to an average entrepreneur in the age between 17 and 24. For average entrepreneurs between 55 and 64 it is 11.9% less probable that they come up with innovative products or services, compared to the reference group.

As it concerns a probit model with an instrumental variable inserted, the marginal effects were omitted for the year dummies.

Table 11 shows the results of the model presented in equation (7), in which the relations of human capital and competition on process innovation are examined. The dependent variable is the newness of technology (see section 3.2.1). Concerning the independent variables, this model is designed in the same fashion as the model presented in Table 10, except that *one-minus-the-mark-up* is not found to be endogenous in this model. Consequently, it is not instrumented by *OTXS.* It is also unlikely that the use of new technology by entrepreneurs affects the industrial product competition.

According to the results, the relations between human capital and competition on process innovation are totally different then on product innovation. None of the relations between process innovation and the human capital indicators are found to be significant. The same goes for *one-minus-the-mark-up.* Even though the relations are not significant, education level and previous business ownership experience are found to be positively related to process innovation, whereas start-up skills is negatively related. It is therefore safe to say that hypothesis (2) is rejected, as none of the variables is significant, and not all of the variables even show a positive relation.

Competition shows a negative relation, even though it is not significant. Furthermore, the marginal effects of *one-minus-the-mark-up* is relatively small (i.e. -0.003). This even further indicates that competition has almost no effect on the *newness of technology.* Consequently, hypothesis (4) is rejected.

The only variables in the model that have a significant relation on the newness of technology are some of the age categories of the entrepreneur (i.e. age categories 35-44 and 45-54) and the year 2005. Moreover, all of the coefficients of the age categories are negative, meaning that entrepreneurs above the age of 25 are less probable to use new technologies compared to the reference group 17-24. The marginal effects show the magnitude of this decreased probability per category.

Table 11 – Human capital and competition on entrepreneurial process innovation (measured by newness of technology) in the United Kingdom between 2003 and 2005.

VARIABLES	(7) Probit EPrsI	(7) Average marginal effects
higheduc	0.094	0.020
	(0.065)	
suskill	-0.074	-0.015
	(0.096)	
pboe	0.128	0.027
	(0.124)	
1-u	-0.013	-0.003
	(0.104)	
age25t34	-0.151	-0.031
	(0.133)	
age35t44	-0.237*	-0.049*
	(0.129)	
age45t54	-0.365***	-0.076***
	(0.138)	
age55t64	-0.184	-0.038
	(0.149)	
2004	0.085	0.019
	(0.071)	
2005	-0.244**	-0.045**
	(0.096)	
Constant	-0.901***	
	(0.155)	
Observations	2,432	

Standard errors in parentheses
Age17t24 is the reference age category
2003 is the reference year
*** p<0.01, ** p<0.05, * p<0.1

An average entrepreneur between the age of 35 and 44 is 4.9% less probable to use new technologies compared to average entrepreneurs between the age of 17 and 24. The probability to use new technologies is 7.6% less for average entrepreneurs between 45-54, compared to the reference group of average entrepreneurs between the age of 17 and 24.

There is no significant difference between 2004 and the reference year 2003. However, as mentioned above, 2005 does show significant differences. The sign of the 2005 coefficient is negative, meaning that all else held constant, entrepreneurs in 2005 are less likely to use new technologies. According to the marginal effects, average entrepreneurs in 2005 are 4.5% less likely to use new technologies compared to average entrepreneurs in 2003.

To summarize, the results show that hypothesis (1) is partially supported, hypothesis (2) is rejected, hypothesis (3) is fully supported and hypothesis (4) is rejected. Only the hypothesis concerning entrepreneurial product innovations show positive results, whereas those concerning entrepreneurial process innovations are rejected.

5.3. *Results of the supporting models*

Previously, competition was measured by *one-minus-the-mark-up*. Table 12 presents the results when this measure is replaced by the expected competition perceived by the entrepreneurs themselves.

Like the previous models, the competition variable is instrumented. This time, the competition measure (i.e. competition level expected by the entrepreneur) is instrumented by *total amount of employees* for both product and process innovation. Whereas in the previous models there is no expected reverse causality between the *mark-up* and process innovation, there probably is reverse causality when using expected competition perceived by the entrepreneur as a measure. It is likely that the expected competition is affected by the newness of technology of the entrepreneur. This is due to the level of the competition measure. The expected competition is on the individual entrepreneur level, whereas *one-minus-the-mark-up* is an industry level competition measure. Even though the Wald test is only marginally significant for process innovation, the instrument is still included.

Compared to Table 10, the results from equation (8) shown in Table 12 have changed a bit. The signs of all relations have stayed the same. The relationships between education level and previous business ownership experience on product innovation are still significant. However, education level had the larger marginal effect of the two, whereas in Table 12, previous business ownership experience has taken the lead. The remaining results are still very similar to the ones shown in Table 10.

Moreover, the results of equation (9) shown in Table 12 have changed little compared to the results in Table 11. All human capital indicators remain insignificantly related to the newness of technology, with the exception of *high* *education*, which has now become marginally positively related to process innovation. Yet, when replacing *one-minus-the-mark-up* with a different competition variable – i.e. the competition level that the entrepreneur expects instrumented by the total amount of employers in the industry – competition remains insignificantly related to process innovation. Changing a key variable is a huge change in a model.

Table 12 – Human capital and the expected competition on entrepreneurial product (measured by newness of products and services) and process (measured by newness of technology) innovation in the United Kingdom between 2003 and 2005.

VARIABLES	(8) Probit EPI	(8) Average marginal effects	(9) Probit EPrsI	(9) Average marginal effects
higheduc	0.169*** (0.065)	0.065***	0.111* (0.064)	0.026*
suskill	0.043 (0.082)	0.016	-0.048 (0.097)	-0.011
pboe	0.174* (0.101)	0.069*	0.114 (0.118)	0.028
cômp	1.040*** (0.223)	0.403***	-0.332 (0.340)	-0.078
age25t34	-0.147 (0.111)	-0.056	-0.147 (0.126)	-0.033
age35t44	-0.103 (0.110)	-0.040	-0.227* (0.124)	-0.051*
age45t54	-0.297*** (0.114)	-0.112***	-0.337** (0.141)	-0.071***
age55t64	-0.337*** (0.127)	-0.125***	-0.179 (0.142)	-0.039
2004	0.036 (0.058)		0.069 (0.071)	
2005	-0.070 (0.071)		-0.195* (0.103)	
Constant	-2.012*** (0.369)		-0.266 (0.674)	
Observations	2,432		2,432	

Standard errors in parentheses
Wald test of exogeneity regression (8): chi2(1) = 4.36 Prob > chi2 = 0.037
Wald test of exogeneity regression (9): chi2(1) = 3.79 Prob > chi2 = 0.052
Instrumented: cômp
Age17t24 is the reference age category
2003 is the reference year
*** p<0.01, ** p<0.05, * p<0.1

In short, even when using a different measure for competition, the overall relations remain relatively the same for both product and process innovation, thus adding to the robustness of the main model. The exception is of course the significant relation of education on process innovation. However, the overall picture remains the same, thus adding to the robustness of the main model.

Table 13 – Human capital and competition on total industry R&D intensity in the United Kingdom between 2003 and 2005.

VARIABLES	(11) Probit EPI
Higheduc	0.001
	(0.001)
Suskill	-0.001
	(0.001)
Pboe	-0.001
	(0.001)
1-û	-0.033***
	(0.004)
age25t34	0.001
	(0.002)
age35t44	0.000
	(0.002)
age45t54	0.000
	(0.002)
age55t64	0.002
	(0.002)
2004	0.001
	(0.001)
2005	0.004***
	(0.001)
Constant	-0.007
	(0.002)
Observations	2,432

Standard errors in parentheses
Wald test of exogeneity: chi2(1) = 85.88 Prob > chi2 = 0.000
Instrumented: 1-û
Age17t24 is the reference age category
2003 is the reference year
*** p<0.01, ** p<0.05, * p<0.1

Table 13 shows the results of equation (11), where the dependent variables are changed for total industry R&D intensity. Whereas the main models use innovation measures on the individual early-stage entrepreneur level, this model uses a measure on industry level. Therefore, this model examines the effects of human capital levels of entrepreneurs and the industries competition level on the innovation of the industry.

The results imply no significant effects of the human capital indicators. According to these results, human capital – in terms of education, start-up skills and previous business ownership experience – of entrepreneurs of new ventures has no association with the industries R&D intensity. This was to be expected, as the human capital of an early-stage entrepreneur is unlikely to affect the R&D intensity of the industry. However, the competition level shows a significant negative relation, which is in contrast to the results of the main model on product innovation (see Table 10). This implies that a higher competition level corresponds to lower R&D intensity on the market, which is in accordance to Schumpeter (1934).

The results in Table 10 and Table 13 suggest that human capital of early stage entrepreneurs is only associated with (product) innovation on the individual level. Moreover, higher competition levels displays a positive relation with product innovation on the individual level, but is negatively associated with innovation on the industry level. However, this is not completely true as the measures are constructed differently. R&D intensity is considered an input, whereas the newness of the product or service is an output (Hansen, 1992). Still, the differences between the results are interesting.

6. Discussion

In this section, the results are analysed. It contains the implications of the findings for this research, how the results compare to the previous literature and what the key and new lessons are from this study. In the first part, the results on entrepreneurial product innovation are analysed, whereas the second part contains the analyses of the results on entrepreneurial process innovation. Finally, the differences between the two are examined.

The results fulfil the expectations to some extent. Both the human capital indicators and the competition measure show strong relationships to the product innovativeness of the entrepreneur, the only exception being *start-up skills*. This indicates that having skills to start a new business, does not affect the newness of the products or services. However, as *start-up* skills is the only specific human capital indicator (whereas education and previous business ownership experience are general human capital indicators), one could argue that specific human capital is not related to innovation. This is also in accordance with the findings of Marvel and Lumpkin (2007), where only the general human capital indicators show significant relations. As there is only one specific human capital variable included in the analyses, this cannot be verified.

An explanation for the insignificant relation of *start-up skills* could be that these particular skills have nothing to do with being innovative, since it only captures whether an entrepreneur has the ability to successfully put the firm on the market. It does not necessarily affect how entrepreneurs discover new economic opportunities. However, these skills would probably be a good predictor to whether the innovative products and services are successfully implemented into the market. Previous literature did find a positive relation with overall skill and innovation (Marvel and Lumpkin, 2007; Subramamiam and Youndt, 2005). Nevertheless, these skills are not as specific as start-up skills.

Of the human capital indicators, education level shows to have the strongest relation with the newness of products or services. In Table 10, education level is not only the most significant relation of the three indicators, it also has the highest average marginal effects. According to previous literature, education increases knowledge and produces new ideas (Dakhili and De Clercq, 2004; Marvel and Lumpkin, 2007;

Chi and Qian, 2010). This is also probably the reason why this indicator is strongly associated with product innovation.

The positive relation between previous business ownership experience and product innovation comes as no surprise either. Marvel and Lumpkin (2007) already argued that individuals with experience are more likely to develop new products and services or even create whole new markets, as they have seen for themselves where opportunities lie. Furthermore, Becker (1964) indicated that education and experience are the factors that reflect an individual's human capital most accurately. This might also explain why *start-up skills* does not have a significant relationship with the newness of products and services.

The positive relation with the *mark-up* and product innovation suggests that higher levels of competition increases the incentives for entrepreneurs to innovate. These results therefore support the arguments of Arrow (1962), Kirzner (1997) and possibly Aghion et al. (2005). The positive relation probably originates from the replacement effect Arrow (1062). Old products are replaced with a new invention, which creates a new market for the innovator. The innovator then becomes a monopolist that receives high economic rents, which is probably the incentive for entrepreneurs to innovate on a highly competitive market. Merely participating (i.e. without innovating) a highly competitive market would only be rewarded with low economic rents. However, by innovating, the entrepreneur might be able to escape competition.

Kirzner (1997) would argue that the industries have not yet reached an equilibrium. There are still economic opportunities, and as long these exist, firms will continue to innovate. Chances that these economic opportunities – or in this study, innovations – increase as more firms operate on the market. Furthermore, as competition increases, entrepreneurs gain incentives to be more 'alert' for the opportunities. Which is why a positive relation fits in the view of Kirzner (1997).

Nevertheless, since the methods applied here do not use longitudinal data, it is not possible to simply say that the inverted-U shape relation by Aghion et al. (2005) does not exist. The positive relation between competition and product innovation might fit in the theory of Aghion et al. (2005), but only if the industries are balanced. However, the relation does tell us that industries with lower economic rents – indicating that there is much competition – are more likely to attract innovative entrepreneurs, as innovating might steal away market rents from multiple competitors.

Interestingly, the average marginal effects of competition are higher than the average marginal effects of all included human capital indicators together. This implies that for an average entrepreneur, the competition level effects his innovativeness more than his human capital. According to these results, it would be most efficient for policy makers to focus their efforts on increasing the competition levels when they want to increase economic growth. If policy makers want to support innovation of new ventures, they might need to consider these results when they are obstructing competition, e.g. through antitrust policies.

The relations of human capital and competition on process innovation did not live up to the expectation. None of the human capital indicators nor the competition measure are significantly related to entrepreneurial process innovation. When assuming that entrepreneurs do not have the option to buy their technological processes from third parties (i.e. all used technologies are developed by the entrepreneurs themselves), the insignificant relations of human capital on process innovation contradict previous literature. Human capital is a prerequisite in order to develop these processes. New technological processes require a human component in order to be created. Consequently, the results present implausible insignificant relationships between the human capital indicators and newness of technology used by the entrepreneur.

The insignificant relation of competition also contradicts the previous literature, when making the same assumption as above. In the literature review, none of the authors mentions a non-existing relation between process innovation and competition. However, the insignificant relation might be explained at the hand of a study by Utterback and Suárez (1993).

Utterback and Suárez (1993) speak of a dominant design, which started as a new design – accompanied with lots of different changes and innovations due to increasing competition – and then became the standard design (i.e. dominant design) in the industry – where all firms create the same design, without major innovations. The beginning of the dominant design, is argued to be the point where competition is most severe on the market. However, in case of a dominant design, firms will try to innovate their processes to be able to offer the products or services cheaper and expand due to economies of scale. Firms that do not have the resources to decrease their prices, will not survive, thus leaving only the firms that were able to increase the efficiency of their processes. As this shake-out occurs, competition levels will drop.

Their research clearly indicate a positive relationship between process innovation and competition before the dominant design has been established, and a negative relation after the dominant design has established. However, there is a main difference with the current study that might explain the non-existing relation. Utterback and Suárez (1993) mainly look at process innovations by incumbent firms, whereas this study focuses on entrepreneurs of new ventures. Utterback and Suárez (1993) do claim there to be an increasing amount of new entrants when the product has not yet reached a dominant design. According to them, this increase in competition is mainly paired with product innovations. However, process innovations occur after the dominant design has been reached. As these process innovations reduce costs and therefore lower prices, new entry barriers are developed. The amount of entrants decreases, and due to non-surviving firms, the competition decreases as well.

However, the reason why the relations on process innovation in this study are insignificant, might be more simplistic. Measuring process innovation of the entrepreneurs is done by asking them if they were using new technologies to produce their products or services. However, this question does not answer if they developed the technology themselves or if they bought it from a third party. It is not unlikely that most of the entrepreneurs that use new technologies simply bought it on the market, instead of creating the innovation themselves. This would explain why human capital indicators have no significant effects on the newness of technology. Individuals do not necessarily need high education levels, experience nor skills to buy technologies from third parties. The same goes for competition. It does not matter whether the competition on a market is low or high, the technology on a market is available for everyone. New ventures actually have an advantage compared to incumbent firms, when it comes to adopting new technologies. Incumbent firms are often stuck in their current processes and changes take long periods of time, as the employees also have to learn to work with the new process. New ventures do not have this limitation, and can adopt any technological process right from the start if they have the resources.

Furthermore, as stated in section 3.2.1, the process innovation measure is obtained by two items in the GEM survey. The first item is a question which is only asked before 2005. Here, the participants were only able to choose between whether or not the technology they use was available a year ago. However, from 2005 on worth, the item captures whether the technology used is younger than 1 year, between 1 and 5 years old, or older than 5 years. The reason for this might be that 1 year is simply too young. Appendix A shows that only 10% of the sample perceive their technology younger than 1 year. If this was expanded to 5 years, results might differ.

To summarize, the relations between education level, previous business ownership experience and competition on entrepreneurial product innovation are significantly positive. This in accordance to the previous literature (Dakhili and De Clercq, 2004; Marvel and Lumpkin, 2007; Chi and Qian, 2010; Arrow, 1962). However, human capital and competition is not significantly related to entrepreneurial process innovation, which is unexpected. There are three possible reasons for this. The first involves the dependent variable for process innovation, i.e. newness of technology. Entrepreneurs might be able to simply buy their technologies of the market, which is widely available for the competition. Consequently, it not accurately measures the process innovations of entrepreneurs, as it is not considered an innovation when competition uses the same technology. Furthermore, technology younger than 1 year might be considered as too young. Second, according to Utterback and Suárez (1993), process innovation mainly occur when a product market has reached a dominant design. As this study uses complete industry competition levels, there is no distinction between pre-dominant design and post-dominant design markets. The effect might therefore not be noticeable. Finally, Utterback and Suárez (1993) argue that process innovation are mainly done by incumbent firms on a post-dominant design market. This indicates that new ventures are not very likely to develop process innovations, resulting in a non-existing relationship between competition and process innovation. The first argument provided above, explains the non-existing relationship for both human capital and competition. However, the latter two arguments only explain the insignificant relationship of competition on process innovation, and not the insignificant effects of human capital indicators.

7. Conclusion

This section contains the conclusions of this study. It is divided into three parts. The first part contains the main findings of the research. The second part contains several limitations of this study. The final part contains recommendations for future research.

7.1. *Main findings*

The main implications of this study concern the effects of human capital and competition level on the innovativeness of early-stage entrepreneurs. This research tries to answer the question of what the effects of education, skills and experience is on product and process innovation among new ventures. In order to answer the research question, several hypotheses were tested. In short, hypothesis 1 is partially supported and hypothesis 3 is fully supported, which implies that education level of the entrepreneur, their previous business ownership experience and the competition level in the industry, are positively related to product innovation amongst new ventures. Hypotheses 2 and 4 were not supported, meaning that there were no relations found between the human capital indicators and process innovations amongst new ventures, and between the competition level of the industry and process innovations.

The expectations for the human capital indicators were clear. Higher levels of human capital increase the probability of the innovativeness of entrepreneurs. These positive relations were only found between education level and previous business ownership experience on product innovation, which is in accordance to the findings of Subramamiam and Youndt (2005). Both of these indicators are considered general individual-specific human capital indicators. Start-up skills – which is a specific human capital indicator, that is also individual specific – did not have a significant relation with product innovation. These start-up skills probably do have impact on the successfulness of the implementation of an innovation. This might imply that specific human capital does not affect the product innovativeness of early-stage entrepreneurs, whereas general human capital does.

However, none of the human capital indicators showed a significant relation with process innovation. An explanation for this, is that the measure for process innovation inaccurately represents the process innovations of early-stage entrepreneurship. The current variable for process innovation only measures whether the entrepreneur uses a new technology, but not whether the entrepreneur developed the technology himself. Furthermore, the measure only captures whether the entrepreneur uses a technology younger than 1 year, which might be too young for unbiased results. Even as it is highly unlikely that there actually is no relation between human capital and process innovation, the possibility is not ruled out.

The expectancy for the effect of competition was less clear, as there were several possible outcomes according to the literature. According to Arrow (1962) and Kirzner (1997), there should be a positive relation. Schumpeter (1934) suggested a negative relationship between competition and innovation. Aghion et al. (2005) suggested an inverted-U relation, which was unlikely to be found in this study, as the data is not longitudinal.

The results show a positive relation between competition level and product innovation, which is in accordance to Arrow (1962) and Kirzner (1997). Arrow (1962) argues that firms gain incentives to innovate in higher competitive industries, as they can escape competition and gain (temporary) monopoly profits, which is probably also the case in this study. Kirzner (1997) would explain the positive relation due to an disequilibrium, in which firms keep innovating until an equilibrium is reached.

However, similar to the human capital indicators, competition level has no significant effect on process innovation. There are multiple explanations for this. The first – similar to the explanation of the insignificance of human capital on process innovation – is the measure for entrepreneurial process innovation. The second and third explanation are provided by Utterback and Suárez (1993). Their first argument is that process innovations mainly occur after a dominant design has been reached, in which all firms produce a relatively similar product. At this stage firms will innovate their processes in order to survive. Only the most efficient firms will survive and will profit from economies of scale as many firms get ‘shaken out’ of the market. The second argument by Utterback and Suárez (1993), is their findings that especially the incumbent firms tend to be most efficient. As this study concerns early-stage entrepreneurs, it could be the case that they do not tempt to try to innovate their processes, as they need to understand the market first. It is not ruled out that there is indeed no relation between competition level and entrepreneurial process innovation. However, it seems highly unlikely.

The results of the main model imply that policy makers can enhance product innovation amongst new ventures by supporting competition and human capital. However, as the results from the model in which the effects of human capital and competition on the total industries'

7.2. Limitations

During this research, several limitations arose to the surface. Some of these were known right from the start of this research and some were found during the process of this research.

Probably the most influential limitation to this research is the measure for process innovation amongst new ventures. This variable is not real solid, as it does not make a distinction between whether the new venture has created the new technology themselves, or whether they bought it from a third party. Furthermore, as shown in Appendix A, only a fragment (i.e. 10%) of the entrepreneur indicated that they use technology that was not available more than a year ago. As this fragment is so small, results might be biased. This fragment is probably so small, as technology that is younger than one year is too new. A measure that would capture a little bit older technology – such as technology younger than 5 years – would probably deliver better results.

Furthermore, both the product and the process innovation measures were based on the perception of the entrepreneur. In other words, it might occur that the entrepreneur sees his product or services as an innovation, while objectively speaking it is actually not, and vice versa. Both measures might suffer from poor judgement of the participants.

Another important limitation of the data is that it is not longitudinal and only covers a short timespan (i.e. 2003-2005). Having longitudinal data over a long time period, would allow implementation of several elements that might influence the innovativeness of early-stage entrepreneurs. The most important result would be that it would allow for denoting whether the competition is actually increasing or decreasing (see section 7.3). Furthermore, the analyses only cover early-stage entrepreneurs in the United Kingdom. Consequently, generalization of the found relations is not possible, as the relations might differ in other countries.

Dakhili and De Clercq (2004), Marvel and Lumpkin (2007) and Chi and Qian (2010) claim that the most important human capital indicators are education, skills and experience. Whereas the education level and previous business ownership experience of the entrepreneur are rather likely to influence innovation, start-up skills is actually not. This is due to two reasons. The first is that these skills have nothing to do with being able to be innovative. Start-up skills do lower the entry barrier to the market for individuals, but this is not the focus of this research. Technical skills would probably do a better job to represent human capital. The second reason why start-up skills probably failed to be significantly positively related to innovativeness of the entrepreneur, is that it is a subjective measure. Moreover, of the complete GEM sample (i.e. 57,660 observation), only 14% considers their start-up skills insufficient. Also, it is unlikely that individuals that are about to start up a new venture consider their skills insufficient, unless they have encountered difficulties already. The variable is therefore not totally reliable.

As start-up skills is the only specific human capital indicator, no implications can be made on the different relations of general human capital and specific human capital on innovation. As Marvel and Lumpkin's (2007) findings imply, there is a possibility that specific human capital indicators show no relation to innovation. However, these same implications cannot be made here, as only a single specific human capital indicator is included.

There are also limitations to the previous business ownership experience measure. As it measures whether the entrepreneur has owned and shut-down a business in the past twelve months, it skips the entrepreneurs who also have business ownership experience longer ago. Furthermore, the measure also fails to capture whether this experience of the entrepreneur is positive or negative, which might have influence on their innovativeness.

Even though in section 4.1, the trend in the *mark-up* does not show any major fluctuations, this competition measure might be influenced by shocks on the market, other than competition. The analyses were made under the assumption that the *mark-up* is only influenced by competition levels. Yet, there could still be other factors that influenced the measure, and therefore falsely portraying the competition level.

7.3. *Future research*

The first thing to include in future research is solid objective measures for both product innovation as process innovation amongst new ventures. This would greatly enhance the robustness of the results. Furthermore, an objective measure should be included to examine the skills of the participant. As stated in section 7.2, technological skill of an entrepreneur is likely to affect innovativeness.

One of the most interesting aspects of human capital is the amount of knowledge spillovers, which could be beneficial to other firms. In other words, when the education level of one firm is particularly high, other firms might benefit as well depending on their knowledge absorptive capabilities, due to spillovers (Cohen, 1990). These indirect effect are not accounted for in the current study. Including one's absorptive capabilities might have an effect on his innovativeness.

Future research should implement more human capital indicators. Especially specific human capital factors need to be included. This would allow for better distinction between general and specific human capital. As the results by Marvel and Lumpkin (2007) (i.e. no relation between specific human capital and innovation) are counterintuitive, it is an interesting aspect to investigate.

The next thing to incorporate in future research is an interaction between human capital and social capital. Subramaniam and Youndt (2005) did include such an interaction. Their findings show a negative relation between human capital and innovation. Yet, the interaction between human capital and social capital is positively associated with innovation. This implies that the relation between human capital and innovation depend on social capital, making it an interesting factor to incorporate.

This study does not make a distinction between increasing competition markets and decreasing competition markets. Here, only the overall competition in the industry is considered. A distinction between increasing and decreasing competition markets is only manageable on longitudinal data. In doing so, pre-dominant design and post-dominant design markets might be detected. In such a model, it is interesting to examine how effects of human capital and competition change between increasing and decreasing industries. Following Utterback and Suárez (1993), increasing competition markets would indicate a pre-dominant design market, thus process innovations rarely occur. Decreasing competition markets would indicate a post-dominant design in which process innovations occur often.

The analyses in this paper only concern the United Kingdom. In order to confirm the relations, the analyses needs to be performed for other/multiple countries. However, some countries measure data differently, such as labour costs and capital costs, which should be accounted for.

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Appendix A

GEM variables comparison between the total sample and the United Kingdom between 2001 and 2008.

	All data (n=57,660)		*United Kingdom (n=4,632)*	
	Frequency	*Percentage*	*Frequency*	*Percentage*
Dependent variables				
Newness of product/ service:				
New to some/ all consumers	*24,155*	*42%*	*1,703*	*37%*
Not new to any consumers	*33,505*	*58%*	*2,929*	*63%*
Newness of technology				
Technology exists less than 1 year	*6,666*	*12%*	*458*	*10%*
Technology exists more than 1 year	*50,994*	*88%*	*4,174*	*90%*
Independent variables				
Education level				
Post-secondary degree or/and graduate experience	*29,756*	*52%*	*1,922*	*41%*
Otherwise	*27,904*	*48%*	*2,710*	*59%*
Start-up skills				
Considers start-up skills sufficient	*48,630*	*86%*	*4,112*	*89%*
Considers start-up skills insufficient	*7,918*	*14%*	*520*	*11%*
Previous business ownership experience	*5,648*	*10%*	*303*	*93%*
Shut down a business in the past year	*52,012*	*90%*	*4,329*	*7%*
Otherwise				
Average age	38		41	

Source: Adult Population Survey, Global Entrepreneurship Monitor 2001 - 2008.

Number of observations among nine main industries in the United Kingdom between 2002 and 2003.

Industries	*2003 (n=993)*	*2004 (n=969)*	*2005 (n=470)*
Agriculture, hunting, forestry and fishing	*31*	*45*	*14*
Mining and quarrying	*28*	*1*	*0*
Manufacturing	*54*	*57*	*34*
Electricity, gas and water supply	*1*	*2*	*0*
Construction	*119*	*107*	*45*
Wholesale, retail trade, hotels and restaurants	*201*	*212*	*105*
Transport, storage and communications	*50*	*41*	*23*
Finance, insurance, real estate and business services	*290*	*297*	*143*
Community, social and personal services	*219*	*207*	*106*

Source: Adult Population Survey, Global Entrepreneurship Monitor 2001 - 2008.

Appendix B

Correlation matrix of all included variables

	newness product	newness technology	higheduc	suskill	pboe	1-markup	age 17-24	age 25t34	age 35-44	age 45-54	age 55-64	2003	2004	2005
newness product	1.000													
newness technology	0.101	1.000												
	0.000													
higheduc	0.105	0.024	1.000											
	0.000	0.234												
suskill	0.024	-0.020	0.017	1.000										
	0.240	0.331	0.390											
pboe	0.029	0.018	0.004	0.025	1.000									
	0.159	0.366	0.851	0.225										
1-markup	0.078	-0.005	0.037	-0.008	-0.040	1.000								
	0.000	0.817	0.071	0.691	0.051									
age 18-24	0.031	0.039	-0.023	-0.047	-0.032	-0.007	1.000							
	0.121	0.052	0.266	0.020	0.118	0.734								
age 25-34	0.015	0.024	0.014	0.028	-0.030	0.037	-0.154	1.000						
	0.472	0.246	0.485	0.170	0.137	0.070	0.000							
age 35-44	0.032	-0.011	-0.030	-0.013	-0.016	0.005	-0.192	-0.417	1.000					
	0.117	0.606	0.139	0.534	0.435	0.802	0.000	0.000						
age 45-54	-0.038	-0.044	0.004	0.002	0.056	-0.026	-0.142	-0.308	-0.383	1.000				
	0.062	0.030	0.839	0.931	0.006	0.205	0.000	0.000	0.000					
age 55-64	-0.041	0.010	0.037	0.015	0.017	-0.018	-0.099	-0.215	-0.267	-0.197	1.000			
	0.041	0.621	0.070	0.459	0.413	0.368	0.000	0.000	0.000	0.000				
2003	0.002	0.001	0.024	-0.012	-0.012	-0.063	-0.006	-0.038	-0.003	0.034	0.015	1.000		
	0.927	0.945	0.237	0.551	0.558	0.002	0.773	0.064	0.897	0.096	0.451			
2004	-0.009	0.049	-0.060	-0.027	0.007	-0.002	0.010	0.022	-0.001	-0.030	0.002	-0.676	1.000	
	0.656	0.015	0.003	0.178	0.734	0.932	0.635	0.270	0.979	0.135	0.913	0.000		
2005	0.009	-0.063	0.044	0.049	0.006	0.081	-0.005	0.019	0.004	-0.005	-0.022	-0.407	-0.398	1.000
	0.661	0.002	0.030	0.016	0.758	0.000	0.818	0.349	0.846	0.826	0.283	0.000	0.000	

Appendix C

Multilevel analysis – Human capital and competition on entrepreneurial product (measured by newness of products and services) and process (measured by newness of technology) innovation in the United Kingdom between 2003 and 2005.

VARIABLES	xtlogit EPI	xtlogit EPrsI
higheduc	0.419***	0.173
	(0.086)	(0.122)
suskill	0.153	-0.141
	(0.130)	(0.177)
pboe	0.285*	0.254
	(0.166)	(0.228)
1-u	0.523***	-0.019
	(0.198)	(0.197)
age25t34	-0.240	-0.262
	(0.181)	(0.237)
age35t44	-0.182	-0.423*
	(0.176)	(0.232)
age45t54	-0.440**	-0.664***
	(0.185)	(0.251)
age55t64	-0.545***	-0.327
	(0.203)	(0.267)
2004	-0.029	0.158
	(0.094)	(0.131)
2005	-0.041	-0.464**
	(0.116)	(0.190)
Constant	-0.295	-1.497***
	(0.227)	(0.279)
Observations	2,432	2,432

Standard errors in parentheses
Age17t24 is the reference age category
2003 is the reference year
*** p<0.01, ** p<0.05, * p<0.1