Empirical explorations of firm innovation, government intervention and firm performance in European countries
Crowley, Frank
Chapter Seven

7. CONCLUSIONS AND DISCUSSION OF THE RESEARCH

7.1 | INTRODUCTION

The purpose of this research was to examine: firstly, the process of innovation within firms; secondly, the innovation-productivity relationship within firms; thirdly, product and service life cycles using the firm as a unit of analysis and; fourthly the subsidy-firm performance relationship in firms from economies in Europe. The data used for this research stems from the third edition (2005) and fourth edition (2009) of the Business Environment and Enterprise Performance (BEEPS) datasets. A number of gaps in the literature existed at the outset of this research. Firstly, the role of location on the innovation performance of firms has been analysed to a lesser extent relative to the role of the firms internal characteristics in explaining innovation patterns. Largely, this is due to the location of firms at a disaggregated level not being available for innovation surveys such as the European Community Innovation Survey (CIS). Secondly, most of our understandings of innovation come from analyses of manufacturing firms and much less attention has been given to the area of service innovation, relative to manufacturing innovation. Thirdly, the innovation-productivity relationship is still unclear at the level of the firm with some studies finding a negative relationship between innovation and productivity. A key objective of this research was to explore this relationship further using counterfactual analyses for innovators and non-innovators across innovation types, sector settings and different economy systems settings. Fourthly, there has been limited literature on the subsidy-firm performance at a European level.

In this thesis, there were four principle papers (chapters three to six) exploring various issues on the process of innovation, the innovation-productivity and the subsidy-firm performance relationship within firms. The first paper (chapter three) focused on a national analysis of the innovation process and innovation-productivity relationship in Irish firms. The second paper (chapter four) focused on a cross-industry and cross-economy analysis of firms in a selection of European economies from
innovation and transition driven economies. The third paper (chapter five) analysed product and service life-cycles at the firm level in innovation driven economies from Europe. The fourth paper (chapter six) analysed the subsidy-firm performance relationship in Europe. In the following section key contributions and implications of the research are outlined for businesses, policymakers and the contribution to the theoretical and empirical literature in the innovation area.

7.2 | IMPLICATIONS OF THE RESEARCH FOR BUSINESSES

7.2.1 | R&D Spending
Both traditional ‘hard’ (R&D spend) and ‘soft’ (other factors) factors affecting innovation play an important role in explaining a firm’s propensity to innovate. For firms in innovation driven economies, R&D expenditure was important for manufacturing and service firms and for product and process innovation. The R&D effect was also important in the Irish study, albeit it was only significant for product innovation. Human capital was also found to be significant in the Irish case for product innovation but was not found to be important for process (technological) or organisational (non-technological) innovation. Similarly, training was found to be important for innovation driven economies in both manufacturing and service firms, but the human capital measure was not found to be as important in the case of manufacturing firms. R&D spending was also significant for service firms in transition economies but was not important for manufacturing firms in transition driven economies. According to Bogliacino et al. (2009), developing economies have distinct patterns of innovation to that found in developed countries. R&D capability and science and technology are pivotal in operating at the technology frontier (Bogliacino, 2009). In contrast, technological change in developing economies is dominated by the acquisition of new machinery and the imitation of new products and processes already introduced and embedded in developed economies (Bogliacino, 2009). Hence, key to achieving innovation success for firms in transition driven economies is the ability of their human capital to absorb new product and process ideas already introduced in more advanced economies. Hence, when the empirical results in chapter four are compared for innovation driven vis a vis transition driven economies, they support the theoretical understandings that the drivers of innovation are different in these type of settings. Critically, whether a firm is located in an innovation driven economy or a transition economy – a firm’s investment in their employees is also important alongside investment in R&D specific expenditure.

7.2.2 | Firm Size
Firm size has been particularly important in explaining innovation in the literature (Tether, 1998). Firm size was found to be significant in the Irish paper, where firm size had a positive and significant effect on process and organisational innovation. However, firm size was not to the forefront in explaining innovation patterns for product and process innovation in innovation driven economies but was more important for process innovations for manufacturing and service firms in transition driven economies. The size of the firm also did not matter for product discontinuation. The results in this work conclude that on the whole, firm size plays a limited role in explaining innovation patterns.
However, other size indicators do matter – for instance a firm's growth does matter. For example, the firm's propensity to spend on new buildings and machinery is a catalyst for all types of innovation and for product discontinuation for manufacturing and service firms. Capital expenditure was found to be important in three of the studies (chapter three to five). Clearly, the process of change in firm inputs generally leads to more change in firm outputs. The influence of market power was explored in chapter five on the firm's product life cycle. That study identified that a firm's monopoly power matters. This may not reflect the firm's size in terms of employees, but is an implicit indicator of influence in the market place. Manufacturing and service firms with more monopoly power are more likely to produce innovate and manufacturing firms with more market power are less likely to discontinue products. Schumpeter (1942) expected that firms with a greater market power were more likely to innovate due to their inherent capacity to have the resources required to invest in innovation activities. Hence, the firms ability to achieve positions where price is greater than marginal cost will enhance their abilities to protect themselves from competitors in order to innovate more and discontinue the production of fewer products.

7.2.3 | Sector Differences

Construction, mining and service firms were significantly less likely to product and process innovate in the Irish case. However, there were no significant differences between the industry type and their propensity to introduce organisational innovations. In chapter four, the specific differences between manufacturing and service firms were compared. It is clear that the innovation process for service firms is more complex from an economic geography perspective than manufacturing firms. Traditional ‘hard’ and ‘soft’ drivers of innovation affect service innovation as much as manufacturing innovation. Overall there are subtle but distinct differences between the innovation process for service and manufacturing firms. Chapter five points out that service and product life cycles (SLC’S and PLC’s) have similar patterns. Firstly, innovation was significant for product/service discontinuation. Hence the phenomenon of a product/service replacement effect is significant in both industry types. Secondly, process innovation was found to be important for innovations in both industry types. Hence, when firms introduce product innovations they appear to be simultaneously thinking about process innovation and vice a versa, process innovation improvements may lead to products innovations, which previously were not possible to produce as the knowledge to produce them at the firm level was absent. Hence, firms do not appear to be just focusing on the tastes and preferences of firms and later focusing on just process innovation. Process innovation and economies of scale concerns are of a significant concern for firms when introducing product innovations.

However, there were also some underlying differences particularly in relation to firm age. Younger firms were identified as being more likely to innovate in manufacturing firms. But, older firms appear to be more dominant in SLC’s – both for innovation and discontinuation. Hence, younger manufacturing firms are finding it easier to break into PLC’s than their counterparts in the service industry, where older firms are dominating. When manufacturing and service firms were broken down further into categories of their technological intensity there were very little differences except where older manufacturing firms in more technologically intensive industries are more likely to
innovate relative to older firms in low technology intensive industries in the manufacturing industry. Hence, the experience of firms is providing a comparative advantage for innovation for service firms and for more technologically intensive manufacturing firms.

7.2.4 | The Role of Location
A key objective of this thesis was to identify the role location has on the propensity of a firm to innovate. Principally, urbanisation effects were analysed using the population size of where a firm is located in as an indicator of urbanisation externalities. Location had a significant role in the propensity of a firm to innovate in the Irish case. Firms located in areas outside the capital of Dublin were significantly less likely to introduce product and organisational innovations. However, firms located in cities with a population of under 50,000 people were significantly more likely to process innovate. In terms of product and process innovation – the product life cycle theories hold in the Irish case – where firms located in higher populated areas are more likely to product innovate where they are closer to principle markets and are therefore, in a better position to ascertain the changing tastes and preferences of consumers. On the other-hand, for firms where cost efficiencies are more important, a more peripheral location is favourable for process innovations where costs of production for land and labour are lower. Interaction variables were also employed to ascertain whether the dummy variable effect of the capital city was driven by localised differences in R&D spending, capital investment and human capital differences. There were no localised significant differences identified for any of these factors. Hence, it appears that urbanisation effects are a significant driver of firm innovation in the Irish case.

In the cross-country analysis in chapter four, the apparent influence of urbanisation effects also stood out for service firms. Urbanisation was of particular importance for service innovation for firms in innovation driven economies and for process innovation for firms in transition driven economies. However, urbanisation effects were not found to be important for manufacturing firms in either innovation or transition driven economies. In chapter five, manufacturing firms located in cities of a population between 50,000 and 250,000 were more likely to discontinue products relative to firms located in the capital city. The localised effects of the age of the firm and sectoral differences were also explored – but again no significant differences were identified at the localised level. Consequently, it is clear that from the analyses conducted in this study that urbanisation effects play a significant role in explaining innovation patterns for firms in Ireland and for service firms in both innovation and transition driven economies. It is further notable that the external environment is influential in explaining innovation in manufacturing and service firms but they are influenced by different actors (domestic/foreign competitors and customers). Manufacturing firms that introduce products in innovation and transition driven economies are more affected by foreign competitors and conversely service firms that introduce service innovations are more affected by domestic competitors.
7.2.5 | Knowledge Disruption and the Innovation-Productivity Relationship

It was theorised in chapter five that knowledge production may lead to a knowledge disruption effect within the firm where firms replace the production of older products with the production of newer products. This hypothesis was identified to be significant and correct. Hence, product/service replacement is a natural phenomenon in the firm and this is the case for both manufacturing and service firms. Hence, the relationship between knowledge production (innovation) and knowledge exploitation (firm productivity) may not always be positive if the disruptive effect at the level of the firm has a greater marginal impact than the benefits accrued from knowledge productions. In the conclusion of chapter five and in the theoretical sections of chapters three and four, it was outlined that some papers have identified a negative relationship between innovation and productivity at the firm level. Hence, key sub-objectives in chapters three and chapter four were to identify if the firms failed to exploit the benefits that accrue from innovation. In the Irish case, there was in fact a negative relationship identified between product innovation and firm productivity for product innovators and organisational innovators. A positive relationship was found between process innovation and productivity for process innovators. Hence, it was concluded from the results in chapter three that there must be short run disruption effects occurring due to innovation.

However, in the cross-country analysis in chapter four, there was a positive effect between innovation and productivity for innovators. In the counterfactual analysis for non-innovators – all innovation types have a positive effect on productivity in the Irish case. The only negative effects identified for non-innovators in the cross-country paper (chapter four) were for manufacturing firms (both product and process) in transition economies. On balance, there is evidence that in some limited cases, the disruptive knowledge effect of innovation did result in negative productivity effects. However, this finding is not consistent and is more isolated to specific cases. The positive effects of innovation on productivity are identified in most sectors and settings and by innovation types. However, innovators do not possess an absolute advantage in production which has important policy implications which are outlined later in the implications of the research for policy-making section.

7.2.6 | The Short Run and Long Run Innovation-Productivity Relationship

It is clear from this research that negative effects between innovation and productivity may be identified as a knowledge disruption effect experienced by the firm. The key question is - what effect could the possibility of knowledge disruptive effects have on the firm’s incentive to innovate? Will it act as a barrier? Do the long run effects of innovation on productivity present a completely positive picture that provide the firm with the incentive to take on the risk and uncertainty of negative effects associated with innovation in the short run? The long run implications of innovation for productivity were not examined in the principle chapters of this thesis. However, Tables 7.1-7.6 in the appendix of this section outline an examination of the long run effects of innovation on a balanced panel sample of 403 firms from transition economies\(^1\). The estimation techniques employed for this

\(^1\) Panel data from the Business Environment and Enterprise Performance Survey (BEEPS) is not available for innovation driven firms. To ensure comparability, only firms that took part in BEEPS series 2, 3 and 4 were analysed. This accounted for 403 firms from transition economies but only accounted for 206 of the transition economies (Members of the European Union) of interest.
analysis are identical to the estimation techniques (endogenous switching model) employed in chapters three, four and six of this thesis. Tables 7.1 and 7.2 provide details on the sample size and descriptive statistics of the data. Tables 7.3 and 7.4 indicate that the treatment effect for innovators has a negative effect on the productivity levels of firms. The analysis presented in Tables 7.3 and 7.4, only measures the treatment effect for this sample of firms over a three year period from 2002 to 2005. Furthermore, the analysis is examining the effect of innovation on productivity levels. Hence, this is similar to the analyses conducted in Chapters three and four and could be interpreted as measuring the treatment effect over the short run. Tables 7.5 and 7.6 examine the analysis of the treatment effect of innovation occurring in the period 2002-2005 on the percentage change in the log of productivity (over a longer time period) from 2002 to 2009 for the sample of firms. Clearly, the long run marginal effects of the percentage change in the log of productivity are substantial and significant for innovators. A positive effect between product innovation and productivity is also identified for non-innovators, however the marginal effect is not as large. This suggests that the positive effects of innovation in the long run should provide enough of an incentive for firms to take on the uncertainty of knowledge disruptions associated with knowledge production in the short run. However, this analysis has limitations (as outlined in footnotes 1 and 2) and needs to be conducted on more countries where larger sample sizes are employed to ensure that the returns in the long run are consistently positive across innovation types, industries and economy settings and for non-innovators as well as innovators. Due to data limitations, that type of analysis was not possible in this thesis.

7.3 | IMPLICATIONS OF THE RESEARCH FOR POLICY-MAKING

7.3.1 | Are Policy-Makers Picking Winners?
Policymakers have tended to pick sectors and regions as targets (Boschma, 2009). These sectors are typically relatively new and ‘exciting’, or where employment growth is forecasted such as in the sector of high technology. Foray (2012) described the high tech sector as exciting goblins that will likely secure government funding due to the perceived ‘good ideas’ of projects from high tech companies whilst other types of companies like sleeping giants (for example, agri-food firms) and hungry dwarfs (for example, low-tech SMEs) will be less impressive in terms of employment growth and good projects and hence will secure little in the way of government funding. In chapters three and four, it is identified that there is some evidence that firms that receive subsidies are more likely to innovate. For instance, Irish firms that received subsidies from a national source were more likely to innovate. Firms in innovation driven economies that received subsidies from regional and EU

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2 Since the sample size derived from each country is small, the samples are not representative samples of the entire population of firms from each country. Hence, it is important to take this into consideration when assessing the reliability of the estimates. However, it does provide some additional information and the analysis was included for this reason. The models were significant at the 1 per cent level. The list of variables in the descriptive statistics is the list of variables employed in the endogenous switching model for the analysis. These variables take the exact definitions as the variables used in chapters three, four, five and six. Please see these chapters for more information on the variable descriptive used for this analysis.
sources, are more likely to product and service innovate. Service firms in transition economies are more likely to innovate if they receive subsidies from national sources. Hence, it could be concluded that subsidies have a positive effect on the likelihood of a firm to innovate in certain sectors and settings. However, from a policy perspective, the importance of subsidies has to be viewed with caution as there is a question of a ‘chicken and egg’ causality concern inherent in this measure. For instance, innovating firms may be more likely to get subsidies as policymakers may be ‘picking winners’ in their distribution of subsidies.

To help with making more concrete conclusions it would be interesting to identify if there was a bias in the allocation of subsidies towards the high tech sector in this sample of firms? In chapter six, this question is analysed. The endogenous switching models indicate that there is a significant simultaneous effect between what type of firm’s policymakers chose and the productivity of firms from innovation and transition driven economies and for employment growth in firms from transition driven economies. Hence, the productivity and employment growth expectations of firms do matter for selection. The firms in innovation and transition driven economies that are more likely to receive subsidies\(^3\) spend more on R&D, are larger, export, are more high tech and are located in more peripheral regions. These results at first glance suggest that policymakers are picking winners. However, it is clear from the heterogeneity treatment analysis in chapter six that the subsidised firms do not have an absolute advantage in production. Hence, policymakers appear to be picking ‘weaker’ firms within these categories.

7.3.2 | Do Subsidies have a Positive Effect on Firm Performance?
In chapter seven, the conditional expectations, treatment and heterogeneity effects of subsidies are analysed. In both, innovation and transition economies, subsidies have a positive effect on the productivity of subsidised and non-subsidised firms. Therefore, intervention has a positive effect on productivity. However, if policymakers had targeted the non-subsidised groups, the marginal productivity treatment effect would have been greater for non-subsidised firms. Hence, interventions by policymakers do result in productivity improvements, but the productivity effect would be even greater if they targeted other firms. In terms of employment growth, subsidy intervention has no effect in innovation driven economies, but it has a positive, significant and strong impact on employment growth for firms in transition driven economies. A key motivation for government intervention by policymakers in transition economies appears to be about sustaining and improving job growth in high added value jobs in more technologically intensive sectors and in larger exporting firms. Overall, it can be concluded that intervention is having a positive effect. However, if productivity improvements are the overall goal, then policymakers should target the non-subsidised firms.

7.3.3 | What are the Geographical Considerations of Policy Interventions?
From the innovation-productivity studies in chapter three and four, another notable pattern is the geographical source of subsidies that are relevant for firms. In innovation driven economies,\(^3\) The type or purpose of the subsidy is unknown.
manufacturing and service firms that receive subsidies from EU and regional sources are more likely to product and service innovate. In transition driven economies, service firms that receive subsidies from national sources are more likely to product and process innovate. Subsidies are not significant for product innovation for manufacturing firms in transition economies. This result appears to highlight that regional providers of subsidies in transition economies are weaker in identifying firms that are more likely to innovate relative to regional subsidy providers in innovation driven economies. Hence, in transition economies, the strength of regional policies and institutions appear weaker than in innovation driven economies.

From the analysis chapter six, it is clear that firms located in more peripheral locations are more likely to receive subsidies. It appears that policy-makers are attempting to balance regional growth by providing more subsidies to more peripheral and lower populated regions. Hirchman (1957), made reference to the social and political consequences of uneven development (a dualism effect) as a result of economic growth that results in winning and losing regions with respect to economic growth. Hence, it may be interpreted that policymakers have a bias in subsidising more peripheral regions in an effort to re-balance growth across regions to dampen the social and political consequences that may occur from economic growth.

7.3.4 | Should Innovation Subsidies go to Innovators or Non-Innovators?
In the subsidy analysis in chapter Six, it is not clear what the type or purpose of the subsidy is when it is allocated to a firm. However, a clear avenue for innovation subsidies is identified in chapter four. It is clear from the results that innovation has a positive effect on the productivity levels of innovating firms and if non innovating firms did innovative – innovation would also have a positive effect on their productivity levels. However, when the counterfactuals are analysed, innovators are not identified as having an absolute advantage in production. This outlines a rationale for policy intervention targeted at non-innovators as well as innovators which could significantly improve market outcomes, especially in cases where the transitional heterogeneity effects are greatest.

However, if policy makers do concentrate on directing interventions towards non-innovators – direct subsidies may not be the most appropriate intervention. Such interventions may result in perverse outcomes where firms may become incentivised to not innovate in order to receive state help. Softer drivers of innovation are important in firms from transition economies and for firms in innovation driven economies like investments in the firms stock of human capital. Human capital has long been identified as a major source of economic growth (Storper and Scott, 2009). Romer (1986), Lucas (1988), and Florida (2002) have argued that education is crucial in contributing to increased economic growth. Workers are seen as creators of new knowledge and are recognised as a competitive asset (Hansen and Niedomysl, 2009). The idea of creativity as a source of growth and competitiveness has received greater attention from academics, planners and policymakers in recent years. Creativity is a complex entity, difficult to understand and to define. According to Fritz and Stuetzer (2009) “creativity is the ability to create new knowledge or to transform existing knowledge”. Human creativity provides the sources of new ideas that may result in innovations.
Developing policy intervention frameworks that will foster educational improvements, continuous training opportunities and a culture of life-long learning will be crucial for firms in both the service and manufacturing sectors and in innovation and transition economies. However, traditional variables like R&D spend and capital investment still plays an important role in Irish firms and in firms from innovation and transition driven economies.

7.4 | IMPLICATIONS OF THE RESEARCH FOR THE THEORETICAL AND EMPIRICAL LITERATURE

7.4.1 | A Theoretical Contribution
Schumpeter’s (1932, 1942) theory of innovation and creative destruction has been the benchmark for most studies that have investigated innovation at the level of the firm. Indeed most firm level surveys like the Community Innovation Survey (CIS) and Business Environment and Enterprise Performance Survey (BEEPS) ask questions that are very similar to the definitions he originally outlined for innovation in firms. In terms of theoretical models attempting to examine innovation since Schumpeter’s (1932, 1942) work – the emphasis has been on the creative and innovative aspect of his ‘creative destruction’ concept. Such examples include the chain-link model of Kline and Rosenberg (1986) and the innovation value chain of Hansen and Birchotts (2007) and Roper et al. (2008). There have been fewer studies in the theoretical literature that have focused on the destructive aspect of the innovation process at the level of the firm.

However, it is not definitive in the empirical literature that innovation always has a positive effect on firm outcomes. In chapter three and chapter four, it was pointed out that the empirical literature on the relationship between innovation and productivity was not definitive. Some studies were finding a negative effect between innovation and productivity (Raffo et al., 2008; Roper et al., 2008) for example. These negative effects were identified for both product innovation (Raffo et al., 2008 for Argentinian firms; and Duguet, 2006 for incremental innovation) and process innovation (Loof and Heshmati, 2006; Van Leeuwen and Klomp, 2006; Mairesse and Robin, 2009). The theoretical literature outlines the importance of innovation for economic growth (Schumpeter, 1934; Romer, 1990; OECD, 2011). Hence, these negative effects identified in firm level analyses are puzzling. It has been hypothesised that these negative effects are a result of time lags due to learning effects (Mohnen and Hall, 2013) or perhaps as a result of natural product life cycle disruptions (Roper et al., 2008). In these instances when the marginal benefit of innovation is greater than the marginal disruption (due to required learning effects or natural product life cycle disruptions) – innovation will have a positive effect on firm productivity. However the opposite effect may occur where the marginal disruptions are greater than the marginal benefits.

In the fifth chapter, it was argued that there was a need to incorporate a disruptive stage to existing theoretical models on the process of innovation that may explain why these negative effects were occurring. It was argued in that chapter that firms may experience a ‘replacement effect’ which...
occurs when firms produce innovations and in return there is a re-evaluation of the firms existing product portfolio and hence a knowledge disruption effect may occur. This idea was adapted to the innovation value chain where the original ideas of Schumpeter’s destructive effect of innovation is incorporated in the revised IVC at the level of the firm. The adapted version of the IVC identifies the firm as firstly, sourcing knowledge, then producing knowledge, which may lead to the firm replacing embedded knowledge of existing products, leading to knowledge disruption, and then finally the firm can exploit the information/knowledge it has gleaned from this process, which may lead to productivity gains or employment gains or so forth. It is this link between knowledge production and knowledge disruption that may have led to the negative results of innovation outcomes on firm performance outcomes. The fifth chapter later finds that this theoretical hypothesis is indeed true and knowledge production leads to a significant replacement effect within the firm disrupting embedded knowledge.

7.4.2 | An Empirical Contribution
This research also contributes to the empirical literature on innovation-productivity studies by employing a novel counterfactual approach for investigating the innovation-productivity relationship. The use of an endogenous switching model enables the examination of the marginal effects of innovation for innovators and non-innovators. This estimation allows a greater understanding of the endogenous relationship between the decision to innovate and the concern of improving firm performance. In chapter five, it was identified that there is knowledge disruption in the firm as a result of innovation. In the Irish case, product innovation was identified as having a negative effect on a firm’s productivity. The assumption that innovation leads to improvements cannot be automatically made. In the short run, innovation can lead to knowledge disruption effects and poorer productivity performances. Consequently, management in firms may on occasion be reluctant to introduce innovations due to the uncertainty inherent in innovation.

The counterfactual analysis following the estimation of the endogenous switching model allows the researcher to explore these issues further and it also provides an understanding of what types of firms have an absolute advantage or otherwise in the market place. Previous studies as already outlined in earlier chapters have either focused solely on the innovation-productivity relationship of innovators or they employ predicted values of the likelihood of innovating for the total sample (which includes predicted values for innovators and non-innovators). Of course this is useful, but the counterfactual analysis used in this research goes a step further to identify whether the marginal effects of innovation are larger or smaller for innovators relative to non-innovators and whether innovators have an absolute advantage in production as a result of heterogeneity effects irrespective of whether or not they decide to innovate. This contribution provides a better understanding of the innovation-productivity and subsidy-firm performance effects and enhances our understanding of these processes.
7.5 LIMITATIONS OF THE RESEARCH AND GUIDELINES FOR FUTURE RESEARCH

7.5.1 Data Limitations – The Definition of Innovation
The Business Environment and Enterprise Survey was a very useful and rich dataset for analysing the innovation and productivity of firms across different types of innovation, industry settings and economy type settings. For instance, it had details on human capital and details on the location of businesses which are not included in the Community Innovation Survey (CIS). Furthermore, the data is collected in developed and developing economies. The latter being an area where the literature is scant in terms of innovation-productivity studies. Furthermore, it allows for cross country comparisons and comparisons between developed and developing economies as the data is consistently collected from country to country. It includes details on various types of innovations, firm performance indicators and many questions on the firm's characteristics. That said, there are of course key limitations of the dataset which impact on the limitations of this research.

The first limitation is with respect to the definition of innovation in the dataset. In the analysis, there were some differences identified between the industry categories of manufacturing and service firms in chapter five. But when the analysis was broken down, only very marginal and subtle differences emerged in the dataset. The innovation definitions employed in this study were broad. For instance, it was not possible to identify if product innovations were new to the firm or new to the market. It would be expected that more knowledge intensive manufacturing and service firms would be more likely to introduce new to the market products as they are closer to the technological frontier. This is possibly a reason why industry differences were not detected as low knowledge intensive firms would be just as likely to introduce new to firm products as that of high knowledge intensive firms. Furthermore, it was not possible to detect the impact of innovations on the firm's revenue as there was no recording in the questionnaire of the contribution of innovations to the firm's sales, in the 2005 dataset.

It would also help to identify the distinct contribution to a firm's overall performance if the number of product and/or process innovations introduced were recorded. Furthermore, a better understanding on the complementarity nature between product and process innovations is required. For instance, when a firm is requested to answer if it has introduced a new product/service, it would be helpful if there were sub-questions that outlined what other resources and/or process innovations were needed by the firm to introduce the new product/service. Similarly, if this approach was applied at the end of the product/service life cycle to the discontinuation of products/services and process innovations – greater clarity would emerge from our understandings of product/service life cycle patterns and the relative importance of innovation, firm age and process innovations in explaining the underlying patterns that emerge.

7.5.2 Data Limitations – The Need for Panel Data
An objective of this research was to get a better understanding of the innovation-productivity connection at the firm level. However, the data employed in this analysis is cross-sectional data.
Consequently, only short run implications of the innovation-productivity relationship could be assessed in depth whilst simultaneously ensuring a large enough sample size to estimate reliable models and results. An estimation using panel data was examined and referenced earlier in this concluding section, but there was only a balanced data available for 403 firms and many of the firms in that sample were from transition economies that are not yet members of the European Union. Other panel data is available but it is of a highly unbalanced nature and does not include data from innovation driven economies. For future work, it would be essential to have a balanced panel data set for innovation driven and transition driven economies to assess the long run implications of innovation for productivity. Such work would resolve any questions about the uncertainty inherent in introducing innovations over the short and long term for firms.

7.5.3 | Limitations with BEEPS on Knowledge Sourcing and Location Information
A further limitation of the research was the inability to explore who the firms are interacting with and the benefits associated with interaction with competitors, suppliers, customers and public knowledge sources for firm innovation and productivity. The literature on innovation systems maintain that firms are heavily influenced by external agents to help them innovate (Baptista and Swann, 1998; Cooke and Morgan, 1999). Fortunately, BEEPS data does allow the researcher to identify the population size of where the firm is located. In some countries, the data is at county or regional level such as in Ireland and Spain. In more recent versions of BEEPS such as the 2009 version, the firm’s location can be identified at a regional level in all countries. However, it would be even more useful if the exact location of the firm could be identified, to allow concrete distinctions to be made between whether it is localised (Marshall, 1890; Porter, 1985) or urbanisation economies (Marshall, 1890) that are more important for driving innovation and productivity. The county or regional level may be too aggregated to pick up any localised effects effectively.

7.5.4 | Service Innovation
A key contribution of this work was the comparison between manufacturing and service firms. Our understanding of innovation has been developed predominantly by papers using manufacturing firms. In this thesis, an assimilation perspective of innovation was taken for the analysis on service firms. As pointed out by Miles (2005), few available survey innovation indicators were designed with services in mind and hence existing surveys may fail to adequately capture the dynamics of service innovations. Coombs and Miles (2000) point out that there are other ways of measuring innovation in service firms. Firstly, there is the demarcation approach which argues that service innovation is very different to that of innovation in manufacturing firms. Plaudits of this approach suggest that innovation in service firms needs to be measured very differently, and measurement should be based on new theoretical foundations distinctive to those employed in the manufacturing literature. Another alternative approach is the synthesis approach which identifies that service innovation brings forward neglected understandings especially with the empirical analysis of innovation in general. Drejer (2004) highlights that acceptance of the synthesis approach brings our understanding of innovation away from a Schumpeterian heritage and hence makes our meaning of innovation unclear. Drejer (2004) argues that the rise of the synthesis approach should not just
be isolated to service innovations, but further claims that some of the ideas emerging from the synthesis approach could be equally applied to our understanding of innovation in manufacturing – in essence, the traditional technological approach to understanding innovation is also too narrow for manufacturing. Drejer (2004) also warns that the synthesis approach may stretch the understanding of innovation too far from its original economic meaning. What is clear from the discussions around the conceptual similarities and differences between innovations in services and manufacturing firms is that there is still further understanding required at a conceptual level for innovation in general and that this needs to carry over to measurement techniques. This is a key area of enquiry for future research.

7.5.5 | Other Innovations
In terms of the Schumpeterian approach to innovation, the focus of analysing innovation at the firm level has been predominantly on product and technological process innovation (particularly the acquisition of new technology for greater production efficiency). However, Schumpeter (1942) identified three further areas of innovation (organisational, input, and market innovation) and these have received considerably less attention in the empirical literature. In chapter three, the non-technological aspect of organisational innovation was explored. It is clear from this research that there are some differences in the factors driving organisational innovation relative to technological process innovation. From this assessment it cannot be assumed that the same factors drive all types of innovation – further research exploring organisation, input and market innovation is required which would help in understanding if there are distinctive innovation processes by innovation type.

7.5.6 | More Research Required on Non-Innovators
Finally, the results suggest that it is important for policymakers to focus interventions towards non-innovators as well as innovators, depending on where the transitional heterogeneity effects are greatest. In chapter three, the treatment effects of innovation are larger for process innovating firms. However, non-innovating service firms in transition driven economies achieve higher treatment effects and have an absolute advantage in production. Non-innovating product manufacturing firms in innovation driven economies also have a greater transitional heterogeneity treatment effect. Furthermore, there are larger treatment effects for non-innovators for product and organisational innovation in the Irish case. It is clear that the cases identified above indicate that intervention towards non-innovators may result in better market outcomes. However, further research is required to identify what the barriers to innovation are for non-innovators? Furthermore, it is necessary to identify what type of interventions should be directed towards non-innovators as interventions in the form of subsidies may result in perverse incentives resulting in perverse market outcomes.
REFERENCES


Conclusions and discussion of the research

Schumpeter (1942). *Capitalism, Socialism, and Democracy*, New York, Harper and Brothers. USA.


APPENDIX

Table 7.1 | Sample Size by Country

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
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<tbody>
<tr>
<td>Bulgaria</td>
<td>39</td>
<td>9.68</td>
<td>9.68</td>
</tr>
<tr>
<td>Croatia</td>
<td>28</td>
<td>6.95</td>
<td>16.63</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>12</td>
<td>2.98</td>
<td>19.6</td>
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<tr>
<td>Estonia</td>
<td>40</td>
<td>9.93</td>
<td>29.53</td>
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<tr>
<td>FYROM</td>
<td>32</td>
<td>7.94</td>
<td>37.47</td>
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<tr>
<td>Hungary</td>
<td>38</td>
<td>9.43</td>
<td>46.9</td>
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<tr>
<td>Latvia</td>
<td>35</td>
<td>8.68</td>
<td>55.58</td>
</tr>
<tr>
<td>Lithuania</td>
<td>30</td>
<td>7.44</td>
<td>63.03</td>
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<tr>
<td>Poland</td>
<td>51</td>
<td>12.66</td>
<td>75.68</td>
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<td>Romania</td>
<td>48</td>
<td>11.91</td>
<td>87.59</td>
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<td>Slovakia</td>
<td>19</td>
<td>4.71</td>
<td>92.31</td>
</tr>
<tr>
<td>Slovenia</td>
<td>31</td>
<td>7.69</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>403</td>
<td>100</td>
<td></td>
</tr>
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</table>


Table 7.2 | Descriptive Statistics of Balanced Panel Data

<table>
<thead>
<tr>
<th>Variable Description</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
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</thead>
<tbody>
<tr>
<td>Percentage change in log of turnover per worker 2002-2009</td>
<td>403</td>
<td>5.783</td>
<td>14.756</td>
<td>-37.564</td>
<td>75.713</td>
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<tr>
<td>Log of turnover per worker 2005</td>
<td>403</td>
<td>10.59</td>
<td>0.866</td>
<td>8.562</td>
<td>12.94</td>
</tr>
<tr>
<td>New product/service</td>
<td>403</td>
<td>0.387</td>
<td>0.488</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Upgrade product/service</td>
<td>403</td>
<td>0.551</td>
<td>0.498</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Log of Capital per worker</td>
<td>403</td>
<td>6.473</td>
<td>4.131</td>
<td>-7.003</td>
<td>16.199</td>
</tr>
<tr>
<td>Log of R&amp;D per worker</td>
<td>403</td>
<td>-0.693</td>
<td>4.121</td>
<td>-7.544</td>
<td>12.283</td>
</tr>
<tr>
<td>Capital city</td>
<td>403</td>
<td>0.313</td>
<td>0.464</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Domestic Firm</td>
<td>403</td>
<td>0.866</td>
<td>0.341</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Large Firm</td>
<td>403</td>
<td>0.199</td>
<td>0.399</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Medium Firm</td>
<td>403</td>
<td>0.256</td>
<td>0.437</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Small firm</td>
<td>403</td>
<td>0.546</td>
<td>0.499</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Multiplant Firm</td>
<td>403</td>
<td>0.097</td>
<td>0.296</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Age of the Firm</td>
<td>403</td>
<td>17.236</td>
<td>19.838</td>
<td>4</td>
<td>180</td>
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<tr>
<td>Exporting Firm</td>
<td>403</td>
<td>0.154</td>
<td>0.361</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Conclusions and discussion of the research

Table 7.3 | Average Expected log of Productivity Per Worker for New Product/Service Innovators and Non-Innovators

<table>
<thead>
<tr>
<th>Sub-Samples</th>
<th>Innovator</th>
<th>Non-innovator</th>
<th>Treatment Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firms that innovated</td>
<td>(A) 10.606</td>
<td>(C) 11.407</td>
<td>TT = -0.801**</td>
</tr>
<tr>
<td>Firms that did not innovate</td>
<td>(D) 10.886</td>
<td>(B) 10.567</td>
<td>TU = 0.319***</td>
</tr>
<tr>
<td>Heterogeneity</td>
<td>BH1 = -0.279***</td>
<td>BH2 = 0.840***</td>
<td>TH = -1.120***</td>
</tr>
</tbody>
</table>

Notes:
1. Variables with *** are significant at 1% level, ** are significant at 5% level and * are significant at 10% level.

Table 7.4 | Average Expected Log of Productivity Per Worker for Upgraded Products and Services for Innovators and Non-Innovators

<table>
<thead>
<tr>
<th>Sub-Samples</th>
<th>Innovator</th>
<th>Non-innovator</th>
<th>Treatment Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firms that innovated</td>
<td>(A) 10.639</td>
<td>(C) 11.168</td>
<td>TT = -0.529***</td>
</tr>
<tr>
<td>Firms that did not innovate</td>
<td>(D) 11.056</td>
<td>(B) 10.588</td>
<td>TU = 0.498***</td>
</tr>
<tr>
<td>Heterogeneity</td>
<td>BH1 = -0.417***</td>
<td>BH2 = -0.609***</td>
<td>TH = -1.026***</td>
</tr>
</tbody>
</table>

Notes:
1. Variables with *** are significant at 1% level, ** are significant at 5% level and * are significant at 10% level.

Table 7.5 | Average Percentage Change of Log of Productivity Per Worker for New Product/Service Innovators and Non-Innovators

<table>
<thead>
<tr>
<th>Sub-Samples</th>
<th>Innovator</th>
<th>Non-innovator</th>
<th>Treatment Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firms that innovated</td>
<td>(A) 5.946</td>
<td>(C) -15.823</td>
<td>TT = 21.769**</td>
</tr>
<tr>
<td>Firms that did not innovate</td>
<td>(D) 6.306</td>
<td>(B) 5.843</td>
<td>TU = 0.363***</td>
</tr>
<tr>
<td>Heterogeneity</td>
<td>BH1 = 0.361</td>
<td>BH2 = 21.666***</td>
<td>TH = 21.306***</td>
</tr>
</tbody>
</table>

Notes
1. Variables with *** are significant at 1% level, ** are significant at 5% level and * are significant at 10% level.

Table 7.6 | Average Percentage Change of Log of Productivity Per Worker for Upgraded Products and Services for Innovators and Non-Innovators

<table>
<thead>
<tr>
<th>Sub-Samples</th>
<th>Innovator</th>
<th>Non-innovator</th>
<th>Treatment Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firms that innovated</td>
<td>(A) 5.572</td>
<td>(C) -22.059</td>
<td>TT = 27.631***</td>
</tr>
<tr>
<td>Firms that did not innovate</td>
<td>(D) 11.860</td>
<td>(B) 6.372</td>
<td>TU = 5.489***</td>
</tr>
<tr>
<td>Heterogeneity</td>
<td>BH1 = 6.289***</td>
<td>BH2 = 28.432***</td>
<td>TH = 22.142***</td>
</tr>
</tbody>
</table>

Notes:
1. Variables with *** are significant at 1% level, ** are significant at 5% level and * are significant at 10% level.