What drives innovation in New Zealand?

Some preliminary results using the Business Operations Survey

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Abstract

This paper investigates the innovative behaviour of New Zealand firms using the *Business Operation Survey* (BOS). A detailed review of the international innovation literature is provided as a precursor to identifying a list of potential regression variables. A set of regression models, with four different innovation outcomes, are presented and the results suggest that New Zealand firms appear to experience smaller positive size and market power effects than found in other countries due, in the main, to the unique characteristics of New Zealand firms. Both investment and favourable business environment appear to play an important role in explaining the drivers of innovation in New Zealand.

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Only people authorised by the Statistics Act 1975 are allowed to see data about a particular business or organisation. The results in this paper have been confidentialised to protect individual businesses from identification.

1. Introduction

What is the key to creating and maintaining sustainable economic growth? The neoclassical growth model approach typically assumes that both capital and labour are subject to diminishing returns and therefore only continuous technological advancements can permanently delay the economy reaching the steady state. Ruttan (1959), however, recognized that innovation could be considered as 'the antecedent to technological change', however, one of the major impediments to research in this area has been what is meant by 'technological change' and how might we measure 'innovation? Although, in principle, innovation can be more readily identified than technological progress, its definition is often debated. The earliest definition of innovation was proposed by Schumpeter (1934), where he suggests that it is the:

> introduction of new goods (…), new methods of production (…), the opening of new markets (…), the conquest of new sources of supply (…) and the carrying out of a new organization of any industry.

Following Schumpeter, many authors have proposed alternative definitions. Usher (1954) defined innovation as "the process of new things emerging in science, technology and art"; Udwadia (1990) described innovation as "the successful creation, development and introduction of new products, processes or services"; Cumming (1998) suggested innovation is "the first successful application of a product and process". Although these definitions are all slightly different, they tend to concentrate on technological product and process (TPP) innovations. The *Oslo Manual, 3rd Edition* (OECD, 2005) expands earlier notions of innovation to include non-technological innovation and provides a definition much more in the spirit of the original Schumpeter intent, i.e.:

> the implementation of a new or significantly improved product, or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations.

With this brief background and informed by these new international guidelines, the objective of this research is to try to uncover the determinants of innovation in New Zealand. To do so we utilized the unique dataset developed by *Statistics New Zealand* (SNZ), namely the prototype *Longitudinal Business Database* (LBD). The database facilitates access to administrative and sample survey data, particularly the *Business Operation Survey* (BOS). As New Zealand's national innovation survey, BOS has been operating annually since 2005 and it uses an integrated collection approach with the innovation module running every second year.

The preliminary analysis on the dataset presented below was guided and informed by Fabling's (2007) work on BOS 2005. Building on this work and following an in-depth review of international empirical literature, a new set of regression models and results are presented to uncover New Zealand's possibly unique drivers of innovation.

The rest of this paper is organised as follows. Section 2 outlines different approaches to the measurement of innovation. Section 3 provides a brief overview of innovation surveys from around the world, paying particular attention to those that relate to New Zealand. Section 4 considers candidates for relevant potential dependent and independent variables that might be used in to estimate and test innovation related research. Section 5 presents the new regression models and results for New Zealand using BOS 2005, 2007 and 2009. Finally, Section 6 concludes.

2. Measurements of Innovation

A fundamental and immediate challenge for any innovation related research is how to measure the variable of interest, "innovation". Currently, there are two types of measures; *indirect* and *direct*. Conventionally, innovation is measured by proxies including R&D and patent based indicators. R&D expenditure is an *indirect* measure as it only measures inputs devoted to (potentially) innovative activities and patent based indicators focus solely on the successful generation of (hopefully) commercial applications. There is, however, a long history of using these measures. The practice of using R&D can be traced back to the 1930s (Holland & Spraragen, 1933), and the use of patents was popularized by Schmookler (1950, 1953, 1954). Most national statistical agencies continue to report some form of R&D and patent statistics and for a number of reasons, including ease of measurement and ease of international comparison, some researchers continue to use such measures to study innovation.

The problem with these indirect measures is that they are relatively narrow due to their potentially weak linkages with innovation and they typically induce large firm bias.

For econometric analysis, however, a much preferred option is to use *direct* measures of innovation, which can either be *objective* or *subjective*. Measuring innovation as an *output*, the number of innovations or 'innovation count' is an objective measure that involves collecting information from new product/process announcements, specialized journals, databases, etc. As a result of its collection method, this measure tends to be biased towards radical/product innovation as opposed to incremental/process innovation where unsuccessful innovations are automatically excluded. Carter and Williams (1957, 1958) were the first to use the output approach, on behalf of the *Science and Industry Committee* (UK), where they conducted a survey of the sources of innovation by examining 201 significant innovations from 116 firms and their characteristics. The same approach was used by the US *National Science Foundation* (NSF) (Little, 1963; Mansfield, 1968; Myers & Marquis, 1969) and the *Organisation for Economic Co-operation and Development* (OECD, 1968; Pavitt & Wald, 1971).

From the late 1970s, however, the use of *subjective* measures of innovation has become increasingly popular. Instead of focusing on output, the subjective measures consider innovation as an *activity* and a range of innovation related data are collected via firm-based surveys. This approach generally provides discrete measures of innovation, subject to human error/bias and, with potentially low response rates, there may be limited representativeness. Germany adopted the activity approach as early as 1979 (Meyer-Krahmer, 1984), and Italy followed in the mid-1980s (Archibugi, Cesaratto, & Sirilli, 1987). Aiming to harmonize national methodologies and collect standardised information on firms' innovation activities, the first edition of the *Oslo Manual* was published in 1992 under the joint effort of the *OECD* & *Eurostat* and made the activity approach the official, preferred method for measuring innovation.

3. Innovation Surveys

Collecting innovation related data via firm based surveys has now become a common practice for many countries (e.g. Canada, United States, Malaysia, Taiwan, Australia) In Europe, the *Community Innovation Survey* (CIS) is the main statistical instrument of the European Union where the main source of data for the "*European Innovation Scoreboard*" and is based on the *Oslo Manual* approach. The first survey was conducted in 1993 covering a three year time span and following a legislative change in 2007, the survey frequency was increased from every four to every two years. Latin American countries have also been very active in terms of conducting innovation surveys. In response to the publication of the *Oslo manual*, the *Bogota Manual* was drafted during 1999-2000. Intended to complement the *Oslo Manual*, additional guidelines were added to suit the differences between regions. Three rounds of survey have been conducted since 1995 with a total of 12 countries participating. However, only Argentina and Chile completed all three rounds.

In addition to efforts made by national governments, various research institutes around the world have undertaken their own innovation surveys. For example, *InnovationLab (Ireland) Ltd*, an academic spin-off from the *Northern Ireland Economic Research Centre*, created the *Irish Innovation Panel* (IIP) by linking five postal surveys on product and process innovation. The *Fraunhofer Institute for Systems and Innovation Research* (ISI) has conducted the *German Manufacturing Survey* every two to three years since 1993. The survey was internationalised in 2001 to meet the demand for internationally comparative data and the *European Manufacturing Survey* (EMS) was established as a result.

Given these, and other, data collection efforts, it is quite surprising that we appear to know so little about the subject. Except common issues around data quality, innovation researchers often have problems accessing the data, as micro innovation data administrated by the state is often considered to be 'highly confidential' and data produced by research institutes is generally very expensive. In both cases, only a small number of people appear to be able to access the data. At best, national statistical agencies report only summary statistics on their national surveys, such that if we really want to understand innovation, its role and its drivers, we must seek to increase access to the detailed data that is available.

In New Zealand the main survey instrument for the collection of innovation data is the *Business Operation Survey (BOS)*, which is an integrated, modular survey developed by *Statistics New Zealand* (SNZ). The survey has been operating annually since 2005 with the latest iteration being 2009. The integrated collection approach minimises the reporting load for New Zealand businesses while collecting the necessary information for research and policy purposes. Up to three "modules" can be included in the survey, each with its own specific objectives. The first module typically focuses on business performance and characteristics. The longitudinal dimension of the information enables changes over time to be analyzed, hence assisting the investigation of causal relationships. The second module operates on a rotational basis where the survey content alternates between innovation and business use of *Information and Communication Technology* (ICT). The innovation module is intended to replace the *Innovation Survey*, which was last run in 2003. The current innovation data collection method follows the guidelines in the third edition of *Oslo Manual*. By including the previous technological product and process (TPP) innovations as well as non-technological innovations, the survey reflects a new and wider scope than the 2003 survey. The third module is the "contestable module", which avoids the need to administer a full standalone survey. The target population for the survey is live enterprise units on SNZ's Business Frame at the population selection date. Its sample design is two-level stratification according to ANZSIC industry and employment size groups. The 'out of scope' industries are excluded, and comprise Government Administration & Defence; Libraries, Museums and the Arts; and Personal and Other Services. After exclusion of non-economically significant enterprises (annual GST turnover less than NZD$30,000) and firms with employment[1] fewer than six, the estimated population size for each survey is between 34,000 and 35,000 enterprises.

In 2006, a two–year feasibility project "*Improved Business Understanding via Longitudinal Database Development*" (IBULDD), previously known as Longitudinal Research of Business Dynamics was implemented by SNZ. The project was designed to identify new official statistics and potential improvements to current official statistics by linking business related data from both administrative and sample survey data (including BOS). A prototype *Longitudinal Business Database* (LBD) has been created as a result. The new and enhanced outputs are extremely valuable for innovation related studies, improving access and usability of micro-data for researchers without adding to respondent load. However, to date, utilisation of the IBULDD data in innovation studies has been limited due to restricted accessibility.

4. Regression Based innovation Researches

A major aim of this paper is describe and evaluate New Zealand's current innovation performance and identify its drivers using appropriate econometric methods. To achieve this aim we firstly define the innovation indicator(s) to be used and identify the potential and available explanatory variables. In this section, a review of the international innovation literature will be reported identifying a list of potential variables.

4.1. Dependent Variables

Recall the earlier discussion on the different measures of innovation, where both *direct* and *indirect* measures were discussed. Historically, the dependent variable(s) typically used by authors in their analyses have comprised the following.

Indirect measures of innovation are often used as the dependent variable. Hamberg (1964), tested the relationship between research and firm size in a double-log regression model, where R&D employment was used as a proxy for research. Sourcing firm R&D

[1] Employment is measured based on rolling mean employment (RME), which is a 12 month moving average of monthly employment count (EC) figure obtained from taxation data.

expenditure data from *Business Week's* "R&D Scoreboard", Link, Seaks, and Woodbery (1988) confirmed that the double-log is an a appropriate specification for testing the 'R&D-to-size' relationship. Grabowski (1968) was particularly interested in the determinants of research expenditures in the drugs, chemicals and petroleum refining industries. Here research intensity was considered as a more appropriate dependent variable than actual expenditures due to the large scale differences between firms. Similar to many others, his choice of size deflator was the total sales of the firm (Levin, Cohen, & Mowery, 1985; Lunn & Martin, 1986). Alternative size deflators for example, total assets and the number of employees were also used as a check for model consistency. Such deflators are preferred by some other authors including Artes (2009), Crepon, Duguet, & Mairesse (1998). Cuervo-Cazurra and Un (2007) analysed the influence of a regional economic integration agreement by focusing on the relative investment in internal R&D as well as the internal and external R&D intensity. Here total sales were used as the deflator. Crepon, *et al*. (1998) preferred to use a stock measure of research rather than a flow measure and as a consequence they used the actual research capital per employee .

In the absence of a "completely satisfactory index of inventive output", Scherer (1965) chose patent statistics as the principal dependent variable for his work, specifically 'the number of US invention patents received' by the sampled firms in 1959. Given the limitations of patent data, many of his hypotheses were also tested with respect to R&D employment and the results showed that similar conclusion emerged whether patents or R&D employment is taken as the 'index of inventive activity'. Krammer (2009) explored the determinants of innovation at a national level in Eastern European transition countries , where the "new- to- the-world" notion of innovation is approximated by the number of patents that the *US Patent and Trademark Office* (USPTO) issued to EEC inventors. Scellato (2006) sourced patent portfolio information from the European Patent Office while examining the impact of financial constraints on innovation activities in the Italian manufacturing sector. In addition to registered patent counts, Beneito (2006) also considered 'utility model counts' as measures of innovation output. According to the definition provided by the *World Intellectual Property Organization* (WIPO), both patents and utility models are exclusive rights granted for an invention, for a limited period of time unless authorized any commercial use of the protected invention is prohibited. The term of protection for utility model is shorter than patents, but it is cheaper and easier to obtain and maintain because of its less stringent requirements. Instead of counts, patent propensity is another dependent variable used in innovation research (Schmiedeberg, 2008), which takes the form of a dichotomous variable, which equals one if the patenting activity is observed and zero otherwise.

In contrast to the research discussed above, the most common approach currently adopted in econometric studies is to use *direct measures* of innovation. In addition to 'patent propensity' Santamaria *et al*.(2009) included two additional dichotomous variables to capture the different innovation outputs (i.e. product and process innovation). Todtling *et al*. (2009) focused on product innovation, but also went a step further by defining 'new to the firm' and 'new to the market' innovations. Weterings and Boschma (2009) included both dichotomous variables for the 'introduction of new products or services' and the 'percentage of turnover due to the sales of those new products or services' in their analysis. Utilizing data from the *Taiwanese Technological Innovation Survey* (TTIS), Tsai (2009; Tsai & Hsieh, 2009; Tsai & Wang, 2009) measured innovation performance based on 'innovative product sales' and 'innovative sales productivity' (i.e. innovative product sales per employee). Kirner, Kinkel and Jaeger (2009) separated product and process innovation and adopted five innovation output indicators, namely the 'share of turnover with new products', 'share of turnover with new product related services', 'labour productivity' (turnover-input/employee), 'rework/scrap rate' and 'production lead time'. Despite the popularity of the notion of TPP innovation, Mol and Birkinshaw (2009) were keen to discover the source of management innovation. To qualify as an innovator the firm has to make major changes in at least one of the following areas: (a) implementation of advanced management techniques; (b) implementation of new or significantly changed organizational structure; (c) changing significantly firm's marketing concepts/strategies e.g. marketing methods. They create a single scale variable which takes the value 0 if there is no effective management innovation activity within the firm, with 1 added for each type of management innovation the firm engaged in, such that the upper bound is set at 3.

4.2. Independent Variables

Previous authors have typically developed their models depending on the specific focus of their study and the availability of data. Assessing a wide range of independent variables sourced from the existing innovation literature, we can assign most variables used to one of three categories; i) *'firm characteristics'* ii) '*firm behaviour/strategy'* and iii) *'overall environment'*.

Firm characteristics variables can either be *'acquired'* or *'inherent'* properties of the firm. As suggested by the description, acquired characteristics can vary over a period of time due to the (intentional or unintentional) actions of the firm, whereas the inherent sectoral characteristics are harder to change (see Table 1).

Table 1 Determinants of Innovation - Firm characteristics

Category	Subcategory	Variables	Selected References
Acquired	Firm Size	Employment	Brewin, *et al*.(2009) and Harris, *et al.* (2009);
		Total Sales	Artes (2009) and Cuervo-Cazurra and Un (2007);
	Financial Capability	Debt to equity ratio	Cuervo-Cazurra and Un (2007) and Munari *et al*. (2010);
	Production Capacity		Armbruster, *et al*. (2008);
	Business Makeup	Ownership	Huergo (2006), Tsai (2009) and Munari *et al.* (2010) ;
		Export status	Leiponen and Byma (2009) and Falk (2008);
		Part of Business /Multi-plant Group	Sadowski and Rasters (2006) and Frenz and Ietto-Gillies (2009);
		Outsourcing/ subcontracting	Cuervo-Cazurra and Un (2007) and Kirner, *et al*.(2009)
	Stock of Knowledge	Absorptive capacity	Tsai (2009) and Tsai and Hsieh (2009)
		Capital/Assets	Kafouros *et al*.(2008) and Zhang (2009);
		Employment	Hewitt-Dundas and Roper (2008) and Freel (2003);
	Firm Age		Saliola & Zanfei (2009) and Weterings and Boschma (2009);
	Product	Diversity	Santamaria, *et al*. (2009) and Siegel and Kaemmerer (1978);
		Complexity	Kirner, *et al*.(2009);
	Geography/Location		Srholec (2010) and Saliola and Zanfei (2009);
Inherent	Sector Profile	Industry dummies	Veugelers and Cassiman (1999) and Faems *et al*. (2005);
		Technology level	Raymond *et al*. (2009) and Todtling, *et al*.(2009);

A classic example of an acquired firm characteristic is *firm size*. Schumpeter (1950) proposed the earliest and one of the most well known testable hypothesis of the determinants of innovation when he advocated the positive relationship between innovation and firm size. Given four principle dimensions of size: employees, sales, income generated and assets (Adelman, 1951), number employed and total sales are typically used to measure firm size.

Despite Schumpeter's historical claim, several research results suggest that large firms are less innovative than smaller firms, and smaller firms are responsible for a large number of patents and innovations relative to their size (Acs & Audretsch, 1988; Scherer, 1965). Pavitt, Robson and Townsend (1987) supported the advantage of firm size in R&D and asserted a U-shaped relationship between innovation intensity and firm size. This implies that both large and small firms have innovation intensity above average where it is the medium sized firms that have below average intensity. It is worth stressing however that, the criteria for 'small' and 'large' firms can differ markedly for different studies. In their 1987 paper for example, large firms are classified as having more than 10000 employees; the employment bracket for medium firms is between 2000 and 9999, and small firms have between 500 and 1000 employees. Care should be exercised, therefore, when comparing results across countries and studies (Hong, Oxley, & McCann, 2010), for example in New Zealand Ministry of Economic Development defines firm size based on an enterprise's employment headcount, and considers firms with 19 or fewer employees to be SMEs, and based on this definition 97.2% of New Zealand enterprises are SMEs as at February 2009, where the number of SMEs has increased 1.3% in the year to February 2009 (Ministry of Economic Development, 2010).

Other size related characteristics include, 'financial capability', 'production capacity' and 'business makeup'. Larger firms tend to face fewer resource constraints especially when undertaking innovative activity. 'Debt to equity ratio' is the most well known measures of a company's financial leverage and is calculated by dividing its total liabilities by stockholders' equity. Himmelberg and Petersen (1994) argued that, given the imperfection of the capital market, internal finance is "the principal determinant of the rate at which small, high-tech firms acquire technology through R&D".

Production capacity may also impact on a firm's innovation performance. Armbruster, *et al*. (2008) identified a positive correlation between degree of capacity utilization and organizational innovation, however it is also possible that limited production capacity may reduce the possibility of product innovation, and production batch size could also affect firm's innovativeness (Love & Roper, 1999).

'Business makeup' can include many aspects where some areas investigated include ownership, export status organizational structure and outsourcing/subcontracting practices. The literature suggests that family owners are more risk averse and as a result tend to invest less in terms of R&D (Munari, *et al*., 2010) while, on the other hand, publicly owned firms may have fewer incentives to make productivity improvements and hence less incentive to innovate (Huergo, 2006). In contrast, multinational companies have been targeted for investigation of the Schumpeterian hypothesis, as they tend to be bigger and more powerful compared to firms that mainly focus on domestic operations (Hirschey, 1981). Baldwin (1979) emphasized the positive linkages between foreign direct investment by US multinational affiliates and labour-skill requirements, which was used as an R&D proxy. In addition to foreign direct investment, exports are the other form of foreign expansion. Gruber, Mehta and Vemon (1967) and Horst (1972) suggested that firms in R&D intensive industries have higher levels of export sales. However, Lin and Chen (2007) argued the reverse, by suggesting that innovation may be required to gain competitive advantage for companies that compete in an international arena. Variables with different levels of detail are used by authors to capture a firm's export status. At one extreme, a dummy variable is used, which takes a value 1 if the firm participates in exporting, zero otherwise (Huergo, 2006). Others however, prefer quantitative measures such as 'export intensity as percentage of sales' (Panne & Beers, 2006). Mol and Birkinshaw (2009) viewed exports from a geographic perspective and asked the firm whether its largest market is 'local, regional, national or international'? As it seems likely that different branches of industry innovate differently, a measure of organisational structure enables researchers to identify whether the firm is a single-location company, a subsidiary of some other company, a main office/headquarters, or a branch establishment. It has been suggested that firms with access to the business group's resources may be more likely to innovate (Leiponen, 2006). In addition, the idea of 'business structure' (i.e. the internal networks of subsidiaries) has been developed based on a specific set of objectives and activities, where it has been proposed that the knowledge transfer between each unit is likely to affect the overall innovation performance of the firm (Frenz & Ietto-Gillies, 2009). Similar arguments have been made for outsourcing and subcontracting practices. The argument here is that once the decision has been made to subcontract some of its production, the firm has made a conscious decision to invest in managing external sources of technology and knowledge (Cuervo-Cazurra & Un, 2007).

The remaining acquired characteristics that have been considered include stock of knowledge, firm age, product characteristics and firm locality.

Stock of knowledge variables measure the firm's existing technological knowledge base from various perspectives. Absorptive capacity is the ability of a firm to recognize, assimilate and apply the valuable, new, external information to commercial ends (Cohen & Levinthal, 1990). In general it is associated with a firm's ongoing in-house R&D activity (Stock, Greis, & Fischer, 2001). Tsai (2009) recognized that the existing knowledge base is accumulated from past learning and intensity of effort, so he opted for a more complicated measure by dividing the firm's total expenditures on in-house R&D activities and training programs for technological activities in the past 3 years by its current number of employees, where the numerator is a stock measure. In addition to absorptive capacity, knowledge can also embedded within a firms' physical and human capital. Santamaria, *et al.* (2009) explored the importance of knowledge diffusion for innovation performance and suggested that the use of machinery and advanced technology such as automatic machines, robots, CAD/CAM, or some combination of these procedures is critical to low-and-medium technology (LMT) firm's innovation success. To approximate the knowledge embedded in a firm's human capital, education related variables such as percentage of graduates in the work force or share of employees with higher education are used as the most common measures employed (Hewitt-Dundas & Roper, 2008; Leiponen, 2006). Empirical evidence presented by Dewar and Dutton (1986) shows a positive association between innovation and knowledge depth, which is measured by the number of technical specialists. Becker and Stafford (1967) assert a positive correlation between the adoption of innovations and administrative size, which is measured by the number of personnel listed as officers in the organization. Carroll (1967) proposed that organizations will be more receptive to innovation if their staff have more diverse backgrounds/experiences, and the presence of a 'project champion[2]' can even be a factor favoring innovation (Rothwell, 1992).

Firm age is generally measured in years, although based upon existing empirical evidence, there are divergent views on its relationship with innovation. Hurley and Hult (1998) proposed the idea that younger firms are more innovative and they argued that firms become less receptive to innovation as the bureaucracy grows with aging, as they lack the infusion of new members into the organization which will result in a shortage of innovative ideas. Other evidence, however, showed that older firms are able to accumulate innovative knowledge and experience and generate more innovations as a result (Sorensen & Stuart, 2000).

Product is the core of all businesses and firms with more diversified product lines may utilize the innovative output better, raising the expected payoff of the R&D investment. Grabowski (1968) identified a positive regression coefficient for the index of diversification

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[2] Project champion is an enthusiastic supporter of the innovation project, an individual who is personally committed to it.

when explaining R&D spending intensity, where diversification was measured by the number of separate 5-digit SIC product classification the firm produces. This conclusion is contradicted by Comanor (1965) and Scherer (1965), however, who assert a negative association between diversification and R&D output/patented invention. Thompson (1965), Siegel and Kaemmerer (1978) confirmed diversity's positive effect on the generation of innovation, though with a quite different reasoning. Their view was that diversity promotes conflict and conflict leads to innovation. Aiken and Hage (1971) provided a less extreme explanation based upon diversity enhancing the cross-fertilization of ideas. Santamaria, *et al.* (2009) found it is easier for diversified firms to develop and adapt new technologies to improve its activities and processes. To be diversified their main product has to represent less than 50% of sales at the 3 digit industry level. Other product characteristics that may impact a firm's innovation performance are the complexity of the product. "Complex products tend to stand at the end of the supply chain and thus naturally incorporate various innovation steps along this chain. Innovations developed and introduced by different suppliers become part of the final product" (Kirner, *et al.*, 2009).

In recent years, the literature on geographical determinants of innovation has increased dramatically (Audretsch, 2003; Herrera, Munoz-Doyague, & Nieto, 2010) and the role of agglomeration as the key catalyst of innovation has been explored in detail. Sedgley and Elmslie (2004) found that agglomeration has positive effects on innovative output even after controlling for differences in human capital, high-tech industry structure and R&D university infrastructure. In innovation studies, location is a variable that is often used to control for inter-regional or inter-country difference (Alegre & Chiva, 2008; Falk, 2008).

As discussed above, sectoral characteristics are typically inherent rather than acquired. The most recognizable sector related variables is a firm's industry classification. Almost all cross sector studies include some form of industrial dummies to isolate the sector effect on innovation. Given the possibility of differences in innovative capacity between high-tech and low-tech firms, variables capturing an industry's technology level, it is surprising that they are only included by a small number of authors (Kafouros, *et al*., 2008; Todtling, *et al.*, 2009).

Insofar as all the variables discussed are characteristics that could possibly describe a successful innovator, the next category of determinants of innovation is firm behavior/strategy.

Firm behaviour/strategy, relates to the specific activities and/or strategies that might make a firm a successful innovator. For the purpose of this study, behaviour/strategy variables are split into *'general'* and *'innovation related'* practices (see Table 2).

The first 'general practice' discussed is a firm's investment behaviour. In classical economic theory, capital and labour are two key factors of production where investment in both areas is not only important to a firm's daily operation, but can also be critical for a firm's innovation performance. Capital investment often takes a tangible form, for example, the acquisition of durable physical goods, such as machines, means of transport and buildings, and have been regarded in many studies as one of the chief motivating forces for innovation (Johnston, 1966). Investment in labor, or human capital, is intangible and arises from for example, vocational training and further education. Such human capital enhancing behavior has become increasingly popular among businesses. Swan and Newell (1995) emphasized the positive influence of on-the-job training on innovation. Although education supports technical progress by allowing mastery of existing scientific knowledge and methods and increases the technical competence in general, it may also hinder innovation by impeding unorthodox thinking and imagination, though a certain amount of technical training is indispensable for any innovator (Baumol, 2005). This argument also applies to general recruitment processes, which suggest the nonequivalence between educational attainment and entrepreneurial talent. However one cannot deny the likely value that a well educated and experienced workforce enhances innovative activity. Note that in the long run, the continuous investment in human capital will become the firm's knowledge base or stock of knowledge discussed in the previous section.

Similarly, inputs that are transferred into the firm would have knowledge and technology embodied within them (Caelile, 2002). Cuervo-Cazurra and Un (2007) focused on determining a firm's input sources, as they argue that external advanced technologies may be obtained from overseas suppliers, and hence reduce the need for internal R&D. Saliola and Zanfei (2009) looked at the amount of inputs bought locally by multinational subsidiaries to approximate embeddedness (i.e. the market relationship of multinationals and local firms), and suggested that an increase in the share of locally purchased inputs will lead to significant performance advantages in innovation.

Perhaps a more efficient way to gather market/technological information is to communicate directly with suppliers of raw materials/machinery and equipment (Rothwell, 1992) and likewise customers. The highest level of communication is carried out in terms of co-operation, which will be discussed later. The communication with customers can take the form of personal visits (Rochford & Rudelius, 1992), feedback via phone or post (Chiesa, Coughlan, & Voss, 1996), or quantitative market research (Khan & Manopichetwattana, 1989b). In addition, the firm can obtain external information by networking with others (Souitaris, 2002). Environmental scanning and sharing of market information can also be effective in detecting market opportunities (Kohli & Jaworski, 1990; Slater & Narver, 1995). Although networking and inter-firm linkages seem to be much more than a communication tool, they reduce the risks and uncertainty which accompanies the innovation process, quoting Arndt and Sternberg (2000, p. 481), “innovative activities or the business innovation process can be viewed as a network process, in which business interrelations and interactions with other partners play a significant part”.

Table 2 Determinants of Innovation - Firm Behaviour/Strategy

Category	Subcategory	Variables	Selected references
General Practice	Investment	Capital	Cohen and Levinthal (1989) and Leiponen (2005);
		Labour	Swan and Newell (1995) and Baumol (2005);
	Input	Source	Cuervo-Cazurra and Un (2007) and Saliola and Zanfei (2009);
	External Communication		Weterings & Boschma (2009) and Jong and Hippel (2009);
	Strategy/ Management		Schmiedeberg (2008) and Pekovic and Galia (2009);
Innovation Practice	R&D	Dummy	Hewitt-Dundas and Roper (2008);
		Expenditure	Herrera, *et al.* (2010) and Leiponen and Byma (2009);
		Intensity	Kafouros, *et al.*(2008) and Panne and Beers (2006);
		Employment	Weterings and Boschma (2009);
	Co-operation	Partners	Huergo (2006) and Tsai and Wang (2009)
		Activities	Mol & Birkinshaw (2009) and Leiponen (2006);
	Technological management		Herrera and Nieto (2008) and Jong andHippel (2009);
	Informal practice	Design	Santamaria, *et al.*(2009) and Kirner, *et al.*(2009)
		Marketing	Marsili and Salter (2006)
		Quality Control	Beneito (2006)

Within the firm, there may be a different type of network where ‘strategy’ is a term commonly used in the management field and relates to “a network of choices to position the firm vis-à-vis its environment and to design organisational structure and processes” (Souitaris, 2002, p. 883). A list of strategy-related variables which have potential impacts on innovation have been identified in the literature (Cooper, 1984). It has been suggested that the top executives of innovative firms have different management attitudes. They believe that the company's performance is driven by manageable practices and the uncontrollable environmental influences have limited impact, in other words, they have an internal, rather than external, locus of control (Miller, Kets de Vries, & Toulouse, 1982). Others have suggested that innovative firms are less risk adverse (Khan & Manopichetwattana, 1989a) and more optimistic about business (Souitaris, 2002). Younger CEOs are also seen as more keen to innovate if they are actively involved in running the business (Khan & Manopichetwattana, 1989a). Management structure can also impact upon the innovation process. Chon and Turin (1984) found that innovative firms are less formalised, where the argument is that openness and flexibility are regarded as a precondition for the initiation of new ideas (Shepard, 1967). McGinnis and Ackelsberg (1983) present a similar idea using the notion of 'loose coupling' of groups and flat hierarchy in the organizational structure. Cross-functional interdisciplinary teams may also be more efficient innovators (Hise, O'Neal, Parasuraman, & McNeal, 1990). It has been suggested that even the 'slack' time of engineers and managers can improve the business' innovative performance (Souitaris, 2002). Increasingly some firms seem to have started to set out strategies with specific foci such as pricing, quality and innovation. A fuller discussion of technological management will be considered in the next section.

With regard to 'innovation related' practices, the importance of R&D to innovation has been well informed over the years. Similar to human capital investment, R&D investment is a type of intangible investment. Since the adoption of direct measures of innovation, the tendency of assigning R&D as the 'left-hand side' regressand has faded, whereas R&D expenditure and intensity (as percentage of total sales) remained the most popular measures of R&D effort, followed by an R&D dummy and employment. Many authors separated internal and external R&D in their research, based on the belief that each contributes differently to the innovation process (Beneito, 2006; Frenz & Ietto-Gillies, 2009).

As a result of globalisation, external R&D often takes the form of outsourcing, partnerships and alliances which are frequently used by firms as a means of technology acquisition. The firm itself is no longer the sole technology provider, instead co-operation with external organisations becomes an important phenomenon within the innovation process. In regression analysis, authors have focused on both co-operation partners and activities. The most common practice is for the firm to co-operate with universities/research institutions (Bonaccorsi & Piccaluga, 1994; Lopez-Martinez, Medekkin, Scanlon, & Solleiro, 1994), or public and private consultants (Bessant & Rush, 1995). The co-operation partners may also be other firms (e.g. customers, suppliers and competitors) in the form of joint ventures (Rothwell, 1992; Swan & Newell, 1995). At one extreme, financial institutions and government could participate in the relationship as funding providers (Souitaris, 2002). At the other extreme, firms can purchase technological know-how from external providers via licensing, which can be seen as an alternative form of intangible investment directly boosting the input of knowledge/idea.

In general terms, 'technological acquisition' is classed as a strategic action that involves various departments throughout the company and requires multiple steps. However, general business strategy can be just as important for innovating firms as firstly, the existence of an innovation budget and its consistency can be crucial factors for innovation (Rothwell, 1992). Their existence shows others the intension to innovate and provides continuity and consistency which are seen as essential elements. The establishment of an R&D department may have a similar effect. Secondly, firms tend to have higher innovation rates if there is a well defined and well-communicated business strategy, with a long term horizon, including plans for new technology investment (Khan & Manopichetwattana, 1989b; Koc & Ceylan, 2007; Swan & Newell, 1995). Thirdly, offering incentives to employees for new ideas generation can enhance innovative potential (Chiesa, *et al.*, 1996). Finally, the decision to use different types of intellectual property protection may enhance innovation outcomes (Jong & Hippel, 2009).

In discussions so far, the innovation related practices considered are mainly formal practices with strong innovation focuses, however some informal practices should not be ignored as they are also potentially beneficial to the overall innovation process. Design is an integral part of product development and Laestadius *et al*. (2005) claim that the creative process can be *rational, innovative* or *artistic*. Marsili and Salter (2006) were interested in the relationship between design and innovation performance and defined design as 'the stages of detailed development that are necessary to translate the first prototype into successful production'. It is worth noting that there is considerable overlap between the concepts of design and R&D. While setting the rules for collection on R&D statistics, the *Frascati Manual* (OECD, 2003) identified the difficulty of drawing the line between experimental development[3] and design with the variability depending on industrial situation. Quoting from the *Oslo Manual*, "Some elements of industrial design should be included as

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[3] Three main categories of R&D activities: basic research, applied research and experimental development.

R&D if they are required for R&D" (OECD, 2005, p. 94). Approaching from a slightly different angle, Kirner, *et al.* (2009) looked at product customisation and pointed out that a firm that develops their products according to customer's specifications performs better in terms of product innovation. Marketing and quality control are the other two informal innovation practices that have been investigated by innovation researchers. The key results show that R&D-marketing integration enables the firm to develop a product that meets the customer's needs (Kahn, 2001), while quality control helps identification of existing problems on the production floor.

The final set of explanatory variables used in innovation regressions is **overall environment** variables (see Table 3).

Table 3 Determinants of Innovation – Overall Environment

Category	Subcategory	Variables	Selected references
Market	Structure	Market Share	Santamaria, *et al*. (2009) and Tingvall and Poldahl (2006)
		Price competition	Okada (2004) and Cuervo-Cazurra and Un (2007);
		Competitor	Huergo (2006) and Kraft (1989)
	Demand		S. O. Becker and Egger (2009) and Santamaria, *et al.* (2009)
Regional	Environment		Regional Panne and Beers (2006) and Srholec (2010)
Institutional	Technological related		Harris, *et al.* (2009) and Hewitt-Dundas and Roper (2008)
	Non-technological related		Mahagaonkar *et.al.* (2009)

Another major tenet of the Schumpeter hypothesis is a focus on the relationship between market structure and innovation. This hypothesis has generally been interpreted as asserting that the firm is more innovative if it operates in an imperfectly competitive market, and possesses some degree of market power. In most cases, a substantial commitment of resources is required for innovative activities, requiring a commensurate profit potential or opportunity in order for a profit-maximising firm to participate. In a perfectly competitive market, with no barriers to entry and the immediate imitation of the innovation by competing firms, there is little incentive to innovate, since the realizable reward will vanish very quickly. As a result the argument goes that "only a firm that can attain at least temporary monopoly power, delaying rival imitation, will find innovation attractive" (Kamien & Schwartz, 1975, p. 14). The free-rider problem will be a huge disincentive for imperfectly competitive firms, but it is that constant fear of losing the means to protect the current market position, that promotes continuous innovation. As a pioneer in the study of innovation, Schumpeter also recognized the importance of non-price competition for monopolistic firms. He contended that "it is not that kind of competition (price) which counts, but the competition from the new commodity, the technology, the new source of supply"(1950, p. 84). It is well known that the notion of non-price competition can be expressed in terms of product differentiation, which creates entry barriers for entrants (Comanor, 1967). This idea was supported by Phillip (1966), where he argues that R&D and innovative behaviour can often act as barriers to entry. The antagonists of the Schumpeterian hypothesis challenge the supposition by disputing that rivalry may not be an overriding concern for a firm with substantial market power where innovation is favoured, but entirely unnecessary. Also, the small number of competitors may stifle the innovative competition, just as price competition is tacitly inhibited (Kamien & Schwartz, 1975). Indeed, a competitive environment may be more supportive of innovation where many authors take the view that a "competitive influence will not only make the adaptation of innovation mandatory, but will spur the quest for technological advance as well"(Horowitz, 1962, p. 299).

There are many aspects of market structure, for instance market share, the number of competitors and the level of price competition. Based on market share, concentration ratios and the Herfindahl index are the most popular measures of market structure. More specifically the so-called "four-firm concentration ratio" measures the percentage of industry sales attributable to the four largest firms, where the number four was chosen because of the availability of the Census data for early periods. Artes (2009) included both concentration ratio and a market share dummy when studying the relationship between market structure and firm's R&D decision in both the long and the short run. Here the concentration ratio is the sum of market share of the main four industries in the product markets where the company operates, weighted by the share of the sales in these markets on total sales of the company and the market share dummy indicates whether the firm has a non-significant market share. In some cases, the concentrations of clients and suppliers are also used to gain a further understanding of the market environment in which the firm operates in (Cuervo-Cazurra & Un, 2007). The Herfindahl Index is the sum of the squared market shares of the firms in the industry and is used by the US competition authorities as a guideline for making decisions on approving mergers and acquisitions (Clyde & Reitzes, 1995). Some authors have taken a simpler option to reflect the market condition, opting for the firm's 'number of competitors' (Huergo, 2006), while others focused on price variables such as price-cost margins and intensity of price competition (Aghion, Bloom, Blundell, Griffith, & Howitt, 2005; Cuervo-Cazurra & Un, 2007).

Despite strong monopoly power, changes in market demand can both substantially affect innovation effort and outcomes. Schmookler (1962) noted the importance of future demand for innovative activity, where a positive association between high demand and technological activities was posited.. There are different ways to capture the changes in market demand. Flaig and Stadler (1994) included demand volatility as a determinant of product and process innovations; Sadowski and Rasters (2006) measure market growth by looking at sales growth between years; Huergo (2006) employed two dummy variables (i.e. expansive and regressive demand) to control for the innovation environment .

Finally, consider variables to capture the regional and institutional environment. Given that no region is the same, the unique properties of the region directly or indirectly influence the firm's innovative behaviour. Brouwer, Budil-Nadvornikova and Kleinknecht (1999) assert that Dutch firms in urban agglomerations devote a higher percentage of their R&D to product development compared with rural firms, and firms in central regions have higher probabilities of announcing new products in journals. Sternberg and Arndt (2001) specify a number of location-specific factors, which are considered to be important in this context.

- Local pools of highly qualified labour provide the skills to innovate.
- "Soft location factors" are amenities such as housing and leisure facilities. A set of favourable soft location factors can retain the locally trained workers, as well as encouraging the migration of workers from outside.
- Industry mix and performance of regional economic structures.
- Local infrastructure conducive to innovation, such as public and private research facilities, institutions of higher education and other technology-transfer institutions.
- The existence of key entrepreneurs, firms with strong industrial R&D activity, trade fairs with strong technology orientation, etc.

Going beyond regional boundaries, institutional variables also refer to wider policy settings. Many countries, including some developing countries, utilise national/regional technology and innovation policies to achieve particular economic goals. Although regional technology and innovation policies are typically set within the jurisdiction, they often induce some unintended or unexpected spatial and firm-related effects outside the region. A good example here is the innovation policies of the European Union. Sternberg's international comparison (1996) suggested that the unintended spatial impacts of technology policies are far greater than the intended impacts. As to non-technology related policies, Marcus (1981) stressed the key role they play in shaping the environment of the firm, and contend that regulations do not only affect the rate or intensity of innovation, but also influence the substance of innovation. Without policy certainty, businesses are unable to correctly assess risk and opportunity, which can result in a reduction of investment in the innovative activity. He suggested that more research is needed to determine the types of policies that are more effective in fostering innovation.

5. Some New Regression Results

The detailed review in Section 4 identified a number of papers focussing on technological innovations such as, product innovation, with fewer looking at the areas of non-technological innovation (i.e. organisational processes and marketing methods).

It is generally accepted that the determinants of innovation vary across different types of innovation due to their distinct nature. As a consequence, we will attempt to explain different types of innovation via separate regression models. Since all innovation output indicators are binary variables, non-linear probit models are used.

A set of explanatory variables were created aimed at matching the extensive variable list summarised from the existing literature (see Table 1 -Table 3 above). However, we were unable to find suitable variables for each subcategory (e.g. geography/location, input source and informal practice) due to survey and data limitations. The regression variables considered are presented as **Table 4**.

Table 4 Variable Definition

Construct	Variables	Description
Innovation Outputs	Products	1 if firm introduced new or significantly improved goods or services to market during the last 2 financial years
	Operational Processes	1 if firm implemented new or significantly improved operational processes during the last 2 financial years
	Organisational/Managerial Processes	1 if firm implemented new or significantly improved organisational/managerial processes during the last 2 financial years
	Marketing Methods	1 if firm implemented new or significantly improved marketing methods during the last 2 financial years
Firm characteristics	Firm Size	log of Rolling Mean Employment (RME), a head-count measure
	Sufficient Production Capacity	1 if more than 95% of goods/services from this business was provided to customer on time and to requirements, 0 otherwise
	Inward Direct Investment (FDI) Intensity	Percentage of overseas ownership/shareholding of the business
	Outward Direct Investment (ODI)Indicator	1 if firm hold any ownership interest/ shareholding in overseas located business, 0 otherwise
	Export Intensity	Percentage of export sales
	Subsidiary	1 if firm belongs to a business group, 0 otherwise
	Updated Equipment	1 if firm's core equipment is fully up to date compare with the best commonly available technology
	Firm Age	log of number of years since the company was created
	High Quality Product	1 if firm's product quality is considered to be higher than its major competitors, 0 otherwise
	Sector Dummies	Dummy variables for 13 industries
Firm behaviour/ strategy	Expansion	1 if firm invested in its expansion (e.g. businesses/assets purchases, market/product development and etc.)
	R&D	R&D expenditure over total sales
	Major Technology Change	1 if firm experienced a major or complete technology change, 0 otherwise
	Formal IP Protection	1 if firm uses some form of formal intellectual property protection (i.e. patents, copyrights, trademarks or registration of design)
Overall environment	Monopoly	1 if firm has no effective competition, 0 otherwise
	Oligopoly	1 if firm has no more than one or two competitors, 0 otherwise
	Monopolistic Competition	1 if firm has many competitors, several dominant, 0 otherwise
	New Export Market	1 if firm entered any new export markets over the last financial year, 0 otherwise
	Transport	1 if firm considered the transport infrastructure is good at its location, 0 otherwise
	Information and Communication Technology	1 if firm considered the ICT infrastructure is good at its location, 0 otherwise
	Water and Waste	1 if firm considered the water and waste infrastructure is good at its location, 0 otherwise
	Skilled Labour Market	1 if firm considered the skilled labour market is good at its location, 0 otherwise
	Unskilled Labour Market	1 if firm considered the unskilled labour market is good at its location, 0 otherwise
	Local Business Networks	1 if firm considered the local business networks are good at its location, 0 otherwise
	Local regulatory process	1 if firm considered the Local body planning and regulatory process are good at its location, 0 otherwise

Table 5 Probit Models – BOS2005

	Products	Operational Processes	Organisational/ Managerial Processes	Marketing Methods
Firm Size	0.011	0.055	0.098*	-0.041
Sufficient Production Capacity	0.101	0.149	-0.033	0.112
Inward Direct Investment (FDI) Intensity	0.002	0.004	0.004*	0.005**
Outward Direct Investment (ODI)Indicator	0.525*	0.421*	0.077	0.472*
Export Intensity	-0.002	0.006**	0.001	-0.001
Subsidiary	-0.183	-0.129	-0.203	-0.353*
Updated Equipment	-0.114	-0.029	0.093	0.089
Firm Age	0.044	-0.046	-0.092	-0.092
High Quality Product	0.169	0.446***	0.193	0.295*
Expansion	0.095	0.307**	0.210	0.085
R&D	0.069	-0.012*	0.002	-0.012
Major Technology Change	0.911***	1.042***	0.711***	0.553***
Formal IP Protection	0.732***	0.131	0.156	0.393**
Monopoly	-0.073	-0.618*	-0.241	-0.027
Oligopoly	0.022	-0.101	-0.183	-0.162
Monopolistic Competition	0.005	-0.202	-0.146	-0.123
New Export Market	0.758***	0.042	0.412*	0.697***
Transport	-0.035	0.112	0.080	-0.042
Information and Communication Technology	0.397**	0.274*	0.092	0.262
Water and Waste	0.168	-0.105	0.061	-0.194
Skilled Labour Market	-0.093	-0.224	0.176	-0.075
Unskilled Labour Market	-0.156	0.041	-0.168	0.100
Local Business Networks	-0.049	0.054	-0.057	0.266*
Local regulatory process	-0.195	-0.083	-0.094	0.050
Constant	-1.816***	-1.421***	-0.960***	-1.240***
No. of Observations	2586	2586	2586	2586

Note: All regressions contained 13 ANZSIC industry dummies, their coefficients are not shown.
legend: * p<.05; ** p<.01; *** p<.001

Based on BOS2005 regression results (see Table 5), the following innovation patterns are observed for NZ firms. In terms of the market environment in which a firm operates, across all innovation types, being in a market environment experiencing 'major technological change' is significantly associated with the likelihood of observing innovations. Major technological change relates to the outcomes of innovations produced by other firms in various parts of the world, and this systemic nature of innovation, whereby the innovation outcomes of firms influence each other, has already been discussed above. Operating in high quality product markets is also associated with higher probabilities of observing innovations in both operating processes and marketing. In terms of structural issues, for NZ firms capacity expansion is associated with a higher likelihood of observing innovations in operational processes, whereas the innovation advantages of scale appears to be only related to organisational or managerial process innovations. Indeed, the degree of monopoly power, which can be considered to be a relative scale indicator, if anything, is associated with a lower probability of observing operational process innovations, presumably due to lower entry threats from potential competitors and therefore reduced innovation pressures. Subsidiary firms are also less likely to be associated with marketing innovations. In terms of international issues, for NZ firms a greater level of overseas ownership is associated with higher levels of three out of the four different types of innovation. Export intensity is related to a greater likelihood of exhibiting operational process innovations, whereas NZ firms recently entering export markets for the first time are also associated with higher likelihoods of exhibiting product and marketing innovation. In terms of the knowledge-related issues which as we have seen are highlighted in the literature, formal IP protection is associated with higher likelihood of exhibiting innovations relating to both the introduction of new products and in marketing methods. However, the expected positive role of R&D was not observed in this sample. In terms of the local environment, good ICT infrastructure reinforces the introduction of technological innovation and excellent local business networks induce the adoption of new marketing methods.

To check the consistency of the model, it was re-run the models using the BOS 2007 and 2009 data. The new sets of results are presented on Table 6 and

Table 7. The regression results reveal that 'major technological change' remained strongly associated with innovation; the size effect on innovation is non-robust with larger firms gaining advantage in process related innovations; subsidiary firms still appear to be associated with a lower likelihood of operational process innovations; and older firms may have difficulty generating non-technological related innovation. Having updated equipment and investment may give firms a temporary advantage in product and marketing innovation, while entering a new export market has a long term effect on innovation, first in product innovation and followed by organisational process innovation. At the regional level, good ICT

infrastructure no longer appears to be associated with any form of innovation whereas a good skilled/unskilled labour market appears now to be associated with opportunities for marketing innovations. Capacity expansion is even more associated with innovations, whereas having a 'sufficient production capacity' and 'local regulatory process' yielded negative coefficients. These results might suggest that most innovations are the result of problem solving processes and in the absence of resource constraints, there is simply no motivation to innovate.

Table 6 Probit Models – BOS2007

	Products	Operational Processes	Organisational/ Managerial Processes	Marketing Methods
Firm Size	-0.003	0.167***	0.191***	-0.012
Sufficient Production Capacity	-0.254*	0.105	-0.139	0.018
Inward Direct Investment (FDI) Intensity	0.000	0.003	0.001	0.001
Outward Direct Investment (ODI)Indicator	0.028	-0.141	0.141	0.072
Export Intensity	0.000	-0.001	0.001	0.002
Subsidiary	0.295	-0.337**	-0.206	-0.036
Updated Equipment	0.333**	0.049	-0.078	-0.249*
Firm Age	-0.115	-0.088	-0.259***	-0.232***
High Quality Product	0.223	0.179	0.211	0.207
Expansion	0.372**	0.313**	0.170	0.242*
R&D	0.043	0.006	0.005	-0.000***
Major Technology Change	0.511***	0.720***	0.469**	0.384*
Formal IP Protection	0.479***	-0.013	0.122	0.505***
Monopoly	-0.029	-0.700*	-0.040	-0.564
Oligopoly	0.285	0.237	0.306	0.367
Monopolistic Competition	0.255	0.130	0.312	0.210
New Export Market	0.515**	0.268	0.136	0.270
Transport	0.193	0.280*	-0.211	0.024
Information and Communication Technology	-0.060	-0.062	-0.079	0.050
Water and Waste	0.042	0.095	0.014	-0.026
Skilled Labour Market	-0.106	0.157	0.086	0.416*
Unskilled Labour Market	0.004	-0.048	-0.018	-0.206
Local Business Networks	0.133	0.041	0.194	0.409**
Local regulatory process	-0.343*	-0.153	-0.040	-0.235
Constant	-1.778***	-1.694***	-1.210***	-1.128***
No. of Observations	2571	2571	2571	2571

Note: All regressions contained 13 ANZSIC industry dummies, their coefficients are not shown.
legend: * p<.05; ** p<.01; *** p<.001

Table 7 Probit Models – BOS2009

	Products	Operational Processes	Organisational/ Managerial Processes	Marketing Methods
Firm Size	-0.011	0.089	0.019	0.122*
Sufficient Production Capacity	0.183	-0.174	-0.018	0.060
Inward Direct Investment (FDI) Intensity	0.002	-0.001	0.000	0.000
Outward Direct Investment (ODI)Indicator	0.259	-0.076	0.308	0.023
Export Intensity	0.002	0.002	0.000	0.001
Subsidiary	0.192	0.109	-0.199	-0.077
Updated Equipment	-0.120	0.003	0.045	0.055
Firm Age	-0.082	-0.105	-0.129*	-0.062
High Quality Product	0.545***	0.376***	0.281*	0.321**
Expansion	0.784***	0.486***	0.504***	0.694***
R&D	0.000**	0.000	0.000	0.000*
Major Technology Change	0.493**	0.841***	0.509*	0.919***
Formal IP Protection	0.334**	0.205	0.243*	0.112
Monopoly	-0.182	0.309	-0.439	-0.191
Oligopoly	-0.077	-0.398*	-0.299	0.010
Monopolistic Competition	-0.023	-0.044	-0.004	0.005
New Export Market	0.262	0.136	0.470**	0.004
Transport	-0.158	-0.067	-0.091	-0.061
Information and Communication Technology	0.038	-0.043	-0.169	-0.045
Water and Waste	0.191	0.008	0.203	0.098
Skilled Labour Market	0.085	-0.035	0.010	-0.096
Unskilled Labour Market	0.005	0.263*	-0.025	0.105
Local Business Networks	-0.102	-0.023	0.091	0.110
Local regulatory process	-0.007	-0.139	0.051	-0.071
Constant	-1.768***	-1.142***	-1.700***	-1.937***
No. of Observations	2445	2445	2445	2445

Note: All regressions contained 13 ANZSIC industry dummies, their coefficients are not shown.
legend: * p<.05; ** p<.01; *** p<.001

6. Conclusions

Innovation is a conceptually difficult notion to capture in empirical data, but the concept has provoked enormous research interest around the world where it is generally accepted that innovation is one of the key driving forces behind economic growth. Current research considers all aspects of the area from what we mean by innovation, to its varied and various measurements and ultimately its drivers. The *Oslo Manual* is one of the foremost international guides on the collection and use of innovation data and this has now had three major revisions, providing impetus for a continuous effort to determine the drivers of innovation. In New Zealand, the government statistical agency provides one of the best survey instruments for collecting innovation data. However, the rich data source has not been fully utilized due to its limited and restrictive access. Extending the existing research on the drivers of innovations in New Zealand was the primary object of this paper guided by previous work (Fabling 2007) and that of researchers from around the world.

Summarizing the various regression results presented in this paper, a number of conclusions can be drawn. Firstly, New Zealand firms appear to experience small positive size and market power effects in comparison with those reported for many other countries and this may be due to the unique firm characteristics. Recall from section 4.2, 97.2% of New Zealand enterprises are SMEs, and they are responsible for 30.6% of all employees (Ministry of Economic Development, 2010). The heavy weight towards SMEs and the relatively flat market structure may have disadvantaged individual businesses in the innovation space as well as potentially New Zealand as a whole. Secondly, general investment in human capital and capital equipment may be more beneficial than R&D projects. R&D projects generally require large quantities of resources from participants, and the pay-off periods tend to be longer. Without sufficient economies of scale, it is potentially risky for firms to participate in large scale R&D and this may also be a clue as to the NZ results reported here. In contrast, small scale investments aimed at technology acquisition, product improvements and market entry are more likely to be cost effective options in the short run. What is clearly evident for NZ firms is that international engagement is strongly associated with innovation, both in terms of newly-exporting firms and particularly for firms engaging foreign direct investment overseas. However, cause and effect here need to be carefully investigated. Finally, while favorable regional environments are widely accepted as being innovation enhancing, it may be the case that once an acceptable level has been reached diminishing marginal returns appear to set in. From a policy prospective, it may therefore be necessary to alter the policy setting in response to the current market environment and in particular, our results suggest that over-investment in ICT infrastructure would not necessarily appear to be a powerful instrument for promoting innovation, once location has been controlled for, given resource constraints and opportunity costs. Obviously, these tentative conclusions based on the results reported here are exactly that, tentative conclusions, and as such, are rather more by way of pointers for further research. Indeed, they are the types of questions which subsequent stages of our research seek to address.

The next stages in our research include testing the stability and robustness of the reported results over the different years and over the different types of innovative activity, by examining the marginal effects, the correlations between the errors, and the stability of the results to the inclusion or exclusion of individual variables, and the inclusion of lagged variables. With respect to possible extensions, panel studies incorporating data from multiple years will be considered in future research and additional information on firm location will be used to assess the effects of geography and agglomeration on innovation. Additional robustness analysis would be appropriate with the added potential of longer term dynamic effects being possible by linking BOS 2005, 2007 and 2009. At this stage of our research, however, it is necessary to identify some limitations of the methodology which needs to be considered in further empirical work and which will not be removed simply by further investigation. Due to the mandatory nature of the *Business Operations Survey*, the large sample size and high responses rates have guaranteed an invaluable data source for the study of innovation in New Zealand, however there is an obvious defect in the survey. As noted above, most New Zealand firms are SMEs, but for administration purposes the target population for BOS excludes firms with 5 or fewer employees, which means that around 90% of enterprises were not sampled by the survey. Fortunately, firms with 5 or fewer employees only accounted for 25.8% of the economy's total output (on a deflated value added basis), such that the exclusion is expected to have a diminished effect on the study, however, the exclusion of such small firms must be noted.

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