Innovation in New Zealand:

A Firm-Level Analysis

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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.

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Abstract

The overall aim of this thesis is to uncover the key determinants of innovation in New Zealand firms and consider some of their likely effects. In order to provide a broad perspective on New Zealand's local innovation processes, a mixed method approach combining both quantitative and qualitative analysis was adopted to allow analysis of both empirical data and case study data. The quantitative part of analysis utilises the unique dataset developed by Statistics New Zealand, namely the prototype Longitudinal Business Database (LBD), and the qualitative analysis includes four in-depth company case studies which complement the regression analyses by uncovering the key patterns of innovation behaviour at the firm level. In summary, a number of conclusions have been drawn from the research. Firstly, firms experience considerably smaller positive size effect because of New Zealand's unique firm demographics, and the small size has limited individual firm's innovation opportunities. Secondly, firms' ability to develop new technologies directly influences their innovative ability, which is highly dependent on the availability of funds and skills. Lastly, innovation in New Zealand has a very strong market focus, while technology suppliers such as universities and Crown Research Institutes only have a limited role in selected industries.

Glossary

A*STAR	Agency for Science, Technology and Research
ANZSIC	Australian and New Zealand Standard Industrial Classification
APEC	Asia-Pacific Economic Cooperation
AWU	Annual Work Units
BAI	Business Activity Indicator
BCS	Business Characteristics Survey
BERD	Business Expenditure on Research and Development
BOS	Business Operation Survey
BPS	Business Practice Survey
BRDIS	Business R&D and Innovation Survey
CAD	Computer-Aided Design
CAM	Computer-Aided Manufacturing
CAQDAS	Computer-Aided Qualitative Data Analysis Software
CIS	Community Innovation Survey
CoREs	Centres of Research Excellence
CRIs	Crown Research Institutes
DOS	Department of Statistics
EEC	European Economic Community
EMS	European Manufacturing Survey
EPO	European Patent Office
ESEE	Spanish Survey of Entrepreneurial Strategies
ET	Economic Transformation
FDI	Foreign Direct Investment
FRST	Foundation for Research, Science and Technology

GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
GIF	Growth and Innovation Framework
GST	Goods and Service Tax
HRC	Health Research Council
IBULDD	Improved Business Understanding via Longitudinal Database Development
ICT	Information and Communication Technology
IIP	Irish Innovation Panel
IPONZ	Intellectual Property Office of New Zealand
IRD	Inland Revenue Department
ISI	Systems and Innovation Research
JPO	Japan Patent Office
KIS	Korean Innovation Survey
LBD	Longitudinal Business Database
LBF	Longitudinal Business Frame
LBIO	Literature-based Innovation Output
LEED	Linked Employer-Employee Database
LMT	Low and Medium Technology
MASTIC	Malaysian Science and Technology Information Centre
MBIE	Ministry of Business, Innovation and Employment
MED	Ministry of Economic Development
MNCs	Multinational Companies
MOE	Ministry of Education
MOEA	Ministry of Economic Affairs
MoRST	Ministry of Research Science and Technology

MSI	Ministry of Science and Innovation
NESTA	National Endowment for Science, Technology and the Arts
NSC	National Science Council
NSF	National Science Foundation
NSI	National System of Innovation
NZMEA	New Zealand Manufacturers and Exporters Association
NZTE	New Zealand Trade and Enterprise
NZVIF	New Zealand Venture Investment Fund
ODI	Outward Direct Investment
OECD	Organisation for Economic Co-operation and Development
PBRF	Performance-based Research fund
PCT	Patent Co-operation Treaty
PVR	Plant Variety Rights
R&D	Research and Development
RS&T	Research Science and Technology
RSI	Regional System of Innovation
RSNZ	Royal Society of New Zealand
SBA	Small Business Administration
SIRD	Survey of Industrial Research and Development
SMEs	Small and Medium Enterprises
SNZ	Statistics New Zealand
SSI	Sectoral System of Innovation
STEPI	Science and Technology Policy Institute
TEC	Tertiary Education Commission
TPP	Technological Product and Process

TSI	Technological System of Innovation
TTIS	Taiwanese Technological Innovation Survey
USPTO	United States Patent and Trademark Office
WIPO	World Intellectual Property Organisation

Chapter 1

Introduction

1.1 Research background

Over recent years the concept of innovation has taken a central role in discussions about growth. At the micro level, we know that firms engage in innovative activities because they are hoping to develop a new product or process that will allow them to increase profits and maintain or improve their market position over time. In some highly successful innovation cases, significant innovations can afford a firm a dominant market position and long-term monopoly rents, but more typically innovation outcomes tend to relate to more modest, but nonetheless important, market gains. As a general principle, Baumol (2002) regards innovation as a "life-and-death matter for a firm" in which the constant need of fighting for survival and the threat of competition encourage firms to innovate.

In practice different firms conduct innovation differently: some conduct research and development (R&D) in house and actively pursue patenting; others co-operate with outside partners or acquire technology externally via licensing; other engage in less-formalised means of promoting innovation such as supporting good practices in design, marketing research and staff training, all of which have becoming increasingly popular. Yet, given the high costs and uncertainty often associated with innovation, the benefits of engaging in innovative activities have been advocated by many authors, including Crepon et al. (1998) who suggested that firm productivity is positively correlated with innovation outputs, Banbury and Mitchell (1995) who identified a positive relationship between long-term survival and the rate at which firms are able to develop new products and processes, and Jin et al. (2004) who concluded that innovative firms outperform non-innovative ones. Although, in principle, innovation can be more readily identified than technological progress, still difficulties remain as to what exactly is innovation, and how can we capture it empirically.

Since the early 1980s, our theoretical and conceptual understanding of innovation has developed significantly. More noticeable are the major changes that have been experienced in empirically-oriented innovation research as a result of the introduction of firm level innovation surveys. Nowadays, collecting innovation related data via firm based surveys has become a common practice for many countries such as Canada, United States, Malaysia, Taiwan, Australia, as well as in almost all EU countries. These survey-led approaches have transformed our understanding of the nature and determinants of innovation. At the same time, the surveys themselves have also been adapted as our conceptual understanding of innovation has increased. As such, the balance of innovation-related research has shifted from a theoretical to a primarily empiricist-led agenda, and increasingly combined both quantitative and qualitative approaches. 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) which superseded earlier ad hoc 2003 surveys. The replication of the survey is intended to track changes in innovation behaviour and outcomes over time. The integrated collection approach also minimises the reporting load for New Zealand businesses while collecting the necessary information for research and policy purposes. The collection of innovation data follows the guidelines in the third edition of *Oslo Manual* (OECD, 2005), which defined innovation as:

> "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".

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 before.

The unique demographic, economic condition and geographic location makes New Zealand an interesting case of the study of innovation. It is possible that the definition and determinants of innovation in New Zealand are different from those of other countries. A New Zealand based study is necessary to improve our understanding of firm-level innovation behaviours. It is worth noting that while some studies have been using innovation to explain other economic phenomenon such as the level of productivity and economic growth, this thesis uses innovation as a dependent variable, the main object of the study.

1.2 Focus of study and methodologies

The overall aim of the thesis is to uncover the key determinants of innovation in New Zealand firms and consider some of their likely effects. In order to provide a broad perspective on New Zealand's local innovation processes, a mixed method approach combining both quantitative and qualitative analysis was adopted to allow analyses of both empirical data and case study data This type of approach has been used successfully by Roper and Hewitt-Dundas (2008).

The quantitative part of the analysis utilises the unique dataset developed by SNZ, namely the prototype Longitudinal Business Database (LBD). The database facilitates access to administrative and sample survey data, particularly the BOS. As New Zealand's national innovation survey, BOS has been operating annually since 2005. It uses an integrated collection approach with the innovation module running every second year producing sample in 2005, 2007 and 2009. A number of regression models are proposed to relate the innovation outcomes to the characteristics of the firms and their environments.

The qualitative analysis includes four in-depth company case studies, which complement the regression analyses by uncovering some key patterns of innovation behaviour at the firm level. Based on the principle research questions, research boundaries are established and case companies are selected according to the sample selection criteria. Followed by a background analysis, the case studies took the form of semi-structured face-to-face interviews. After each interview, the recording was transcribed verbatim, and a text-mining tool, *Leximancer*, (version 4) was used to provide preliminary analysis of the case results.

1.3 Thesis outline

The remainder of the thesis is organised as follows. *Chapter 2* reviews various definitions and measures of innovation. *Chapter 3* presents an extensive review of the literature on determinants of innovation. *Chapter 4* outlines different innovation surveys by type and region/nation, and summarises the survey variables used in empirical studies and their significance. *Chapter 5* assesses New Zealand's recent innovation performance and provides an overview of the current framework. *Chapter 6* introduces the regression models and reports the quantitative results. *Chapter 7* details the research design and research results for the case studies, where a text-mining tool *Leximancer* was used for analysis. *Chapter 8* proposes a number of policy recommendations. Finally, *Chapter 9* concludes.

2 Chapter 2

Definitions and Measures of Innovation

2.1 Definitions of innovation

The idea of innovation has been studied widely in various contexts, however, defining innovation is often problematic. The earliest definition of innovation was proposed by Schumpeter (1934, p. 66), where he suggests that innovation 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 organisation of any industry".

Following the traditional approach, Schumpeter divides the process of technical change into three parts: *invention*, *innovation* and *imitation*, and emphasises innovation as a "change in the form of the production function". This is similar to Solow's definition of technological change (Solow, 1956), except that Schumpeter did not include capital in the production function. Ruttan was not convinced by Schumpeter's theory, and tried to distinguish between invention, innovation and technological change as these terms have been become almost synonymous. He argued that there was no theoretical basis for the observed pattern of innovative behaviour suggested by

Schumpeter, invention is a "subset of technical innovations which are patentable" (1959, p. 605). He also argued that we should use Usher's concept of invention (1954) as a definition of innovation, which is "the process of new things emerging in science, technology and art". Tinnesand (1973) was also interested in the interpretation of the meaning of the word "innovation", where he collected a large number of definitions from 188 publications and classified the meaning of the word into six different categories. The findings were:

- the introduction of a new idea – 36 percent;
- a new idea – 16 percent;
- the introduction of an invention – 14 percent;
- an idea different from existing ideas – 14 percent;
- the introduction of an idea disrupting prevailing behaviour – 11 percent;
- an invention – 9 percent.

Although each category is slightly different, they are clearly related to the concept of new creations.

"Creativity" was generally recognised as an important precursor to innovation, until in the late 1960s the definition of innovation has subtly changed (Cumming, 1998). A new idea cannot be defined as an innovation until its practicality has been demonstrated. As Badawy (1988) suggested, "creativity brings something new into being" and innovation "brings something new into use”. With these ideas the distinction between invention and innovation becomes clearer; an invention is a discovery without any practical use, and an innovation is an invention that provides economic value to other parties beyond the inventors. During the late 1980s, the definition of innovation has become richer by including the concept of success. A typical example is used by Udwadia (1990), where he defined innovation as “the successful creation, development and introduction of new products, processes or services”. With the intention to construct a succinct definition of innovation that meets current thinking, Cumming (1998) described innovation as “the first successful application of a product and process”. Up to this point, most authors defined innovation from an “outsider point of view”. Gordon & McCann (2005) took the insider or the innovator’s standpoint, and argued that all identifiable innovations possess three common features: *newness*, *improvement*, and *the overcoming of uncertainty*.

2.1.1 *Technological versus non-technological innovation*

During the development of definitions of innovation, most concentrate on technological innovations. Nelson and Winter (1977, p. 37) suggested using the term innovation “as a portmanteau to cover the wide range of variegated processes by which man’s technologies evolve over time”. Within technological innovation, a distinction is normally made between product and process innovation. Freeman (1982) made this distinction very clear in his definition of innovation, “first commercial application of a new process or product”, where process innovation involves adopting new technology in the actual production of new goods (or services) and product innovation involves incorporating new technology into new or existing goods (or services). In practice, for goods, the distinction between product and process innovation is relatively clear, however it is difficult to draw the line for services. For clarity, the *Oslo Manual* (OECD, 2005, p. 53) suggests that, with respect to services, a product innovation should involve “new or significantly improved characteristics of the service offered to customers”; and a process innovation should involve “new or significantly improved methods, equipment and/or skills used to perform the service”. Moreover, the difference between “innovation process” and “process innovation” may not be obvious to some readers. The innovation process is the process of innovation, which “comprises the technological development of an invention combined with the market introduction of that invention to end-users through adoption and diffusion”. The iterative process includes the first introduction of a new innovation, as well as the reintroduction of an improved innovation. In contrast, a process innovation is aiming to increase output productivity by improving a standardised production process (Garcia & Calantone, 2002).

Since 2005 the sole focus on technological innovation has changed as the notion of innovation has been extended in the third edition of the *Oslo Manual* (OECD, 2005) to include non-technological innovation such as organisational and marketing innovation.

2.1.1.1 *Organisational innovation*

The concept of organisational innovation originated in the business management field. Initially, the concept of organisational innovation was not entirely independent of technological innovation. Thompson (1965, p. 2) defined organisational innovation as "the generation of new ideas, processes, products and service", which is almost the same as the definition of technological innovation. Becker and Whisler (1967) regard innovation as an "organisational or social process", where the importance of risk involvement and the first adoption of the idea are emphasised. However, the source of the idea was seen to be irrelevant. Recognising the frequency of combining the idea of invention and innovation, Mohr (1969) distinguished organisational innovation from technological innovation by excluding both the creation of an idea and its first or early use from the definition. Taking Mohr's point of view, Rowe and Boise (1974) introduced the notion of "organisation choice without external pressure" into the definition. More recently, Damanpour (1991, p. 556) conducted a meta-analysis of the relationships between organisational innovation and its potential determinants, and defined innovation as the "adoption of an internally generated or purchased device, system, policy, programme, process, product, or service that is new to the adopting organisation". This definition encapsulates all the current thinking, and at the same time it is "sufficiently broad to include different types of innovation pertaining to all parts of organisations and all aspects of their operation".

However, it is worth noting that these debates on the notions of organisational innovation and organisational change still exist (Becker & Whisler, 1967; Hage, 1999). Trott (1998) simply regards organisational innovation as a type of organisational or managerial change that involves new products, processes, ventures, systems, production methods, commercial arrangements or services. More recently, the *Organisation for Economic Co-operation and Development* (OECD) (2005) suggested that the distinguishing feature of organisational innovation is the novelty of implementation of an organisational method and it must be the result of strategic decisions taken by management.

As the definition of organisational innovation became clearer, the causal relationship between technological innovation and organisational innovation became stronger. A case study by Calia, Guerrini, & Moura (2007) suggested that technological networks provide the necessary resource for business model reconfiguration, which often results in organisational innovation.

2.1.1.2 ***Marketing innovation***

Compared to technological and organisational innovation, research on marketing innovation has been almost totally neglected. This is surprising given the history of marketing innovation is just as long as technological innovation. New marketing techniques were included in the definition of innovation by Schumpeter, though it was criticised as being 'special', as it was not confined to technological production (Johnston, 1966). Levitt (1960) recognised the profitable possibilities of marketing innovations, and suggested that the unsolicited, unplanned, accidental nature of marketing innovation is the result of little systematic corporate effort. Peterson, Rudelius and Wood (1972) looked at the life insurance industry and studied the adoption and diffusion of marketing innovations.

However it is not until 2005 that the *Oslo Manual* (third edition), which has become the foremost international source of guidelines for innovation research, includes the notion of marketing innovation. It defines a marketing innovation as "the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing"(OECD, 2005, p. 49). Undoubtedly, its importance in innovation research has been marked.

2.1.2 *"Innovativeness"*

The interchangeable use of the constructs "innovation" and "innovativeness" is another issue when defining innovation. The inconsistency may be due to the different preferences of various communities and the particular audience (Garcia & Calantone, 2002). In general, innovativeness can be referred to as either firm (or organisational) innovativeness or product innovativeness, where firm innovativeness relates to a firm's proclivity towards innovation (Salavou, 2004), and product innovativeness focuses on the novelty factor of the innovation.

2.1.2.1 ***Organisational innovativeness***

Organisational innovativeness has been commonly defined as the propensity for a firm to develop or create new products (Ettlie, et al., 1984) or to adopt innovations (Damanpour, 1991; Subramanian, 1996). Jin, Hewitt-Dundas and Thompson (2004, p. 257) develop a quadratic typology of innovativeness and consider innovativeness as "the core capability of organisations to master and maintain holistic value-creating dynamics, in which the opportunities of change are exploited and new ideas are generated, translated and implemented into practice", which capture both ideas of creative and adoptive innovation. In addition, the concept can be treated as an aspect of a firms' culture, the openness to new ideas (Hurley & Hult, 1998). Recognising the various conceptual approaches of organisational innovativeness, which refer to different aspects within the organisational setting, namely technology-related, behaviour-related and product-related, Salavou (2004) asserted that researchers need to consider innovativeness as a multidimensional phenomenon rather than unidimensional, and researchers should shift the emphasis from organisational to product innovativeness.

2.1.2.2 ***Product innovativeness***

In all cases, product innovativeness represents a totally different concept. Typically, product innovativeness is used as a measure of the innovations' novelty level. By definition, an innovation has to be new, at least, new to the firm. The *Oslo Manual* (OECD, 2005) uses three of these concepts to discuss the novelty factor of innovations, namely, *new to the firm*, *new to the market* and *new to the world*, where new to the firm indicates the lowest level of novelty and new to the world indicates the highest level. If an innovation is new to the market it must be new to the firm, where the market is the firm itself and its competitors, and it can either be a geographic region or product line. Similarly, if an innovation is new to the world it must be new to the market, where the world includes all markets and industries, both domestic and international. This categorisation allows researchers to identify the developers and adopters of innovation or the market leaders and followers.

Hence, it provides detailed information for examining the diffusion patterns of innovation. However, a literature review by Garcia and Calantone (2002) suggests that many authors also look at new to the world, new to the adopting unit, new to the industry, new to the market and new to the consumer. Most concepts have been defined based on the firms' or producers' perspective, though the consumer perspective is also important. Lawton and Parasuraman (1980) identified one dimension of product innovativeness, which emphasises the degree of change in the user's consumption patterns as a requirement of product adoption. Atuahene-Gima (1995) is concerned with changes in consumer's established usage patterns, habits and experiences using a combined notion of new to market/consumer. Salavou (2004) also discusses the compatibility of a new product in regard to the consumption patterns of existing and potential customers.

The other way to look at product innovativeness is to focus on the impact of the innovations. One of the well-known theoretical typologies is the dichotomy of radical versus incremental innovation (Lin & Chen, 2007). Radical innovations tend to create major disruptive changes: O'Connor & McDermott (2004) associated radical innovations with high risk and high uncertainty projects with high profit possibility. Incremental innovations have relatively less impact on the firm and the market; it is a small continuous advancement. Other than radical versus incremental innovations, many typologies try to capture similar ideas, for example, discontinuous/continuous (Anderson & Tushman, 1990), radical/routine (Meyers & Tucker, 1989), really new/incremental (Song & Montoya-Weiss, 1998), etc, whereas other authors are looking to develop more complicated categorizations (Abernathy & Clark, 1985; Chandy & Tellis, 2000; Henderson & Clark, 1990). Henderson and Clark (1990) reference the design literature, and made the distinction between the product as a system and the product as a set of components, hence defining two types of knowledge required for successful product development. They propose a tetra-categorisation of innovation as they agree the traditional dichotomous categorisation of innovation is incomplete and potentially misleading. Innovations are classified into incremental, modular, architectural, and radical, where incremental and radical innovations are the extreme points; and modular innovation changes only the core design concepts embodied in components; whereas architectural innovation changes the architecture of a product, or in other words, how components linked together, but leaves the core design concepts and components of a product unchanged. Under such categorisations, authors were able to identify disastrous effects on industry incumbents caused by seemingly minor product improvements, such as architectural innovation. Recognising such disruptive nature, Tushman & Anderson (1986) proposed competence-enhancing versus competencedestroying innovation; Bower and Christensen (1995) grouped innovation into disruptive and sustaining; the boundaries of these concepts are often confounded and unclear (Ehrnberg, 1995).

2.1.2.3 ***Other notions of innovativeness***

For completeness, there are other uses of the term innovativeness, and some usages will be more relevant to this study than others. Inspired by the theory of growth accounting, Mairesse and Mohnen (2001, p. 8) suggest that innovativeness is "the unexpected (or unexplained or residual) part of the actual observed share of innovative sales, which remains unaccounted for by the model as it stands". There are also studies of the adoption of new products, where the term consumer innovativeness is introduced. Midgley and Dowling (1978) adopted Rogers and Shoemaker's definition (1971, p. 27), suggesting that innovativeness is "the degree to which an individual is relatively earlier in adopting an innovation than other members of his system".

2.2 Measures of innovation

2.2.1 *Indirect and direct measures*

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/patent based indicators. R&D expenditure is an *indirect* measure as it only measures inputs devoted to innovative activities and patent based indicators focus solely on the successful generation of 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 popularised by Schmookler (1950, 1953, 1954). For a number of reasons, including ease of measurement and perhaps for ease of international comparisons, most national statistical agencies continue to report some form of R&D and patent statistics.

The problem with these indirect measures is that they are relatively narrow due to their potentially weak linkages with innovation and the induced large firm bias. For econometric analyses, a 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 collects information from new product/process announcements, specialised 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 OECD (1968; Pavitt & Wald, 1971).

Since the late 1970s, 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, et al., 1987). Aiming to harmonise 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.

2.2.2 *Measuring "innovativeness"*

2.2.2.1 ***Measurement approaches - organisational innovativeness***

A number of measures have been proposed to capture the idea of organisational innovativeness where it seems that the characterisation of an organisation as innovative depends on the definition given by researchers (Subramanian, 1996). The temporal and the cross-sectional measures seem to be the popular choices for early research, where the temporal measure emphasises the elapsed time of adoption (Rogers, 1983) and the cross-section measure concentrates on the number of innovations adopted by a firm. The use of temporal measures has been heavily criticised. It has been argued that the adopting firm does not have full control over the actual time of adoption, hence such measures cannot capture the organisation's true innovative capacity (Avlonitis, et al., 1994). Also, organisational innovativeness should be an enduring organisational trait; therefore an appropriate measure should be able to capture the consistency of the innovative behaviour. With the temporal measure, it is difficult to generalise to other innovations, especially if the measurement was only based on a single innovation criterion. Hence, the results may be idiosyncratic, and insufficient to represent the innovativeness of the organisation (Salavou, 2004). In comparison, cross-sectional measures are more reliable, because a wide range of innovations can be covered, and it is less subject to product related and situation-specific constraints (Midgley &

Dowling, 1978). This type of measure however has been also criticised in particular, because it ignores the time of adoption and the assumption of homogenous innovative output is rather unrealistic.

Saviotti and Metcalfe (1984) argued that individual measures of innovation only provide a partial picture of innovation performance, while multi-indicators of innovation overcome such deficiencies by approaching the problem from different angles.

Recognising the limitation of unidimensional measures and its ineffectiveness in detecting relationships between external environment, organisational innovativeness and organisational performance, Subramanian and Nilakanta (1996) proposed a multidimensional measure which incorporates three dimensions:

1) Mean number of innovations adopted over time;
2) Mean adoption time of innovations over time;
3) Consistency of adoption time of innovation;

They demonstrate that this multidimensional measure of innovativeness is superior when compared to unidimensional measures in both validity and usefulness, however, it only measures the adoptive aspect of innovativeness, and the creative aspects were omitted. Jin, Hewitt-Dundas and Thompson

(2004) captured both aspects of organisational innovativeness using the construct of 'soft' and 'hard' innovativeness, where 'soft' innovativeness refers to the capacity to source and utilise outside ideas and 'hard' innovativeness refers to the capacity to develop output. Soft and hard innovativeness were measured separately using four elements; for soft innovativeness, the four elements are intensity[1] of new techniques, intensity of new technology, intensity of external links and intensity of external grants; for hard innovativeness, the four elements are: percentage of sales due to new products introduced for the first time in the last three years, number of new products introduced in the last three years, percentage of sales due to technical improvement, percentage of sales due to changes in existing product in the last three years. Notice that, the measurements of hard innovativeness focus on mainly new products rather than processes, as most innovative processes may not directly increase sales. The measure can be biased for process innovative organisations.

One problem with multi-indicators of innovation is that there is not an overall measure of the innovation rate; the partial variables are not directly comparable; and authors often standardise individual measures in order to

[1] The intensities were evaluated according to the number of adoptions, established links and obtained grants, on scale of 4, with zero is the lowest and 4 the highest intensity.

develop a combined proxy measure for comparison of the heterogeneous variables (Souitaris, 2002).

By looking at the aforementioned measures of organisational innovativeness, it is clear that there is no one single measure that appears to be most appropriate. Salavou (2004) suggests that the 'rule of thumb' for measuring organisational innovativeness is to realistically make use of available measures in the context.

2.2.2.2 *Measurement approaches - product innovativeness*

As discussed above, product innovativeness is either defined as an innovation's novelty level or its impact. Its measurement, however, is more like a categorisation than a scale measure.

The novelty factor of an innovation is a relative concept, which is determined at the time of the creation or adoption. It depends on the characteristics of the innovation, as well as the characteristics of other innovations in the same context. For instance, if an innovation is 'new to the firm', then the innovation may be more novel than all other products or processes within the operating firm; the domain widens for a 'new to the market' innovation, the innovation must be novel compared with all other products or processes in one specific market.

When measuring the impact of an innovation, authors tend to use different criteria, depending on which theoretical typologies are proposed. A typical example is provided by O'Connor & McDermott (2004), where they argue that a radical innovation must be at least new to the market, with "unprecedented performance features or with already familiar features that offer potential for a five to ten times (or greater) improvement in performance, or a 30 to 50 percent (or greater) reduction in cost", otherwise the innovation is considered to be incremental. Since the impact of an innovation may not become apparent until long after it has been introduced, due to the limited time period reviewed in an innovation survey, in practice OECD (2005) prefer to measure innovativeness in terms of novelty as opposed to focusing on the impact of innovations.

2.2.2.3 *Other measurement approaches*

The Legatum Institute Global Development [2] measures a country's innovativeness by looking at exports of innovation high-technology goods as a percentage of GDP, which is somewhat similar to a measure of organisational innovativeness, the share of sales in innovative product.

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[2] The Legatum Institute is the newest branch of Legatum, which is an international investment group founded by billionaire Christopher Chandler.

3 Chapter 3

Determinants of Innovation

3.1 Schumpeterian hypotheses

Following the revival of New Growth Theory, the importance of innovation has been heavily stressed. Schmookler (1966) argued that innovation is an essentially economic phenomenon, which can be adequately understood in terms of the familiar analytical apparatus. As a key to improved competitiveness, growth and higher standard of living, explaining such phenomena becomes a core issue in economics. The Schumpeterian hypothesis is the earliest and one of the most well known testable hypotheses of the determinants of innovation, which was first brought to prominence by Schumpeter (1942). Two fundamental tenets of the hypothesis were proposed which involve the relationship between innovation, firm size and market structure. According to conventional wisdom, the argument presented in Schumpeter's early writings is quite different from that in his later work, and the change was a reaction to developments in the contemporary economy. The use of "two Schumpeters" has been popular among authors such as Phillips (1971), Freeman (1982) and Nelson (1977). In essence, they argued that the "early" Schumpeter or Schumpeter Mark I (1934) emphasises the importance of new small entrepreneurs in innovation, while the "later" Schumpeter or

Schumpeter Mark II (1942) favours large monopoly firms. Langlois (2003) defends Schumpeter's position by suggesting that the coexistence of the theories does not reflect a change of opinion and the apparent tension arises from ignorance of the economic process. In short, entrepreneurs bring innovations to life, but monopoly formalise the innovation process for greater benefits.

Despite the coexistence of Schumpeter Mark I and II, most authors consider Mark II as the original and only Schumpeter hypothesis, and hence promote the positive effect of size and market power on innovation. Moreover, over the years there has been debate around both neo- and post-Schumpeterian theories. These concepts are mainly discussed in the context of evolutionary economics (Andersen, 1995), which is not something we were able to elaborate on in this chapter. The term "neo-Schumpeterian" will be used in Section 3.1.2, however it refers to a new generation of theoretical models testing the relationship between competition and innovation.

3.1.1 *Firm size*

Looking at the Schumpeterian Mark II hypothesis in two separate parts, the first major tenet of the hypothesis is the positive relationship between innovation and firm size. Due to the difficulty of measuring innovative output, early empirical studies focused on the relationship between firm size and innovative inputs, and then inferred a positive relationship between firm size and innovative output given the non-decreasing returns to scale in the production of innovations (Comanor, 1967). This conclusion has been generally supported, though a few controversial issues need to be discussed.

3.1.1.1 *Firm size and innovative input*

What is the relationship between firm size and innovative input? The general perception is that larger firms have fewer resource constraints and more autonomy in decision-making. On average, more resources are devoted to innovative activities in absolute terms in large firms compared with small and medium firms. Cohen and Klepper (1996) summarise the findings of studies of US firms based on National Science Foundation R&D data from the 1950s and early 1960s. They observed that firms are likely to report an increasing R&D effort with size expansion especially for firms in the largest size ranges and also that R&D employment tends to increase with total employment across all sizes.

However, this relationship is not undisputed. Mueller (1967) found a negative relationship between research intensity and sales, though Comanor (1967) and Horowitz (1962) found that at most, a very weak positive association between innovative input intensity and firm size exists. According to Worley (1961), there is a tendency for medium sized firms to hire relatively more R&D personnel than largest and smallest firms. Markham (1965) also concluded that research intensity tends to increase with firm size up to a certain point then level off or decrease afterwards, where the turning point can vary from industry to industry. The chemical industry is a notable exception in this case with no upper limits for research intensity (Grabowski, 1968; Scherer, 1965b).

The other way to consider whether larger firms contribute a disproportionately large share of R&D effort is to look at the elasticity of R&D with respect to firm size. Link, Seaks and Woodbery (1988) could not reject the null hypotheses of unitary elasticity at the 95 percent confidence level in eight of the nine industries studied, which suggests that most firms' contribution to R&D is proportionate to their size. Cohen & Klepper (1996) argue the inconsistency in empirical evidence indicates the non-systematic relationship between firm size and the elasticity across the full range of firm sizes, while the non-rejection of unitary elasticity was mainly due to the limited testing power as a result of the small number of observations. Moreover, Kamien and Schwartz (1975) emphasise that the relationship between firm size and innovational effort could change, once account is taken of other relevant factors and research participation rates.

3.1.1.2 *Economies of scale*

The question here is whether it is reasonable for one to make inferences concerning firm size and innovative output given the association between firm size and innovative input. Fisher and Temin (1973) contend that the empirical tests do not verify the Schumpeter hypothesis, as they show that a positive and increasing relationship between innovative input (i.e. R&D employment) and firm size is neither necessary nor sufficient to warrant a positive and increasing relationship between innovative output and firm size even if the production function for innovation is increasing return to scale. Their result was invalidated by Rodriguez (1979), who pointed out an elementary error[3] in the model, where a firm's R&D activity will necessarily make losses under the profit maximizing conditions. The error was acknowledged by Fisher and Temin (1979), although it was contended that the correction strengthens rather than weakens the previous conclusion. Based on a modified formulation of the Fisher and Temin's model, Kohn and Scott (1982) claim the legitimacy of empirical tests of the Schumpeterian hypothesis, which was later criticised by Mukhopadhyay (1985) who claimed that the increasing returns to scale in the production of R&D should not be taken for granted. Lunn (1982) also made a similar point by comparing two different models of the production of

[3] When assuming the average product per worker is increasing, Fisher and Temin failed to take into account the condition that marginal product must exceed the average product.

innovation, which result in different policy prescriptions based on consistent empirical observations. Empirically, many studies suggest that R&D is more efficient in small and medium firms, there seems to be a broad consensus emerging that large firms do not possess advantages in R&D, and may actually be disadvantaged by size. Kamien and Schwartz (1975) propose that the innovation process, more specifically the efficiency and quality of innovation, may be affected by the firm size, as well as the size of the R&D programme within a firm. After reviewing wide ranging evidence, they suggest that there are economies of scale in the innovation production function only up to a "modest" size.

3.1.1.3 *Firm size and innovative output*

Despite the controversy regarding economics of scale, many researchers have shifted their focus towards exploring the direct relationship between firm size and innovative output. Various 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, 1965a).

Cohen and Klepper (1996) were intrigued by the ambiguities between various empirical results, and tried to explain why larger firms invest proportionally more in R&D than smaller firms if they have no advantage in R&D competition. They demonstrated the size advantage in R&D by constructing a theoretical model based on the concept of R&D cost spreading, which stresses the notion that a large firm with greater levels of output can lower the average cost of R&D.

The advantage of firm size in R&D is again supported by Pavitt, Robson and Townsend (1987) who investigated the size distribution of innovating firms in a UK based on a survey of 4378 innovations between 1954 and 1983. They asserted a U-shaped relationship between innovation intensity and firm size rather than the r-shaped previously suggested. This implies that both large and small firms have innovation intensity above average, it is the medium sized firms that have a below average intensity. It is worth noting however that, the criteria for small and large firms can differ for different studies. This is a crucial issue we will return to later. Here the large firms are classified to have more than 10000 employees, the employment bracket for medium firms is between 2000 and 9999, and small firms have between 500 and 1000 employees. Therefore, extreme care should be taken when comparing results across studies.

3.1.2 *Market structure*

Another major tenet of the Schumpeterian hypothesis is a focus on the relationship between market structure and innovation. The 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.

Given Schumpeter's preference for imperfect over perfect competition, he suggests that monopolistic firms are more motivated to innovate. 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 realisable reward will vanish very quickly. As a result "only a firm that can attain at least temporary monopoly power, delaying rival imitation, will find innovation attractive" (Kamien & Schwartz, 1975, p. 14). Indeed, the free-rider problem will still be a huge disincentive for imperfectly competitive firms, but it is that constant fear of losing and the means to protect the current market position, that promotes continuous innovation. As a pioneer in the study of innovation, Schumpeter also recognised 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” (1942, 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 is supported by Phillip (1966), where he argues that R&D and innovative behaviour can often act as barriers to entry.

The positive association between imperfect competition and innovation has been heavily debated among economists. The antagonists of the Schumpeterian hypothesis challenge Schumpeter’s suppositions by disputing that rivalry may not be an overriding concern for a firm with substantial market power, 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 hold 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). As argued earlier, imitation can be a major concern for innovators. In a competitive market the problem is reciprocal, firms learn from each other and the free flow of information benefits all. The situation is less desirable in the imperfectly competitive market with less peer support, the innovation process tends to be less efficient, resulting in a slower rate of progress (Brozen, 1951).

Among all the ongoing controversies, the second round of theoretical development was underway, which is now referred to as the *Neo-Schumpeterian analyses*. The main objective of this research agenda appears to be attempts to unite the traditional microeconomic models of competition with Schumpeter's model. Most authors here concentrate on the relationship between R&D rivalry and innovative activities, and use of the Cournot oligopoly framework is particularly popular. Horowitz (1963) was interested in the research motives of a Cournot oligopolist. Based on the assumptions of linear demand and zero cost production, he provides support for the original Schumpeterian hypotheses by suggesting that the research expenditure will increase with (a) a lower number of sellers, (b) a lower probability of research rivalry, and (c) a higher degree of patent protection. Applying a Cournot assumption, Scherer (1967) constructed a model to incorporate a convex trade-off between development time and cost, as well as the timing and reaction of rival inventors, the conclusion showed that rivalry stimulates new product development. Baldwin and Childs (1969) employed Scherer's model and recognised that firms may opt for slower development, where imitation maybe more desirable than innovation.

Extending to a more generic competition model, Gilbert and Newbery (1982) propose the notion of "efficiency effect" in an auction model of R&D and argue that a monopolist maintains its market domination through continuous innovation. Reinganum (1983) constructs a patent race model where the monopoly firm engages in a game of innovation with a challenger. The existence of a "displacement effect" means that the monopolist is less likely to patent the innovation, as current economic rents will be displaced by a completely new set. Kamien and Schwartz (1976) agree that the complete absence of rivalry may induce rapid innovation in some circumstance, while a market structure somewhere between perfect competition and monopoly will be the most conducive to innovation with an optimum degree of non-competitiveness. On a similar line, the inverted-U relationship between competition and innovation is advocated by Aghion et al. (2005), which implies that closely competing firms are the most innovative.

3.1.3 *Combined effect of size and power*

Undoubtedly, large firm size and monopolistic power are two distinctively different concepts, though they are likely to be related. Horowitz (1962) reports a high correlation between industrial concentration and the two size indices with respect to both employment and value added, however he failed to provide solid arguments on causality.

According to Adelman (1951), the concentration ratio measures the degree of oligopoly as well as the relative size of the largest firms, therefore, there is no surprise that absolute and relative firm size are correlated, but one should not draw conclusions regarding a firm's market power based on its size, or vice verse.

Examining the evidence from the previous two sections, neither the size nor the monopolistic power individually appears to have a clear impact on innovation. It has been noted that most studies tested only one aspect of the hypothesis in isolation from the other (Link, 1980). Acs and Audretsch see the neglected interaction between firm size and market structure in the empirical studies, and provide evidence for a modified Schumpeterian hypothesis, which argues that "large firms should have the relative innovative advantage in concentrated markets imposing significant entry barriers, while the small firms should have the innovative advantage in markets more closely resembling the competitive model" (1987, p. 570).

Nutter argued that small monopolistic firms should be more innovative, "just as the prospect of monopolistic position raises the odds in favour of the most risky innovations, so bigness makes possible the most expensive" (1956, p. 524).

Nevertheless, most studies consider only the direct effects of firm size and market structure on innovation, and reverse causation has been neglected. Dasgupta and Stiglitz (1980, p. 276) emphasised the reciprocal relationship by stating "industrial concentration and research intensity are simultaneously determined".

3.2 Source of innovation

3.2.1 *Source of innovation - demand-pull*

In order to identify other determinants of innovation, we will consider here the potential sources of innovation. One basic approach explores issues based on the idea of "demand-pull" theories, which suggest that innovation is driven by market forces, encouraged by an existing desire of the users.

Schmookler (1966, p. 184) regarded innovation as an economic activity pursued for profit, technical problems and unsatisfied consumer needs or wants, which offer opportunities for potential economic gain, i.e. “demand induces the inventions that satisfy it”.

If innovation is demand induced, the first step is for the need to be recognised, and as such market intelligence becomes valuable. In this case, the most efficient way to gather market information is by communicating with suppliers of raw materials/machinery and equipment (Rothwell, 1992) and customers (the highest level of communication is carried out in terms of co-operation, which has been discussed before). The communication with customers can take the form of personal visits (Rochford & Rudelius, 1992), feedbacks via phone or post (Chiesa, et al., 1996), or quantitative market research (Khan & Manopichetwattana, 1989a). 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”.

Once the needs are recognised, to obtain the greater expected profit the firm has greater incentive to innovate, and hence creates a set of strategies that promote innovation. A list of strategy-related variables which have potential impact on innovation have been identified in the existing literature (Cooper, 1984).

First, 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 continuality and consistency which are essential.

Second, 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).

Third, the literature indicates that 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 internal locus of control instead of external (Miller, et al., 1982). Innovative firms are less risk adverse (Khan & Manopichetwattana, 1989a) and more optimistic about the business (Souitaris, 2002). In addition, younger CEOs are more keen to innovate if they are actively involved in running of the business (Khan & Manopichetwattana, 1989a).

Finally, organisational status and some operational procedures can also impact upon the innovation process. The debate on flexible production and the associated vertical disintegration of production recognises the importance of organisational status (Sternberg & Arndt, 2001). Chon and Turin (1984) found that innovative firms are less formalised, where the argument goes that openness and flexibility are regarded as 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 organisational structure. Cross-functional interdisciplinary teams can be more efficient on innovations (Hise, et al., 1990). Offering incentives to employees for new ideas generation can enhance innovative potential (Chiesa, et al., 1996), even the ‘slack’ time of engineers and managers can improve the business innovative performance (Souitaris, 2002).

The pure demand-pull theories have been criticised on three different levels (Dosi, 1982). The first and perhaps the greatest concern relates to its underlying approach, which is undermined by the general theory of prices, which contends that prices are set by both supply and demand functions. The second difficulty arises in defining demand functions using utility functions given the feasibility of the utility concept. Thirdly, there are logical as well as practical difficulties in interpreting the innovative process through such an approach, for example, the demand-pull theory has limited power in explaining why an innovation occurs at a definite point in time given the range of potential needs is close to infinite. In addition, the complex process between the recognition of a consumer need and the final outcome of a new product is omitted. In conclusion, Dosi (1982, p. 150) summarised three weaknesses in innovation theories which are based upon demand-pull:

> "first, a concept of passive and mechanical 'reactiveness' of technological changes vis-à-vis market condition; second, the incapability of defining the why and when of certain technological developments instead of others and of a certain timing instead of others; third, the neglect of changes over time in the inventive capability which do not bear any direct relationship with changing market conditions".

3.2.2 *Source of innovation - supply-push*

Empirical evidence suggests that the source of innovation varies significantly across industries (von Hippel, 1988), as a result, it leads us to the other basic approach in this literature, the so called "technology-push" theories. This approach suggests that innovation is stimulated by the suppliers based on the presence of a technological opportunity[4].

Rosenberg (1974, p. 92) gave great credit to Schmookler's analysis of the demand-pull theory, and recommended it should be "the starting point for all future attempts to deal with the economics of inventive activity and its relationship to economic growth". However, the overwhelming emphasis on demand and the ignorance of the supply side was criticised as the whole story. The demand-pull and technology-push hypothesis was tested by Scherer (1965a). First, he ran a linear regression of patents granted on sales for all industries, and it explained 42.2 percent of the variation in patents. He then ran separate regressions for each of the 14 industries and 84.7 percent of the variation was explained in this case with an incremental gain of 42.5 percent. This suggests that inter-industry difference is at least as important as the inter-firm difference. Four broad classes were created based on the levels of the estimated regression coefficients, 1) electrical, 2) a combined group of general chemicals, stone, clay and glass, 3) the moderates, which consists of petroleum, rubber products, fabricated metal products, machinery and transportation equipment, 4) the unprogressives, which consists of food and

[4] Scherer (1965a, p.1121) defined technological opportunity as the "differences in technical investment possibilities unrelated to the mere volume of sales and typically opened up by the broad advance of knowledge".

tobacco, textiles and apparel, paper and allied products, miscellaneous products, miscellaneous chemicals, primary metals. Separate regressions of patents on sales for these four groups explained 83.6 percent of the variance in patenting, which indicates that the four group classification has counted for most significant inter-industry differences in patenting relative to sales.

A decade later, *Evolutionary Economists* introduced the notion of “technological trajectories”, i.e. the patterns of normal problem solving activity on the grounds of technological paradigms (Dosi, 1982), or cumulative and self-generating directions of technical development without repeated reference to a firm’s external environment (Souitaris, 2002). Pavitt (1984) popularized the concept, and based on his initial results many researchers presented their own variations (Archibugi, et al., 1991). Pavitt’s three part taxonomy aims to explain the sectoral differences in three areas: sources of technology, users’ needs and means of appropriating. The three categories of firms he uses are supplier dominated, production intensive (large scale producer and specialised suppliers) and science-based. Although the firms within each class have technology-related similarities, they are not necessarily homogenous (Niosi, 2000). De Marchi, Napolitano and Taccini (1996) tested Pavitt’s model based on survey data for technological innovations in the Italian manufacturing industry during the 1981-1985 period. Both the realism of the predicted association between industrial sectors and patterns of technical change, and the predictive power of the model were examined. With one exception, the test results appear to be consistent with the model's predictions. Since the model is a coherent set of predictions, even one unrealistic prediction should lead to rejection of the model as a whole. Souitaris (2002) attempted to assess whether firms in different Pavitt technological trajectories have significant differences in innovation determinants. The research proposition gained empirical support for Greece, where there was a difference in innovation determinants within the four classes of firms. For 'supplier dominated' firms, competitive environment, strength of marketing, acquisition of external information, inclusion of technology plans in the business strategy, attitude towards risk and internal co-ordination are the most important determinants of innovation. For 'scale intensive' firms, the ability to finance innovation projects and quality of personnel (education and experience) had the largest effect on innovation. For 'specialised supplier' firms, high growth rate, export, and promotion of new ideas are essential for high rates of innovation. Finally, technology-related variables, quality of personnel, growth rate of profits and panel discussion with customers affect the 'science-based' firms the most.

In summary I would conclude with support for Mowery and Rosenberg (1979, p. 150), where they state:

> "both the underlying, evolving knowledge base of science and technology, as well as the structure of market demand, play central roles in innovation in an interactive fashion, and neglect of either is bound to lead to faulty conclusions and policies."

3.3 Systems of innovation

What's a system? Carlsson, *et al*. define a system as "a set of interrelated components working towards a common objective" (2002, p. 234), and suggest that systems are made up of three key elements, i.e. *components*, *relationships* and *attributes*.

Components are the different operating parts within the system boundaries, which can be of variety of types, for example individuals, firms, universities, research institutes and public policy agencies. In some cases the boundaries of the system can be defined easily by geography or administrative units, while in others the determination of the relevant boundaries can either be a theoretical or methodological issue.

Relationships indicate the links between the components. The interdependence between the components can have a significant impact on the system as a whole, such that if the characteristics of a component change the other components will adjust their characteristics accordingly. Technology transfer is one of the most important types of relationship in innovation systems, which can involved both market and non-market interactions. Sometimes the unintentional non-market transfers are referred to as technological spillovers.

Attributes are the characteristics of the components that determine the performance of a system. Carlsson, et al. (2002) identified four types of capabilities, which are required for the system/actors to generate, diffuse and utilise technology successfully.

1) Selective (or strategic) capability; receiver competence and absorptive capacity
2) Organisational (integrative or coordinating) ability; to organise and coordinate resources and activities
3) Technical or functional ability; implement and utilise technology efficiently
4) Learning (or adaptive) ability; the ability to change with markets and technology trends

3.3.1 *Early concepts*

The notion of an innovation system goes back to Friedrich List's concept of '*the National System of Political Economy'* (1841), where he not only recognised the interdependence between tangible and intangible investment but also advocated a broad range of policies designed to accelerate industrialisation and economic growth. Moreover, the system view of innovation is consistent with Schumpter's early work (1934) as he emphasises the rise of innovation within the economic system, and distinguishes between the view of 'economic life'- " the economic system's tendency towards a equilibrium position" and the 'economic development' view, where "changes in economic life are not forced upon it from without but arise by its own initiative, from within"(pp. 62-63). However his theory paid little attention to "multiple sources of information inputs from within and from outside the innovating organisation and the importance of (…) the supporting network of scientific and technical institutions, the infrastructure, and the social environment (Freeman, 1990, p. 26).

Perhaps the earliest system concept was proposed by Leontief (1941), where his input/output analysis focuses on flows of good and service among sectors at a given point of time. One shortfall of the model is that being static it only identified a one-way link among the components.

Dahmen (1970) developed another concept, the so-called "development blocks". It is defined as "a set of factors in industrial development which are closely interconnected and interdependent" (1991, p. 136). By recognising that innovations create opportunities, and these opportunities can only be realised if sufficient resources/skills and product markets are in place, each innovation necessarily provokes a rise of ‘structure tension’. The notion of disequilibrium incorporated in this concept is compatible with Schumpeter’s view of ‘economic life’ and ‘economic development’.

3.3.2 *National system of innovation*

The majority of studies of innovation systems started in the 1980s. The system of innovation approach was first developed via the notion of national systems, and the concept was widely diffused through a series of research programmes by scholars including Freeman (1987), Lundvall (1992) and Nelson (1993).

In order to gain an understanding of the concept, it is best to start by defining the term itself. Freeman (1987, p. 1) considers a National System of Innovation (NSI) to be “the network of institutions in the public and private sectors whose activities and interactions imitate, import, modify and diffuse new technologies”. For Lundvall, the definition of innovation is argued to be both broad in some dimensions and narrow in others, where narrowly defined, NSI are “organisations and institutions involved in searching and exploring” (e.g. R&D departments, research institutes and universities), and in a broad sense NSI are “constituted by elements and relationships which interact in the production, diffusion and use of new and economically useful knowledge”

(1992, pp. 12-13). Nelson defines NSI as "a set of institutions whose interactions determines the innovative performance" (1993, pp. 2-3).

Given that the original intention for studying NSI was to inform national economic policy, the boundary of the system is 'national', which distinguishes the research from others that focus on different levels of the economy, for example, technological, regional, and sectoral systems of innovation. Also, the national component shows that the focus of the research is at the national level and hence country-level comparisons are permitted. Freeman's historical review of NSI studies showed that countries have different systems for development and diffusion of innovation within their national economies (1995). The word 'system' has often been interpreted in a mechanistic way based on the assumption that policy initiatives can be used to build clusters or regional systems from scratch, however this results in a misinterpretation suggesting that such a system can be easily constructed, governed and manipulated. According to Lundvall (2007, p. 101) the innovation process is an "intricate interplay between micro and macro phenomena", therefore such systems are "complex and characterised by co-evolution and self-organising".

Since the mid-1980s, the concept of National Innovation Systems has attracted an enormous amount of attention both in academic and policy circles. However it also generated numerous criticisms. One set of criticisms relates to its inclusiveness and 'unscientific' approach due to its trans-discursive nature (Miettinen, 2002). In relation to such criticisms, there has been a tendency to make the distinction between the core and the wider setting of the system, where the core of the innovation system is the firm in interaction with other parties such as firms and knowledge infrastructures, and the wider setting includes the national education system, labour markets, financial market, intellectual property rights, product market competition status and welfare regimes.

3.3.3 *Other systems of innovation approaches*

Recognising that the most meaningful innovation systems might not coincide with national borders, developments of other system approaches began. Since then these concepts have been adopted by policy makers from many countries and international organisations including the OECD, the World Bank and the EU Commission. In summary, other than the NSI there are currently three other existing systems of innovation approaches, i.e. the Technological System of Innovation (TSI), the Regional System of Innovation (RSI) and Sectoral System of Innovation (SSI). In principle, a NSI can be viewed as the aggregate of a set of technological, regional and sectoral systems. Carlsson (2003) examined 750 innovation system related publications, the results showing that half of the literature refers to NSI, the remaining half is equally distributed between studies of RIS (25 percent) and studies of TSI (19 percent)/SSI (6 percent).

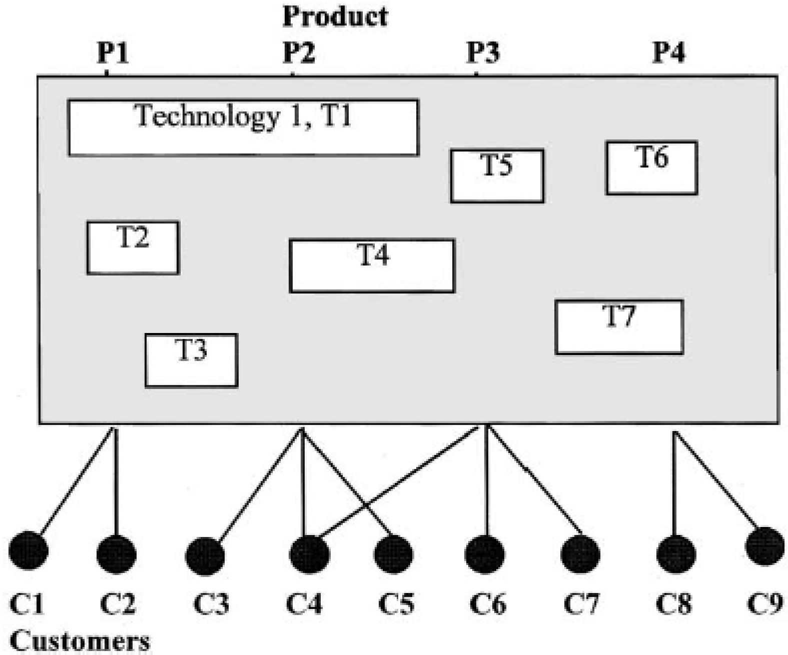
3.3.3.1 *Technological Systems of Innovation*

The work on TSI started in 1988 prompting a stream of publications beginning with Carlsson and Stankiewicz (1991), where they defined the system as:

> "a network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure or set of infrastructures and involved in the generation, diffusion, and utilisation of technology" (p. 111).

As its name implies, the technological system focus on generic technologies, unlike the NIS the boundary of the TIS, is not so clear, and that makes it important to understand the level of analysis. Carlsson, *et al.* (2002) identified three levels of analyses, and the differences between these three approaches are illustrated in Figure 3-1, where P1, P2, and etc. indicate the different types of product; T1, T2, and etc. are technology types; C1, C2, and etc. denote groups of customers served by different products.

Figure 3-1 Illustration of the three levels of analyses



Source: B. Calsson et al. (2002)

The most obvious approach to delineate the technological system is to consider a specific technology or a set of closely related technologies, and then analyses the various applications of such technologies (e.g. Technology T1 is used in product P1and P2). If necessary the analysis could extend to the relevant groups of customers, in the case of T1, all customers between group C1 and C5 are included. The second level of analysis begins at the product level, consequently the technology boundaries are defined by the technologies incorporated within the particular product (e.g. P1 consists of technology T1, T2 and T3) and the market comprises all customer groups addressed by the product (e.g. C1 and C2). Finally, the third level of analysis concentrates on a set of products (complements or substitutes) that are captured by a common market. Assuming product P1-4 all fall within the same market (e.g. health care), all technologies and customers can be included in the analysis. In this case the relation between products and customer groups can be investigated; however a detailed analysis on the technology level is unlikely to be feasible due to the vast range included.

3.3.3.2 *Regional systems of innovation*

The emergence of localised production systems in the 1980s has drawn considerable attention in the fields of economic geography and regional development. Cook (1992) used RSI to explain innovative activities within geographic regions at the sub or supra-national level. The concept originated from two main bodies of theory and research.

The first is systems of innovation. There is no doubt that the early work on NSI had a significant impact on the development of RSI, in particularly the literature has conceptualised innovation as an evolutionary and social process (Edquist, 2004). As summarised by Doloreux (2002) there are five elements of the evolutionary perspective.

1) Both unstable conditions in markets and institutional/organisational configurations within economies determine the processes of change.
2) Externalities and spatial agglomeration factors are crucial in the process of change.
3) Innovation has a significant impact on overall economic performance.
4) Norms, rules and conventions are formed within institutions.
5) The fundamental social-economic imperative in the systems are learning, creation, access, process and diffusion.

The social aspect of innovation refers to the work of Autio (1998) and Asheim and Isaksen (1997), who emphasised the importance of interactive learning, collaboration and networking while building competitive advantage. Niosi *et al.* (1993) distinguish between four different types of links among institutions, which are (1) financial flows, (2) legal and policy links, (3) technological, scientific, and informational flows, (4) social flows (or in other words organisational innovations and human resource flows).

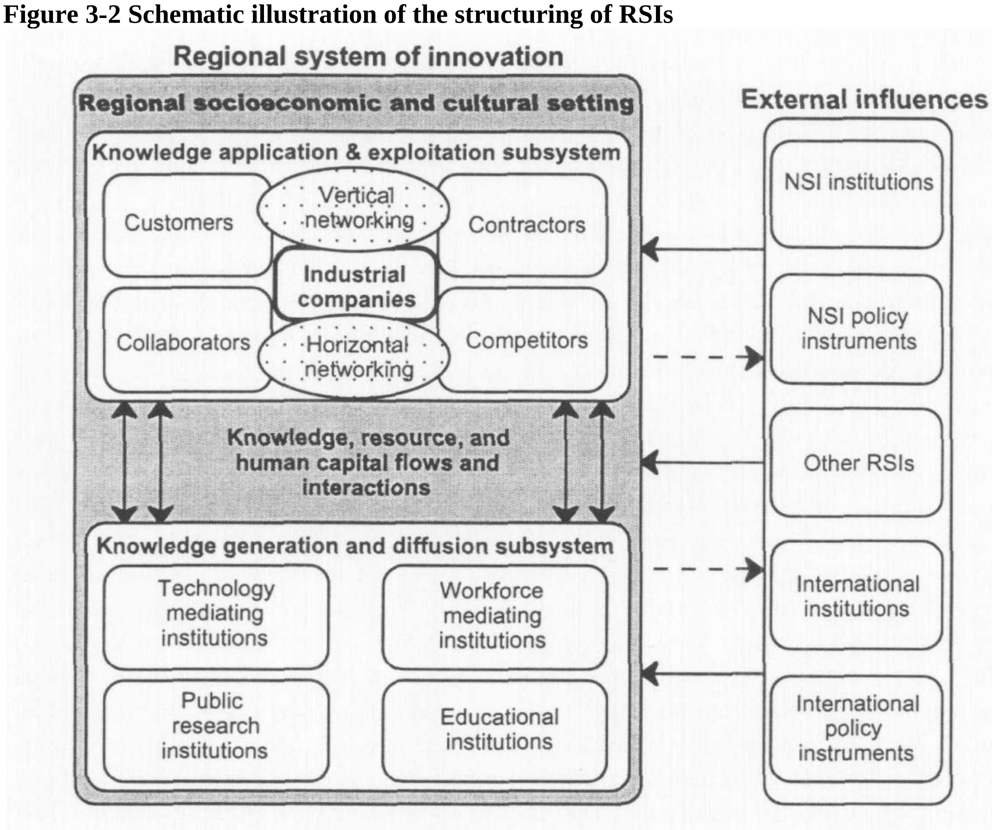
The second body of literature comes from regional science, and it deals with issues such as spatial concentration, proximity, agglomeration and clusters. One typical example is Saxenian's (1994) study of the electronics industry in Silicon Valley in California and along Route 128 in Massachusetts. The basic argument is that some regions have a more innovative supportive culture as a result of territorial rules, conventions and norms. Firms within these regions can benefit from these localised advantages during the knowledge creation and diffusion process, and public institutions such as universities, research organisations and technology transfer agencies within the region may also play an important role.

Unfortunately, there is no generally accepted definition of RSI, although Cook, *et al*. (1998, p. 1581) describe RSI as a system "in which firms and other organisations are systematically engaged in interactive learning through an institutional milieu characterised by embeddedness". Based on this description it is difficult to ascertain the precise distinction between RSI and other systems of innovation concepts, in fact some authors consider regional systems as a subset of a national system instead as a separate concept (Archibugi & Michie, 1997). To clarify the notion, Doloreux and Parto (2005) suggest that:

> "a set of actors (included within RIS) produces pervasive and systemic effects that encourage firms within the region to develop specific forms of capital that are derived from social relations, norms, values and interactions within the community in order to reinforce regional innovative capability and competitiveness".

Autio (1998) insists that RSI and NSI are two distinctly different concepts, as NSI carries less socio-culture elements and RSI has a direct focus on interactions between agents. He also proposed a schematic illustration of the structuring of RSIs, as shown in Figure 3-2 below, where other than the two sub-systems within the main structure of the RSI (i.e. the knowledge application and exploitation sub-system and the knowledge generation and diffusion sub-system), external influences such as NSI institutions, policy instruments, other RSIs and etc., also interact with the system.

Figure 3-2 Schematic illustration of the structuring of RSIs



3.3.3.3 ***Sectoral systems of innovation***

The notion of SSI was launched in 1997, where Breschi and Malerba (1997, p. 131) define SSI as: “the specific clusters of the firms, technologies, and industries involved in the generation and diffusion of new technologies and in the knowledge flows that take place amongst them”. Given that the system boundary is set at an ‘industry’ or ‘sector’ level, the system concept not only focus on the interdependence within clusters of industries, it also reflected on the idea that different sectors and industries operate under different technological regimes with different knowledge base, knowledge accumulations, technological opportunities and appropriability conditions, Pavitt’s work on “technological trajectories” (refer to section 3.2.2) has a huge influence on this matter.

Due to the similarities between SSI and TSI, authors often consider these two concepts together (Chang & Chen, 2004).

4 Chapter 4

Innovation Surveys

Since the early 1980s, our theoretical and conceptual understanding of innovation has developed significantly. Most noticeable are the major changes that have occurred in empirically-oriented innovation research as a result of the introduction of firm level surveys. Nowadays collecting data via firm based surveys has become a common statistical practice, where these survey-led approaches have transformed how researchers carry out their analysis. At the same time, the surveys themselves have also been adapted as our conceptual understanding of innovation has increased. Bearing in mind that most surveys are self-reported, the validity of the data are subject to cognitive and situational issues[5].

4.1 Complementary versus 'true' innovation surveys

Before going into the details of individual surveys, it is important to distinguish the difference between a complementary innovation survey and a 'true' innovation survey. A 'true' innovation survey is a survey that is custom-designed to collect a full set of innovation data. There are two types of complementary surveys, where Type I surveys only focus on a specific aspect

[5] Cognitive issues occur when the respondents did not understand the question or they do not have the knowledge or memory to answer the question accurately; and situational issues refer to the setting of the survey such that certain questions may have a socially acceptable response.

of innovation, and the Type II surveys not only contain questions encountered in the innovation surveys, but also information on many other variables.

A typical example of a Type I complementary survey is a R&D survey. The NSF and the U.S. Census Bureau have been collecting a broad range of firm-level R&D data annually between 1953 and 2008 using the *Survey of Industrial Research and Development* (SIRD). Similarly the Agency for Science, Technology and Research (A*STAR) and the Department of Statistics (DOS) in Singapore introduced their annual *National Survey of R&D* in 2002, and since 2004 Statistics New Zealand has conducted an R&D survey every second year. Other examples of Type I surveys include the 2007 *Survey of Commercialisation of Innovation* by Statistics Canada and the 1997 *Survey on Organisational Changes and Computerisation* by France's National Institute for Statistics and Economic Studies and *et.al*.

Compared to Type I complementary surveys, Type II surveys have a wider focus and are often used as substitutes by researchers if no 'true' innovation survey was readily available at the time. A few prominent examples are the World Bank administered *Investment Climate Survey*, Chinese National Bureau of Statistics' annual survey on large and medium size enterprises and the *Spanish Survey of Entrepreneurial Strategies* (ESEE).

4.2 Innovation surveys around the world

Collecting innovation data via 'true' innovation surveys are, however, preferable. 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*" 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. Additional to the collective effort, many countries (both developed and developing) have their own official innovation survey where a few examples are listed below.

Malaysia's *National Survey of Innovation* is conducted by the Malaysian Science and Technology Information Centre (MASTIC). Adopting the OECD guidelines, four national surveys have been undertaken since 1995 and the latest survey in 2005 covered the periods from 2002 to 2004. The main focus of the survey is on product and process innovation in the manufacturing sector.

In **South Korea**, the Korean Innovation Survey (KIS) is undertaken every three years by the Science and Technology Policy Institute (STEPI). The available datasets are:

- Technology Innovation Survey 2000 (1996-1999)
- KIS 2002: Manufacturing Sector (2000-2001)
- KIS 2003: Service Sector (2001-2002)
- KIS 2005: Manufacturing Sector (2002-2004)
- KIS 2008: Manufacturing sector (2005-2007)

Based on the *Oslo manual*, both technological and non-technological innovations are included in the 2005 and 2008 surveys.

The **Taiwan** Technological Innovation Survey (TTIS) was jointly conducted by the National Science Council (NSC) and the Ministry of Economic Affairs (MOEA) in 2002 and 2005. The sampling frame was generated by a stratified random sampling process based on firm size and industry, and it is representative of the population of traditional Taiwanese manufacturing firms.

Canada has an on-going programme to measure product and process innovation. A series of surveys of innovation and technologies has been conducted every three to four years since the early 1990s. The Survey questionnaire was designed by the Science, Innovation and Electronic Information Division of Statistics Canada in collaboration with Industry Canada, Natural Resource Canada, and various government departments.

In the **United States** innovation surveys are a relatively new phenomenon. In order to broaden the relevance and usefulness of the R&D statistics, the NSF replaced SIRD by the *Business R&D and Innovation Survey* (BRDIS). A pilot questionnaire was mailed-out in Jan 2009 to collect data for the calendar year 2008.

The collection of innovation statistics in **Australia** began in the 1990s. The first two surveys in 1994 and 1997 predominantly focused on the manufacturing and mining industries, where services and non-technological innovations were excluded. The practice has continued in the 2000s, and two more survey was conducted in 2004 and 2006. Since 2007 the integrated *Business Characteristics Survey* (BCS) has been introduced, and a longitudinal dataset created and updated annually. Such changes allow more comprehensive data integration and give greater flexibility in the measurement of a range of business characteristics. The characteristics of innovation outputs are released biennially.

Finally, in **New Zealand** the main survey instrument for the collection of innovation data is the BOS, which is an integrated, modular survey developed by SNZ. The survey has been operating annually since 2005. It uses an integrated collection approach with the innovation module running every second year. The innovation module is intended to replace the *Innovation Survey*, which was last run in 2003. In 2006, a two–year feasibility project "Improved Business Understanding via Longitudinal Database Development" (IBULDD) was implemented by SNZ aiming to link business related data from both administrative and sample survey data, a prototype LBD was created as a result.

Despite efforts made by state 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.

Rather than using secondary data many authors have opted for primary sources by constructing independent innovation surveys, which allow them to focus on a specific sector or issues. Moreover, authors may prefer different survey methods. Panne and Beers (2006) carried-out a postal survey from September 2000 and August 2002, where a sample of 398 innovative Dutch firms were selected using the Literature-Based Innovation Output (LBIO) method. Two years after product launch, participating firms were re-contacted for follow up. Alegre and Chiva (2008) surveyed 82 Italian and 100 Spanish firms in the ceramic tile industry during June and November 2004, where the questionnaire was addressed to company directors. Weterings and Boschma (2009) gathered cross-sectional data on 265 software firms located in the Netherlands through two consecutive telephone surveys during 2002 and 2003. Zhang et al. (2009) employed a web-based interview method, and surveyed 104 wholly-owned manufacturing subsidiaries of multinational companies (MNCs) located in three Chinese economic development zones. Using multiple survey methods (i.e. a telephone survey, personal interviews and a WWW-survey), Todtling, Lehner and Kaufmann (2003) surveyed Austrian firms in manufacturing and service sectors during 2000 and 2003. Supported by the Austrian National Bank, their initiative was a part of a two year project for Austria (RINET).

4.3 Survey related research

Given the large number of innovation surveys, a structured review of the survey related innovation literature seems sensible and appropriate. In this section, the list of potential dependent and explanatory variables used in the innovation-survey based literature will be identified and discussed.

4.3.1 *Dependent variables*

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

Indirect measures of innovation are often used as the dependent variable. 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, et al., 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) who 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 (1965a) 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. 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 European Economic Community (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 Organisation* (WIPO), both patents and utility models are exclusive rights granted for an invention, for a limited period of time unless authorised any commercial use of the protected invention is prohibited. The term of protection for the 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 take 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) had a sole focus on product innovation, but 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. Utilising data from the 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 technological product and process (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 organisational 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.

4.3.2 *Independent variables*

Previous authors have typically developed their models differently depending on the specific focus of the study. 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'.

4.3.2.1 ***Firm characteristics***

In most innovation analysis, firm-specific variables are treated as being 'acquired' or 'inherent' properties of the firm, or in other words as being endogenous or exogenous. Although no aspects of a firm are entirely exogenous in the long run, for the purposes of many models it is assumed that *acquired characteristics* can vary over a period of time due to the (intentional or unintentional) actions of the firm, whereas the *inherent characteristics* are harder to change (see Table 4-1).

Table 4-1 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 the acquired firm characteristics is *firm size*. As we have already mentioned, the empirical evidence suggests that innovation at the firm level appears to vary according to firm size. Schumpeter (1942) 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. Despite such historical claims and countless pieces of research, the debate over the effect of size continues to date. Given four principle dimensions of size: employees, sales, income generated and assets (Adelman, 1951), the number employed and total sales are typically used to measure firm size.

Some other size related characteristics are '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. These issues are important in terms of the relationship between competition and innovation, as the ability of small firms to innovate may be critically dependent on access to suitable long-term capital. Market competition depends on firm entry possibilities which may themselves depend on capital availability. 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 the degree of capacity utilisation and organisational innovation, however it is also possible that limited production capacity may reduce the possibility of product innovation, and production batch size could also affect a firm's innovativeness (Love & Roper, 1999).

'Business makeup' can include many aspects, where some areas investigated include ownership, export status, organisational structure and outsourcing/ subcontracting practices. The literature here 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) emphasised the positive linkages between foreign direct investment by US multinational affiliates and labour-

skill requirements, which was used as an R&D proxy. This approach is based on the argument that multinational firms innovate more than domestic firms because of a combination of features, namely that they have greater internal resources to devote to innovation as a result of their internal scale, greater knowledge-acquisition possibilities due to their multinational and multilocational structure, and the greater rewards to their innovative efforts due to their global market access (McCann & Acs, 2011). Secondly, exports are the other form of foreign expansion in addition to foreign direct investment, 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'? Thirdly, organisational structure is another important element of business makeup, which 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). Moreover, a business's structure (i.e. the internal networks of subsidiaries) is developed based on a specific set of objectives and activities, where it has been proposed that the knowledge transfer between each units 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 recognise, 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, et al., 2001). Tsai (2009) recognised 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 three 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 organisation. Carroll (1967) proposed that organisations will be more receptive to innovation if their staff have more diverse backgrounds/experiences, and the presence of a 'project champion[6]' 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. On the one hand, 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 organisation which will result in a shortage of innovative ideas. On the other hand, other evidence, shows that older firms are able to accumulate innovative knowledge and experience and generate more innovations as a result (Sorensen & Stuart, 2000).

As well as age, product diversification also appears to be related to innovation outcomes. Comanor (1965) and Scherer (1965a) argue that there is a negative association between diversification and R&D outputs or patented invention. However, most empirical evidence appears to point in the other direction, in that innovation is associated with diversification. One argument here is that firms with more diversified product lines may utilise their innovative outputs better by diversifying their innovative developments over a broader range of

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

markets, thereby raising the expected payoff of the R&D investment. Evidence in support of this argument comes from Grabowski (1968) who identified a positive regression coefficient for the index of diversification when explaining R&D spending intensity. Thompson (1965) and Siegel and Kaemmerer (1978) also confirmed diversity's positive effect on the generation of innovation, although 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, while Santamaria, *et al.* (2009) argue that the effect of diversification on innovation primarily comes about because it is easier for diversified firms to develop and adapt new technologies to improve their activities and processes. As well as product diversity or specialisation, a final issue to be considered is that of product complexity. The effect of product complexity on innovation is unclear because the complexity of a product may make incremental changes to the product either harder to achieve, due to the need for fundamental redesigns, or ironically easier to achieve, due to the possibilities for small variations (Kirner, et al., 2009).

In recent years, the literature on geographical determinants of innovation has increased dramatically (Audretsch, 2003; Herrera, et al., 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 at the beginning of this section (4.3.2.1), sectoral characteristics are typically inherent rather than acquired. The most recognisable 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).

4.3.2.2 ***Firm behaviour/strategy***

Firm behaviour/strategy relates to the specific activities and/or strategies that could 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 4-2).

The first ‘general practice’ considered 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) emphasised 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 value that a well educated and experienced workforce has on enhancing 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.

Table 4-2 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);
	Source of Input	Local vs. Imports	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 and Hippel (2009);
	Informal Practice	Design	Santamaria, *et al.*(2009) and Kirner, *et al.*(2009)
		Marketing	Marsili and Salter (2006)
		Quality Control	Beneito (2006)

Similarly, inputs that are transferred into the firm would have knowledge and technology embodied within (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.

Recall from section 3.2.1, the importance of external communication and business strategy/management have been heavily stressed in the demand-pull theory. More often, multiple parties are involved in the communication processes (e.g. customers, suppliers and competitors), and the interactions can take many different forms, where the most effective way of communicating is through face-to-face interactions. However once a certain level of trust has been established between exchange parties, other channels of communication can be used as substitutes (Gallaud & Torre, 2005). Not surprisingly, most communication mechanisms are not designed for the purpose of innovation, though such interactive learning processes facilitate the exchange of knowledge, and often become an excellent source of innovation. Within the firm, there is a different type of network. Strategy is a term commonly used in the management field and is referred to as "a network of choices to position the firm vis-à-vis its environment and to design organisational structure and processes" (Souitaris, 2002, p. 883). In particular, Cooper (1984) emphasised that "the new product strategies firm elect are indeed closely tied to the performance results achieved." Increasingly more 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 later.

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 lapsed, whereas R&D expenditure and intensity (as percentage of total sales) remain the most popular measures of R&D effort, followed by an R&D dummy and employment. Many authors separate 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. 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, et al., 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. Their existence of technological strategy shows the intention to innovate and provides continuity and consistency which are seen as essential elements. The establishment of a R&D department may have a similar effect. 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 (Koc & Ceylan, 2007). The decision to use different types of intellectual property protection may also enhance innovation outcomes (Jong & Hippel, 2009).

In discussion 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. Product design is an integral part of product development and Laestadius *et al*. (2005) claimed 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[7] and design with the variability depending on industrial situation. Quoting from the *Oslo Manual*, "Some elements of industrial design should be included as 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

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

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.

4.3.2.3 ***Overall environment***

Table 4-3 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		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)

The final set of explanatory variables used in innovation regressions are *overall environment variables* (see Table 4-3). 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. 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 concentration of clients and suppliers are also used to gain a further understanding of the market environment in which the firm operates (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 for example, 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, et al., 2005; Cuervo-Cazurra & Un, 2007).

Despite strong monopoly power, changes in market demand can affect both innovation effort and outcomes substantially. 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 to rural firms, and firms in central regions have higher probabilities of announcing new products in journals. 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 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.

5 Chapter 5

Innovation in New Zealand

5.1 Innovation performance overview

Similar to most developed countries, New Zealand sees innovation as a crucial determinant of competitiveness and future growth. A rigorous assessment of New Zealand's current innovation performance is necessary to reveal its strengths and weaknesses, to help build a solid foundation for further analysis. As discussed in Section 2.2, there are two different measures/indicators of innovation, namely *indirect* and *direct*. In this section we will evaluate New Zealand's innovation performance from these two perspectives.

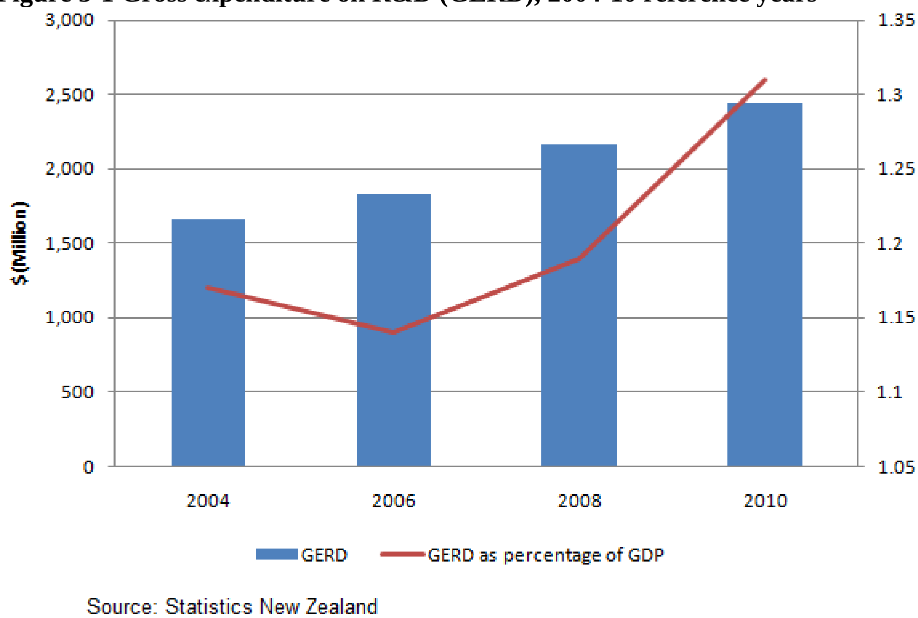
5.1.1 *Indirect indicators*

R&D and patent based indicators are widely recognised as indirect measures of innovation, which refer to the inputs devoted to innovative activity and the successful generation of commercial applications, respectively.

5.1.1.1 ***Research and development***

In New Zealand the main survey instrument for the collection of R&D related data is the R&D survey, which was run every two years since 2004. Adopting definitions from the *Frascati Manual*, the survey suggests that "research and experimental development comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications" (OECD, 2003, p. 30), and it collects data on the level of R&D activity, employment, and expenditure details.

Figure 5-1 Gross expenditure on R&D (GERD), 2004-10 reference years

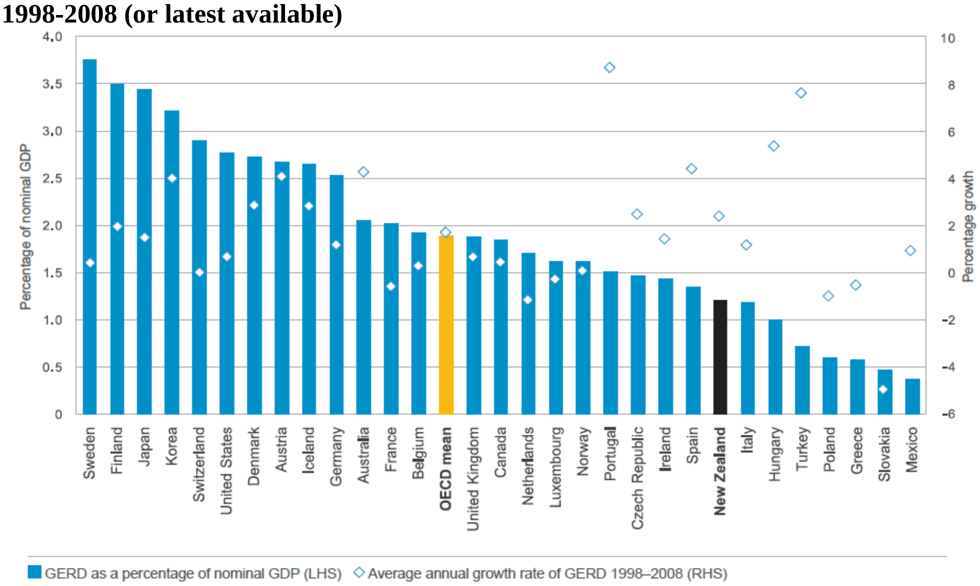


Over the last four survey periods (i.e. 2004-2010) a growth trend in terms of Gross Expenditure on R&D (GERD) has been experienced (see Figure 5-1). The latest 2010 figure was $2,444 million, which represents 1.31 percent of Gross Domestic Product (GDP)[8]. This level of GERD as a percentage of GDP is lower than the OECD average, where New Zealand ranked 23rd out of 30

8 Statistics NZ GDP current price expenditure measure, year end 31 March.

OECD countries. However there appears to be a catching-up process as the growth of New Zealand's GERD has been slightly higher than the OECD average (see Figure 5-2). Note that the annual growth rate is calculated as a ten-year compound annual growth rate.

Figure 5-2 GERD as a percentage if nominal GDP, 2008; and average annual growth, 1998-2008 (or latest available)

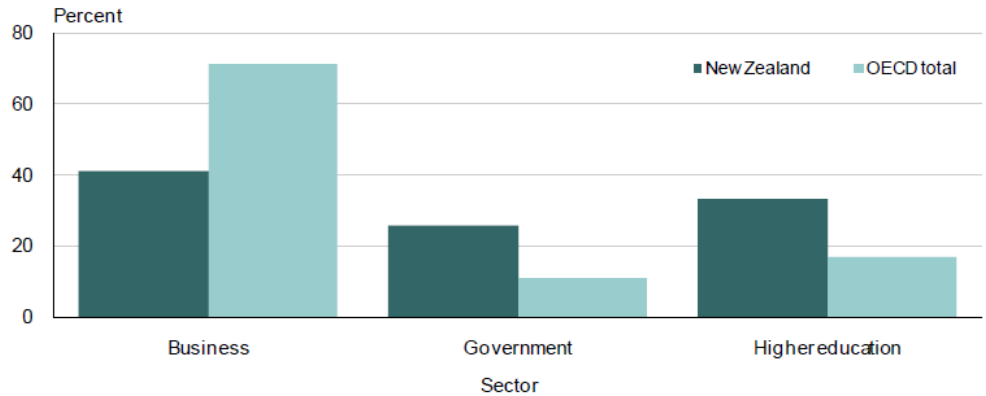


Source: OECD database, Science and Technology Patents, Main science and technology indicators 2009

In the R&D survey, GERD can be divided between business, government and higher education sectors. State-owned enterprises and private non-profit organisations are included in the business sector. Both universities and their commercial arms are a part of higher education sector in the 2010 Survey. Prior to 2010 universities were the only tertiary education institutions included in the higher education sector, and the commercial arms of universities were included in the business sector.

In 2010 the business sector made up 41 percent of the total expenditure, the government sector was responsible for 26 percent and the remaining 33 percent was contributed by the higher education sector. Compared to the rest of the OECD, New Zealand's R&D investment has a very different sector profile. As a proportion of GERD, government and higher education sectors invested more than OECD average, while R&D in the business sector was somewhat lacking (see Figure 5-3).

Figure 5-3 Sector expenditure on R&D as a proportion of GERD, New Zealand and OECD total



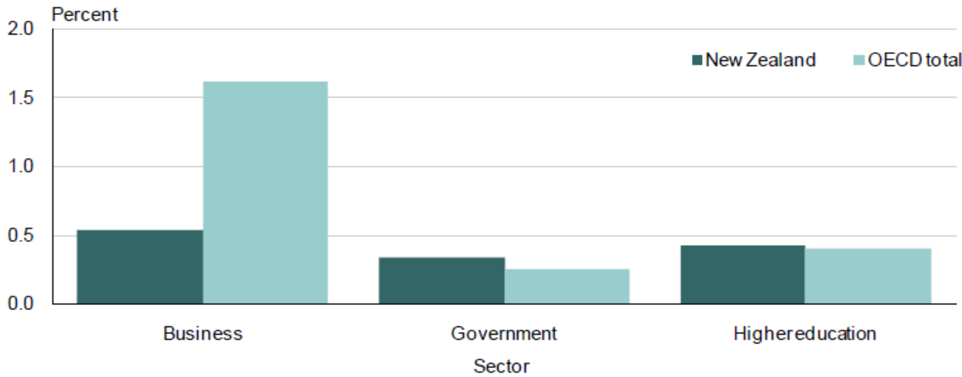
1. Gross expenditure on research and development.
2. 2010 reference year for New Zealand, 2008 reference year for OECD total.

Source: Statistics New Zealand and OECD

In terms of percentage of GDP, New Zealand has similar levels of government and higher education R&D expenditure compared with the OECD average.

The shortage of R&D investment in the business sector was even more prominent with expenditure at 0.54 percent of GDP, which is only a third of the OECD average of 1.63 percent (see Figure 5-4).

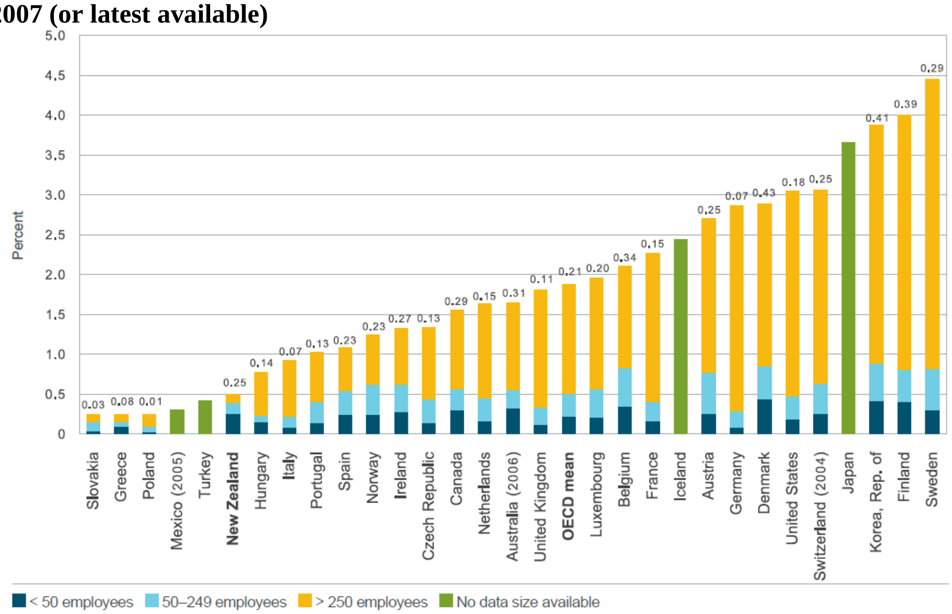
Figure 5-4 R&D as proportion of GDP by sector, New Zealand and OECD total



1. 2010 reference year for New Zealand, 2008 reference year for OECD total.

Source: Statistics New Zealand and OECD

Figure 5-5 BERD by size class of firms as a percentage of total industry value added, 2007 (or latest available)



Note: The numbers above the bar reflect values for < 50 employees

Sources: OECD, Measuring Entrepreneurship: A digest of indicators, 2009 edition, Business R&D intensity, by size class of firms; Statistics New Zealand, Research & Development Survey, customised data request; Statistics New Zealand, Infoshare database, national accounts

Looking at business expenditure on R&D (BERD) in detail, it appears that as a proportion of total industry value added, New Zealand businesses with 50 employees or fewer fund a similar level of R&D to their counterparts in other OECD countries, however larger firms with more than 50 employees invested much less by international standards (see Figure 5-5).

5.1.1.2 ***Patents***

A patent is an exclusive right granted by the Government for any invention that is a "method of new manufacture". The New Zealand register of patents is administered by the Intellectual Property Office of New Zealand (IPONZ), which is responsible for the granting and registration of all types of intellectual property rights including trademarks, design and plant variety rights (PVR). A qualified patentee may exclude others from commercialising the patented invention for up to 20 years from the date that IPONZ receives a complete application provided that the necessary criteria have been met. The renewal fees are paid at the end of the fourth, seventh, tenth and thirteenth years of the patent's existence. During the month of August 2011, a total of 123 patent applications were received in New Zealand, of which 54 applications were from the Auckland region (see Table 5-1).

Table 5-1 Patent application in New Zealand by region, for the month of August 2011

Region	Number of Applications
Auckland	54
Bay of Plenty	2
Canterbury	15
East Coast	1
Waikato	20
Hawkes Bay	1
Manawatu-Wanganui	1
Marlborough	1
Northland	3
Otago	5
Southland	4
Taranaki	2
Tasman-Nelson	2
Wellington	12
Total	123

Source: IPONZ

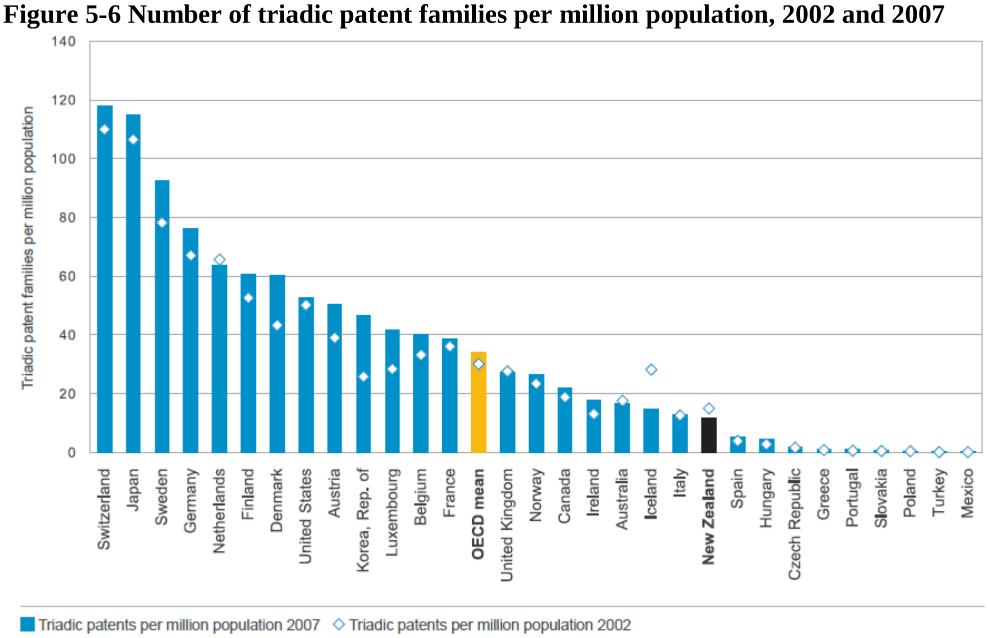
Obtaining a patent is a costly exercise for most businesses and filing an application with IPONZ can only protect the invention within New Zealand. Further actions are required to obtain patent protection overseas where available options include:

- Filling application with other overseas intellectual property offices; or
- Filling an International Application under the Patent Co-operation Treaty (PCT).

Both options are likely to incur substantial costs. Given New Zealand's small domestic market, without international protection, that provided by New Zealand patents are extremely limited.

OECD's Main Science and Technology Indicators collect information on triadic patent families, which are a set of patents taken at the European Patent Office (EPO), the Japan Patent Office (JPO), and granted by the USPTO, to protect the same invention. Figure 5-6 shows that over the period 2002-2007 the number of triadic patents per million population in New Zealand has fallen, and based on the 2007 figure New Zealand ranked 21st in the OECD.

Figure 5-6 Number of triadic patent families per million population, 2002 and 2007



Source: OECD, Main Science and Technology Indicators, December 2009, Table 65 Number of triadic patent families (priority year)

5.1.2 *Direct indicators*

As discussed in Section 4.2, BOS is the main survey instrument for the collection of innovation data in New Zealand. Statistics New Zealand developed the integrated, modular survey in 2005. The integrated collection approach minimises the reporting load for New Zealand businesses, while collecting the necessary information for research and policy purposes. The module structure of the survey is presented in Table 5-2.

Table 5-2 Business Operations Survey module structure

	Module content			
	Module A	**Module B**	**Module C**	**Module D**
2005	Business operations	Innovation	Business practices	N/A
2006	Business operations	ICT	Employment practices	N/A
2007	Business operations	Innovation	International engagement	N/A
2008	Business operations	ICT	Business strategy and skills	N/A
2009	Business operations	Innovation	Business practices	N/A
2010	Business operations	ICT	Price and wage setting	Financing
2011	Business operations	Innovation	International engagement	N/A

Note: ICT – Information and communication technology; N/A – Not applicable

Source: Statistics New Zealand

Typically three "modules" are included in each survey, and each with its own specific objectives. The first module focuses on business performance and characteristics. The longitudinal dimension of the information enables the changes over time to be analysed, hence assisting the investigation of causal relationships. The second module operates on a rotational basis, the survey content alternates between innovation and business use of Information and Communication Technology (ICT). The third module is the "contestable module", which avoids the need to administer a full standalone survey. In 2010 an additional module was added to gain a better understanding of the financing situation of businesses post the global financial crisis. The biennial innovation module replaced the national *Innovation Survey* to provide direct measures of innovation.

The 2005 BOS results revealed an overall innovation rate of 52 percent, which suggests that 52 percent of New Zealand businesses undertook activity or activities during the last two financial years for the purpose of developing or introducing new or significantly improved innovations. The rate of innovation can be divided into two distinct categories to identify innovators' current status; 47 percent of businesses had implemented innovations (i.e. the innovation has been introduced), and 5 percent of businesses had ongoing or abandoned innovations (i.e. the innovative activity was still in progress or had been abandoned during the two-year period). Four types of innovations have been identified being: *product innovations, process innovations, organisational innovations* and *marketing innovations*. The innovation rates for each type of innovation are at a similar level around 30 percent (see Table 5-3), with no prominent type identified.

In 2007, the overall innovation rate decreased to 47 percent, the drop was likely caused by a reduction of businesses with implemented innovations, and the innovation rates for different types of innovation also decreased between 3 and 6 percentage points. As a result of implementing the Australian and New Zealand Standard Industrial Classifications (ANZSIC) in 2006 in the BOS, the 2007 innovation rates have been revised with minor changes around 1 percentage point, while BOS 2009 revealed no noticeable rate changes.

Table 5-3 Innovation in New Zealand, last two financial years at August 2005, 2007 and 2009

	Percentage of all businesses			
	2005(1)	2007(1)	2007(2)	2009(2)
Innovators(3)				
With implemented innovations	47	42	41	41
With ongoing or abandoned innovation activity	5	5	5	5
Total innovators	**52**	**47**	**46**	**46**
Non-innovators	48	53	54	54
Type of innovation(4)				
Goods or services	30	26	26	26
Operational processes	29	23	23	23
Organisational or managerial processes	31	27	26	26
Marketing methods	29	26	25	25

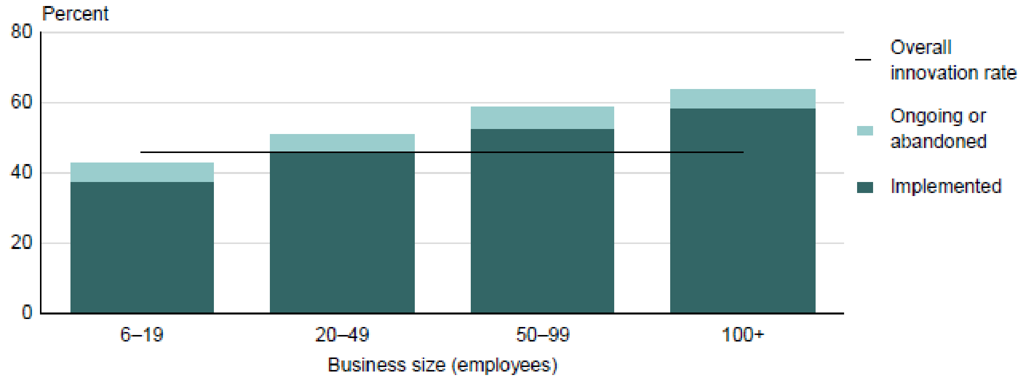
1. Results for 2005 and 2007 are presented on ANZSIC 1996 basis.
2. Results for 2005 and 2007 are presented on ANZSIC 2006 basis.
3. If a business has implemented an innovation, it is included under the 'Implemented' category, even if it has ongoing or abandoned innovations.
4. Percentages may add to over the stated total as business can perform more than one type of innovation.

Note: All counts (not percentages) in this survey were randomly rounded to base 3 to protect confidentiality, so actual figures may differ from those stated. Due to rounding, some figures may not sum to stated total. Percentages may add to over the stated total as business can have both implemented, or ongoing or abandoned innovations.

Source: Statistics New Zealand

To fully assess New Zealand's innovation performance, it is necessary to view innovation rates from different perspectives. First, innovation rates can be calculated based on different business size. The BOS2009 results show that the innovation rate increases with business size, the highest innovation rate of 64 percent was achieved by the business size group with 100+ employees (see Figure 5-7).

Figure 5-7 Innovation rate by business size, last two financial years at August 2009

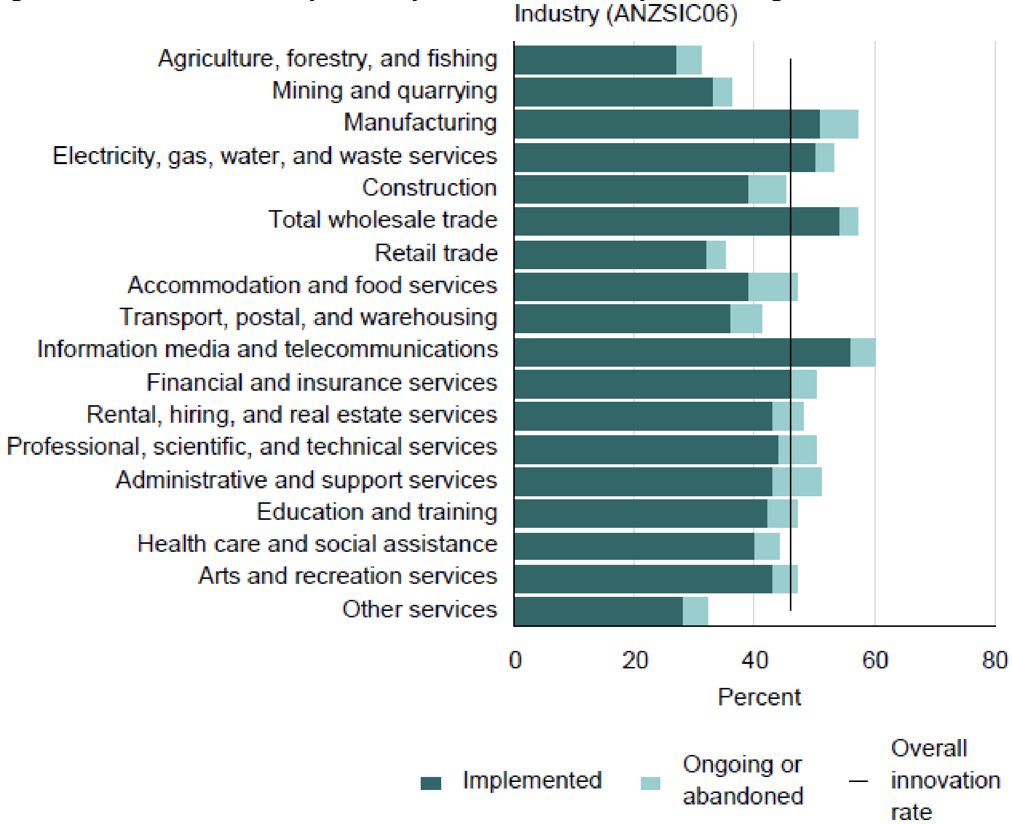


Note: If a business has implemented an innovation it is included under the 'Implemented' category, even if it also has ongoing or abandoned innovations.

Source: Statistics New Zealand

Secondly, industries tend to have different abilities to innovate, and face different opportunities. Among all, the information media and telecommunication services industry has the highest innovation rate, at 60 percent, followed by the manufacturing and wholesale trade, at 57 and 56 percent respectively (see Figure 5-8). Notice that the industry with the highest innovation rate (i.e. information media and telecommunication services) contributed only 3 percent to GDP, and the second most innovative industry (i.e. manufacturing) had the highest GDP contribution at 14 percent. New Zealand is famous for its agriculture-based outputs, where the primary agriculture sector represents 5 percent of GDP, but only had a innovation rate of 32 percent. Therefore, there may not be a direct correlation between the rate of innovation and the economic importance of an industry.

Figure 5-8 Innovation rate by industry, last two financial years at August 2009



Source: Statistics New Zealand

By way of international comparison, New Zealand seems to have a slightly lower overall innovation rate than Australia and Finland, and the rates of individual innovation types were similar to other countries (See Table 5-4). However, comparisons of innovation rates should be treated with caution, only high level comparisons are appropriate due to the differences between survey design, methodologies used, populations and reference periods.

Table 5-4 Rates of innovation activity by selected countries

Country	Innovation activity					Number of years	Employee-size threshold
	Goods or services (product)	Operational processes	Organisational or managerial processes	Marketing methods	Total innovation rate		
	Percent						
Australia[1]	29	25	29	20	52	2[2]	5
Finland	31	23	25	22	48	3[3]	10
New Zealand	**26**	**23**	**26**	**25**	**46**	**2[4]**	**6**
Ireland	28	35	32	27	45	3[3]	10
Denmark	22	21	28	25	42	3[3]	2[5]
Norway	21	18	20	20	34	2[3]	5

Sources: National Statistical agencies in each country

1. Australian results differ from those published, as they exclude businesses with less than 5 employees.
2. The reference period for Australia is the two calendar year 2007–2008.
3. The reference period for the European countries is the three calendar year 2006–2008, and the most recently published results are included.
4. The reference period for New Zealand is the last two financial years as at August 2009.
5. The employee-size threshold for Denmark differs for different industries.

5.2 *Innovation framework*

This section provides an overview of the innovation framework in New Zealand, including the conceptual framework, funding sources and key actors. Some recent changes will also be discussed.

5.2.1 *Conceptual framework*

Aiming to pursue the long-term sustainable growth, the *Growth and Innovation Framework* (GIF) was released by the New Zealand Government in 2002. The framework aimed at strengthening the foundation of the economy and building effective innovation. It recommended that the Government concentrate its policies and resources in four areas (Office of the Prime Minister, 2002).

1) Enhancing the existing innovation framework. e.g. better linkages between industry and universities, and development of mentoring frameworks.
2) Developing, attracting and retaining skills and talents.
3) Increasing global connectedness. e.g. identify and attract appropriate foreign direct investment and support for trade related initiatives aimed at promoting exports.
4) Focusing innovation initiatives in areas with the maximum impact. e.g. biotechnology, information and communication technology and creative industries.

The GIF was followed by the *Economic Transformation* (ET) agenda which was announced in March 2006. This continued the Government's long term commitment to improving income per capita through innovation and raised productivity. One major recommendation was that workplaces must provide "the environment, incentives, and opportunities for people to be innovative, creative and responsive to change" (New Zealand Cabinet, 2006, p. 8). Five complementary and linked sub-themes have been proposed, namely; *globally* *competitive firms; world class infrastructure; innovative and productive workplaces; environmental sustainability; and Auckland – an internationally competitive city*.

In 2011 the National Government announced a 120-point economic development action plan[9] for building a stronger economy. In particular the six key areas in the *Business Growth Agenda* are:

- Capital markets.
- Innovation.
- Skilled and safe workplaces.
- Natural resources.
- Infrastructure (including electricity, broadband, transport).
- Export markets.

Focusing on building innovation (2012), the Government is aiming to

- Encouraging business innovation;
- Strengthening research institutions;
- Growing the innovation workforce;
- Building international linkages;
- Improving intellectual property settings;
- Development of the innovation infrastructure;

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9 http://stevenjoyce.co.nz/economic_development_action_plan.pdf

- Boosting public science investment.

At the regional level, the importance of innovation has been recognised by a number of regional/local governments. In particular, the Auckland Regional Council highlighted innovation in its 2002 *Auckland Regional Economic Development Strategy*, and the implementation of the strategy was set out in the *Metro Project Action Plan launched in 2006*. On 1 November 2010, the Auckland Council amalgamated one regional council and seven territorial authorities, and development of "an internationally connected innovation system" was prioritised by the new unitary authority (2011, p. 84).

5.2.2 *Research funding sources and allocation*

The research system in New Zealand is heavily reliant upon government support (see Table 5-5). In 2008, the Government contributed 42 percent of total funds for R&D, which is significantly higher than the OECD average of 28 percent. Compared with the OECD average of 65 percent, New Zealand businesses only funded 41 percent of R&D, and the remaining funds came from universities, overseas and other funding sources. In 2010 the gap between New Zealand business and government contribution widened to 8 percent due to an increase in government funds and a reduction in business funds.

Even though most of the R&D activities are funded by the Government (46 percent in 2010), only a small percentage is undertaken by the government sector (recall from section 5.1.1.1 the government sector is responsible for 26 percent of the total expenditure in 2010), which means that a substantial proportion of government funding is invested into other research sectors. To understand this issue further, Table 5-6 illustrates the allocation of funding by sources and research sectors for the 2010 reference year. As a general trend, funds are primarily spent within the same sector as the source, with the exception being government funds, where less than half of the total funding (46 percent) is spent within the sector. Moreover, funds sourced from overseas are mainly business oriented, and higher education benefits the most from other funding sources.

Table 5-5 R&D funding by source of funds 2008 and 2010 reference years

Source of funds	2008		2010	
	$(million)	Percent	$(million)	Percent
New Zealand business	880	41	940	38
New Zealand government[1]	912	42	1,117	46
New Zealand universities	187	9	200	8
Overseas	103	5	131	5
Other funding sources	79	4	56	2
Total	**2,161**	**100**	**2,444**	**100**

1. Includes New Zealand local government agencies.

Note: Due to rounding, some figures may not add to stated totals.

Source: Statistics New Zealand

Table 5-6 Source of funds for R&D by research sector 2010 reference year

Source of funds	Business	Government	Higher education	Total
	$(million)			
New Zealand business	814	83	42	940
New Zealand government(1)	85	514	519	1,117
New Zealand universities	C	C	191	200
Overseas	86	22	24	131
Other funding sources	C	C	27	56
Total	**1,013**	**629**	**802**	**2,444**
	Percent			
New Zealand business	80	13	5	38
New Zealand government	8	82	65	46
New Zealand universities	C	C	24	8
Overseas	8	3	3	5
Other funding sources	C	C	3	2
Total	**100**	**100**	**100**	**100**

1. Includes New Zealand local government agencies.
Note: Due to rounding, some figures may not add to stated totals.
Symbol:
C confidential
Source: Statistics New Zealand

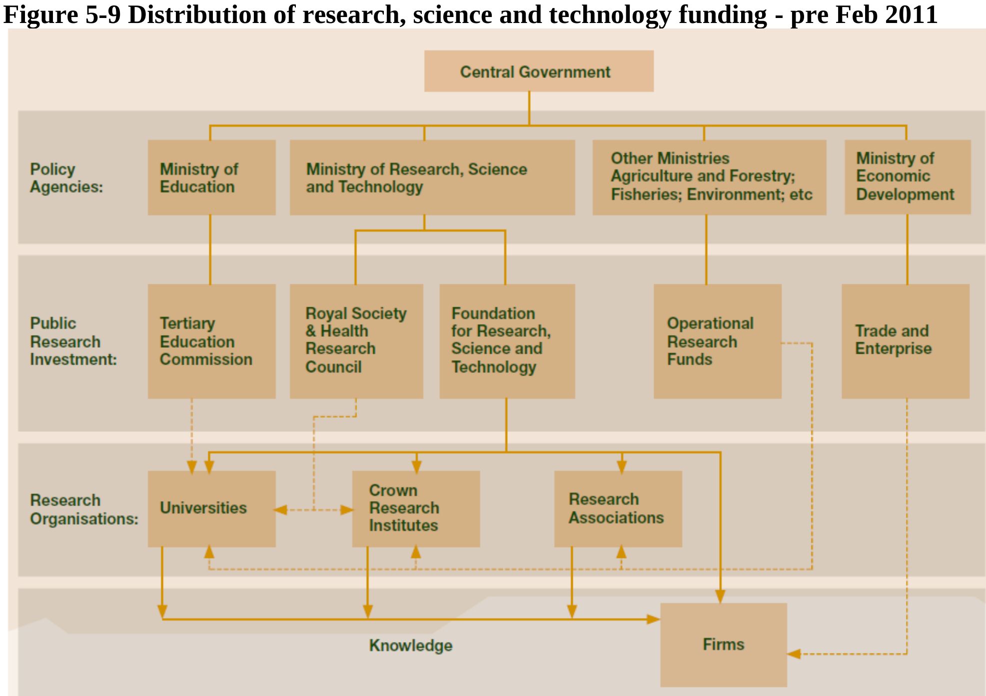
5.2.3 *Key actors within government funding system*

In New Zealand there are traditionally four types of key actors within the government funding system, namely policy agencies, public research investment agencies, research organisations and firms (See Figure 5-9).

Policy agencies are generally government ministries that are responsible for high-level policies and strategies. In particular, the Ministry of Education (MOE) administered *Vote Education* which amounted to $2,204 million as of the 2011/12 Budget. The MOE is responsible for building a high-quality education system as well as providing leadership in tertiary research. The

Ministry of Research Science and Technology (MoRST) influences Government's investment by providing policy advice on the RS&T portfolio. The Ministries of Agriculture and Forestry; Fisheries; and Environment have secondary influence on research directions, especially in their specialised areas. The Ministry of Economic Development (MED) administered the *Vote Economic Development* which amounted to $179 million as of the 2011/12 Budget. One of its purposes is to foster economic development by encouraging innovation in businesses.

Figure 5-9 Distribution of research, science and technology funding - pre Feb 2011



Public research investment agencies are mostly Crown Entities with funding capabilities. In many cases, investment agencies are contracted by the policy agency to allocate funding in the specified policy area. For example, the Tertiary Education Commission (TEC) works directly under the auspices of the MOE. Governed by a Board appointed by MoRST, Foundation for Research, Science and Technology (FRST) managed the most of the Government's Vote RS&T funds. While the Royal Society of New Zealand (RSNZ) and Health Research Council (HRC) also had contractual relationships with MoRST. New Zealand Trade and Enterprise (NZTE) is governed by a Board, who are jointly responsible to the both the MED and the Minister of Trade.

Aiming to deliver a public surplus and improve public sector performance, during 2011 and 2012 the National Government undertook a number of structural reforms in the public sector. On February 2011, a new Ministry of Science and Innovation (MSI) was formed by a merger of the MoRST, and FRST. The new Ministry combined the policy and investment functions of both agencies, and Vote RS&T was replaced by *Vote Science and Innovation* which currently stands at $743 million as of the 2011/12 Budget. On July 2012, the Government further established the Ministry of Business, Innovation and Employment (MBIE) merging MSI with the MED, Department of Labour and the Department of Building and Housing. The establishment of the new super-Ministry is set to improve vertical coherence between decision-making and implementing bodies.

Within the funding system, research organisations are responsible for performing the actual research work. Universities, Crown Research Institutes (CRIs) and private research associations are the three common types of research organisations, where both universities and CRIs are owned by the Government. Currently, there are eight universities[10] in New Zealand and their main sources of research funding come from: (1) R&D contracts and earmarked grants (as a part of Vote Science and Innovation) distributed through government investment agencies such as MSI, RSNZ and the HRC; (2) universities' own income from endowments, shareholding, property and student fees; (3) general grants received through Vote Education.

The first two income sources are often referred to as "external research income" that finance specific research projects, and the Vote Education funding is primarily made available through the Performance-Based Research fund (PBRF) and Centres of Research Excellence (CoREs)[11] fund. The

[10] Auckland University of Technology, Lincoln University, Massey University, University of Auckland, University of Canterbury, University of Otago, University of Waikato and Victoria University of Wellington.

[11] Funds are directed to seven CoRE, which is hosted by a university and comprises a number of partner organisations (e.g. other universities, CRIs and wānanga).

number of state-owned, semi-commercialised CRIs[12] within the country is also set at eight. They receive direct funding from Vote Science and Innovation, and often compete with universities and private research associations for public- and private- sector research contacts distributed by investment agencies such as RSNZ and HRC. In October 2009 a Crown Research Institute Taskforce was established to examine the purpose, governance and funding of CRIs. The taskforce reported back with a list of recommendations (2010), which included clarifying the exact role of each CRI in a Statement of Core Purpose; increasing the proportion of direct funding to CRIs, contestable, open access funding should remain at a smaller scale; providing incentives for collaboration in new multi-disciplinary areas of research; and creating a greater degree of certainty to enable CRIs to retain and develop capability, and act strategically within a longer time frame. The overall intent of the CRI Taskforce's recommendations was endorsed by the Government, and a reform of the CRIs is underway. The establishment of the new Ministry aligns with the part of the Taskforce recommendation on the role of government agencies.

Last but not least, firms make up the final piece of the government funding system. After all the economic value of science and knowledge cannot be

[12] AgResearch, Plant and Food Research, Institute of Environment Science and Research Ltd (ESR), Scion, GNS Science, Industrial Research Ltd (IRL), Landcare Research and National Institute of Water and Atmospheric Research (NIWA).

realised until it is utilised by firms. Similar to the research organisations, individual firms can apply for funding/grants from the Government. The MBIE runs a number of funding programme annually including:

- *Technology Transfer Vouchers*: available to businesses new to R&D or who need external R&D expertise. These vouchers make it easy for businesses to work with research organisations on R&D projects.
- *Project Funding*: provides up to 50 percent funding for businesses with high growth potential to undertake R&D projects to develop new technology products, processes or services.
- *Technology Development Grants*: contestable processes which provide funding for R&D-intensive businesses. Businesses awarded the grant must be able to demonstrate a strong history of R&D and the potential to generate benefits for the New Zealand economy.
- *Capability Funding*: provides funding to employ students on fellowships or internships and to engage world-class experts to build R&D capability. It is targeted at helping both early stage and mature businesses successfully plan for and realise results from R&D investments.
- *Global Experts*: a fast, professional and confidential service that locates, pre-screens and qualifies national and international experts and

connects them with New Zealand businesses to help solve innovation challenges from concept through to commercialisation.

- *Innovation Entrepreneurs Programme*: a new initiative to support up and coming entrepreneurs in the digital technologies sector.

Furthermore, NZTE created a nationwide network of Regional Business Partners to target businesses with short to medium term growth potential that are most likely to succeed internationally. They offer a range of services and funds, for example, the budget for the International Growth Fund is around $9.6 million for the year to 30 June 2010, and this figure rose to around $30 million in the following 12 months. Other sector specific funds include the Red Meat Sector Market Development Contestable Fund and Australia New Zealand Biotechnology Partnership Fund.

New Zealand Venture Investment Fund (NZVIF) Limited, although not a typical investment agency, it is another Crown owned entity that is worth mentioning. Incorporated in 2002, the company is not designed specifically to commercialise RS&T, but to help the development of the venture capital market in New Zealand. It is contracted directly by the Government, and its funds are invested into New Zealand high-growth potential companies through two vehicles, i.e. Venture Capital Fund and Seed Co-investment Fund.

6 Chapter 6

Regression Analyses

Recall from Section 5.1.2, the BOS provides an invaluable data source for innovation related studies. Compared with the datasets used by most international econometric studies, the BOS dataset has a relatively large sample size and high response rates. For the 2005 Survey, the estimated population size was 34,761 enterprises. The survey sampled 5,595 businesses, which achieved a response rate of 80.1 percent, (Statistics New Zealand, 2007). Please refer to Appendix 1 for more information on target population and sample design.

The first BOS regression-based innovation analysis was undertaken by Fabling (2007). Using the BOS 2005 survey, he sought to gain a better understanding of innovative firms in New Zealand using a broader innovation measurement than previously considered. Electricity, Gas & Water Supply; and Sport & Recreation industries were excluded from his analysis to create consistent industry coverage between the *Business Practice Survey* (BPS 2001) and the BOS. For the purpose of his regression analysis, innovating firms are separated into three distinct groups depending on the type of innovation they have introduced over the last two financial years, i.e. product and/or operational process only (PP) innovators; organisational/managerial process and/or marketing only (OM) innovators; and innovators with a combination (COMBO) of PP and OM innovations. His econometric analysis involved the use of multinomial probit regressions, which regressed each of the innovation groups on firm characteristics, combinations of innovation activities and various sources of innovation ideas. A full description of the variables are listed as Appendix 2.

His regression results suggested that:

- firm size, export performance and Outward Direct Investment (ODI) all have significantly positive coefficients, but these results are not robust to the introduction of firm practices,
- subsidiary firms are significantly less likely to be innovative,
- the contemporaneous relationship of R&D intensity to innovation outcome is weak, and negative,
- innovation-specific employee training dominates general employee training ,
- internal activities such as machinery/computer upgrades, change strategy/management techniques, organisational restructuring are significantly related to innovation outcomes,
- the strongest positive effect of sources of innovation ideas comes from existing staff.

6.1 Replication of the existing BOS analysis

Based on Fabling's approach, we initially repeat his approach using BOS 2005, 2007 and 2009 to consider the robustness of his results. Fabling (2007) excluded Electricity, Gas & Water Supply; and Sport & Recreation industries from the BOS dataset to ensure the consistent industry coverage between BOS and BPS. Since we will not be making comparisons with the BPS, due to the non-comparability caused by the changes in survey instrument and inclusion of non-TPP innovations, all surveyed industries are included in this analysis. This means that 111 additional firms are added back into the 2005 sample when compared to Fabling.

Before undertaking the regression analysis, Fabling calculated the headline innovation rates using the BOS 2005 sample. The headline rates are the percentage of innovating firms in the overall population by different innovation outcomes and groups. Based on the new sample set, the 2005 headline rates were produced and the 2007 and 2009 headline innovation rates were recreated, the results are shown as Table 6-1.

Table 6-1 Headline rates for individual innovation outcome and innovation group

	2005		2007		2009	
Headline innovation rates (2yr):	**Number**	**Rate**	**Number**	**Rate**	**Number**	**Rate**
Introduced new products	7959	23%	7056	20%	6873	19%
Introduced new operational processes	7116	20%	5562	16%	6045	17%
Introduced new organisational/managerial processes	9252	27%	7734	22%	8094	22%
Introduced new marketing methods	8319	24%	7665	22%	7512	21%
Innovation groups(2yr):	**Number**	**Rate**	**Number**	**Rate**	**Number**	**Rate**
PP: Introduced product AND/OR operational process innovations ONLY	3687	11%	3228	9%	3369	9%
OM: Introduced orgnaisational/managerial process AND/OR marketing method innovations ONLY	4923	14%	4947	14%	5034	14%
COMBO: Introduced combination of "technological" & "non-technological" innovations	7887	23%	6441	18%	6462	18%
NON: No innovation introduced over the period	18264	53%	20385	58%	21486	59%
	34761	100%	35001	100%	36345	100%

With a larger final estimated population size in 2007 and 2009, headline rates are generally lower than in 2005, the one exception being the percentage of OM innovators, which remained at 14 percent in both years. For individual innovation outcomes, the largest decrease was in the introduction of new organisational/managerial processes at 5 percent, and the same rate of reduction was experienced by the COMBO innovation group. The small differences between the individual innovation headline rates suggests that no one type of innovation is more important than the others, and the high percentage in the COMBO group leads to the conclusion that many businesses are participating in more than one type of innovation activity.

As described above, once the additional sectors (i.e. Electricity, Gas & Water Supply, and Sport & Recreation industries), have been included, the next stage in the analysis involved the estimation of a series of multinomial probit regressions using, firstly, the set of dependent and independent variables proposed by Fabling.

Compared with Fabling's original BOS findings, only minor changes in terms of estimated coefficients and their significances were found when using the extended BOS 2005 data (the new regression results are shown in Table 6-2). For example, the share of in-house R&D is no longer positively related to COMBO and firms that entered a new export market are no longer likely to be a driver of OM innovators, but its association with COMBO innovators remains significant; there appears to be a negative association between firm age and COMBO innovation, though this result is not robust; and firms are more likely to innovate if market research was conducted. Despite these changes, the main conclusions stated in the previous section regarding the 2005 survey still hold.

Table 6-2 Multinomial probit models - BOS 2005

	r1_2005			r2_2005			r3_2005			r4_2005		
	PP	**OM**	**COMBO**	**PP**	**OM**	**COMBO**	**PP**	**OM**	**COMBO**	**PP**	**OM**	**COMBO**
lnrme	0.220***	0.211***	0.228***	0.076	0.078	-0.034	0.122	0.001	0.038	0.104	0.022	-0.053
lnage	0.015	-0.087	-0.165**	0.122	-0.016	-0.115	0.108	0.071	-0.087	0.161	0.036	-0.090
Export intensity	0.009**	0.006**	0.008***	0.007	0.006*	0.004	0.007*	0.004	0.007*	0.005	0.005	0.002
Inward Direct Investment (FDI) intensity	0.006*	0.002	0.005	0.009**	0.004	0.006	0.008**	0.005	0.007*	0.010**	0.006	0.007*
Outward Diectr Investment (ODI)indicator	0.613**	0.527*	1.235***	0.881*	0.668*	1.313**	0.102	-0.006	0.589	0.702	0.483	0.981
Subsidiary firm	-0.448**	-0.366*	-0.274*	-0.598*	-0.541	-0.424	-0.872***	-0.718**	-0.719**	-0.841**	-0.787*	-0.709*
Entered new export market				0.125	0.568	0.917**				-0.092	0.453	0.924**
Invested in expansion				0.074	0.116	0.161				0.178	0.172	0.273
R&D intensity				-0.001	-0.019	-0.001				-0.001	-0.017	-0.027*
Share of in-house R&D				0.002	-0.003	0.005				0.002	-0.005	0.006
Part of a merger or acquisition				-0.229	0.025	0.147				-0.928*	-0.365	-0.203
General Training				-0.430	-0.766***	0.292				-0.481*	-0.728**	0.209
Innovation supporting activities												
Machinery and equipment				0.943***	0.549*	0.636**				0.677**	0.445	0.424
Computer hardware & software				0.491*	0.743***	0.946***				0.286	0.500*	0.720***
Acquired other knowledge				0.005	0.026	0.251				-0.070	-0.046	0.250
Design				0.666*	0.473	0.522				0.451	0.370	0.303
Marketing New Products				0.869***	0.213	1.139***				0.754**	0.104	1.080***
Trained employees				1.341***	1.104***	0.901***				0.991***	0.719***	0.500*
Changed marketing strategy				-0.106	0.669*	0.985***				-0.020	0.726**	0.973**
Market research				0.873**	0.831**	0.674*				0.643*	0.667*	0.470
New strategy/management techniques				0.217	1.055***	1.095***				-0.153	0.727**	0.812***
Organisational restructuring				0.028	0.840***	0.747***				0.014	0.674*	0.543*
Co-operative arrangements				0.808*	0.680	1.067**				0.426	0.539	0.864*
Sources of innovation ideas												
New staff							-0.507*	0.554*	0.313	-0.540*	0.447	0.325
Existing staff							1.929***	1.470***	1.426***	1.399***	0.984***	0.866***
Business group							0.770*	0.909**	0.936**	0.627	0.541	0.536
Customers							0.326	0.355	0.752***	-0.042	-0.219	0.122
Suppliers							0.145	0.149	0.057	0.111	0.008	-0.133
Competitors							0.600**	0.489*	0.571**	0.550*	0.483	0.452
Other industries							0.085	-0.224	0.251	0.132	-0.337	0.213
Professional advisors							0.190	0.556**	0.400	0.079	0.393	0.297
Books/patent/internet							0.279	0.359	0.419*	0.057	-0.057	-0.060
Conferences/exhibitions							0.787***	0.566*	0.869***	0.167	0.110	0.255
Industry/employer organisations							0.216	0.607**	0.395	0.079	0.248	-0.144
Universities/ polytechnics							-0.420	-0.448	-0.032	-0.673	-0.673	-0.168
CRIs & other Research Institutes							0.246	0.183	0.141	0.458	0.386	0.117
Government agencies							-0.544	-0.589	-0.346	-0.321	-0.501	-0.417
Constant	-2.149***	-1.734***	-1.635***	-2.878***	-2.484***	-3.495***	-3.489***	-3.121***	-3.148***	-3.496***	-2.948***	-3.769***
N	5091			4362			4716			4134		

Note: The above are multinomial probit models with innovation group as the dependent variable, where NON is the base outcome.

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

Table 6-3 Multinomial probit models - BOS 2007

	r1_2007			r2_2007			r3_2007			r4_2007		
	PP	OM	COMBO	PP	OM	COMBO	PP	OM	COMBO	PP	OM	COMBO
lnrme	0.189**	0.212***	0.261***	0.159*	0.103	-0.019	0.147*	0.079	0.075	0.142*	0.059	-0.089
lnage	-0.005	-0.223**	-0.343***	0.06	-0.143	-0.242*	0.1	-0.158	-0.261**	0.097	-0.131	-0.117
Export intensity	0.008*	0.001	0.008**	-0.003	-0.003	-0.001	0.003	-0.001	0.004	-0.004	-0.005	-0.003
Inward Direct Investment (FDI) intensity	0.001	0	-0.001	0.004	-0.004	-0.002	0.004*	0	0.001	0.006*	-0.002	0
Outward Diectr investment (ODI)indicator	0.534	0.331	0.669**	-0.52	-0.229	-0.061	-0.548*	-0.265	0.099	-1.009**	-0.314	-0.19
Subsidiary firm	0.25	-0.016	0.393*	-0.111	-0.088	0.315	-0.121	-0.037	0.371*	-0.103	-0.106	0.369
Entered new export market				0.429	0.176	0.169				0.359	0.215	0.177
Invested in expansion				0.372*	0.046	0.316				0.370*	0.105	0.413*
R&D intensity				-0.006	-0.021	-0.000*				-0.01	-0.022	0
Share of in-house R&D				0.006	-0.003	0.005				0.004	-0.004	0.002
Part of a merger or acquisition				-0.373	-0.341	-0.212				-0.468	-0.481	-0.407
Innovation supporting activities												
Machinery and equipment				0.432**	0.043	-0.187				0.372*	-0.143	-0.362
Computer hardware & software				-0.001	-0.03	0.127				-0.23	-0.213	-0.075
Acquired other knowledge				-0.042	-0.491*	0.293				0.007	-0.574*	0.242
Design				0.276	-0.409	0.344				0.23	-0.599*	0.045
Marketing New Products				1.196***	0.861***	1.745***				1.174***	0.925***	2.041***
Trained employees				-0.013	-0.405	0.165				-0.174	-0.490*	0.006
Changed marketing strategy				0.201	1.246***	1.371***				0.002	1.074***	1.204***
Market research				0.243	0.006	-0.182				0.075	-0.252	-0.561*
New strategy/management techniques				0.435*	1.486***	1.758***				0.174	1.125***	1.502***
Organisational restructuring				-0.09	0.903***	0.670***				-0.313	0.831**	0.551*
Co-operative arrangements				1.315***	1.125***	1.577***				0.832***	0.593**	1.079***
Sources of innovation ideas												
New staff							0.232	0.514*	0.461*	-0.079	0.261	0.119
Existing staff							0.837***	0.768***	1.231***	0.785***	0.804***	1.230***
Business group							0.489*	0.296	0.343	0.328	0.13	0.175
Customers							0.262	0.355	0.563**	0.3	0.048	0.094
Suppliers							0.938***	0.425*	0.472*	0.754**	0.581*	0.561*
Competitors							0.251	0.437*	0.705***	0.33	0.690**	0.868***
Other industries							-0.098	-0.029	0.441	0.197	0.088	0.572*
Professional advisors							-0.204	0.348	0.367	-0.41	0.206	0.274
Books/patent/internet							0.386	0.44	0.329	0.196	0.334	-0.004
Conferences/exhibitions							0.727***	0.552**	0.662***	0.768***	0.213	0.295
Industry/employer organisations							-0.930***	-0.550*	-1.018***	-0.600*	-0.26	-0.680**
Universities/ polytechnics							0.258	-0.548	0.174	0.211	-0.586	-0.006
CRIs & other research institutes							0.152	0.052	0.356	0.16	-0.416	0.214
Government agencies							0.075	0.316	0.381	-0.469	0.251	-0.156
Constant	-2.154***	-1.640***	-1.703***	-3.144***	-2.572***	-3.069***	-2.896***	-2.301***	-2.904***	-3.190***	-2.552***	-3.613***
N	4938			3813			4428			3561		

Note: The above are multinomial probit models with innovation group as the dependent variable, where NON is the base outcome.

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

Table 6-4 Multinomial probit models - BOS 2009

	r1_2009			r2_2009			r3_2009			r4_2009		
	PP	OM	COMBO	PP	OM	COMBO	PP	OM	COMBO	PP	OM	COMBO
lnrme	0.115*	0.151**	0.275***	0.011	0.055	0.076	0.021	0.051	0.127	-0.025	0.009	0.024
lnage	0.051	-0.112	-0.249***	0.162*	-0.013	0.005	0.132	-0.020	-0.130	0.165*	-0.013	0.022
Export intensity	0.005*	0.001	0.008***	0.004	-0.005	0.003	0.005	0.001	0.007*	0.005	-0.001	0.003
Inward Direct Investment (FDI) intensity	0.000	-0.004	-0.001	-0.001	-0.004	-0.005	0.000	-0.003	0.000	-0.001	-0.004	-0.005
Outward Diectr investment (ODI)indicator	0.231	0.234	0.472*	-0.139	-0.188	-0.009	0.036	0.122	0.401	-0.024	0.026	0.249
Subsidiary firm	0.406*	0.280	0.124	0.196	-0.113	-0.154	0.193	0.233	0.110	0.087	-0.127	0.037
Entered new export market				0.112	0.729	0.578				0.105	0.368	0.297
Invested in expansion				0.765***	0.331	0.807***				0.811***	0.277	0.774***
R&D Expenditure				0.000	0.000	0.000				0.000	0.000	0.000
Share of in-house R&D				0.004	-0.002	0.005				0.000	-0.006	0.001
Part of a merger or acquisition				-0.216	0.180	-0.402				-0.183	0.047	-0.343
General Training				-0.158	-0.127	-0.208				-0.273	-0.436	-0.353
Innovation supporting activities												
Machinery and equipment				0.307	0.186	0.482**				0.254	0.016	0.302
Computer hardware & software				-0.050	0.297	-0.019				-0.114	0.364	-0.129
Acquired other knowledge				-0.043	0.033	0.040				-0.280	0.076	0.046
Design				0.447*	0.138	0.489*				0.333	-0.017	0.303
Marketing New Products				1.224***	0.835***	1.744***				1.028***	0.723**	1.587***
Trained employees				0.650**	0.517*	0.097				0.693**	0.547**	0.038
Changed marketing strategy				0.311	1.373***	1.427***				0.044	1.152***	1.202***
Market research				0.175	0.097	-0.019				0.179	0.187	-0.014
New strategy/management techniques				0.131	1.246***	1.598***				-0.003	1.034***	1.374***
Organisational restructuring				-0.155	0.354*	0.699***				-0.165	0.290	0.720***
Co-operative arrangements				1.515***	0.857***	1.744***				1.247***	0.237	1.246***
Sources of innovation ideas												
New staff							-0.107	0.665**	0.700***	-0.287	0.638**	0.345
Existing staff							1.186***	1.075***	1.394***	1.031***	0.942***	1.423***
Business group							0.699**	0.212	-0.051	0.908**	0.263	-0.093
Customers							0.365	0.182	0.742***	-0.045	-0.263	0.084
Suppliers							0.177	0.034	0.087	0.382	0.116	0.174
Competitors							0.133	0.426*	0.344	0.020	0.319	0.151
Other industries							0.405	0.400	0.802***	-0.024	0.193	0.650*
Professional advisors							0.082	0.732***	0.717***	0.213	0.581**	0.449*
Books/patent/internet							0.298	0.200	0.216	0.083	-0.101	-0.052
Conferences/exhibitions							0.145	0.191	0.424*	0.027	-0.007	0.079
Industry/employer organisations							-0.374	-0.055	-0.348	-0.345	0.006	-0.206
Universities/ polytechnics							0.348	-0.629	0.032	0.356	-0.410	0.203
CRIs & other research institutes							-0.023	-0.339	0.131	-0.948*	-0.497	-0.512
Government agencies							0.242	0.083	0.078	0.209	0.308	0.466
Constant	-2.525***	-1.709***	-1.931***	-3.590***	-3.191***	-4.368***	-3.413***	-2.845***	-3.476***	-3.845***	-3.653***	-5.059***
N	4620			3669			3933			3333		

Note: The above are multinomial probit models with innovation group as the dependent variable, where NON is the base outcome.

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

In the next stage, the robustness of the model over time was considered by using the BOS 2007 and 2009 data. The regression results are presented as Table 6-3 and Table 6-4 above. Due to the absence of the Business Practices module in 2007, the question regarding ‘general training’ was not surveyed and, as a result, one independent variable ‘General Training’ is omitted from all 2007 regressions. Also, instead of R&D intensity, R&D expenditure is used in 2009 regressions as the financial figures are no longer surveyed.

Comparing the regression results derived from BOS 2005, 2007 and 2009 (i.e. Table 6-2 to Table 6-4), we see a different picture. Firstly, in terms of firm characteristics, the positive size effect on PP and the negative age effect on ‘COMBO’ appear to be the strongest when based on the 2007 data; the consistent non-innovativeness of the subsidiary firms disappears, and the effect of export performance, ‘Foreign Direct Investment (FDI)’ and ‘ODI’ continue to be non-robust. Secondly, the only significant general firm practice in the 2007 and 2009 regressions seems to be whether the firm ‘invested in expansion’, where the advantage induced by ‘entering new export markets’ has disappeared. As regards innovation supporting activities, the results reveal that ‘innovation specific training’ and ‘market research’ may not enhance innovation, while ‘marketing new products’ and ‘co-operative arrangements’ are crucial for all innovator groups. Finally, the level of significance has increased for many sources of innovation ideas, other than existing staff originally proposed, suppliers and competitors are also excellent sources for new innovative ideas in 2007, while in 2009 the use of professional advisors are crucial for 'OM' innovators. The apparent instability of the estimated results over time may, however, be indicative of model misspecification. In the next section, extensions to and variations of, the original Fabling formulations will be considered.

6.2 Models and results

In this section we will consider modeling the drivers of innovation by recourse to economic theory. This will lead us to reformulate, refine and extend the empirical model produced by Fabling - the results of which will be discussed and analysed below.

As discussed in Section 3.1, the Schumpeterian hypothesis is the earliest testable hypotheses of the determinants of innovation. Given the amount of political attention given to innovation related research, it is surprising that very little has been achieved since Schumpeter (1942) in terms of theoretical developments where the majority of effort has been concentrated on empirically-oriented innovation research due, in the main, to the introduction of firm level surveys. Without doubt, the improvements within the survey design and the increasing data availability have pushed the development of theoretical concepts, however, there is no single theoretical model or set of models that can be cited from which empirically testable counterparts can be tested. At best, models of innovation are 'heuristic', with no discussion regarding, e.g. functional forms, systems of equations, etc.

Therefore, based on the commonly acknowledged theoretical aspects of the Schumpeter hypothesis, the following model will be used as the starting point for our regression analyses.

$$\text{Innovation indicator(s)} = f\,(\text{fc, fbs, oe})$$

where	fc	= firm characteristics
	fbs	= firm behaviour/strategy
	oe	= overall environment

6.2.1 *Stage one - probit models*

The review in Section 4.3 identified a large number of papers focusing on technological innovations such as, product innovation, with fewer looking at the areas of non-technological innovation (i.e. organisational processes and marketing methods). As we have seen, it is generally accepted that the determinants of innovation vary across different types of innovation due to their distinct nature and, as a response, some authors have tended to try and explain different types of innovation via separate regressions. The segregation of innovation groups (i.e. PP, OM & COMBO) is not common in the literature, as suggested by Fabling himself "the breakdown into innovation groups is inconsistent with our advocated holistic view of the firm" (2007, p. 7). Therefore, the stage one model will include four separate regressions, each represents a different type of innovation output (i.e. product, operational process, organisational/managerial process and marketing innovations).

Utilising information collected from BOS 2005, a set of explanatory variables were created (see Table 6-5) aimed at matching the extensive variable list summarised from the existing literature (see Table 4-1 - Table 4-3 above). However, we were unable to find suitable variables for all subcategories (e.g. geography/location, input source and informal practice) within BOS due to survey limitations and confidentiality issues.

Since the innovation output variables are not mutually exclusive, the original multinomial probit regression-based estimation used earlier is no longer applicable and a probit model was used instead. The BOS2005-based probit regression results from this new approach are presented as Table 6-6.

Table 6-5 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 Intensity	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 6-6 Stage 1 - 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**	0.21	0.085
R&D Intensity	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	0.08	-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	0.1
Local Business Networks	-0.049	0.054	-0.057	0.266*
Local Regulatory Process	-0.195	-0.083	-0.094	0.05
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 these BOS2005 regression results, the following innovation patterns can be observed for New Zealand 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 highly 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 a higher probability of observing innovations in both operating processes and marketing. In terms of structural issues, for New Zealand firms, capacity expansion is associated with a higher likelihood of observing innovations in operational processes, whereas the innovation advantages of scale appear to be only related to organisational or managerial process innovations. Indeed, the degree of monopoly power, which if anything, can be considered to be a relative scale indicator, 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 New Zealand firms a greater level of overseas ownership is associated with higher levels of three out of the four different types of innovation, and foreign direct investment assists firms with non-technological related innovations. Export intensity is related to a greater likelihood of exhibiting operational process innovations, whereas New

Zealand 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 intellectual property protection is associated with a 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 using the BOS2007 and 2009 data. The new sets of results are presented as Table 6-7 and Table 6-8. Note that in 2009 the variable "R&D intensity" has been replaced by "R&D expenditure" due to changes in survey design.

The 2007 and 2009 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 up-to-date equipment may give firms a temporary advantage in product innovation, but not in terms of marketing innovation. 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 and transportation infrastructure appears now to be associated with positive innovation opportunities. Capacity expansion is more strongly associated with innovation, however 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 6-7 Stage 1 - 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**	0.17	0.242*
R&D Intensity	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*	-0.04	-0.564
Oligopoly	0.285	0.237	0.306	0.367
Monopolistic Competition	0.255	0.13	0.312	0.21
New Export Market	0.515**	0.268	0.136	0.27
Transport	0.193	0.280*	-0.211	0.024
Information and Communication Technology	-0.06	-0.062	-0.079	0.05
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	-0.04	-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 6-8 Stage 1 - 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 Expenditure	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 17 ANZSIC industry dummies, their coefficients are not shown.
legend: * p<.05; ** p<.01; *** p<.001

6.2.2 *Stage two - model fine tuning*

After initial construction of the stage one models reported above, stage two models were proposed to fine-tune the previous models, and two additional variables are included, namely an R&D indicator and labour productivity.

6.2.2.1 ***R&D indicator***

As a direct innovative input, the role of R&D in innovation has been emphasised over the years (Dar & Ahmed, 2009). Mairesse and Mohnen (2005) reassess the importance of R&D in the innovation process using CIS3 data. They measure innovation using five dichotomous innovation indicators (i.e. process innovation, 'new to the firm' product innovation, 'new to the market' innovation, patent applications and patent holdings); and three censored continuous indicators (i.e. the share of sales in 'new to the firm' products, the share of sales in 'new to the market' products and the share of patent-protected sales), and found that R&D intensity[13] is positively correlated with all the measures.

Contradicting their findings, our stage one regression results show that the variable 'R&D intensity' has no significant impact on the probability of observing innovations. Similarly, Fabling (2007) reported a non-positive

[13] R&D intensity is measured by R&D expenditures per employee (in logs).

relationship between R&D intensity and innovation groups using the same dataset as ours, where a replication of his work can be found in section 6.1.

To investigate this issue further, a variable named 'R&D indicator' will be added to the regression, which is a binary variable equal to one for firms that report positive R&D expenditure and zero otherwise. Since the variable 'R&D intensity' is calculated as R&D expenditure divided by total sales, a positive R&D intensity must set the R&D indicator at one.

6.2.2.2 ***Labour productivity***

Measured by GDP per capita, since the 1970s, New Zealand's productivity performance has been relatively poor by international comparison and this trend has continued for at least 25 years. The Government has made several recent attempts to overcome this productivity challenge including the establishment of the 2025 Taskforce[14] and the New Zealand Productivity Commission[15], where innovation has been identified as the one of the key drivers for productivity growth (The New Zealand Treasury, 2008). Many authors around the world also tested the relationship between innovation and

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[14] The purpose of the Taskforce was to provide credible recommendations to lift productivity growth rate and close the income gap with Australia by 2025. The Taskforce's initial appointment was for three years until 30 June 2012. Four detailed reports were planned during that period, where the preparations for the last two reports were stopped due to the early termination of the advisory group in June 2011.

[15] Established on April 2011, the independent Crown Entity is responsible for providing a source of independent advice on productivity-related matters.

productivity empirically, and found positive correlations (Crepon, et al., 1998; Huergo & Jaumandreu, 2004). The question here is whether more productive firms are also more innovative. In order to test this, a suitable measure of productivity is required. So far all our regression analyses are based on data from BOS, however it does not provide financial data at individual firm level, which are essential for calculation of labour productivity.

Recall from Section 4.2, a two–year feasibility project IBULDD was implemented in 2006 by SNZ. The aim of the project was to link business related data from both administrative and sample survey data, and as a result a prototype LBD was created (Fabling, et al., 2008a). Built around the Longitudinal Business Frame (LBF), the integrated components of the LBD are represented in Table 6-9. Utilising the linked Business Activity Indicator (BAI), the generation of the productivity variable is possible, where labour productivity is calculated by value-added (i.e. sales minus purchases) divided by employment.

The main source of the BAI data is the Inland Revenue Department's (IRD) Goods and Service Tax (GST) return form. In New Zealand, a business must register for GST if it carries out a taxable activity and if its turnover was over $60,000 for the last 12 months; or is expected to go over $60,000 for the next 12 months; or was less than $60,000, but invoiced prices include GST. Since both sales and purchases data are GST inclusive, appropriate conversions were applied to adjust the data to an ex-GST basis, see Fabling, Grimes, and Stevens (2008b) for a detailed discussion on this issue.

Table 6-9 Integrated components of the prototype LBD

Administrative data Linked to the LBF		
Business Activity Indicator (BAI)	1992-2011	The BAI is a monthly series based on the supply of administrative data from Inland Revenue (IRD). The main source of this data is IRD's GST (Goods and Services Tax) 101 form. GST is a tax based on the sale of goods and services.
Financial accounts (IR10)	1999-2010	The Accounts information form (IR10) collects a general summary of information relating to the business and its operations (profit and loss statement and balance sheet). IRD supplies IR10 data to Statistics NZ where it is transformed and linked to IBULDD.
Company tax returns (IR4)	1999-2010	The IR4 income tax return is compulsory for businesses that are registered as companies. It includes income, tax calculation, funds and /or transfers, provisional tax, and disclosure. IR4 data is supplied to Statistics NZ by IRD and is then linked to IBULDD.
Linked Employer-Employee Database (LEED)	2000-2010	A Statistics NZ integrated datebase that provides an insight into the operation of New Zealand's labour market, such as jobs and worker flows. Created by linking a longitudinal employer series from the Business Frame to a longitudinal series of Employer Monthly Schedule (EMS) payroll data from IRD.
Overseas Merchandise Trade data	1988-2011	A daily shipment-level series based on adminstrative data supplied by the New Zealand Customs Service. In the LBD this data is aggregated to monthly and provides information on the importing and exporting of merchandise goods between New Zealand and other countries.
Government assistance data	2000-2006	Provides information on the assistance provided directly to businesses by the Foundation for Research, Science and Technology, New Zealand Trade and Enterprise, and Te Puni Kokiri.
Sample survey data linked to the LBF		
Annual Enterprise Survey (AES)	1997-2010	Provides annual financial performance and financial position information about industry groups operating within New Zealand. AES is the basis of the national accounts (produced by Statistics NZ).
Business Operations Survey (BOS)	2005-2011	Collects measures of business performance and a range of practices and behaviours which may have some impact on that performance, including innovation and business use of information and communication technology.
Innovation Survey	2003	Collected information on the characteristics of innovation in New Zealand private-sector businesses.
Research & Development Survey (R&D)	Biennianlly 1996-2010	Collects information in business, government and higher education (university) spending on R&D.
Business Practice Survey (BPS)	2001	Collected information on business and management practices.
Business Finance Survey (BFS)	2004	Collected information on the capital structure of businesses in New Zealand, the sources of finance they use and their recent financing experiences.
Source: Fabling, Gretton, & Claire, 2008		

6.2.2.3 *Regression results*

After including the two additional variables (an R&D indicator and labour productivity), the probit models were re-run for 2005, 2007 and 2009, and the regression results are presented as Table 6-10, Table 6-11 and Table 6-12, respectively. From the results it can be seen that the variable 'labour productivity' failed to show significant impact on any of the innovation outcomes, while the 'R&D indicator' is highly significant in all three years, and its positive association with product innovation is particularly prominent. The positive R&D effect was the strongest in 2009 with the positive impact reflected in all four regressions. With 'R&D intensity' being insignificant in both stage one and stage two models, it suggests that innovation in New Zealand is driven by the intention of R&D not the level of expenditure.

The coefficients and significance of all other variables have changed somewhat during the stage-two modeling process, however the main conclusions of the analyses remain basically the same with only a few points to note.

The 2007 results reveal that subsidiary firms have a better chance at producing product innovation; firms facing monopolistic competition are more likely to experience organisational/managerial processes innovation; and good water and waste infrastructure increases the probability of operational processes innovation.

While in 2009 entering a new export market; obtaining a formal IP protection; and working within a good labour market (both skilled and unskilled) are no longer advantageous for the generation of innovation; and monopoly and oligopoly firms appear less incentivised to innovate.

Table 6-10 Stage 2 - probit models - 2005

	Products	Operational Processes	Organisational/ Managerial Processes	Marketing Methods
Firm Size	-0.004	0.055	0.095	-0.041
Sufficient Production Capacity	0.213	0.215	0.039	0.119
Inward Direct Investment (FDI) Intensity	0.003	0.002	0.004	0.006**
Outward Direct Investment (ODI)Indicator	0.522	0.313	-0.114	0.606**
Export Intensity	-0.003	0.002	0.002	-0.003
Subsidiary	-0.113	-0.13	-0.171	-0.348*
Updated Equipment	-0.15	-0.004	0.098	0.155
Firm Age	0.005	-0.073	-0.092	-0.092
High Quality Product	0.189	0.397**	0.227	0.330*
Expansion	0.018	0.310**	0.094	-0.05
R&D Expenditure	-0.01	-0.025	0.041	-0.008
Major Technology Change	0.987***	1.000***	0.742***	0.586***
Formal IP Protection	0.704***	0.114	0.1	0.336*
Monopoly	0.062	-0.735*	-0.219	0.209
Oligopoly	0.045	-0.15	-0.146	-0.117
Monopolistic Competition	0	-0.17	-0.173	-0.065
New Export Market	0.453*	0.241	0.084	0.451*
Transport	-0.007	0.218	-0.006	-0.129
Information and Communication Technology	0.329*	0.224	0.021	0.262
Water and Waste	0.228	-0.109	0.138	-0.234
Skilled Labour Market	-0.041	-0.115	-0.012	-0.174
Unskilled Labour Market	-0.146	-0.026	-0.179	0.178
Local Business Networks	0.035	-0.01	0.099	0.350**
Local Regulatory Process	-0.255	-0.059	-0.024	0.066
R&D Indicator	0.808***	0.772**	0.596**	0.468
Labour Productivity	-0.043	-0.004	-0.019	-0.105
Constant	-1.445*	-1.409*	-0.874	-0.29
No. of Observations	2184	2184	2184	2184

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

Table 6-11 Stage 2 - probit models - 2007

	Products	Operational Processes	Organisational/ Managerial Processes	Marketing Methods
Firm Size	0.023	0.189***	0.232***	0.035
Sufficient Production Capacity	-0.214	0.005	-0.142	0.046
Inward Direct Investment (FDI) Intensity	-0.002	0.001	-0.002	0.001
Outward Direct Investment (ODI)Indicator	-0.112	-0.271	0.004	0.091
Export Intensity	-0.001	-0.001	0.001	0.003
Subsidiary	0.392*	-0.242*	-0.098	0.044
Updated Equipment	0.336**	0.111	-0.077	-0.215
Firm Age	-0.134	-0.067	-0.265***	-0.228***
High Quality Product	0.153	0.2	0.175	0.334*
Expansion	0.215	0.304**	0.088	0.131
R&D Intensity	0.005	0.000***	0.000***	0.000
Major Technology Change	0.541**	0.695***	0.435**	0.371*
Formal IP Protection	0.419**	0.104	0.151	0.564***
Monopoly	0.088	-0.843**	-0.036	-0.539
Oligopoly	0.293	0.057	0.27	0.281
Monopolistic Competition	0.283	0.21	0.432**	0.255
New Export Market	0.529*	0.292	0.096	0.189
Transport	0.200	0.295*	-0.266	-0.034
Information and Communication Technology	-0.095	-0.098	-0.093	0.022
Water and Waste	0.103	0.310*	0.133	0.157
Skilled Labour Market	-0.01	0.094	-0.077	0.355
Unskilled Labour Market	-0.022	-0.079	0.028	-0.242
Local Business Networks	0.125	0.067	0.269*	0.454***
Local Regulatory Process	-0.416*	-0.24	-0.185	-0.236
R&D Indicator	0.921***	0.318	0.653**	0.314
Labour Productivity	-0.029	-0.01	0.065	-0.057
Constant	-1.477*	-1.780**	-2.075***	-0.882
No. of Observations	2169	2169	2169	2169

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

Table 6-12 Stage 2 - probit models - 2009

	Products	Operational Processes	Organisational/ Managerial Processes	Marketing Methods
Firm Size	0.009	0.146**	0.105*	0.012
Sufficient Production Capacity	0.206	0.107	-0.181	0.037
Inward Direct Investment (FDI) Intensity	0.002	0.000	-0.001	0.000
Outward Direct Investment (ODI)Indicator	0.218	0.015	-0.076	0.291
Export Intensity	0.000	0.001	0.002	0.000
Subsidiary	0.229	-0.117	0.107	-0.054
Updated Equipment	-0.076	0.051	0.004	0.023
Firm Age	-0.124*	-0.116*	-0.147*	-0.120*
High Quality Product	0.533***	0.288*	0.339**	0.225
Expansion	0.666***	0.684***	0.489***	0.386**
R&D Expenditure	0.000	0.000	0.000	0.000
Major Technology Change	0.433*	0.754***	0.795***	0.410*
Formal IP Protection	0.217	0.042	0.085	0.150
Monopoly	-0.613*	-0.431	0.293	-0.442
Oligopoly	-0.030	0.041	-0.376*	-0.362*
Monopolistic Competition	-0.010	0.002	-0.004	-0.016
New Export Market	0.316	-0.004	-0.012	0.166
Transport	-0.080	0.014	-0.050	-0.035
Information and Communication Technology	0.034	-0.060	-0.016	-0.142
Water and Waste	0.164	0.073	0.004	0.196
Skilled Labour Market	0.109	-0.099	-0.034	0.023
Unskilled Labour Market	0.022	0.088	0.253	-0.051
Local Business Networks	-0.157	0.070	-0.041	0.146
Local Regulatory Process	0.019	-0.065	-0.128	0.088
R&D Indicator	0.876***	0.375*	0.375*	0.645***
Labour Productivity	-0.093	-0.001	-0.009	-0.092
Constant	-0.896	-1.900**	-0.939	-0.728
No. of Observations	2121	2121	2121	2121

Note: All regressions contained 17 ANZSIC industry dummies, their coefficients are not shown. legend: * p<.05; ** p<.01; *** p<.001

6.2.3 *Stage three - spatial factors*

The construction of the stage one models were based on the outcome of the extensive literature review presented in section 4.3, and more specifically the selected independent variables were selected to match each subcategory listed in Table 4-1, Table 4-2 and Table 4-3.

However, as identified in section 6.2.1 ‘geography/location’ was one of unmatched subcategories due to confidentiality issues. In the remainder of this section, alternative *spatial measures* will be considered and incorporated into the stage two regressions.

Mameli, Faggian and McCann (2008) sought to explain employment growth in Italian local labour systems and in order to test the role of agglomeration, two spatial variables (i.e. specialisation and diversity) were calculated using firm level employment data. Utilising firm level employment data from the New Zealand LBD, we were able to recreate these variables using the formulas given below.

The *Specialisation Index* is a location quotient, and measures the shares of industry employment in a region relative to the share of the overall national employment. In particular, it can be represented as:

$$Specialisation_{i.j} = \frac{E_{i,j}/E_j}{E_{i,n}/E_n}$$

where E = employment, i = industry, j = region and n = nation.

The *Diversity Index* is a proxy for Jacobs externalities (Jacobs, 1969), computed as the inverse of a modified Herfindahl index where it is the sum of the square proportions of employment shares in other sectors (*i*') except the one considered (*i*). The detailed formula can be shown as:

$$Diversity_{\,i,j} = \frac{1/\sum_{\substack{i=1 \\ i' \neq i}}^{s} [\frac{E_{i',j}}{E_j - E_{i,j}}]^2}{1/\sum_{\substack{i'=1 \\ i' \neq i}}^{s} [\frac{E_{i'}}{E - E_i}]^2}$$

where E = employment, i = industry and j = region.

Note the industries are defined using the level one ANZSIC[16], as a result of its latest revision in 2006 the number of level one industries has increased from 13 to 17; the regions are defined using the Territorial Authority, as at the end of 2009 there were 73 territorial authorities, comprising of 15 cities and 58 districts.

To gain a better understanding of the spatial variables created, a list of summary statistics have been produced, and comparisons are made between the New Zealand and the Italian data[17]. As shown on Table 6-13, along with the large disparity in numbers of observations, there are obvious spatial

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[16] ANZSIC96 was used for year 2005 and 2007, while the 2009 variables were created based on ANZSIC06.

[17] The summary statistics for the Italian data were produced by F. Mameli using data from their journal paper (Mameli, et al., 2008).

differences between the two countries. In terms of specialisation, the New Zealand index has higher mean and median, however both the range and the standard deviation are lower than the Italian index, in other words on average New Zealand industries are more specialised compared to industries in Italy, although the sectoral differences within New Zealand is small. In terms of the degree of diversity, all reported summary statistics for New Zealand are at a lower level, the greater mean, median and range for Italy imply a relatively diverse industrial environment. Given the size of New Zealand economy, the summary statistics are aligned with our expectations.

Table 6-13 Summary Statistics – spatial variables

Variable	Specialization				Diversity			
	BOS			Italian Data	BOS			Italian Data
	2005	2007	2009		2005	2007	2009	
Obs.	5445	5298	5514	34496	5445	5298	5514	34496
Min	0.038	0.030	0.026	0.000	0.000	0.000	0.000	0.083
Max	25.350	27.996	59.923	386.972	0.430	0.423	0.444	1.702
Mean	1.410	1.423	1.425	0.857	0.096	0.096	0.101	0.578
Median	1.100	1.144	1.127	0.433	0.022	0.025	0.027	0.555
Std. Dev.	1.169	1.230	1.574	4.113	0.131	0.129	0.139	0.189

Incorporating the spatial variables into the stage three models allows us to examine the effect of geography and concentration.

As can be seen in Table 6-14, Table 6-15 and Table 6-16, the only significant spatial variable was ‘specialisation’, and it was negatively associated with product innovation in 2005. It is often assumed that the concentration of an industry in an area facilitates knowledge spillovers and specialised labour pooling, but over-representation of an industry can contribute to a slower growth (Glaeser, et al., 1992), especially for a small country like New Zealand with limited benefits to proximity. The insignificance of spatial effects may also be a result of New Zealand's small size, which without sufficient economies of scale may mean that spatial concentration cannot reach a level that is beneficial for innovation creation and economic growth.

Table 6-14 Stage 3 - probit models - 2005

	Products	Operational Processes	Organisational/ Managerial Processes	Marketing Methods
Firm Size	0.008	0.061	0.091	-0.043
Sufficient Production Capacity	0.215	0.194	0.041	0.104
Inward Direct Investment (FDI) Intensity	0.004*	0.002	0.004*	0.007**
Outward Direct Investment (ODI)Indicator	0.434	0.320	-0.146	0.682***
Export Intensity	-0.002	0.001	0.002	-0.002
Subsidiary	-0.144	-0.143	-0.157	-0.349*
Updated Equipment	-0.148	-0.011	0.104	0.159
Firm Age	-0.024	-0.074	-0.112	-0.138
High Quality Product	0.204	0.375**	0.200	0.323*
Expansion	0.020	0.314*	0.089	-0.020
R&D Intensity	-0.011	-0.026	0.033	-0.009
Major Technology Change	0.972***	0.955***	0.748***	0.627***
Formal IP Protection	0.677***	0.126	0.128	0.355*
Monopoly	0.031	-0.911**	-0.213	0.183
Oligopoly	0.044	-0.132	-0.155	-0.160
Monopolistic Competition	0.000	-0.164	-0.170	-0.096
New Export Market	0.487*	0.284	0.090	0.419*
Transport	-0.025	0.206	-0.026	-0.153
Information and Communication Technology	0.343*	0.216	0.033	0.291
Water and Waste	0.201	-0.108	0.123	-0.226
Skilled Labour Market	-0.045	-0.142	0.043	-0.151
Unskilled Labour Market	-0.138	-0.033	-0.161	0.192
Local Business Networks	0.046	0.003	0.102	0.340**
Local Regulatory Process	-0.245	-0.010	-0.034	0.052
R&D Indicator	0.786***	0.776**	0.606**	0.460
Labour Productivity	-0.046	0.014	-0.014	-0.099
Specialisation	-0.151*	-0.036	-0.009	-0.006
Diversity	0.164	0.002	-0.843	-0.741
Constant	-0.994	-1.501*	-0.830	-0.216
No. of Observations	2145	2145	2145	2145

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

Table 6-15 Stage 3 - probit models - 2007

	Products	Operational Processes	Organisational/Managerial Processes	Marketing Methods
Firm Size	0.014	0.199***	0.226***	0.034
Sufficient Production Capacity	-0.210	-0.003	-0.129	0.073
Inward Direct Investment (FDI) Intensity	-0.002	0.001	-0.003	0.001
Outward Direct Investment (ODI)Indicator	-0.117	-0.197	0.009	0.164
Export Intensity	0.000	-0.001	0.001	0.003
Subsidiary	0.494**	-0.232	-0.020	0.063
Updated Equipment	0.290*	0.093	-0.140	-0.291*
Firm Age	-0.106	-0.074	-0.255***	-0.216**
High Quality Product	0.206	0.198	0.232	0.395**
Expansion	0.273	0.270*	0.148	0.192
R&D Intensity	0.005	0.000***	0.000***	-0.000**
Major Technology Change	0.499**	0.657***	0.417**	0.341
Formal IP Protection	0.342*	0.119	0.066	0.458**
Monopoly	0.107	-0.869**	-0.045	-0.505
Oligopoly	0.315	0.006	0.240	0.312
Monopolistic Competition	0.331	0.164	0.453**	0.294
New Export Market	0.496*	0.317	0.085	0.199
Transport	0.223	0.274	-0.268	-0.025
Information and Communication Technology	-0.045	-0.153	-0.051	-0.016
Water and Waste	0.078	0.336*	0.115	0.169
Skilled Labour Market	0.019	0.080	-0.017	0.388
Unskilled Labour Market	-0.025	-0.062	-0.015	-0.223
Local Business Networks	0.037	0.056	0.182	0.388**
Local Regulatory Process	-0.384*	-0.167	-0.108	-0.130
R&D Indicator	0.987***	0.275	0.711***	0.346
Labour Productivity	-0.034	-0.013	0.060	-0.071
Specialisation	-0.064	-0.060	0.022	-0.003
Diversity	0.128	0.226	-0.368	0.232
Constant	-1.299	-1.512*	-2.102**	-0.823
No. of Observations	2133	2133	2133	2133

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

Table 6-16 Stage 3 - probit models - 2009

	Products	Operational Processes	Organisational/ Managerial Processes	Marketing Methods
Firm Size	0.012	0.155**	0.107*	0.010
Sufficient Production Capacity	0.208	0.119	-0.207	0.032
Inward Direct Investment (FDI) Intensity	0.002	0.000	-0.001	-0.001
Outward Direct Investment (ODI)Indicator	0.220	-0.007	-0.065	0.297
Export Intensity	0.000	0.001	0.002	0.000
Subsidiary	0.222	-0.115	0.099	-0.051
Updated Equipment	-0.060	0.068	-0.030	0.032
Firm Age	-0.120*	-0.123*	-0.169**	-0.121*
High Quality Product	0.516***	0.262*	0.372**	0.201
Expansion	0.677***	0.693***	0.466***	0.419***
R&D Expenditure	0.000	0.000	0.000	0.000
Major Technology Change	0.448*	0.729***	0.806***	0.406*
Formal IP Protection	0.203	0.051	0.100	0.138
Monopoly	-0.601*	-0.450	0.311	-0.424
Oligopoly	-0.034	0.031	-0.380*	-0.341
Monopolistic Competition	-0.003	0.017	-0.034	0.012
New Export Market	0.290	-0.014	-0.035	0.177
Transport	-0.065	0.020	-0.069	-0.001
Information and Communication Technology	0.025	-0.049	-0.043	-0.161
Water and Waste	0.165	0.103	-0.023	0.199
Skilled Labour Market	0.118	-0.083	-0.080	0.036
Unskilled Labour Market	0.028	0.101	0.250	-0.042
Local Business Networks	-0.170	0.069	-0.041	0.145
Local Regulatory Process	0.007	-0.105	-0.063	0.075
R&D Indicator	0.866***	0.382*	0.385*	0.631***
Labour Productivity	-0.100	0.010	-0.014	-0.097
Specialisation	-0.001	0.010	-0.025	0.055
Diversity	0.335	-0.486	0.327	0.233
Constant	-0.837	-2.073**	-0.742	-0.895
No. of Observations	2094	2094	2094	2094

Note: All regressions contained 17 ANZSIC industry dummies, their coefficients are not shown. legend: * p<.05; ** p<.01; *** p<.001

6.2.4 *Stage four - bivariate probit models*

So far in the analysis, three stages of probit regression analyses have been undertaken to examine the possible determinants of innovation in New Zealand. Based on the probit model, the four innovation outcomes have been assumed to be independent of each other, however this description is not entirely accurate, as often one type of innovation can lead to the generation of another type(s) of innovation, and businesses can, and many do introduce more than one type of innovation during the period surveyed.

Table 6-17 Correlation between innovation outcomes 2005, 2007 and 2009

2005	Products	Operational Processes	Organisational /Managerial Processes	Marketing Methods
Products	1.000			
Operational Processes	0.355	1.000		
Organisational/Managerial Processes	0.274	0.390	1.000	
Marketing Methods	0.345	0.307	0.394	1.000

2007	Products	Operational Processes	Organisational /Managerial Processes	Marketing Methods
Products	1.000			
Operational Processes	0.360	1.000		
Organisational/Managerial Processes	0.257	0.383	1.000	
Marketing Methods	0.320	0.318	0.373	1.000

2009	Products	Operational Processes	Organisational /Managerial Processes	Marketing Methods
Products	1.000			
Operational Processes	0.368	1.000		
Organisational/Managerial Processes	0.269	0.419	1.000	
Marketing Methods	0.350	0.336	0.396	1.000

As shown in Table 6-17, the correlation between different innovation outcomes for the three survey years (i.e. 2005, 2007 and 2009) range from 0.269 to 0.419, and suggest moderate correlation.

In order to take account of such correlation, we will use the bivariate probit regression (biprobit) approach. Given there are four different innovation outcomes, six combinations of biprobit model can be formulated. Based on the definitional difference between technological and non-technological innovation, in the rest of this section the biprobit model will concentrate on the interactions within the group of technological innovations and non-technological innovations. Two sets of regression results will be reported using data from all three survey years (see Table 6-18 and Table 6-19). Within each biprobit model a likelihood-ratio test is performed by comparing the likelihood of the full bivariate model with the sum of the log likelihoods for the univariate probit models. A positive and significant test statistics (**athrho**) indicates the superiority of the biprobit models.

Table 6-18 Biprobit - products and operational processes

	2005		2007		2009	
	Products	Operational Processes	Products	Operational Processes	Products	Operational Processes
Firm Size	0.011	0.066	0.016	0.195***	0.014	0.157**
Sufficient Production Capacity	0.210	0.176	-0.225	-0.022	0.218	0.128
Inward Direct Investment (FDI) Intensity	0.004*	0.002	-0.002	0.001	0.002	0.000
Outward Direct Investment (ODI)Indicator	0.442	0.339	-0.126	-0.219	0.204	-0.010
Export Intensity	-0.003	0.001	0.000	0.000	-0.001	0.001
Subsidiary	-0.161	-0.169	0.485**	-0.168	0.232	-0.101
Updated Equipment	-0.153	0.006	0.269*	0.111	-0.079	0.063
Firm Age	-0.033	-0.078	-0.105	-0.084	-0.119*	-0.126*
High Quality Product	0.204	0.367**	0.211	0.195	0.524***	0.270*
Expansion	0.026	0.308*	0.279*	0.248*	0.686***	0.683***
R&D Intensity[1]	-0.008	-0.025	0.007	0.000***	0.000	0.000
Major Technology Change	0.971***	0.955***	0.508**	0.657***	0.443*	0.712***
Formal IP Protection	0.665***	0.129	0.358**	0.153	0.209	0.064
Monopoly	0.049	-0.787*	0.082	-0.917***	-0.587*	-0.453
Oligopoly	0.054	-0.130	0.299	0.052	-0.051	0.030
Monopolistic Competition	0.025	-0.156	0.319	0.175	-0.017	0.029
New Export Market	0.496*	0.278	0.503*	0.299	0.281	-0.013
Transport	-0.028	0.200	0.227	0.280	-0.063	0.037
Information and Communication Technology	0.337**	0.228	-0.039	-0.141	0.041	-0.034
Water and Waste	0.205	-0.100	0.077	0.315*	0.147	0.090
Skilled Labour Market	-0.055	-0.159	0.018	0.083	0.092	-0.098
Unskilled Labour Market	-0.145	-0.053	-0.023	-0.045	0.034	0.092
Local Business Networks	0.043	0.016	0.050	0.072	-0.160	0.077
Local Regulatory Process	-0.235	-0.017	-0.379*	-0.180	0.012	-0.093
R&D Indicator	0.782***	0.777**	0.961***	0.270	0.858***	0.398*
Labour Productivity	-0.051	0.009	-0.031	-0.022	-0.103	0.003
Specialisation	-0.137	-0.032	-0.059	-0.050	0.003	0.018
Diversity	0.138	-0.026	0.114	0.161	0.311	-0.446
Constant	-0.952	-1.468*	-1.354	-1.459*	-0.849	-2.045**
athrho	0.524***		0.556***		0.574***	
No. of Observations	2145		2133		2094	

Note: 2005 and 2007 regressions contained 13 ANZSIC industry dummies and 2009 regression contained 17 ANZSIC industy dummies, their coefficients are not shown. legend: * p<.05; ** p<.01; *** p<.001;

1. R&D expenditure was used to replace R&D Intensity in 2009.

Table 6-19 Biprobit - organisational/managerial processes and marketing methods

	2005		2007		2009	
	Organisational /Managerial Processes	Marketing Methods	Organisational /Managerial Processes	Marketing Methods	Organisational /Managerial Processes	Marketing Methods
Firm Size	0.088	-0.043	0.230***	0.039	0.114*	0.014
Sufficient Production Capacity	0.020	0.093	-0.140	0.043	-0.204	0.026
Inward Direct Investment (FDI) Intensity	0.004*	0.007**	-0.003	0.001	-0.002	-0.001
Outward Direct Investment (ODI)Indicator	-0.122	0.652***	0.008	0.169	-0.097	0.320
Export Intensity	0.002	-0.002	0.001	0.003	0.002	0.000
Subsidiary	-0.163	-0.327*	-0.008	0.063	0.110	-0.048
Updated Equipment	0.094	0.151	-0.152	-0.289*	-0.029	0.019
Firm Age	-0.102	-0.137	-0.268***	-0.224***	-0.180**	-0.131*
High Quality Product	0.219	0.336*	0.238	0.391**	0.383***	0.194
Expansion	0.079	-0.027	0.143	0.195	0.469***	0.397**
R&D Intensity[1]	0.028	-0.007	0.000**	-0.000***	0.000	0.000
Major Technology Change	0.746***	0.649***	0.414**	0.340	0.810***	0.438*
Formal IP Protection	0.123	0.354*	0.089	0.459**	0.106	0.139
Monopoly	-0.218	0.201	-0.027	-0.455	0.332	-0.415
Oligopoly	-0.163	-0.173	0.270	0.309	-0.362*	-0.328
Monopolistic Competition	-0.161	-0.105	0.459**	0.302	-0.015	0.016
New Export Market	0.110	0.416*	0.085	0.214	-0.053	0.205
Transport	-0.029	-0.151	-0.232	-0.013	-0.081	-0.017
Information and Communication Technology	0.055	0.313	-0.039	0.025	-0.031	-0.146
Water and Waste	0.109	-0.221	0.112	0.145	-0.019	0.193
Skilled Labour Market	0.010	-0.176	-0.019	0.388	-0.080	0.024
Unskilled Labour Market	-0.135	0.209	-0.015	-0.234	0.255	-0.027
Local Business Networks	0.107	0.327*	0.204	0.385**	-0.035	0.133
Local Regulatory Process	-0.041	0.057	-0.138	-0.127	-0.086	0.061
R&D Indicator	0.604**	0.446	0.709***	0.353	0.390*	0.627***
Labour Productivity	-0.017	-0.096	0.061	-0.067	-0.011	-0.098
Specialisation	-0.008	-0.008	0.025	0.003	-0.043	0.057
Diversity	-0.877*	-0.771	-0.306	0.277	0.362	0.228
Constant	-0.812	-0.248	-2.134***	-0.865	-0.715	-0.857
athrho	0.537***		0.669***		0.637***	
No. of Observations	2145		2133		2094	

Note: 2005 and 2007 regressions contained 13 ANZSIC industry dummies and 2009 regression contained 17 ANZSIC industy dummies, their coefficients are not shown. legend: * p<.05; ** p<.01; *** p<.001;
1. R&D expenditure was used to replace R&D Intensity in 2009.

The results shown as Table 6-18 indicate that a product innovator is most likely to be a young subsidiary firm with inward direct investment, who produces high quality products, invests in R&D and other expansionary activities; experienced major technology change within the business in recent years, uses official rights to protect its intellectual properties and is actively entering new export markets. Preferably the firm locates in an area with good ICT infrastructure, and the market environment is competitive enough such that the firm is still incentivised to engage in new product development.

Similarly, an operational process innovator tends to be a young non-monopoly firm that produces high quality products, invests in R&D and other expansionary activities; and experienced major technology change. However, it is likely to be larger in size and locates in an area with good water and waste infrastructure.

Moving onto non-technological innovations, Table 6-19 shows that an organisational/managerial process innovator can be characterised as a larger but relatively young firm with inward direct investment as well as R&D investments. The firm has experienced a major change in technology, works within a monopolistic competition market, and a less diversified region. Investment in expansion and production of high quality products may occasionally assist the introduction of new organisational/managerial processes.

Finally, a marketing methods innovator is best described as a young non-subsidiary firm with both inward and outward direct investment, it produces high quality products, protects itself using official intellectual property rights; has experienced major technology change; surrounds itself by good local business networks, and possibly entered a new export market or has recently expanded.

6.3 Summary

At the beginning of the chapter, Fabling's (2007) multinomial probit models were reconstructed using BOS data, where the dependent variables were three innovation groups (i.e. PP, OM and COMBO), and the explanatory variables included a number of firm characteristics, innovation supporting activities and various sources of innovation ideas. The regression analyses revealed a number of interesting results such as larger firms are more innovative; internal innovation supporting activities such as staff training, change strategy/management techniques and organisational restructuring are innovation enhancing; and new/existing staff, suppliers and competitors are preferred sources of innovation.

However, these results appeared to be non-robust when compared over time (see Table 6-2 to Table 6-4). Moreover, there were concerns around two main groups of explanatory variables in Fabling's model (i.e. 'innovation supporting activities' and 'sources of innovation ideas'), such that because of the routing in the survey design respondents were presumed to be innovators, hence these variables are likely to introduce a bias towards innovation.

Aiming to improve model specification, a new model was proposed as an extension to the Fabling approach. Different from its predecessor, it comprised four separate probit regressions, one for each type of innovation (i.e. product, operational processes, organisational/managerial processes and marketing method innovations). Appropriate dependent variables were selected from the BOS and additional variables including labour productivity and spatial factors were generated, utilising data from the LBD to allow targeted testing.

Recognising that one type of innovation can often lead to the introduction of other type(s) of innovation, it was unrealistic to assume independence of four probit regressions, and hence bivariate probit models were proposed to take into account the correlation within the group of technological and non-technological innovations.

The quantitative analyses in this chapter has provided some insights into the drivers of innovation in New Zealand by mapping correlations between innovation outcomes and a range of firm level factors. Based on the literature review undertaken in Section 4.3.2., firm level factors from three broad categories were predetermined, namely, ‘firm characteristics’, ‘firm behavior/strategy' and 'overall environment'. The tested variables and summary of the regression results are listed in Table 6-20.

Overall, the regression results suggest that factors such as firm size, high quality product, investment/R&D capability, major technology change, formal IP protection and new export market are systematically and positively related to innovation; while many external issues such as those related to geography, market structure, business environment appear to have little influence. In other words, firm level innovations in New Zealand are highly dependent on the firms' internal ability to develop new technologies and market demand.

Notice that BOS and the LBD were unable to provide suitable data for some of the subcategories (i.e. financial capability, source of input, external communication, strategy/management, co-operation, informal practice and institutional environment) which have been highly endorsed by various international studies, and the positive role of internal organisational activities and sources of innovation ideas were also emphasised by Fabling (2007). In order to gain a complete understanding of firm level innovation in New Zealand, further investigation would be necessary. The complex nature of the phenomena means that some inductive reasoning may be needed to complement and confirm our regression analyses, and assist our understanding of the underlying dynamics of innovation.

Table 6-20 Regression results summary

Category	Subcategory	Variables	Effect on innovation outcomes
Firm Characteristics	Firm Size	log of Employment	Poistive effect on process innovation
	Financial Capability	N/A	N/A
	Production Capacity	Sufficient Production Capacity	Insignificant
	Business Makeup	FDI Intensity	Postive effect on non-technology related innovation, but results were inconsistent over time
		ODI Indicator	
		Export Intensity	Insignificant
		Subsidiary	Significant, but not robust
	Stock of Knowledge	Labour Productivity	Insignificant
		Updated Equipment	Significant, but not robust
	Firm Age	log of Firm Age	Negative
	Product	High Quality Product	Positive
	Geography/ Location	Specialisation	Insignificant
		Diversity	Negative effect on organisational innovation, but not robust
	Sector Profile	Industry dummies	Collectively significant
Firm Behaviour/ Strategy	Investment	Expansion	Positive
	Source of Input	N/A	N/A
	External Communication	N/A	N/A
	Strategy/ Management	N/A	N/A
	R&D	R&D indicator	Positive
		R&D Intensity	Insignificant
	Co-operation	N/A	N/A
	Technological management	Major Technology Change	Positive
		Formal IP Protection	Positive effect on product & marketing innovation
	Informal practice	N/A	N/A
Overall Environment	Market Structure	Monopoly Oligopoly Monopolistic Competition	Compared with perfect competition, technology related innovations are less likely to occur in monoploy firms; while monopolistic competitive firms are better at organisational innovation
	Market Demand	New Export Market	Positive effect on product & marketing innovation
	Regional Environment	Transport ICT Water and Waste Skilled Labour Market Unskilled Labour Market Local Business Networks Local body planning and regulatory process	Most environmental factors were statistically insignificant, except better local business networks seem to encouage marketing innovation and good ICT infrastructure was important for product innovaiton between 2003-2005
	Institutional	N/A	N/A

7 Chapter 7

Case Studies

In Chapter 6 regression analyses was undertaken to try to understand innovation in New Zealand firms. This follows the approach followed by the vast majority of studies of such questions that have been undertaken in numerous other countries. Given the available data we were able to identify correlations between innovation outcomes and a range of firm level factors.

However, such results were not sufficient for us to make claims regarding the causality of the relationships, and being based on self-reported surveys, the validity of the quantitative results remain somewhat fragile.

In this chapter we will use case studies to seek to understand further the dynamic innovation processes at the level of the firm. This will also help us to not only validate/confirm the quantitative results presented above, but also to receive information that goes beyond the questions raised by BOS. Using case studies in economics is somewhat unusual in the context of trying to understand innovation. In part, this is a preference of methodology, but also a result of the growing availability of BOS-type surveys. However, such surveys, although consistent over time and often administered by national agencies, do not provide opportunities for 'open ended' answers or 'additional comments'. A case study approach overcomes such issues, though at the expense of sample size and hence potential representativeness.

7.1 Research method

Initially introduced in anthropology, the use of case studies first appeared around 1900 (Johansson, 2003). In the business related fields, case studies have been used in strategic management since the late 1970s (Campbell, 1975; Miles, 1979). Recently, interest in this methodology has seen a revival (Eisenhardt & Graebner, 2007; Siggelkow, 2007) in the approach. Suited to both qualitative and quantitative evidence, case study as a research strategy (Yin, 1981) should not be confused with other types of evidence (e.g. qualitative and quantitative data) and types of data collection methods (e.g. phenomenology, ethnography and grounded theory). It is appropriate to answer 'what' and 'how' questions, "preferred in examining contemporary events, when the relevant behaviours cannot be manipulated" (Yin, 2003, p. 7), and it studies complex phenomena in their context rather than independent of context (Pettigrew, 1973).

Compared to other research methods, case study has often been criticised for its lack of methodological rigor. Miles (1979, p. 600) stated that "qualitative research on organisations cannot be expected to transcend story-telling" without renewed efforts at methodological inquiry. Yin (1981) agreed that improvements in methodology can still be made, but reaffirmed case study as a systematic and valid research tool.

Modern case study methodologies are guided by two key approaches proposed by Stake (1995) and Yin (2003), where they use different terms to describe a variety of case studies. Based on the distinguishing characteristics of the case study, Yin's multiple-case studies is particularly appropriate for understanding innovation at the firm level.

Our principle research questions are listed below:

- What does innovation mean to New Zealand firms?
- What are the drivers and sources of innovation in New Zealand firms?
- What issues are currently faced by innovating firms?

7.2 Case selection

Selection of cases is an important aspect of case study research. Establishing the unit of analysis, research boundaries and sample selection criteria are critical for a rigorous case study design (Baxter & Jack, 2008).

Based on the research questions, the unit of analysis is *a firm that has developed or introduced at least one new or significantly improved goods and* *services; operational processes; organisational/managerial processes; marketing methods in the last three financial years*.

The objective of case selection is not to design a statistically representative sample, but to allow analytical generalisation, which is a process separate from statistical generalisation; and generalise from empirical observations to theory, rather than a population (Gibbert, et al., 2008). Such a sampling method is often referred to as ‘theoretical sampling’, where both ‘literal’ and ‘theoretical’ replications are necessary for analytical generalisation (Yin, 2003). In our particular case, ‘literal’ replication requires the theoretical sample to include firms that face similar market dynamics to ensure similar results are observed with different cases, while ‘theoretical’ replication aims to identify contrasting results by including firms with different characteristics. Eisenhardt (1989) recommended a cross-case analysis involving *four to 10 case studies* to provide a good basis for analytical generalisation.

7.2.1 *Research boundaries*

New Zealand depends heavily on international trade due to its geographical isolation and small population. Mabin (2011) justified the importance of the tradable sector by suggesting exporting firms are more productive on average and the sector helps to reduce the country’s external vulnerabilities. In fact, exports of goods and services account for nearly one third of real expenditure

GDP (The New Zealand Treasury, 2010). Currently, there is no official definition of what defines the 'tradable sector', however the New Zealand Treasury measures the sector:

> "as the volume of output (i.e. real GDP) in primary and manufacturing industries (highly exposed to overseas trade) combined with the volume of service exports (as it is difficult to estimate what services are tradable)", and "non-tradable output is estimated as a residual with total real GDP, and therefore includes government" (Mabin, 2011, p. 4).

As a rule of thumb, the tradable sector typically includes internationally competitive industries, and industries within the non-tradable sector that have a heavy domestic focus, which means that firms operating within the tradable sector face different market dynamics and risk factors compared to their counterparts in the non-tradable sector. To ensure the logic of literal replication, *the research boundaries* are defined as "all private firms that at the selection date were engaging in the production of goods and services in New Zealand's tradable sector".

7.2.2 *Sample selection criteria*

In order to generate a level of variation within the sample, the firms were differentiated according to their size (employment), industry and location.

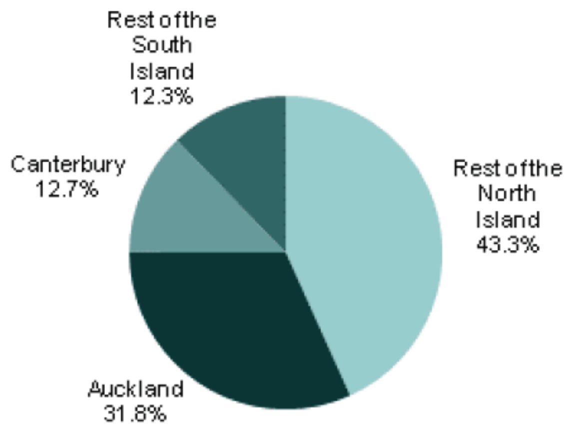
Based on the number employed (both part-time and full time), four size groups were selected. The smallest size group is 0-19 employees, as at February 2012, 97 percent of enterprises employed fewer than 20 employees (Statistics New Zealand, 2012b). This size group reflects the importance of small and medium enterprises (SMEs) to the New Zealand economy. The two intermediate size groups are 20-49 and 50-99. Enterprises that fall into these categories are no longer small and their growth potential cannot be ignored. Enterprises with 100 or more employees accounted for less than one percent of total enterprises, but employed 48 percent of total employees. The 100+ threshold is necessary to acknowledge these firms' economic contribution.

The selection of industries was limited to the tradable sector, which strictly follows the boundaries of the study (refer to Section 7.2.1). When estimating output for the tradable sector, the New Zealand Treasury has included three broad groups of industries: agriculture, manufacturing and the export service sector. At least one company from each sector should be selected to ensure diversity.

Geographically, New Zealand comprises two main adjacent islands, the North and the South Island. As at June 2011, 24 percent of the population resides in the South Island and 76 percent in the North Island. The population is heavily concentrated in the northern half of the North Island, with nearly one third of the total population living in the Greater Auckland Region. Also, Auckland is the most popular business location (see Figure 7-1), and has the largest employee count by broad region (see Figure 7-2). It generates the greatest regional GDP in the country. Such economic significance makes Auckland the first targeted region of the study.

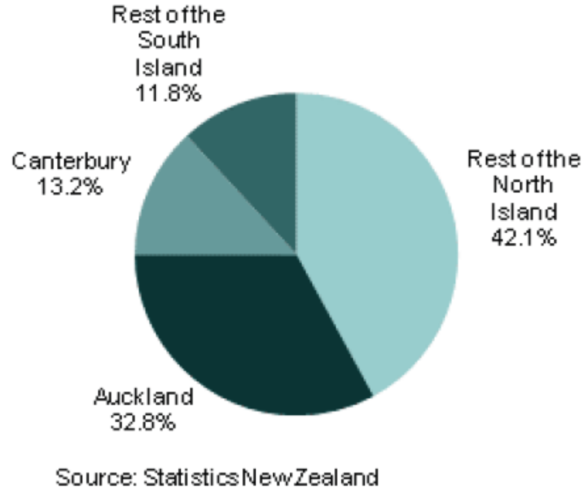
Canterbury has been chosen as the other targeted region for a similar reason. In the South Island, Canterbury hosts more than half of the businesses, employs more workers than the rest of the island, and is the largest GDP contributor. Nevertheless, selecting cases outside the target regions are also important, as they can act as a comparison and are used to identify any regional based advantages.

Figure 7-1 Number of business locations by broad region



Source: Statistics New Zealand

Figure 7-2 Employee count by broad region



7.3 Data collection

The case studies took the form of semi-structured face-to-face interviews. Based on the sample selection criteria proposed in the previous section, a list of suitable companies were selected from the NZMEA (New Zealand Manufacturers and Exporters Association) database[18]. Invitation letters were sent to the Managing Director or Senior Manager of the company, a short questionnaire on firm characteristics (see Appendix 4) was also attached to ensure the company fit our selection criteria. The final list included four companies, which were selected to maximise expected variation.

As part of each company case study, a background analysis was compiled based on publicly available company information, which were used to

[18] Please refer to Appendix 3 for more background information on NZMEA and its database.

construct customised interview guides. A list of interview questions were sent to the interviewee(s) one week prior to the session, and focused upon three areas of enquiry (see Appendix 5). First, we were interested to understand the market environment in which the company operates. Second, we investigated the underlying motivation for innovating by focusing on the "business perspective of innovation" and "innovation in practice". More specifically, what are the sources and drivers of innovation and what factors are important for the innovation process? Lastly, our focus turned to "spatial factors" that businesses may or may not be concerned about and whether there are any changes that can or should be made to encourage innovative activities.

Very little structure was imposed on the interviews. By asking open-ended questions the informants were able to express their opinions using their own constructs. As interviews progressed, follow-up questions were asked to elicit greater detail or clarification, where these seemed to be relevant. The interviews were recorded digitally and each took around 60 minutes.

7.4 Company profile

A total of four companies were selected for analysis, the respondent companies are identified as Company A to D for confidentiality purposes. The company profiles are listed as Table 7-1.

Table 7-1 Company profiles

Company	A	B	C	D
No. of employees	8	40	90	350
Sector	Service - Software	Manufacturing	Manufacturing	Primary - Processing
Headquarter location	South Island-Canterbury	North Island-Auckland	North Island	South Island
No. of establishments	2	5	7	3
Age	10	11	30	70
Innovator	YES	YES	YES	YES
Export Intensity	80%	99%	45%	80%
Market structure	Monopolistic competition	Monopolistic competition	Oligopoly	Oligopoly

As a part of the case selection process, firm characteristics such as employment size, sector and the location are predetermined to allow theoretical replication. Specifically, the companies studied each fell within different employment size groups, where the smallest company employs eight people and the largest 350. Two of the four companies are manufacturers in the North Island, and the software and primary processing companies are located in the South Island.

Despite these differences there are similarities between these companies, such that they all have more than one physical site, have been in operation since 2002, have carried out at least one type of innovation during the last three financial years, and large percentage of sales revenue have coming from exports. In terms of market structure, Company A and B are working within monopolistic competition markets, where there are many competitors and low barriers to entry, they are price takers and sell differentiated products. Company C and D are oligopolies, who are price makers facing limited competition due to large barriers to entry.

7.5 Data analysis

Traditionally, the first step when analysing qualitative data involves the development of an elaborate coding scheme, followed by extensive coding efforts. Many researchers have deemed the process messy, burdensome and unrewarding, others found themselves overwhelmed by the amount of information and confused by conflicting interpretations (Miles, 1979; Vaivio, 2008). With the advancement in computer technology, however, a growing number of researchers are opting to use Computer-Aided Qualitative Data Analysis Software (CAQDAS) such as NVivo, NUD *IST, and ATLAS.ti (Chua & Mahama, 2007; Rogge, et al., 2011; Whiting, 2008). Crofts and Bisman state that utilisation of CAQDAS will not only reduce the enormity of data, but can also “enhance systematisation, logic, transparency, speed, and rigour in the research and analysis process” (2010, p. 183).

To analyse our case study results, an Australian-developed text-mining tool, *Leximancer*, (version 4) was used. Its theoretical underpinnings are based on *content analysis*. Weber (1990) who provides a concise introduction to the methodology and the various techniques used. The software was evaluated by Smith and Humphreys using a set of evaluation criteria taken from content analysis, namely stability, reproducibility and correlative validity, and they concluded that “there is an abundance of rich and complex information that can be extracted by means such as *Leximancer*” (2006, p. 277).

After each interview, the oral recording was transcribed verbatim and the accuracy of the transcription was verified against the original recording and the hand-written interview notes taken by researchers during the interview. Each transcription was kept in a separate Word document for easy reference, and these files were uploaded into the software. In order to focus on the responses of the interviewee, the questions asked by the interviewers were excluded from the analysis.

To analyse the data, *Leximancer* converts the raw documents into a more useful format by applying the appropriate tags such as, dialog tags for each speaker and file tags for an individual file, punctuation and stop words such as ‘and’ and ‘of’ are removed. A ranked list of terms (the so-called concept seeds) is automatically generated using word frequency, position and co-occurrence usage. The merging of word variants, such as singular and plurals of the same concept were allowed and additional modifications made to the auto concept list are shown in Appendix 6. Starting with these concept seeds, the thesaurus learning process intelligently develops a thesaurus of terms associated with each seed, thereafter higher level ‘themes’ are identified, which are clusters of concepts.

The concept frequency and co-occurrence are used to compile a co-occurrence matrix and from the statistical algorithm, two-dimensional concept maps were generated to show the relationships between concepts and themes.

7.6 Interview outcomes

The semi-automatic content analysis tool is capable of analysing a document or collection of documents. The four cases were analysed individually and then collectively to allow both within-case and across-case comparisons. The corresponding concept maps are presented as Figure 7-3 to Figure 7-7.

Here are a few hints for reading a concept map.

- The concepts are shown as black text labels, the larger grey dot point behind the label indicates more frequent use of the concept across the text.
- The themes are heat-mapped according to the colour wheel, which means the ‘hottest’ or most important themes appears in red, and the next hottest in orange, and so on.

- The size of the theme shows the concept groupings, the default rate of 33 percent is used. All the themes will disappear from the map if the theme size is set to zero percent.
- The name of the theme is taken from the name of the largest concept within the theme circle, which is indicated using an underscore.
- The grey line joining the concepts shows the most-likely connection between concepts. It should not be used to identify causal relationships.

Figure 7-3 Concept map - case 1

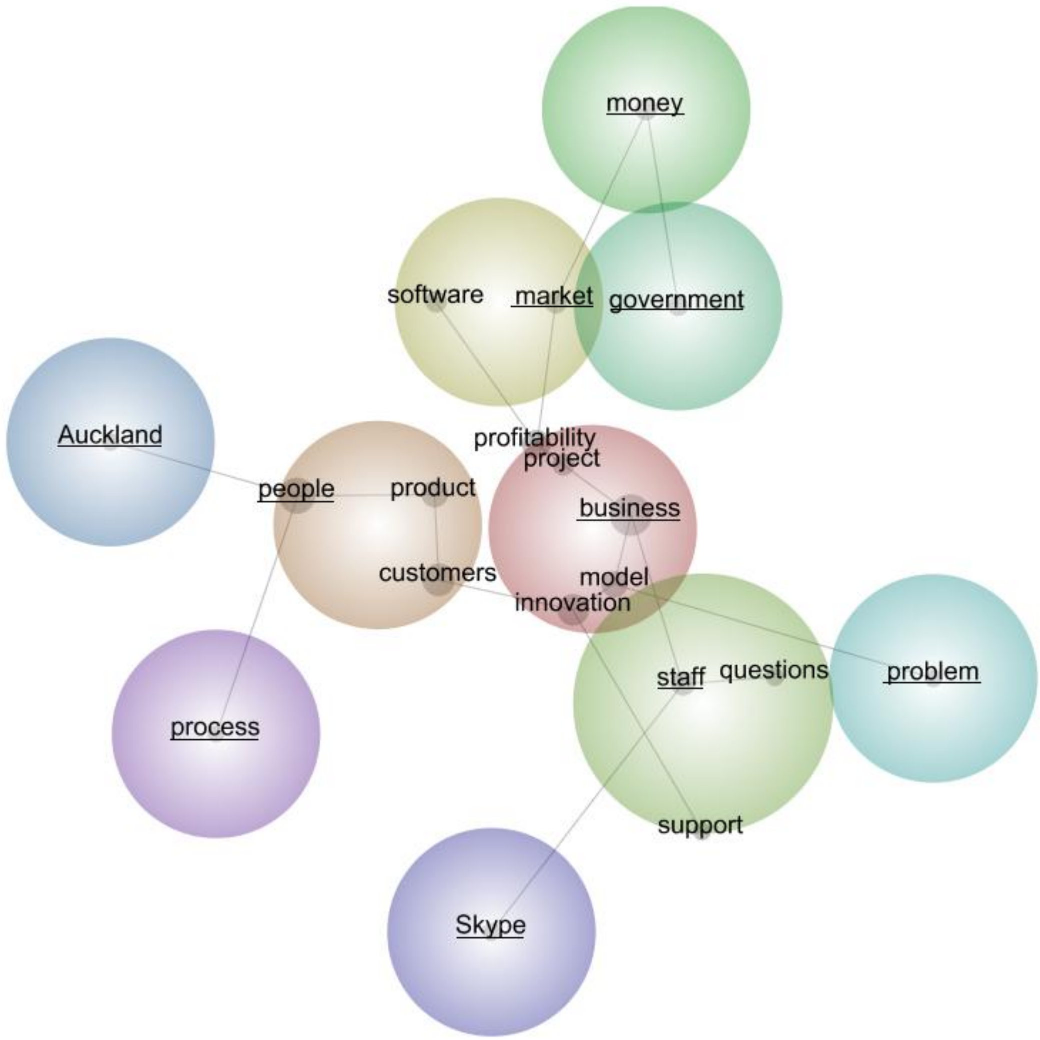


Figure 7-4 Concept map - case 2

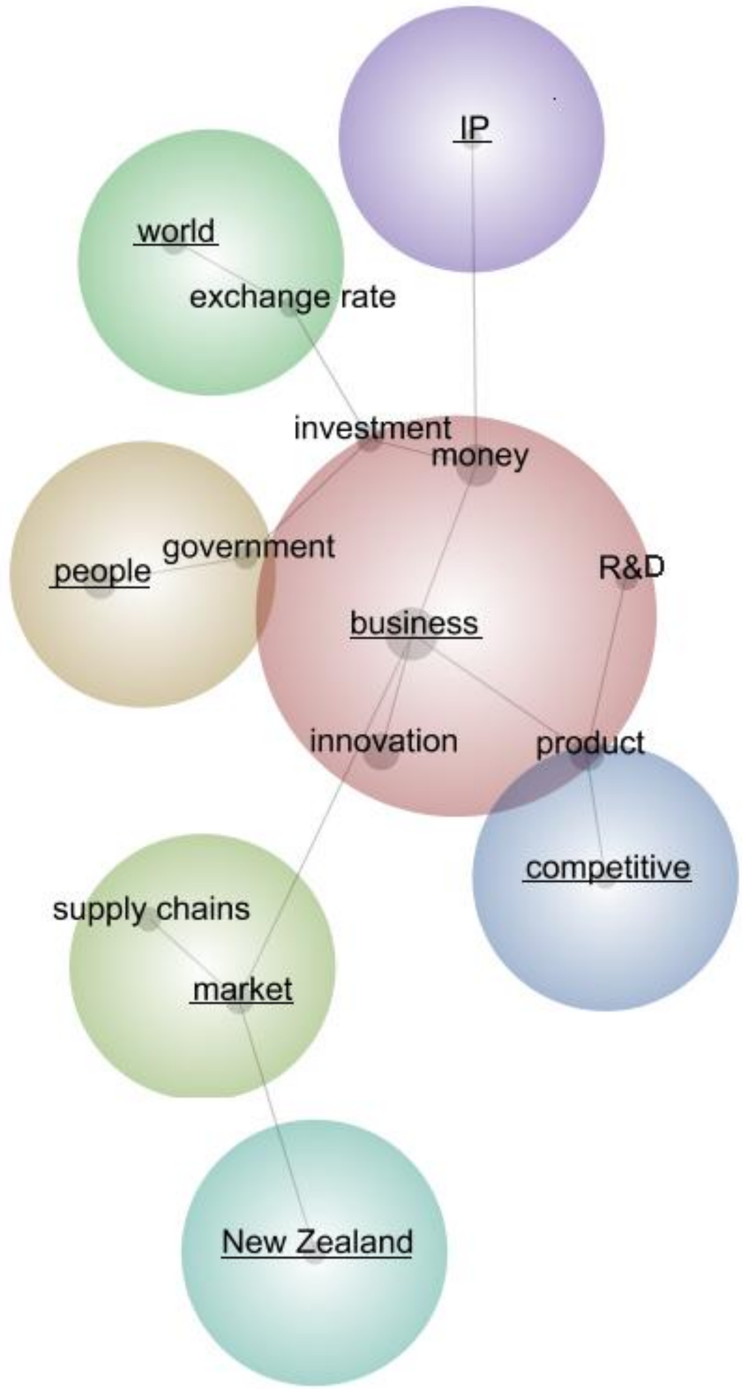


Figure 7-5 Concept map - case 3

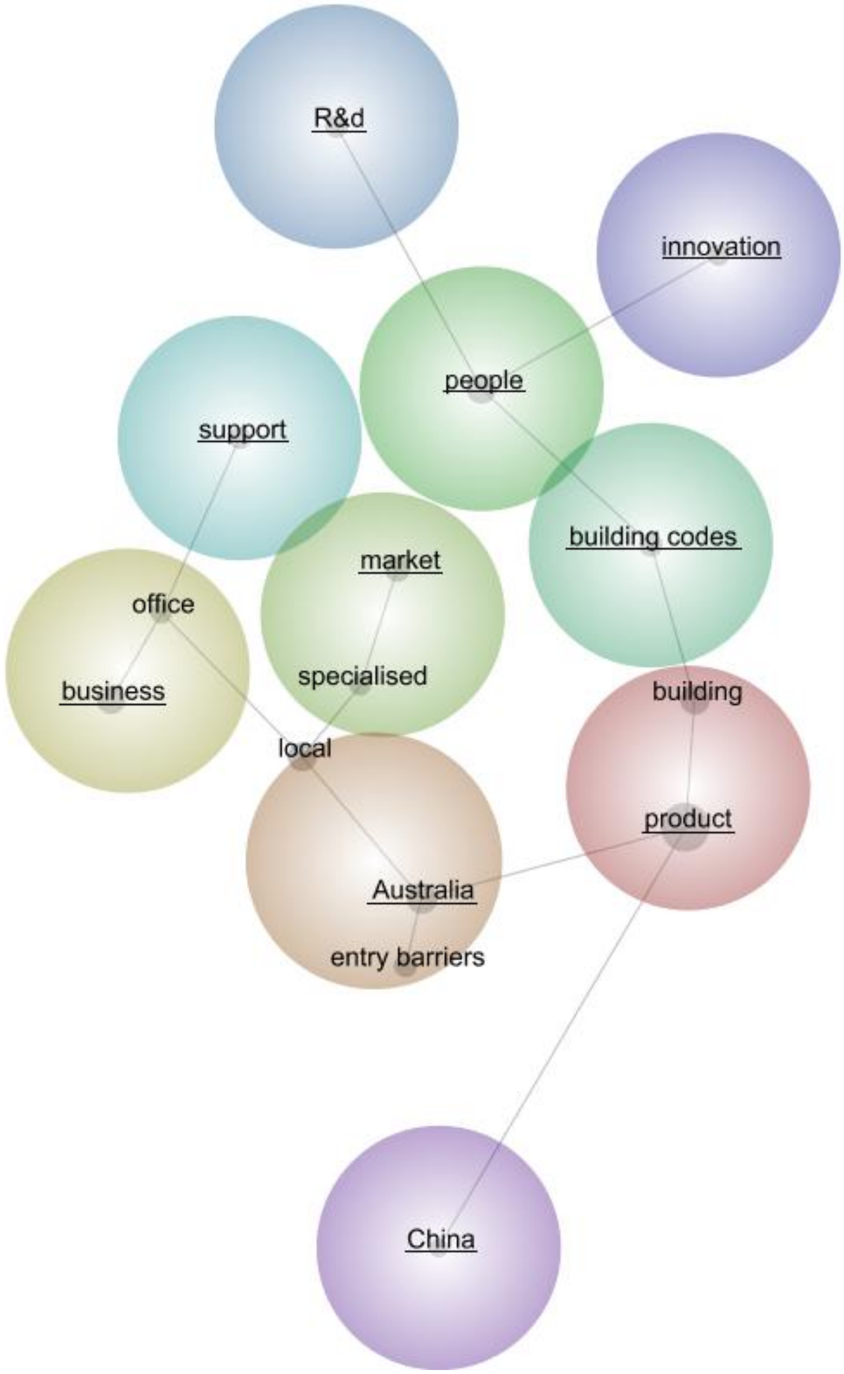


Figure 7-6 Concept map - case 4

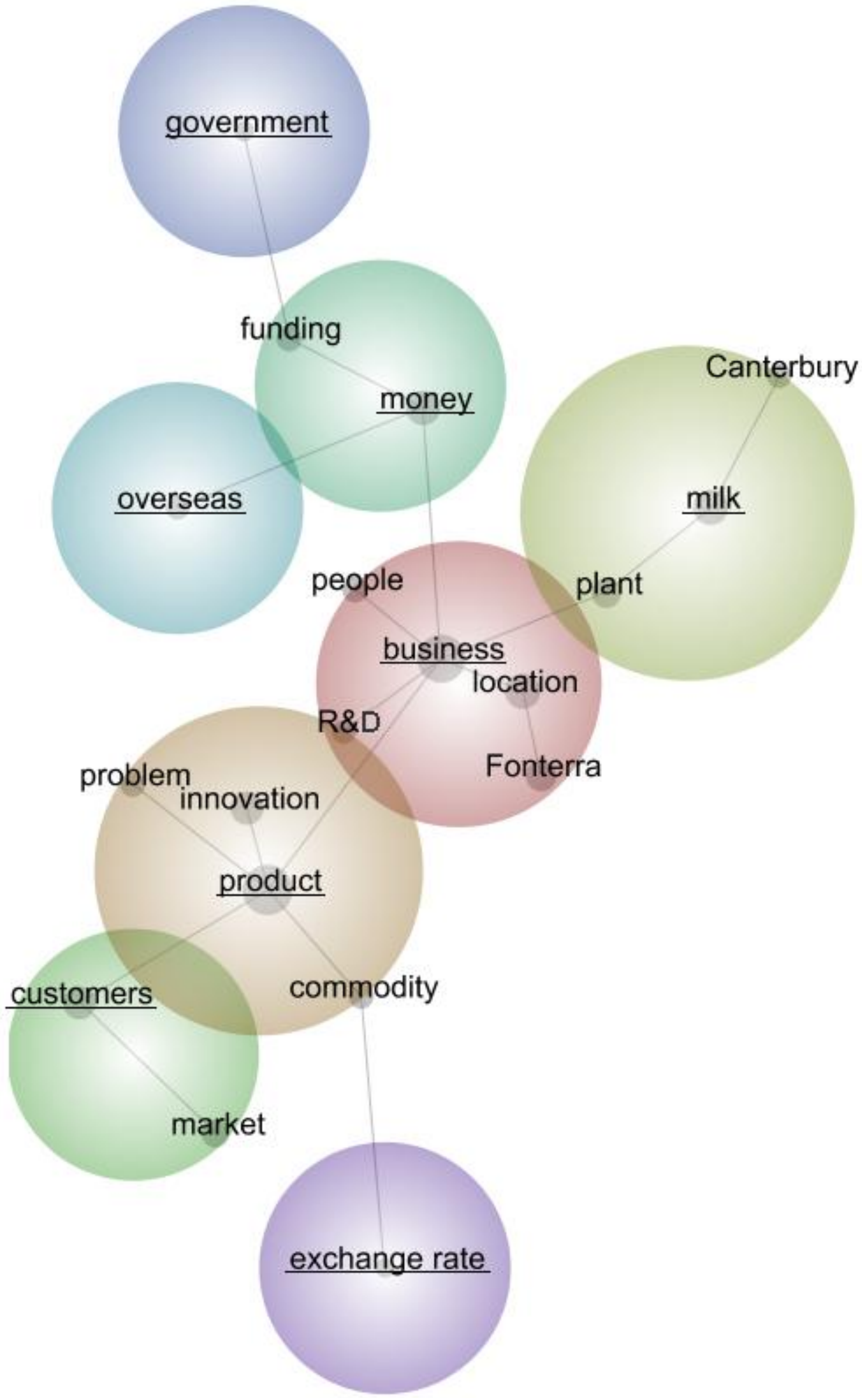
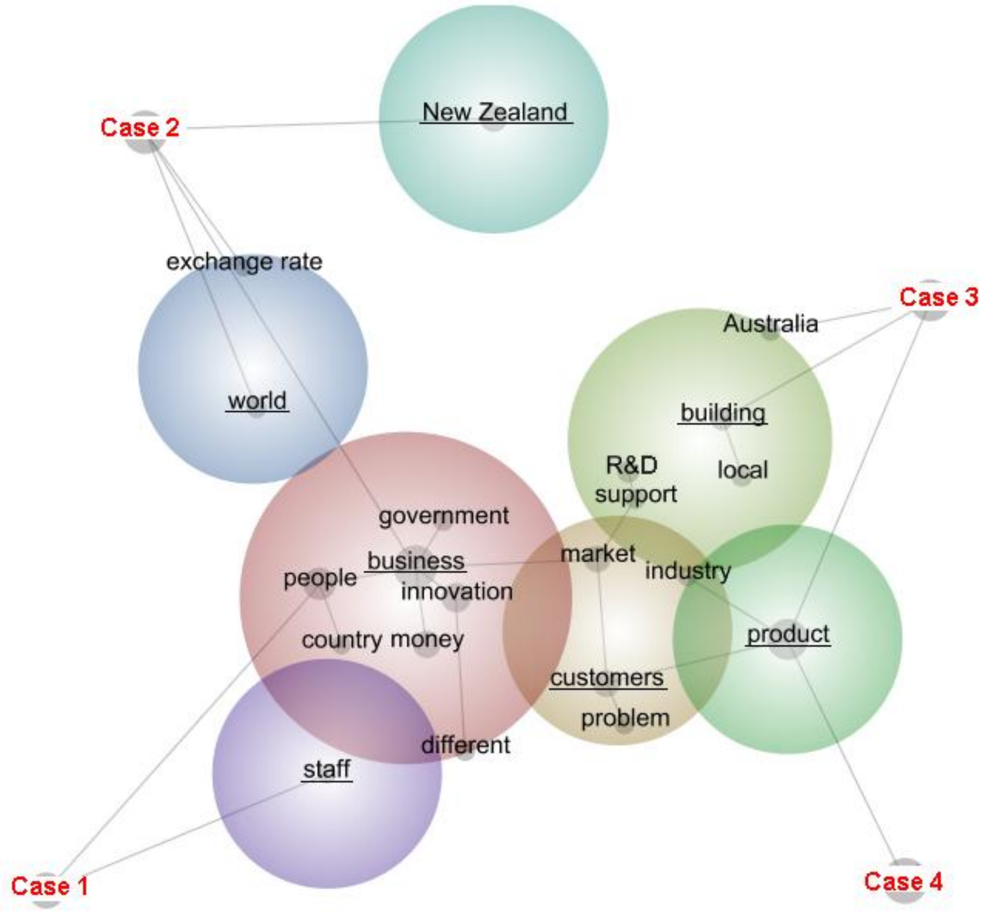


Figure 7-7 Concept map - all cases



7.6.1 *Dominant themes*

During the analysis, several themes were identified. The top five themes and their connectivity are listed in Table 7-2, where connectivity is the *summed co-occurrence counts of each concept within the theme, with all available concepts*. It provides an estimate of the coverage of a theme across the data.

Table 7-2 Top five themes

Case	Top 5 Themes	Connectivity	Case	Top 5 Themes	Connectivity
1	business	100%	All	business	100%
	people	67%		customers	37%
	market	17%		building	31%
	staff	17%		product	31%
	money	9%		New Zealand	14%
2	business	100%			
	people	22%			
	market	18%			
	world	12%			
	New Zealand	6%			
3	product	100%			
	Australia	81%			
	business	44%			
	market	39%			
	people	31%			
4	business	100%			
	product	81%			
	milk	47%			
	customers	33%			
	money	32%			

For individual case results, the theme ‘business’ has been identified in all four cases by *Leximancer*, and the highest connectivity (100 percent) was achieved in every case except in Case 3. This term is used by interviewees to denote themselves, other similar organisation or trade. The next popular themes were ‘people’ and ‘market’ found in three of the four cases, followed by ‘product’ and ‘money’, which were found in two of the cases. Interpret these themes literally, and consider them as matters that our interviewees are concerned about. The variation in themes also indicates the structural difference between the concept maps, in particular the structure of the concept maps are very similar for Case 1, 2 and 4, such that the top theme ‘business’ were surrounded by other lower ranked themes.

When analysing the cases collectively, the case tags have been included in the concept map, the connections between themes and cases are shown using the grey lines. ‘Business’ remained the top theme, followed by themes such as ‘customers’, ‘building’, ‘product’ etc. Based on the distribution of themes, Case 1 and 2 are more closely related, while there are more similarities between Case 3 and 4.

Next, the results of the interpretive analysis will be presented to reflect each research question proposed in Section 7.1. Please refer to the concept maps to allow for a better understanding of the cases, both individually and collectively.

Interview participants will be identified by the codes corresponding to their respective companies, for example, the interviewee from Company A will be referred to as Informant A.

7.6.2 *Business perception of innovation*

One of the main purposes of the case studies was to create a useful link between theory and practice. While defining innovation theoretically can be challenging, quantifying innovation in practice is even more difficult. The perspectives on innovation among entrepreneurs, academics and policy makers can be quite different, see for example, Massa and Testa's, (2008) study on Italian SMEs. During the interview, the interviewees were asked to define innovation, so that their meaning of innovation could be revealed.

Unlike academics and policy makers, businesses tend to define innovation based on their own experiences. Although innovation was not a foreign concept for our interviewees, the perceptions of innovation were slightly different between interviewed firms. Note all companies had separate R&D departments except Company A.

Informant A understands innovation as something new and fresh, and prefers to use the word 'solution' as their business model is based on problem solving. Aiming to create a competitive advantage across the entire supply chain, Informant B extends the definition of innovation from product development to other parts of the business such as procurement, manufacturing and marketing. Concentrating on product innovation, Informant C describes innovation as "supplying products that are perhaps a little smarter than those offered by the opposition and that enables the customers' needs to be met better than they had been previously". Lastly, Informant D regards innovation as "doing something completely new", but more importantly it is about finding "a better, more efficient or cost effective way to do things".

Despite the definitional differences, all four companies see innovation as an important part of their 'day-to-day' operations, and a successful innovation must deliver higher margins. As suggested by Informant D "if [the new product] doesn't return significantly more, it's usually around the 15 to 20 percent mark, than an equivalent commodity product, then we don't do it, and we won't go near it".

The non-technological innovations (i.e. managerial process and marketing innovations) are often carried out to complement the introduction of new products and processes, however these practices are rarely identified by interviewees as a type of innovation with the exception being Informant B. Government's preference toward technological innovation has also contributed to the apparent neglect of non-technological innovation.

7.6.3 *Innovation drivers and sources*

Companies at different stage of their life cycle innovate to achieve different business goals. Aiming for a healthy level of profitability, Company A innovates to keep up with the current technologies and the increasing competition. Taking a more proactive approach, Company B innovates to lead the market and gain competitiveness. Compared with the younger/smaller firms, maintaining and increasing market share are the main priorities for Company C and D, where cost savings and higher profitability can also prompt innovation.

As with many things in business, innovation is easier said than done. Based on our case study results, there is no evidence to suggest that larger firms are more innovative than smaller ones, nonetheless smaller firms seem to follow a different model of innovation that revolves around people, specially entrepreneurs. In Informant A's words, "the question about what drives innovation, should be **who drives innovation**". The same view was shared by Informant B, who asserts that innovation "starts off with a visionary leader who identifies the market opportunity and then motivates a team of people to go and attack that market". In comparison, innovations in large firms are more systematic and less dictated, the role of entrepreneurs is replaced by high level business plans and strategies, supported by other key skills within the organisation.

Regarding the source of innovation, evidence was found to support both demand-pull and supply-push theories (see Section 3.2 for more detail). The more visionary Company B, was the only interviewed company that adopted the "lead the market approach" and actively developing supply-pushed innovation. As described by Informant B, "if you want to follow the market you ask a customer, if you want to lead the market you've got to predict where the market's going to go". In contrast, other companies have a heavy focus on the demand side, and proportionally smaller effort on the supply side. Informant A reports: "70 to 80 percent of [product] functionality is directly driven by customer feedback, and the rest would be driven by technical feedback". Informant C says that "a lot of [innovation] is driven by listening carefully or observing problems being experienced by the customer", and "the actual project initiation would, very rarely come from R&D". Similarly, Informant D states "everything…in terms of innovation, in terms of products, all comes from customers".

Given customers are the leading sources of new ideas for innovation, other parties within the innovation system also play a role in providing innovative ideas. Both Company B and C have close relationships with their suppliers, as it is impossible to "build a new product without knowing what components are available in the market". "Watching the literature pretty carefully… and attend[ing] a number of trade shows", Company C keeps a close watch on "where other companies are heading with their products, not necessarily with a view to copying but more, to see what's interesting and maybe [there is] something that can be done". Informant D calls themselves a fast follower, as they "haven't got the biggest R&D department…in the country or in the world, …so [they] let the big player come up with the new products and work out how they have been done and very quickly implement a very similar or better product". Cooperation with higher education and research institutes are more common in some sectors due to the available government incentives and the available resource. "[Universities] have a lot of equipment that we need every now and then, and we can't justify getting them ourselves, so we work with them" says Informant D. In other sectors, companies don't see the need for cooperation as "we sort of know what we're doing and we're ahead of the university".

7.6.4 *Common challenges*

Innovation at the firm level tends to be integrated into businesses' daily operations. Starting with a simple idea, the operationalisation of innovation requires the necessary funds and skills, and once in product form commercialisation will take the innovation to market where hopefully the successful sales records will allow the firm to continue to innovate. During the case study interviews, a number of common challenges were identified by our interviewees, which were skill shortages, funding issues and the overall environment.

7.6.4.1 ***Skill shortages***

People are at the heart of the business and the skills they bring are crucial throughout the entire innovation process. As at March 2012, New Zealand's unemployment rate was 6.7 percent, yet skill shortages were still reported by the interviewed companies. In particular, the larger companies believe there is a shortage of employees with technical skills. Technical personnel are regarded by many as "the brain of the business", responsible for transforming an idea into an innovative product. A shortage of such key skills can significantly reduce a firm's ability to innovate. Informant D describes finding skilled and experienced staff is like "find(ing) a needle in a haystack", "we're looking overseas as well, then you will run into visa issues and payment issues, what we can offer in New Zealand is a salary in New Zealand dollars, which is often half the value they can get overseas".

For smaller firms, their main problem is about establishing markets, and turning innovation into profits, and they perceive that there is a shortage of sales skills. Informant A criticises New Zealand businesses' commercialisation skills and refuses to hire university graduates on the sales role, as an ideal candidate will need to have "some sort of real world business background and not educational business background". Informant B also pointed out the importance of commercialisation and found it difficult to attract the "tier 1 people" to "get products from New Zealand into the market and sold".

7.6.4.2 ***Funding issues***

Innovation is a tricky business, it is both time consuming and financially costly. There are few ways to fund an innovation. Risk averse owners will typically run the project using cash flows or retained earnings. Informant A depicts its business strategy as "bootstrapping", such that the company will "only spend what [is available] and only scale according to what can be handled". Company B undertook a 'ground up' development in 2008 and since then they spent every cent that they made on R&D. Similarly, Company C is "very wary about debt, …[and] reluctant to borrow to fund new projects". The self-funding method brings certainty to the project, though the growth of the company is limited at "a certain rate based on current turnover and profitability".

Companies can overcome this disadvantage by getting access to other funding sources, and two of interviewed companies have funded innovation using government grants. “We’re getting a lot of [government] support at the moment, …everyone [in our industry] is using as much funding as they can. Everyone finds it extremely good” says Informant D. Since most government grants are project based contestable funds, it means there is no guaranteed approval, and only a handful of companies can benefit. Even then successful companies will need to adjust their R&D programme/business plan to suit. “A gap between…the $200,000, $300,000 funding projects” was identified by Informant D. Company C was forced to use a recommended outside consultant, which turned out to be “more of a hindrance than a help”. The company prefers the non-discretionary schemes such as the R&D tax credit, and considers the application process as non-transparent, and “the Government is playing games by trying to pick winners”. Informant A refused to apply for government assistance as the application process “was taking more time than [the company] was saving money”.

Overall, innovating firms in New Zealand have limited ability to access capital for innovation. While some firms were disadvantaged by the under-developed capital markets, the immature angel/venture capital markets and the small private equity market, others were avoiding the more risky funding sources by choice.

7.6.4.3 ***Business environment***

The business environment is a set of conditions that the firm operates within, mostly uncontrollable in nature which directly and indirectly affect the functioning of the businesses as well as their innovation capability. Many of these environmental factors are embedded within the area/region that the business operates in.

As part of sample selection process, companies were selected on the basis of the location of their headquarter locations. While the initial decisions on business location were either intuitive or happenstance, as the business grows over time, expanding/shifting operation to other parts of the country and overseas became a strategic decision. All regions have their pros and cons, but available infrastructure and skill availabilities were some of the main issues concerning businesses.

Informant A says: "[the sales and support team] moved out of Christchurch because Christchurch [broadband] infrastructure is failing us…the power cuts, distractions, emotions [because of the earthquake] are just distractions you don't need". Informant D suggests that "having a deep water port that [the company could export directly from] would save an enormous amount of money".

Informant C worries about their ability to attract skills and the limited skill pool, "we've done ourselves no favours being located in Wellington, probably Christchurch or Auckland would be better, because they've both got an engineering school. [When advertised] you don't get 50 applicants, you get maybe two or three and if you're lucky one of those people will be very good".

Since our interviewed companies are actively exporting, this means that their business performance is influenced by other international markets. The biggest problem currently facing Company A is cancellations from their US customers, and a lot of it is due to the recent global economic conditions.

Focusing on building a robust business model, Informant A believes their business "will be able to weather the economic storm". Likewise, the number one concern for Company C is the global financial crisis as their business is "dependent on the fortunes of the building industry…and building work stops during a recession". Informant C "noticed that Australia and New Zealand cycles tended not to be in sync", taking a more active approach, the company moved into the Australian market to "provide a slightly better continuity in terms of manufacturing side, … [and] a form of insulation".

Also confronting the challenging global economic conditions, the main concern expressed by Informants B and D was the high exchange rate risk.

Informant B sees the exchange rate as the biggest single determinant of business success, the volatile exchange rate means “one minute [the business is] making 30, 50 [percent] margin, and the next minute [it’s] shipping money with every product [it] sells”. Being in the primary industry, Informant D reckons “[the exchange rate] is more of an influence…than commodity prices”. In fact, they [can do all the cost savings [they] want in the plant, make all the products that [they] want, but when that dollar goes up … all hell breaks loose”. As the biggest company in our sample, Company D is the only company that has a hedging policy, “we buy foreign exchange a long way ahead to try and mitigate that risk, sometimes we win, sometimes we lose but at least we know what our rate is going to be” says informant D.

7.7 Key findings

Overall, a number of interesting findings were revealed from the case studies. In particular, the study pointed out four key factors that affect innovation in New Zealand firms, which are “Product”, “Market”, “People” and “Money”.

- Product – As an important part of daily operation, New Zealand businesses are highly aware of the importance of innovation, although most businesses have concentrated a majority of their innovation efforts on improvements to existing products or new product developments. Other types of innovation also exist in firms, but mainly as a complement to product innovations.

- Market – Most firm-level innovations in New Zealand are market oriented, or in other words, demand driven. Innovation is carried out to fulfill customer needs, technology providers such as higher education and research institutes have limited participation during the innovation process, as there often is a mismatch between market opportunities and the technology available.

- People – People are the key to any successful business and the skills they bring are crucial throughout the entire innovation process. New Zealanders are well known for their innovative mentality, however competing within a highly mobile labour market, the lack of key technical and commercialisation skills has prevented our businesses from reaching their full innovative potential.

- Money – Like most business ventures, innovation requires a significant amount of investment. Sufficient levels of funding are the prerequisite for any successful innovation. Compared with other countries, businesses in New Zealand tend to be small in size and risk adverse. The limited cash flow and capital options mean that many businesses are pursuing incremental innovations with lower investment requirements and quicker returns. However, these more affordable innovations have limited economic benefits, and innovations with high growth impact are mostly sold to overseas companies.

8 Chapter 8

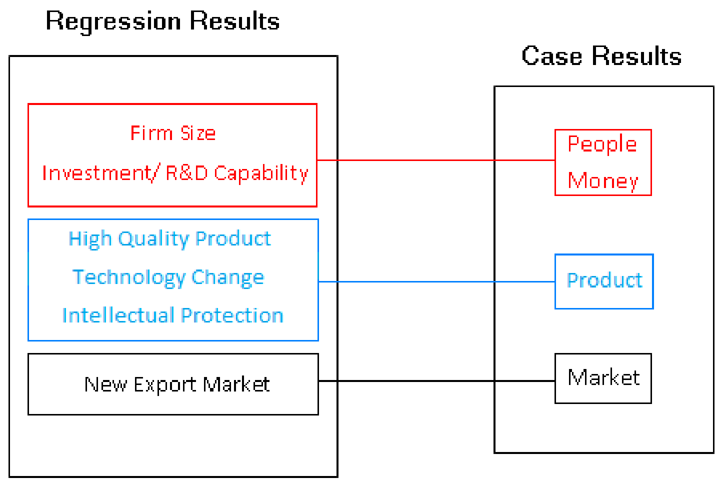
Policy Recommendations

8.1 Discussion

Aiming to achieve a balance between the analysis of qualitative and quantitative aspects of innovation, different research methods were used to investigate innovation behaviour at the firm level. More specifically, the regression analyses in Chapter 6 portrayed the characteristics of different types of innovators, and variables such as *firm size, high quality product, investment capability, technology change, intellectual protection* and *new export markets* have been positively correlated with various types of innovation. The case studies in Chapter 7 reveal the *internal processes of generating and managing innovation*, and four key factors (i.e. *product, market, people and money*) have been identified.

By analysing innovation from two different angles, we were able to gain a better understanding of innovation in New Zealand firms, such that the regression results provide a snapshot of innovators, and the case results explain how businesses became innovative. Coded in different colours, Figure 8-1 shows the linkages between two sets of results.

Figure 8-1 Result integration



Thinking in terms of system of innovation, innovation in New Zealand firms can be best described as 'internalised'. In a textbook sense, New Zealand is institutionally almost ideal for promoting local entrepreneurship and the importance of innovation is well recognised by firms. However, in a small and isolated economy, market/technology opportunities can only be realised if there are necessary skills and funds available and likewise a local market to trial the innovations, which means businesses are most likely to pursue incremental innovations with lower investment requirements and faster returns. While most New Zealand businesses are continuous innovators, the more affordable innovations have limited economic benefits, and innovations with high growth impact are generally sold to overseas companies. As a result, New Zealand has become an innovative country with a relatively poor economic performance. For the exact same reasons, businesses tend to source their innovative ideas from customers or suppliers, while higher education and research institutes play little or no role which is particularly true for SMEs with a non-agriculture focus. Moreover, there was little evidence of agglomeration effects within the regions. Given the country's small size and lack of economies of scale, the absence of the agglomeration effect is somewhat expected, where not only the spatial variables in regressions were insignificant, the case companies also saw little benefit to networking or clustering.

Since the 1990s (Porter, 1990) innovation increasingly came to be seen as related to geography, clustering, networks and agglomeration in the international literatures. More recently, the role of the region has been emphasised by international organisations as a way to unleash economic growth. The National Endowment for Science, Technology and the Arts (NESTA) report (Anyadike-Danes, et al., 2009) on economic and social outcomes in UK cities and regions suggests that a very small percentage of firms, and in particular fast-growing firm, account for a very large percentage of employment growth. Moreover, this growth tends to be particularly marked in certain places. Entrepreneurship and innovation appear to be spatially concentrated and it provides normative arguments regarding why SMEs should be prioritised by policy, and more controversially, in particular high growth places. This argument is slightly different to that which is offered by the OECD (2011) report *Regions and Innovation Policy*, which classified all OECD regions into particular types of places, according to their combinations of innovation features. The OECD report is based on the OECD regional database plus numerous case studies conducted under the auspices of the OECD territorial and urban policy reviews, and the argument of the report is that all regions differ significantly and there can be no one-size-fits-all policy. As such, innovation policies must be tailored to the context, but essential elements of all policies are that they ensure that all relevant stakeholders have the incentives to maximise their engagement. The importance of this multi-level governance agenda has been highlighted for many years by the OECD, and implies that the policy design issues relating to governance and institutional coordination are critical, and must be appropriate for the context. These governance and more contextually-nuanced arguments also reflect a more general and fundamental shift in the thinking about innovation away from a hard-science and R&D-centered discussion based on capital expenditure and technical infrastructure to something which also includes softer governance and institutional issues.

As a part of the *Europe 2020* vision, a comprehensive innovation strategy has been set out to deliver 'smart', sustainable and inclusive growth. The concept of 'smart specialisation' involves a process of developing a vision, identifying competitive advantage, setting strategic priorities and allowing policies to maximise the knowledge-based development potential of any region, strong or weak, high-tech or low-tech. The integrated, place-based economic transformation agendas have been strongly advocated by the European Commission, as well as the *Synergies Expert Group* established by the Commission's Directorate-General for Research and Innovation.

From New Zealand's perspective, concentrating on any particular region may yield limited benefit given the insignificance of agglomeration effects. In fact, it may be more appropriate to treat the country as whole to allow for economics of scale. However, the arguments provided regarding regional innovation policy design are still valid at the national level, such that what might be an appropriate innovation policy in a large decentralised and centrally-located economy such as Germany is unlikely to be appropriate in a small and geographically isolated economy such as New Zealand. Examining all available evidence, a number of policy recommendations are proposed in the rest of this chapter.

8.2 Recommendation 1: growth-friendly environment for exporters

As one of the earliest testable hypotheses on innovation, the Schumpeterian hypothesis suggests that entrepreneurs bring innovations to life and monopoly formalises the innovation process for greater benefits. The similar U-shaped relationship between innovation intensity and firm size have been endorsed by international empirical studies (Pavitt, et al., 1987). Given that large monopoly firms are more equipped to fund their own innovation projects, policy makers around the world began to target SMEs because of their innovative and growth potentials. Since the 1990s, a number of policies and support programmes have been rolled out to boost countries' innovation performance. The first SME-specific innovation promotion project in Europe, known as 'CRAFT (Co-operative Research Projects)', was piloted during the Third Framework Programme between 1990 and 1994 (The European Communities, 2000). Recently, the Asia-Pacific Economic Cooperation (APEC) proposed the Start-up Accelerator Initiative to support start-ups and young entrepreneurs in the APEC region by encouraging further collaboration between member economies (2012). So would New Zealand benefit from an innovation support programmes specifically targeted at SMEs?

The answer is not certain. As revealed by the quantitative analysis in Chapter 6, large firms (measured in terms of employment) are more likely to introduce process innovations, and innovators are most likely to be firms that can afford to invest in R&D, market development and other expansionary activities. Similarly, the case study in Chapter 7 pointed out the importance of 'money' within the innovation process, as most innovations are funded by retained earnings, which suggests that firms with higher turnover/profitability have a natural advantage in innovation. Typically, SMEs are defined using numerical criteria such as, staff numbers and firm's assets/profitability level. Therefore, our results are actually suggesting that *non-SMEs in New Zealand are more innovative*, or in other words, firms need to grow to a certain size before their innovation potential can be unleashed. Given that over 97 percent of firms are SMEs, an appropriate policy response for encouraging innovation should focus on firm growth/profitability.

New Zealand may be ranked as the 'number one country for starting a business', but growing a business in New Zealand is not as easy. A strategy that concentrates on cost reduction is unlikely to be growth enhancing as it also restricts firm's ability to invest. Facing a small domestic market, New Zealand firms have to take advantage of international market opportunities in order to grow their revenue line.

As reflected in the case studies (see Section 7.6.4.3), the strong New Zealand dollar and the high exchange rate risk have hindered export companies' ability to earn. More predictable returns from international markets reduce business risk, allow long term business planning, and hence encourage more innovation related investment.

Huchet-Bourdon and Korinek (2012) examined the impact of exchange rates and their volatility on trade flows in New Zealand and Chile. They suggest that, compared with larger economies, exchange volatility has a larger impact on trade flows in the small, open economies. Adopting a flexible exchange rate regime, the value of New Zealand dollar is determined by financial markets, where non-trade related factors such as market sentiment and interest rates have significant influence compared with trade related factors, especially in the short run.

The conventional inflation targeting mechanism has also contributed to the problem. Controlling domestic inflation in a way that does not increase the cost of capital or the exchange rate is an important element when competing and achieving a reasonable return from global markets. It is difficult to eliminate all non-trade related factors, however, and some unnecessary fluctuations within the exchange rate can be avoided by adjusting the policy framework appropriately. Countries such as Switzerland and Singapore have engaged in direct exchange rate interventions, while the United States influences their exchange rate by adopting quantitative easing. Policies in New Zealand should aim to address the exchange rate issue, to ensure there is a level playing field for our exporters, so they have a chance to survive and grow in the international market.

8.3 Recommendation 2: sector-specific innovation support schemes

R&D has been identified as an important part of the innovation process from the beginning of the study of innovation. Ample empirical evidence suggests that R&D expenditures are a *sine-qua-non* for firm level innovation activities (Bayoumi, et al., 1999; Frenkel, et al., 2001; Stokey, 1995). Based on the regression results, whether a firm carries out R&D has a significant impact on their innovation outcomes, and the case studies showed that there is no one size fits all solution for innovation.

The primary sector has relatively explicit and constrained aims and objectives, therefore the technology can be easily transferred to producers. Discretionary grant-based schemes can be easily set up to allow additional co-operation between the public research institutes and the companies, which will bring in fresh ideas and opportunities that encourage more innovation, and the government is able to target specific industries and has more control over the innovation projects.

In contrast, innovation in the manufacturing sector is more likely to be demand rather than technology driven. As a result, a co-operation with CRIs and external consultants tends to be less effective than an inter-business co-operation, which means the spill-over from government R&D may be limited. In this case, instead of forcing co-operation arrangements, the government should provide financial support, but leave businesses to discover and develop their own innovation opportunities. Without high administration and compliance costs for eligible businesses, the non-discretionary schemes similar to the R&D tax credit announced in the 2007 Budget are preferred by most manufacturers. “As of today more than 20 OECD governments provide fiscal incentives to sustain business R&D, up from 12 in 1995 and 18 in 2004” (OECD, 2010, p. 1). Reintroduction of non-discretionary schemes will bring New Zealand on par with other countries, and may be necessary to boost the level of business R&D.

In sum, designing different support packages for different sectors will likely allow more efficient use of government funding.

8.4 Recommendation 3: skills for business development

Human talent is essential to the innovation process (Leiponen, 2005). Due to New Zealand’s small population, instead of recruiting within the region, firms tend to hire people throughout the country, which explains why both skilled and unskilled local labour markets fail to show any significance in the bivariate probit regression analyses. However, skill shortages have a significant impact on firms’ innovation performances, as revealed by our case study results.

“Brain drain” has been a concern in New Zealand since the 1980s (Sceats, 1987), which is used to describe the hemorrhaging of talent from less developed to more developed economies. Introduced in 1973, the Trans-Tasman Travel agreement allows for the free movement of New Zealand and Australian citizens between the two nations. Over the years many New Zealander have decided to go overseas for better paid career opportunities, in comparison there are considerably fewer Australians living in New Zealand. “In 2006, there were 389,467 New Zealand-born residents in Australia and 62,634 Australia-born residents in New Zealand” (Poot, 2009, p. 2). The situation has worsened during the past couple of years due to the increasing disparities of income, living standards and business opportunities, and the 2011 Canterbury earthquake and aftershocks have also prompted an increase in departure from Christchurch. In the year ending July 2012, there were 53,873 departures from New Zealand to Australia, offset by 14,024 arrivals from Australia, New Zealand’s net loss of permanent and long term migrants were 39,849 people (Statistics New Zealand, 2012a).

Solving New Zealand’s skill shortage issue, the first step is to keep our existing skills. Famous for the ‘Number 8 Wire mentality’ (aka ‘kiwi ingenuity’) New Zealanders have the reputation for their unique approach to overcoming problems, even when they do not have all the necessary means.

Many of these abilities are vital for our innovation process, but are not recognised by the formal education system. It is potentially dangerous to disregard the problem of brain drain by suggesting that the inflow of overseas citizens to New Zealand is more highly skilled (2012). By providing the necessary support, the government can help businesses to achieve their full potential, so they can keep our brightest by providing the necessary rewards and opportunities.

Secondly, New Zealand needs to attract the right skills. The current immigration policy gives preference to people with high qualifications, while there is little testing of the adaptability of the skills. Communications between the businesses, the education sectors and the immigration agencies need to improve to ensure that firms are getting the most relevant skills.

Lastly, New Zealand needs to attract the right people. New Zealand is well known for its natural beauty and the "clean and green" image. While beneficial for tourism and the agriculture sector, the supposed attraction often attracts the wrong type of people for growing businesses. Repositioning New Zealand in the international job market is essential to draw people with the right mental drive.

8.5 Summary

As a long time member of the OECD, New Zealand seems obsessed with comparing ourselves with other developing countries based on various indicators. We are proud to follow international guidelines and world best practices, but what we have forgotten is how different New Zealand is compared to the rest of the world, which means that adopting off-the-shelf policies may not benefit New Zealand.

Disadvantaged by the small size and isolated geographical position, New Zealand's textbook-perfect macroeconomic and institutional framework is making local firms vulnerable in the international trade system. Policy intervention is needed to maximise the country's innovation potential. A wide range of policy settings are necessary to support innovation. Political actions such as reform of monetary policy, tax support towards R&D and skill investments are a few of the crucial drivers for business innovation. However, these are only a selection of issues that are impacting innovation performance in New Zealand, policies around depreciation and patents would also affect innovation incentives.

9 Chapter 9

Conclusions

Innovation is a conceptually difficult notion to capture, but the concept has provoked enormous research interest around the world. Given all the data collected and the research efforts undertaken, it is clear that our empirical awareness of innovation has been pushed forward significantly over the last two decades. Yet, overall, it is still quite surprising how little we know about the subject of innovation, even though there is almost universal agreement regarding its crucial role in economic growth and development.

Referred to as "kiwi ingenuity", New Zealanders are very creative people; what's puzzling is that the economic performance of New Zealand remains poor in spite of a nearly textbook perfect macroeconomic and institutional framework. The unique demographic, economic condition and geographic location of New Zealand means that the drivers of innovation and growth may be different, hence a New Zealand based study is necessary to improve our understanding of firm-level innovation behaviours.

Following the third edition of *Oslo Manual*, one of the foremost international guides on the collection and use of innovation data, New Zealand's national statistical agency provides one of the best survey instruments for collecting innovation data. However, this rich data source has not been fully utilised due to its limited and restrictive access, until recently.

Guided by previous work of researchers from around the world, the research presented here considers many aspects of innovation, from what we mean by innovation, to its varied and various measurements. After an extensive review of international innovation surveys, a series of regression analyses were undertaken. Given the self-reported nature of the surveys and the limited longitudinal data, a number of detailed case studies were also undertaken to complement and test the validity of the quantitative results. The combined use of quantitative and qualitative research methods enables a better understanding of the dynamic innovation processes in New Zealand firms.

9.1 Research outcomes

Summarising the research results, a number of conclusions can be drawn. Firstly, one main conclusion of this thesis rests on the controversial firm size effect of innovation. According to research results presented in this thesis, large firms in New Zealand appear to be better innovation performers than small firms. Apparently, this result contradicts the international consensus that suggests a U-shape relationship between innovation and firm size. However, when considered more carefully, such a result is consistent with the international literature if we accept the practical differences and context in which the terms large, medium and small firms are used in practices.

As discussed in Section 3.1.1.3, different studies across countries tend to define small and large firms differently, in particular the definition of SMEs in New Zealand is very different when compared to definitions in other countries. New Zealand's 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. On 1 January 2005, the European Commission adjusted the 1996 definition using the updated thresholds (see Figure 9-1), and defined medium sized enterprise as firms with fewer than 250 annual work units (AWU)[19], annual turnover[20] no more than €50 million or an annual balance sheet total[21] of less than €43 million (2003). In the United States, the bar for small businesses is even higher. The Small Business Administration (SBA) defines a SBA small business size standard for every private sector industry aiming to reflect industry differences accurately. The standard is usually stated either in terms of numbers of employees or average annual

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[19] Similar to the Full Time Equivalent (FTE) measurement, a full time worker is counted as one annual work unit, and part-time staff and seasonal workers are counted as fractions of one unit.

[20] Income received in the reference year after rebates paid outs, excluding value added tax or other indirect taxes.

[21] Refers to the value of the company's main assets.

receipts [22]. Within the manufacturing sector, the size standard for approximately 75 percent of the industries is 500 employees, with the remaining industries having a higher threshold at 750, 1000 or 1500 employees.

Figure 9-1 Definition of SMEs- European Commission

Enterprise category	Headcount: Annual Work Unit (AWU)	Annual turnover		Annual balance sheet total
Medium-sized	< 250	≤ €50 million (in 1996 € 40 million)	or	≤ €43 million (in 1996 € 27 million)
Small	< 50	≤ €10 million (in 1996 € 7 million)	or	≤ €10 million (in 1996 €5 million)
Micro	< 10	≤ €2 million (previously not defined)	or	≤ €2 million (previously not defined)

Source: European Commission

Compared to the U.S. and European thresholds, New Zealand's SMEs are micro or even nano, not small or medium, which means that based on New Zealand's definition, international studies are also suggesting that *non-SMEs in New Zealand are more innovative*.

[22] Average of total income plus cost of goods sold for the latest three fiscal years; for exclusion receipts refer to SBA's website, http://www.sba.gov/services/contractingopportunities/sizestandardstopics/indexguide/index.html.

Firm size and investment capability are critical for firm–level innovation, however New Zealand firms experience considerably smaller positive size effect compared with those reported in many other countries because of its unique firm demographics. In particular, the small firm size and limited investment capability have impacted the country's innovation style. As revealed in the case studies, the majority of firms are less willingly to undertake risky innovation, and they will only fund it using cash flow or retained earnings. As a result, most firm–level innovations are incremental improvements with low investment commitments and faster return, while most radical innovations are sold to multinationals for future development and commercialisation. In other words, the small size has limited individual firm's innovation opportunities and the heavy weight towards SMEs has limited New Zealand's growth potential.

Secondly, technology advancement is the essence of innovation in New Zealand firms. Even though both technological and non-technological related innovations are carried out by firms at approximately similar rates (see Table 6-1). According to the case studies, businesses tend to implement other types of innovation to complement the introduction of product innovations. Highly dependent on the availability of funds and skills, firms' inner ability to develop new technologies directly influences their ability to develop new product, hence impacts firms' overall innovation performance. In New Zealand, institutional factors have considerably less influence on innovation outcomes, the insignificance of estimated coefficients may be explained by diminishing marginal returns, such that the current conditions have already reached an acceptable level, and additional investments will only yield limited benefit to innovative activities. Therefore, more efforts should be made to attract appropriate funds and skills, which is essential for generation of product innovation.

Finally, innovation in New Zealand firms has a very strong market focus and highly demand driven, whereas technology suppliers such as universities and CRIs only play a limited role in a number of primary related industries. Facing a small domestic market, New Zealand firms have to actively seek and enter other international markets for additional growth, while innovation increases the chance of success. International engagement is found to be positively associated with innovation outcomes, in particular newly-exporting firms out perform in terms of product and marketing innovation.

9.2 Limitations

At this stage of our research, it is necessary to identify some limitations of the methodology which need to be considered in further work. 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 previously, most New Zealand firms are SMEs, but for administration purposes the target population for BOS excludes firms with 5 or fewer employees, which implies that around 90 percent of enterprises were not sampled by the survey. Fortunately, firms with five or fewer employees only accounted for 25.8 percent 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.

9.3 Future research

Based on our research results, it is clear that New Zealand faces a size issue. What's not clear is whether New Zealand firms are simply too small to make a difference on the global scale; or their inability to scale up to the threshold has hindered firms from undertaking technological leaps; or it is the policy framework in New Zealand that has limited the ability of firms to achieve scale and critical mass.

While the widespread growth in surveys has allowed researchers to increase our understanding of innovation, more improvements should be made around data quality and survey designs to allow panel studies in future research by incorporating data from multiple years. More specifically, the current sampling method used in the BOS, the two-level stratification according to ANZSIC industry and employment size groups, is not designed to track firms over their business life, and does not support the generation of a true panel as firms can drop in and out of the sample in any given year.

Qualitative studies with different case designs would complement our understanding of firm level innovation, such that different research questions can be addressed by altering the research boundaries and sample selection criteria. Researchers could also design case studies based on certain policy initiative, hence assist the detailed design of innovation policy.

Last but not least, empirical work on innovation has now far outstripped theoretical work on innovation, much of which is still struggling with variants of neo-classical growth-accounting framework. A comprehensive theoretical innovation model will help to improve our understanding of empirical results and undoubtedly to lead to more revealing empirical results and testing.

Appendix 1 Technical information - Business Operation Survey

The target population for the survey is live enterprise[23] units on Statistics New Zealand's Business Frame that at the population selection date:

- are economically significant enterprises (those that have an annual GST turnover figure of greater than $30,000),
- have six or more employees,
- have been operating for one year or more,
- are classified to Australian and New Zealand Standard Industrial Classification – New Zealand Version 1996 (ANZSIC96/06) codes listed as 'in scope' in List 1-1 and List 1-2 below,
- are private enterprises as defined by New Zealand Institutional Sector 1996 Classification (NZISC96) listed in List 2 below.

<u>List 1-1ANZSIC96 code</u>
In scope
A – Agriculture, Forestry and Fishing
B – Mining and Quarrying
C – Manufacturing
D – Electricity, Gas and Water Supply
E – Construction
F – Wholesale Trade
G – Retail Trade
H – Accommodation, Cafes and Restaurants
I – Transport and Storage
J – Communication Services
K – Finance and Insurance
L – Property and Business Services
N – Education
O – Health and Community Services
P91 – Motion Picture, Radio and Television Services
P93 – Sport and Recreation
Out of scope
M – Government Administration and Defence

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[23] An enterprise is defined as a business or service entity operating in New Zealand, such as a company, partnership, trust, government department or agency, state-owned enterprise, university or self-employed individual.

P92 – Libraries, Museums and the Arts
Q – Personal and Other Services.

List 1-2 ANZSIC06 code
In scope
A – Agriculture, forestry and fishing
B – Mining
C – Manufacturing
D – Electricity, gas, water and waste services
E – Construction
F – Wholesale trade
G – Retail trade
H – Accommodation and food services
I – Transport, postal and warehousing
J – Information media and telecommunications
K – Financial and insurance services
L – Rental, hiring and real estate services
M – Professional, scientific and technical services
N – Administrative and support services
P – Education and training
Q – Health care and social assistance
R91 – Sport and recreation activities
R92 – Gambling activities
S94 – Repair and maintenance.
Out of scope
O – Public administration and safety
R89 – Heritage activities
R90 – Creative and performing arts activities
S95 – Personal and other services
S96 – Private household employing staff and undifferentiated goods and service
producing activities of households for own use

List 2 NZISC96 codes
In scope
NZISC96 code – description
1111 – Private corporate producer enterprises
1121 – Private non-corporate producer enterprises
1211 – Producer boards
1311 – Central government enterprises
2211 – Private registered banks

2221 – Private other broad money (M3) depository organisations
2291 – Private other depository organisations nec
2311 – Private other financial organisations excluding insurance and pension funds
2411 – Private insurance and pension funds.
Out of scope
1321 – Local government enterprises
21 – Central bank
2212, 2213, 2222, 2223, 2292, 2293, 2312, 2313, 2412, 2413 – Central and local government financial intermediaries
3 – General government
4 – Private non-profit organisations serving households
5 – Households
6 – Rest of world

The sample design is a two-level stratification according to ANZSIC industry and employment size groups based on information from Statistics NZ's Business Frame. The first level of stratification was ANZSIC groupings. Within each of the ANZSIC groups there is a further stratification by employment size group. The four employment size groups used in the sample design are:

- 6–19 employees (small)
- 20–29 employees (medium 1)
- 30–49 employees (medium 2)
- 50 or more employees (large).

Appendix 2 Variable descriptions for Fabling's model

Dependent Variables	Description
PP	Introduced product AND/OR operational process innovations ONLY
OM	Introduced orgnaisational/managerial process AND/OR marketing method innovations ONLY
COMBO	Introduced combination of "technological" & "non-technological" innovations
Independent Variables	**Description**
lnrme	log of Rolling Mean Employment (RME), a head-count measure
lnage	log of number of years since the company was created
Export intensity	Percentage of export sales
Foreign/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
Subsidiary firm	1 if firm belongs to a business group, 0 otherwise
Entered new export market	1 if firm entered any new export markets over the last financial year, 0 otherwise
Invested in expansion	1 if firm invested in its expansion (e.g. businesses/assets purchases, market/product development and etc.)
R&D intensity	R&D expenditure over total sales
Share of in-house R&D	Percentage of R&D expenditure related to in-house R&D activities
Part of a merger or acquisition	1 if firm merged with or acquired a shareholding in any other New Zealand or overseas business over the last financial year, 0 otherwise
General Training	1 if firm provided general training to any of its employees, 0 otherwise
Machinery and equipment	1 if firm acquired machinery and equipment during the last 2 financial years while trying to innovate, 0 otherwise
Computer hardware & software	1 if firm acquired computer hardware and software during the last 2 financial years while trying to innovate, 0 otherwise
Acquired other knowledge	1 if firm acquired other knowledge during the last 2 financial years while trying to innovate, 0 otherwise
Design	1 if firm carried out design work during the last 2 financial years while trying to innovate, 0 otherwise
Marketing New Products	1 if firm marketed the introduction of new goods or services during the last 2 financial years while trying to innovate, 0 otherwise
Trained employees	1 if firm provided employee training during the last 2 financial years while trying to innovate, 0 otherwise
Changed marketing strategy	1 if firm changed marketing strategies significantly during the last 2 financial years while trying to innovate, 0 otherwise
Market research	1 if firm conducted market research during the last 2 financial years while trying to innovate, 0 otherwise
New strategy/ management techniques	1 if firm implemented new business strategies or management techniques during the last 2 financial years while trying to innovate, 0 otherwise

Organisational restructuring	1 if firm experienced organisational restructuring during the last 2 financial years while trying to innovate, 0 otherwise
Co-operative arrangements	1 if firm had any co-operative arrangements during the last 2 financial years for the purpose of innovation, 0 otherwise
New staff	1 if firm considered new staff as a important source of ideas or information for innovation during the last two financial years, 0 otherwise
Existing staff	1 if firm considered existing staff as a important source of ideas or information for innovation during the last two financial years, 0 otherwise
Business group	1 if firm considered other businesses within the business group as a important source of ideas or information for innovation during the last two financial years, 0 otherwise
Customers	1 if firm considered customers as a important source of ideas or information for innovation during the last two financial years, 0 otherwise
Suppliers	1 if firm considered suppliers as a important source of ideas or information for innovation during the last two financial years, 0 otherwise
Competitors	1 if firm considered competitors and other businesses from the same industries as a important source of ideas or information for innovation during the last two financial years, 0 otherwise
Other industries	1 if firm considered business from other industries (not including customers or suppliers) as a important source of ideas or information for innovation during the last two financial years, 0 otherwise
Professional advisors	1 if firm considered professional advisors, consultants, banks or accountants as a important source of ideas or information for innovation during the last two financial years, 0 otherwise
Books/patent/ internet	1 if firm considered books, journals, patent disclosures or internet as a important source of ideas or information for innovation during the last two financial years, 0 otherwise
Conferences/ exhibitions	1 if firm considered conferences, trade shows or exhibitions as a important source of ideas or information for innovation during the last two financial years, 0 otherwise
Industry/employer organisations	1 if firm considered industry or employer organisations as a important source of ideas or information for innovation during the last two financial years, 0 otherwise
Universities/ polytechnics	1 if firm considered universities or polytechnics as a important source of ideas or information for innovation during the last two financial years, 0 otherwise
CRIs & other Research Institutes	1 if firm considered Crown Research Institutes, other research institutes, or research associations as a important source of ideas or information for innovation during the last two financial years, 0 otherwise
Government agencies	1 if firm considered government agencies as a important source of ideas or information for innovation during the last two financial years, 0 otherwise

Appendix 3 NZMEA and NZMEA database

Background

The Canterbury Manufacturers' Association (CMA) was founded in 1879, is New Zealand's only industrial organisation with a sole focus on the manufacturing and exporting sectors. From the outset, those who volunteered to provide governance for the Association sought to encourage and support manufacturing in Canterbury and the South Island.

Since 2000, CMA has gradually extended its focus to a national level. In August 2007 the New Zealand Manufacturers and Exporters Association was launched, incorporating the CMA and the New Zealand Engineering Federation (NZEF). As a membership organisation, the Association's primary focus is to deliver the highest quality of service, directly and indirectly, to its members. It assists individual members with their specific issues, whether it is a day-to-day operational complication or long-term business strategy planning. The Association actively participates in the political debates and submissions, representing New Zealand manufacturers and exporters as a whole, not just its members, but the entire industry sector. Therefore, it is important to keep a close relationship with its existing members as well as non members within the sector.

The formation of the NZMEA database

During the 1990s, New Zealand economy experienced a phase of rapid growth. As the number of manufacturers increases, the Association faced a challenge as how to manage the company profiles efficiently. In the early stages, the ManFed database was adopted for general business use, which was constructed by the New Zealand Manufacturers' Federation[24]. As the complexity of the information increased, an upgrade of the database was soon required. After consulting with the main user groups in 2001 a Microsoft Access database was specifically designed for the Association. This database is much more than a contact list, a comprehensive company profile is created for each company. It also allows companies to be sorted according to the specific characteristics of the company, subsequently, a sub-set of the database can be created. Another user-friendly feature of the database is that all information can be easily accessed via Microsoft Outlook, though no information can be changed without authorisation.

Starting from scratch, the ManFed database was transferred into the new system, and several databases were purchased from a local research and marketing company,

[24] During May 2001, New Zealand Manufacturers Federation and the New Zealand Employers Federation merged to become Business New Zealand.

Finda Ltd[25]. Also all existing company information was entered, which includes information from business cards, company annual reports, newsletters and any publicly available sources. Like most databases, the NZMEA database requires constant maintaining and updating, this means keeping contact with the existing companies, at the same time, looking out for inflow and outflow within the sector and adjusting the database accordingly. Since 2004, the Association established a service call routine, which helps the network building process, and ensures that the database is relatively well updated.

What's included in the NZMEA database

The information within the NZMEA database can typically be categorised into two groups, the general contact details and the company profile; the general contact details include the company name, contact phone numbers and the mailing address; the company profiles are more concerned with the company's operation and background. The available data includes the membership status, company Standard Industrial Classification (ANZSIC), export destinations, staff numbers and annual turnovers. The details of these elements will be explained in the rest of this appendix.

First, NZMEA membership may be granted to any person, partnership, firm, company or association whether incorporated or not, the membership status describes the current relationship between two parties.

Secondly, all companies are assigned into the appropriate ANZSIC06 code, which is the official industrial classification used in New Zealand and Australia.

Thirdly, if the company is currently exporting, its export destinations are recorded. The relevant countries or areas are selected in the database, which are Australia, Asia, North America, South America, Europe, Africa and South Pacific.

Lastly, both total staff numbers and annual turnover are recorded. However, these figures are more likely to be an approximation than the exact number, especially in the case of annual turnovers.

Note that due to the confidentiality issue, company information is only available within the association, which cannot be released to the general public. Such information includes company name, membership status and mailing address. Information supplied by members is confidential to the Association and is not supplied even to other members.

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[25] Company web address: http://finda.co.nz/

Appendix 4 Pre-interview questionnaire

Name(s):_______________ Company:_____________________________

Email:________________________________ Ph:____________________

Physical Address: ____

____

1. How many staff work for your company including both part-time and full-time employees? ___________________
2. Does your business export? ☐ Yes / ☐ No

If yes, approximately what percentage of sales comes from exports (i.e. 30%)? _____

3. How long has your business been in operation (to the nearest year)? _____
4. How many establishments (sites/physical locations) does your company have?

   ☐ One ☐ More than one, how many? ________

5. In the last three financial years, did your business develop or introduce any new or significantly improved goods and services; operational processes; organisational/ managerial processes; marketing methods? ☐ Yes / ☐No

Appendix 5 Case study questions

Firm Characteristics

1. Please describe the competition your business faces?
2. What is the current key strategy or main focus of your firm?
3. What are the problems your firm is currently facing?
4. Do you consider your firm to be a leader of your sector of business?

Innovation related questions

5. What does the term innovation mean to you and your business? How would you define innovation?
6. Did your business introduce any new products (goods or service), new processes or new marketing or organisational methods in the past year? If yes which kind, how many and what motivated the innovation(s)?
7. How does your business innovate? Is innovation a part of day to day operation or are specific activities and resources devoted to the process (e.g. R&D, IP protection, market research and etc.)?
8. Why does your business innovate? Do you think innovation increases your business' productivity and profitability?
9. What's do you think are the key drivers of successful innovation outcomes? (Skills, Capital, Networks or opportunity)? What role do customers, suppliers and other firms play during the process?
10. Does your firm collaborate with other businesses or academic establishments as part of the innovation process?
11. Do you think New Zealand firms are generally innovative when compared with overseas firms?
12. What role do you think Government and government agencies should have in the innovation process/system? Have you received any funding to support innovation in your firm through government agencies?

Spatially related questions

13. Why did your business locate at its current location? How was the initial decision made?
14. Is your business happy with its current location? Are you planning to move location in the near future? If yes, why?
15. What kind of relationship does your business have with your main suppliers and customers and where are they located?
16. Does location play a role in the innovation process in your firm? e.g. proximity to universities; customers; suppliers; similar firms, etc?
17. Do you look overseas for examples of successful innovations (new products; processes, etc) if so where?

Appendix 6 Modifications made to auto concepts generated by Leximancer

Modification	Case 1	Case 2	Case 3	Case 4	All cases
Automatically generated concepts manually removed	couple, day, doing, million, saying, sell, talking, things, time, top, trying, understand, use, whole, work	cos, cost, create, doing, level, look, million, real, sell, shift, stuff, things, time, trying, whole, work	better, course, doing, example, flat, means, sense, sorts, terms, things, time, work	better, cos, different, difficult, doing, guess, look, making, moment, pay, things, time, whole, work, year	better, coming, cos, day, doing, example, look, pay, probably, real, saying, sell, talking, terms, things, time, trying, whole, work, year
Concepts merged	customers/users; people/ person	business/company; product/hardware; money/dollars	business/company; Australia/ Australian; product/ product names*	business/company; place names*	business/company; product/ product names*
Compound concept created	Nil	supply chain, exchange rate	entry barriers, building codes	exchange rate	exchange rate

* the concept names omitted for privacy reasons

References

Abernathy, W. J., & Clark, K. B. (1985). Innovation: Mapping the winds of creative destruction *Research Policy, 14*(1), 3-22.

Acs, Z. J., & Audretsch, D. B. (1987). Innovation, market structure, and firm size. *The Review of Economics and Statistics, 69*(4), 567-574.

Acs, Z. J., & Audretsch, D. B. (1988). Innovation and large and small firms: An empirical analysis. *The American Economic Review, 78*(4), 678-690.

Adelman, M. A. (1951). The measurement of industrial concentration. *The Review of Economics and Statistics, 33*(4), 269-296.

Aghion, P., Bloom, N., Blundell, R., Griffith, R., & Howitt, P. (2005). Competition and innovation: An inverted-U relationship. *The Quarterly Journal of Economics, 120*(2), 701-728.

Aiken, M., & Hage, J. (1971). The organic organisation and innovation *Sociology, 5*(1), 63-82.

Alegre, J., & Chiva, R. (2008). Assessing the impact of organisational learning capability on product innovation performance: An empirical test. *Technovation, 28*, 315-326.

Andersen, E. S. (1995). *Neo- and post-Schumpeterian contributions to evolutionary economics.* Paper presented at the Paper presented at the Conference on Economics and Evolution, arranged by the Belgian-Dutch Association for Post-Keynesian Economics.

Anderson, P., & Tushman, M. L. (1990). Technological discontinuities and dominant designs: a cyclical model of technological change. *Administrative Science Quarterly, 35*(4), 604-633.

Anyadike-Danes, M., Bonner, K., Hart, M., & Mason, C. (2009). *Measuring business growth: High-growth firms and their contribution to employment in the UK.* London: NESTA.

APEC Secretariat. (2012). *Support for SME innovation, supply-chain integration*. St Petersburg, Russia: Scoop.

Archibugi, D., Cesaratto, S., & Sirilli, G. (1987). Innovative activity, R&D and Patenting: The Evidence of the Survey on Innovation Diffusion in Italy. *Science Technology Industry Review 2*, 135-190.

Archibugi, D., Cesaratto, S., & Sirilli, G. (1991). Sources of innovative activities and industrial organisation in Italy *Research Policy, 20*(4), 299-313.

Archibugi, D., & Michie, J. (1997). *Innovation policy in a global economy*. Cambridge: Cambridge University Press.

Armbruster, H., Bikfalvi, A., Kinkel, S., & Lay, G. (2008). Organisational innovation: The challenge of measuring non-technical innovation in large-scale surveys. *Technovation, 28*, 644-657.

Arndt, O., & Sternberg, R. (2000). Do manufacturing firms profit from intraregional innovation linkages? An empirical based answer *European Planning Studies, 8*(4), 465-486.

Artes, J. (2009). Long-run versus short-run decisions: R&D and market structure. *Research Policy, 38*, 120-132.

Asheim, B., & Isaksen, A. (1997). Location, agglomeration and innovation: towards regional innovation systems in Norway? . *European Planning Studies, 5*(3), 299-330.

Atuahene-Gima, K. (1995). Adoption of new products by the sales force: The construct, research propositions, and managerial implications. *Journal of Product Innovation Management, 14*, 498-514.

Auckland Council. (2011). *Auckland unleashed: The Auckland plan disscussion document* Auckland: Auckland Council.

Audretsch, D. B. (2003). Innovation and spatial externalities. *International Regional Science Review, 26*(2), 167-174.

Autio, E. (1998). Evaluation of RTD in regional system of innovation *European Planning Studies, 6*(2), 131-140.

Avlonitis, G. J., Kouremenos, A., & Tzokas, N. (1994). Assessing the innovativeness of organisations and its antecedents: Project innovstrat. *European Journal of Marketing 28*(11), 5-28.

Badawy, M. K. (1988). How to prevent creativity mismanagement. *IEEE Engineering Management Review, 16*(2), 63.

Baldwin, R. E. (1979). Determinants of trade and foreign investment: Further evidence. *The Review of Economics and Statistics, 61*(1), 40-48.

Baldwin, W. L., & Childs, G. L. (1969). The fast second and rivalry in research and development. *Southern Economic Journal, 36*(1), 18-24.

Banbury, C. M., & Mitchell, W. (1995). The Effect of Introducing Important Incremental Innovations on Market Share and Business Survival. *Strategic Management Journal, 16*, 161-182.

Baumol, W. J. (2002). *The free-market innovation machine: Analyzing the growth miracle of capitalism*. N. J.: Princeton University Press.

Baumol, W. J. (2005). Education for innovation: Entrepreneurial breakthroughs versus corporate incremental improvements. *Innovation and the Economy, 5*, 33-56.

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report, 13*(4), 544-559.

Bayoumi, T., Coe, T. D., & Helpman, E. (1999). R&D spillovers and global growth *Journal of International Economics, 47*(2), 399-428.

Becker, S. O., & Egger, P. H. (2009). Endogenous product versus process innovation and a firm's propensity to export. *Emporical Economics, First Online* (DOI 10.1007/s00181-009-0322-6).

Becker, S. W., & Stafford, F. (1967). Some determinants of organisational success. *The Journal of Business, 40*(4), 511-518.

Becker, S. W., & Whisler, T. L. (1967). The innovation organisation: A selective view of current theory and research. *The Journal of Business, 40*(4), 462-469.

Beneito, P. (2006). The innovative performance of in-house and contracted R&D in terms of patents and utility models. *Research Policy, 35*, 502-517.

Bessant, J., & Rush, H. (1995). Building bridges for innovation: The role of consultants in technology transfer. *Research Policy, 24*(1), 97-114.

Bonaccorsi, A., & Piccaluga, A. (1994). A theoretical framework for the evaluation of university-industry relationship. *R&D Management, 24*(4), 229-247.

Bower, J. L., & Christensen, C. M. (1995). Disruptive technologies: Catch the wave. *Harvard Business Review*(January-February), 44-53.

Breschi, S., & Malerba, F. (1997). Sectoral innovation system: technological regimes, schumpeterian dynamics, and spatial boundaries. In C. Edquist (Ed.), *Systems of innovation: technologies institutions and organisations* (pp. 130-156). London and Washington: Printers.

Brewin, D. G., Monchuk, D. C., & Partridge, M. D. (2009). Examining the adoption of product and process innovations in the Canadian food processing industry. *Canadian Journal of Agricultural Economics, 57*, 75-97.

Brouwer, E., Budil-Nadvornikova, H., & Kleinknecht, A. (1999). Are urban agglomerations a better breeding place for product innovation? An analysis of new product announcements. *Regional Studies, 33*(6), 541-550.

Brozen, Y. (1951). Invention, innovation, and imitation. *The American Economic Review, 41*(2), 239-257.

Caelile, P. R. (2002). A pragmatic view of knowledge and boundaries: boundary objects in new product development *Organisation Science 13*(4), 442-255.

Calia, R. C., Guerrini, F. M., & Moura, G. L. (2007). Innovation networks: From technological development to business model reconfiguration *Technovation, 27*, 426-432.

Campbell, D. T. (1975). Degrees of freedom and the case study. *Comparative Political Studies, 8*, 178-193.

Carlsson, B. (2003). Innovation systems: A survey of the literature from a Schumpeterian perspective *Elgar companion to Neo-Schumpeterian economics, June*.

Carlsson, B., Jacobsson, S., Holmen, M., & Rickne, A. (2002). Innovation systems: analytical and methodological issues *Research Policy, 31*, 233-245.

Carlsson, B., & Stankiewicz, R. (1991). On the nature, function and composition of technological systems. *Journal of Evolutionary Economics, 1*, 93-118.

Carroll, J. (1967). A Note on departmental autonomy and innovation in medical school. *The Journal of Business, 40*(4), 531-534.

Carter, C. F., & Williams, B. R. (1957). *Industry and technical progress: Factors governing the speed of application of science*. London: Oxford University Press.
Carter, C. F., & Williams, B. R. (1958). *Investment in innovation* London: Oxford University Press.
Chandy, R. K., & Tellis, G. J. (2000). The incumbent's curse? Incumbency, size, and radical product innovation *Journal of Marketing, 64*(3), 1-17.
Chang, Y.-C., & Chen, M.-H. (2004). Comparing approaches to systems of innovation: the knowledge perspective *Technology in Society, 26*, 17-37.
Chiesa, V., Coughlan, P., & Voss, C. A. (1996). Development of a technical innovation audit. *Journal of Product Innovation Management 13*(2), 105-136.
Chon, S. F., & Turin, R. M. (1984). Organisational structure, decision making procedures and the adoption of innovations. *IEEE Transactions on Engineering Management, 31*, 154-161.
Chua, W. F., & Mahama, H. (2007). The effect of network ties on accounting controls in a supply alliance: field study evidence. *Contemporary Accounting Research, 24*(1), 47-92.
Clyde, P. S., & Reitzes, J. D. (1995). *The effectiveness of collusion under antitrust immunity, the case of liner shipping conferences*. Retrieved from http://www.ftc.gov/reports/shipping.pdf.
Cohen, W. M., & Klepper, S. (1996). A reprise of size and R&D. *The Economic Journal, 106*(437), 925-951.
Cohen, W. M., & Levinthal, D. A. (1989). Innovation and learning: The two face of R&D. *The Economic Journal, 99*(397), 569-596.
Cohen, W. M., & Levinthal, D. A. (1990). Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly, 35*(1), 128-152.
Comanor, W. S. (1965). Research and technical change in the pharmaceutical industry. *The Review of Economics and Statistics, 47*(2), 182-190.
Comanor, W. S. (1967). Market structure, product differentiation, and industrial research. *The Quarterly Journal of Economics, 81*(4), 639-657.
Cook, P. (1992). Regional innovation systems-competitive regulation in the New Europe. *Geoforum, 23*(3), 365-382.
Cook, P., Ursnga, M. G., & Etxebarria, G. (1998). Regional systems of innovation: an evolutionary perspective *Environment and Planning A, 30*(9), 1563-1584.
Cooper, R. G. (1984). The strategy-performance link in product innovation. *R&D Management 14*(4), 247-259.
Crepon, B., Duguet, E., & Mairesse, J. (1998). Research, innovation and productivity: An econometric analysis at the firm level. *NBER Working Paper 6696*
Crofts, K., & Bisman, J. (2010). Interrogating accountability- An illustration of the use of Leximancer Software for qualitative data analysis. *Qualitative Research in Accounting and Management, 7*(2), 180-207.

Crown Research Institute Taskforce. (2010). *How to enhance the value of New Zealand's investment in Crown Research Institutes*. Wellington: The Taskforce.

Cuervo-Cazurra, A., & Un, C. A. (2007). Regional economic integration and R&D investment. *Research Policy, 36*, 227-246.

Cumming, B. S. (1998). Innovation overview and future challenges. *European Journal of Innovation Management, 1*(1), 21.

Dahmen, E. (1970). *Entrepreneurial activity and the development of Swedish industry, 1919-1939*. Homewood, IL: American Economic Association Translation Series.

Dahmen, E. (1991). Development blocks in industrial economics. In B. Carlsson (Ed.), *Development Blocks and Industrial Transformation-The Dahménian Approach to Economic Development* Stockholm: The Industrial Institute for Economic and Social Research.

Damanpour, F. (1991). Organisational innovation: A meta-analysis of effects of determinants and moderators. *Academy of Management Journal, 34*(3), 555-590.

Dar, I. R., & Ahmed, M. S. (2009). Role of research and development in product innovation: a correlation study *International Review of Business Research Papers, 5*(4), 147-156.

Dasgupta, P., & Stiglitz, J. (1980). Industrial structure and the nature of innovative activity. *The Economic Journal, 90*(358), 266-293.

De Marchi, M., Napolitano, G., & Taccini, P. (1996). Testing a model of technological trajectories. *Research Policy, 25*, 13-32.

Dewar, R. D., & Dutton, J. E. (1986). The adoption of radical and incremental innovations: An empirical analysis. *Management Science, 32*(11), 1422-1233.

Doloreux, D. (2002). What we should know about regional systems of innovation *Technology in Society, 24*, 243-263.

Doloreux, D., & Parto, S. (2005). Regional innovation system: Current discourse and unresolved issues. *Technology in society, 27*, 133-153.

Dosi, G. (1982). Technological paradigms and technological trajectories. *Research Policy, 11*(3), 147-162.

Edquist, C. (2004). Systems of innovation -a critical review of the state of the art In J. Fagerberg, D. Mowery & R. Nelson (Eds.), *Handbook of innovation*. Oxford: Oxford University Press.

Ehrnberg, E. (1995). On the definition and measurement of technological discontinuities. *Technovation, 15*(7), 437-452.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Journal, 14*(4), 532-550.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: opportunities and challenges. *Academy of Management Journal, 50*(1), 25-32.

Ettlie, J. E., Bridges, W. P., & O'Keefe, R. D. (1984). Organisation strategy and structural differences for radical versus incremental innovation. *Management Science, 30*(6), 682-695.

European Commission. (2003). *The new SME definition: User guide and model declaration* Enterprise and Industry Publication

Fabling, R. (2007). Just how innovative are New Zealand firms? Quantifying & relating organisational and marketing innovation to traditional science& technology indicators Ministry of Economic Development Occasional Paper 07/04.

Fabling, R., Gretton, J., & Claire, P. (2008a). *Developing the prototype longitudinal business database: New Zealand's experience*. Paper presented at the Paper presented at Statistics Research Institute (SRI) seminar, Korea.

Fabling, R., Grimes, A., & Stevens, P. (2008b). *A comparison of qualitative and quantitative firm performance measures*: Ministry of Economic Development Occasional Paper 08/04.

Faems, D., Looy, B. V., & Debackere, K. (2005). Interorganisational collaboration and innovation: Toward a portfolio approach. *Journal of Product Innovation Management, 22*, 238-250.

Falk, M. (2008). Effect of foreign ownership on innovation activities: empirical evidence for twelve European countries. *National Institute Economic Review, 204*(1), 85-97.

Fisher, F. M., & Temin, P. (1973). Returns to scale in research and development: What does the Schumpeter hypothesis imply? *The Journal of Political Economy, 81*(1), 56-70.

Fisher, F. M., & Temin, P. (1979). The Schumpeterian hypothesis: Reply. *The Journal of Political Economy, 87*(2), 386-389.

Flaig, G., & Stadler, M. (1994). Success breeds success: The dynamics of the innovation process. *Emporical Economics, 19*, 55-68.

Freel, M. S. (2003). Sectoral patterns of small firm innovation, networking and proximity. *Research Policy, 32*, 751-770.

Freeman, C. (1982). *The economics of industrial innovation* (Second ed.). Cambridge: MIT Press.

Freeman, C. (1987). *Technology policy and economic performance: lesson from Japan*. London: Frances Printers.

Freeman, C. (1990). Schumpeter's business cycles revisited *Evolving technology and market structure: Studies in Schumpeterian economics* (pp. 17-38). Ann Arbor: The University of Michigan Press.

Freeman, C. (1995). The 'national system of innovation' in historical perspective. *Cambridge Journal of Economics, 19*(1), 5-24.

Freeman, C., Clark, J., & Soete, L. (1982). *Unemployment and technical innovation*. London: Frances Printer.

Frenkel, A., Shefer, D., Koschalzky, K., & Walter, G. H. (2001). Firm characteristics, location and regional innovation: a comparison between Israeli and German industrial firm. *Regional Studies, 35*(5), 413-427.
Frenz, M., & Ietto-Gillies, G. (2009). The impact on innovation performance of different sources of Knowledge: Evidence from the UK Community Innovation Survey. *Research Policy, 38*, 1125-1135.
Gallaud, D., & Torre, A. (2005). Geographical proximity and the diffusion of knowledge. In G. Fuchs, P. Shapira & A. Koch (Eds.), *Rethinking regional innovation and change. Path dependency or regional breakthrough?* (pp. 127-146). Dordrecht: Springer Verlag.
Garcia, R., & Calantone, R. (2002). A critical look at technology innovation typology and innovativeness terminology: a literature review. *Journal of Product Innovation Management 19*, 110-132.
Gibbert, M., Ruigrok, W., & Wicki, B. (2008). What passes as a rigorous case study? . *Strategic Management Journal, 29*, 1465-1474.
Gilbert, R., & Newbery, D. (1982). Preemptive patenting and the persistence of monopoly. *American Economic Review, 72*, 514-526.
Glaeser, E., Kallal, H., Scheinkman, J., & Shleifer, A. (1992). Growth in cities. *Journal of Political Economy, 100*(1126-1152).
Gordon, I. R., & McCann, P. (2005). Innovation, agglomeration, and regional development. *Journal of Economic Geography, 5*, 523-543.
Grabowski, H. G. (1968). The determinants of industrial research and development: A study of the chemical, drug, and petroleum industries. *The Journal of Political Economy, 76*(2), 292-306.
Gruber, W., Mehta, D., & Vemon, R. (1967). The R&D factor in international trade and international investment of United States industries. *The Journal of Political Economy, 75*(1), 20-37.
Hage, J. T. (1999). Organisational innovation and organisational change. *Annual Review of Sociology, 25*, 597-622.
Harris, R., Li, Q. C., & Trainor, M. (2009). Is a higher rate of R&D tax credit a panacea for low levels of R&D in disadvantaged regions? *Research Policy, 38*, 192-205.
Henderson, R. M., & Clark, K. B. (1990). Architectural innovation: The reconfiguration of existing product technologies, and the failure of established firms. *Administrative Science Quarterly, 35*, 9-30.
Herrera, L., Munoz-Doyague, M. F., & Nieto, M. (2010). Mobility of public researchers, science knowledge transfer, and the firm's innovation process. *Journal of Business Research, 63*(5), 510-518.
Herrera, L., & Nieto, M. (2008). The national innovation policy effect according to firm location. *Technovation, 28*(8), 540-550.
Hewitt-Dundas, N., & Roper, S. (2008). Ireland's innovation performance:1991 to 2005. *ESRI Quarterly Economic Commentary, 2008*(2), 46-68.

Himmelberg, C. P., & Petersen, B. C. (1994). R & D and internal finance: A panel study of small firms in high-tech industries. *The Review of Economics and Statistics 76*(1), 38-51.
Hirschey, M. (1981). Market power and foreign involvement by U.S. multinationals. *The Review of Economics and Statistics, 64*(2), 343-346.
Hise, R. T., O'Neal, L., Parasuraman, A., & McNeal, J. U. (1990). Marketing/R&D interaction in new product development: Implications for new product success rates. *Journal of Product Innovation Management, 7*(2), 142-155.
Holland, M., & Spraragen, W. (1933). Research in hard times. Washington: Division of Engineering and Industrial Research, National Research Council.
Horowitz, I. (1962). Firm size and research activity. *Southern Economic Journal, 28*(3), 298-301.
Horowitz, I. (1963). Research Inclinations of a Cournot Oligopolist. *The Review of Economic Studies, 30*(2), 128-130.
Horst, T. (1972). Firm and industry determinants of the decision to invest abroad: An empirical study. *The Review of Economics and Statistics, 54*(3), 258-266.
Huchet-Bourdon, M., & Korinek, J. (2012). *Trade effects of exchange rates and their volatility: Chile and New Zealand*: OECD Trade Policy Working Papers.
Huergo, E. (2006). The role of technological management as a source of innovation: Evidence from Spanish manufacturing firms. *Research Policy, 35*, 1377-1388.
Huergo, E., & Jaumandreu, J. (2004). Firm's age, process innovation and productivity growth. *international Journal of Industrial Organisation, 22*, 541-559.
Hurley, R. F., & Hult, G. T. M. (1998). Innovation, market orientation and organisational learning: A integration and empirical integration and empirical examination. *Journal of Marketing, 62*(3), 42-54.
Jacobs, J. (1969). *The economy of cities*. New York: Vintage.
Jin, Z., Hewitt-Dundas, N., & Thompson, N. J. (2004). Innovativeness and performance: Evidence from manufacturing sectors. *Journal of Strategic Marketing 12*(4), 255-266.
Johansson, R. (2003). *Case study methodology.* Paper presented at the the International Conference on Methodologies in Housing Research, Stockholm.
Johnston, R. E. (1966). Technical progress and innovation. *Oxford Economic Papers, New Series, 18*(2), 158-176.
Jong, J. P. J. d., & Hippel, E. v. (2009). Transfers of user process innovations to process equipment producers: A study of Dutch high-tech firms. *Research Policy, 38*, 1181-1191.

Kafouros, M. I., Buckley, P. J., Sharp, J. A., & Wang, C. (2008). The role of internationalization in explaining innovation performance. *Technovation, 28*, 63-74.
Kahn, K. B. (2001). Market orientation, interdepartmental integration, and product development performance. *The Journal of Product Innovation Management, 18*, 314-323.
Kamien, M. I., & Schwartz, N. L. (1975). Market structure and innovation: A survey. *Journal of Economic Literature, 13*(1), 1-37.
Kamien, M. I., & Schwartz, N. L. (1976). On the degree of rivalry for maximum innovative activity. *The Quarterly Journal of Economics, 90*(2), 245-260.
Kaufmann, A., Lenhner, P., & Todtling, F. (2003). Effects of the internet on the spatial structure of innovation networks. *Information Economics and Policy, 15*(3), 402-424.
Khan, A. M., & Manopichetwattana, V. (1989a). Innovative and non innovative small firms: types and characteristics. *Management Science, 35*(5), 597-606.
Khan, A. M., & Manopichetwattana, V. (1989b). Models for distinguishing innovative and noninnovative small firms. *Journal of Business Venturing, 4*(3), 187-196.
Kirner, E., Kinkel, S., & Jaeger, A. (2009). Innovation paths and the innovation performance of low-technology firms- An empirical analysis of German industry. *Research Policy, 38*, 447-458.
Koc, T., & Ceylan, C. (2007). Factors impacting the innovative capacity in large-scale companies. *Technovation, 27*(3), 105-114.
Kohli, A., & Jaworski, B. J. (1990). Market orientation: The construct, research proposition, and managerial implications. *Journal of Marketing, 54*(2), 1-18.
Kohn, M. I., & Schwartz, N. L. (1982). Scale economics in research and development: The Schumpeterian hypothesis. *The Journal of Industrial Economics, 30*(3), 239-249.
Kraft, K. (1989). Market structure, firm characteristics and innovative activity. *Journal of Industrial Economics 37*, 329-336.
Krammer, S. M. S. (2009). Drivers of national innovation in transition: Evidence from a panel of Eastern European countries. *Research Policy, 38*, 845-860.
Labour and Immigration Research Centre. (2012). *Permanent and long term migration: The big picture*. Wellington: Department of Labour.
Laestadius, S., Pedersen, T., & Sandven, T. (2005). Towards a new understanding of innovativeness and of innovation based indicators. *Journal for Perspectives on Economic Political and Social Integration, 11* (1-2), 75-122.
Langlois, R. N. (2003). Schumpeter and the obsolescence of the entrepreneur. *Advances in Austrian Economics, 6*, 287-302.
Lawton, L., & Parasuraman, A. (1980). The impact of the marketing concept on new product planning. *Journal of Marketing, 44*(1), 19-25.

Leiponen, A. (2005). Skills and innovation *International Journal of Industrial Organisation, 23*, 303-323.

Leiponen, A. (2006). Managing knowledge for innovation: The case of business-to-business services. *Journal of Product Innovation Management 23*, 238-258.

Leiponen, A., & Byma, J. (2009). If you cannot block, you better run: Small firms, cooperative innovation, and appropriation strategies. *Research Policy, 38*(9), 1478-1488.

Leontief, W. (1941). *The structure of american economy,1919-1929. An empirical application of equilibrium analysis*. Cambridge, MA: Harvard University Press.

Levin, R. C., Cohen, W. M., & Mowery, D. C. (1985). R&D appropriability, opportunity and market structure: new evidence of some Schumpeterian hypothesis. *American Economic Review, 75*, 20-24.

Levitt, T. (1960). Growth and profits through planned marketing innovation. *Journal of Marketing, 24*(1), 1-8.

Lin, C. Y.-Y., & Chen, M. Y.-C. (2007). Does innovation lead to performance? An empirical study of SME in Taiwan. *Management Research News, 30*(2), 115-132.

Link, A. N. (1980). Firm size and efficient entrepreneurial activity: A reformulation of the Schumpeter hypothesis. *The Journal of Political Economy, 88*(4), 771-782.

Link, A. N., Seaks, T. G., & Woodbery, S. R. (1988). Firm size and R&D spending: Testing for functional form. *Southern Economic Journal, 54*(4), 1027-1032.

List, F. (1841). *The national system of political economy* (English ed.). London: Longman.

Little, A. D. (1963). *Patterns and problems of technical innovation in American industry* Washington: report submitted to the NSF, C-65344.

Lopez-Martinez, R. E., Medekkin, E., Scanlon, A. P., & Solleiro, J. L. (1994). Motivations and obstacles to university and industry co-operation (UIC): a Mexican case. *R&D Management, 24*(1), 17-31.

Love, J. H., & Roper, S. (1999). The determinants of innovation: R&D, technology transfer and networking effects. *Review of Industrial Organisation, 15*(1), 43-64.

Lundvall, B. (Ed.). (1992). *National system of innovation : towards a theorem of innovation and interactive learning*. London: Printer.

Lunn, J. (1982). Research and development and the Schumpeterian hypothesis: Alternate approach. *Southern Economic Journal 49*(1), 209-217.

Lunn, J., & Martin, S. (1986). Market structure, firm structure and research and development. *Quarterly Review of Economics and Business 26*, 31-44.

Mabin, G. (2011). *New Zealand's exchange rate cycles: Impacts and policy*. Wellington New Zealand Treasury

Mahagaonkar, P., Schweickert, R., & Chavali, A. S. (2009). *Sectoral R&D intensity and exchange rate volatility: A panel study for OECD countries*: Kiel Working Papers number 1531.

Mairesse, J., & Mohnen, P. (2001). To be or not to be innovative: An exercise in measurement. *Science, Technology and Industry Review (OECD), 27*, 103-129.

Mairesse, J., & Mohnen, P. (2005). The important of R&D for innovation: a reassessment using French survey data. *Journal of Tecnology Transfer, 30*(1-2), 183-197.

Mameli, F., Faggian, A., & McCann, P. (2008). Employment growth in Italian local labour systems: issues of model specification and sectoral aggregation. *Spatial Economic Analysis, 3*(3), 343-360.

Mansfield, E. (1968). *Industrial research and technological innovation: An econometric analysis*. New York: W. W. Norton.

Marcus, A. A. (1981). Policy uncertainty and technological innovation *The Academy of Management Review, 6*(3), 443-448.

Markham, J. W. (1965). Market structure, business conduct, and innovation. *The American Economic Review, 55*(1-2), 323-332.

Marsili, O., & Salter, A. (2006). The dark matter of innovation: design and innovative performance in Dutch manufacturing. *Technology Analysis & Strategic Management, 18*(5), 515-534.

Massa, S., & Testa, S. (2008). Innovation and SMEs: Misaligned perspectives and goals among entrepreneurs, academics, and policy makers. *Technovation, 28*(7), 393-407.

McCann, P., & Acs, Z. J. (2011). Globalization: Countries, cities and multinationals. *Regional Studies, 45*(1), 17-32.

McGinnis, M. A., & Ackelsberg, M. R. (1983). Effective innovation management: Missing link in strategic planning? . *Journal of Business Strategy, 4*(1), 59-66.

Meyer-Krahmer, F. (1984). Recent results in measuring innovation output *Research Policy, 13*, 175-182.

Meyers, P. W., & Tucker, F. G. (1989). Defining roles for logistics during routine and radical technological innovation. *Journal of Academy of Marketing Science, 17*(1), 73-82.

Midgley, D. F., & Dowling, G. R. (1978). Innovativeness: The concept and its measurement *The Journal of Consumer Research 4*(4), 229-242.

Miettinen, R. (2002). *National Innovation System - Scientific concept or political rhetoric*. Helsinki: Sitra.

Miles, M. B. (1979). Qualitative data as a attractive nuisance: the problem of analysis *Administrative Science Quarterly 24*(4), 590-601.

Miller, D., Kets de Vries, M. F. R., & Toulouse, J. M. (1982). Top executive locus of control and its relationship to strategy, environment and structure. *Academy of Management Journal, 25*(2), 237-253.

Mohr, L. B. (1969). Determinants of innovation in organisation. *American Political Science Review, 63*, 111-126.

Mol, M. J., & Birkinshaw, J. (2009). The sources of management innovation: When firms introduce new management practices. *Journal of Business Research, 62*, 1269-1280.

Mowery, D. C., & Rosenberg, N. (1979). The influence of market demand upon Innovation: A critical review of some recent empirical studies *Research Policy, 8*(2), 102-153.

Mueller, D. C. (1967). The firm decision process: An econometric investigation. *The Quarterly Journal of Economics, 81*(1), 58-87.

Mukhopadhyay, A. K. (1985). Returns to scale in R&D and the Schumpeterian hypothesis: A comment. *The Journal of Industrial Economics, 33*(3), 359-361.

Munari, F., Oriani, R., & Sobrero, M. (2010). The effects of owner identity and external governance systems on R&D investments: A study of Western European firms. *Research Policy, 39*(8), 1093-1104.

Myers, S., & Marquis, D. G. (1969). *Successful industrial innovation: A study of factors underlying innovation in selected firms* Washington: NSF69-17.

Nelson, R. (1977). *The Moon and the Ghetto*. New York: Norton.

Nelson, R. (Ed.). (1993). *National innovation systems: a comparative analysis* New York: Oxford University Press.

Nelson, R., & Winter, S. (1977). In search of a useful theory of innovation *Research Policy, 6*, 36-76.

New Zealand Cabinet. (2006). *Economic transformation: Giving effect to the five themes*. Wellington.

New Zealand Government. (2012). *Building innovation - the business growth agenda progress report*. Wellington.

Niosi, J. (2000). Science-based Industries: a new Schumpeterian taxonomy. *Technology in Society, 22*(4), 429-444.

Niosi, J., Saviotti, P., Bellon, B., & Crow, M. (1993). National systems of innovation: in search of a workable concept. *Technology in Society, 15*, 207-227.

Nutter, G. W. (1956). Monopoly, bigness, and progress. *The Journal of Political Economy, 64*(6), 520-527.

O'Connor, G. C., & McDermott, C. M. (2004). The human side of radical innovation. *Journal of Engineering and Technology Management, 21*, 11-30.

OECD. (1968). *Gaps in technology: General report*. Paris.

OECD. (2003). *Frascati manual 2002: Proposed standard practice for surveys on research and experimental development* Paris: OECD.

OECD. (2005). *Oslo manual: Guidelines for collecting and interpreting innovation data* (3rd ed.). Paris: OECD.

OECD. (2010). *R&D tax incentives: rationale, design, evaluation* Paris: OECD.

OECD. (2011). *Regions and innovation policy*. Paris: OECD.

Office of the Prime Minister. (2002). *Growing an innovative New Zealand*. Wellington
Okada, Y. (2004). R&D and productivity in Japanese manufacturing industries. *NBER Working Paper 11540*.
Panne, G. v. d., & Beers, C. v. (2006). On the Marshall-Jacobs controversy: It takes two to tango. *Industrial and Corporate Change, 15*(5), 877-890.
Pavitt, K. (1984). Sectoral patterns of technical change: Towards a taxonomy and theory. *Research Policy, 13*, 343-373.
Pavitt, K., Robson, M., & Townsend, J. (1987). The size distribution of innovation firms in the UK: 1945-1983 *The Journal of Industrial Economics, 35*(3), 297-326.
Pavitt, K., & Wald, S. (1971). *The conditions for success in the technological innovation*. Paris: OECD.
Pekovic, S., & Galia, F. (2009). From quality to innovation: Evidence from two french employer survey. *Technovation, 29*(12), 829-842.
Peterson, R. A., Rudelius, W., & Wood, G. L. (1972). Spread of marketing innovations in a service industry. *The Journal of Business, 45*(4), 485-496.
Pettigrew, A. (1973). *The politics of organisational decision marking*. London, UK: Tavistock.
Phillips, A. (1966). Patents, potential competition, and technical progress. *The American Economic Review, 56*(1/2), 301-310.
Phillips, A. (1971). *Technology and market structure: A study of the aircraft industry*. Lexington, Mass: D.C. Health.
Poot, J. (2009). Trans-Tasman migration, transnationalism and economic development in Australia. Motu Economic and Public Policy Research
Porter, M. E. (1990). *The competitve advantage of nations*: The Free Press.
Raymond, W., Mohnen, P., Palm, F., & Loeff, S. S. v. d. (2009). *Innovative sales, R&D and total innovation expenditures: Panel evidence on their dynamics*: CIRANO Working Papers 2009s-29.
Rochford, L., & Rudelius, W. (1992). How involving more functional areas within a firm affects the new product process. *Journal of Product Innovation Management, 9*(4), 287-299.
Rodriguez, C. A. (1979). A comment on Fisher and Temin on the Schumpeterian hypothesis. *The Journal of Political Economy, 87*(2), 383-385.
Rogers, E. M. (1983). *Diffusion of innovations* (3rd ed.). New York: The Free Press.
Rogers, E. M., & Shoemaker, F. F. (1971). *Communication of innovations*. New York: The Free Press.
Rogge, K. S., Schneider, M., & Hoffmann, V. H. (2011). The innovation impact of the EU emmission trading system- finding of company case studies in the German power sector. *Ecological Economics 70*, 513-523.
Roper, S., & Hewitt-Dundas, N. (2008). Innovation persistence: Survey and case-study evidence. *Research Policy, 37*, 149-162.

Rosenberg, N. (1974). Science, invention and economic growth *The Economic Journal, 84*(333), 90-108.

Rothwell, R. (1992). Successful industrial innovation: critical factors for the 1990s. *R&D Management, 22*(3), 221-239.

Rowe, L. A., & Boise, W. B. (1974). Organisational innovation: Current research and evolving concepts. *Public Administration Review, 34*(3), 284-293.

Ruttan, V. W. (1959). Usher and Schumpeter on invention, innovation, and technological change. *The Quarterly Journal of Economics, 73*(4), 596-606.

Sadowski, B. M., & Rasters, G. S.-. (2006). On the innovativeness of foreign affiliates: Evidence from companies in The Netherlands. *Research Policy, 35*, 447-462.

Salavou, H. (2004). The concept of innovativeness: Should we need to focus? *European Journal of Innovation Management 7*(1), 33-44.

Saliola, F., & Zanfei, A. (2009). Multinational firms, global value chains and the organisation of knowledge transfer. *Research Policy, 38*, 369-381.

Santamaria, L., Nieto, M. J., & Barge-Gil, A. (2009). Beyond formal R&D: Taking advantage of other sources of innovation in low- and medium-technology industries. *Research Policy, 38*, 507-517.

Saviotti, P. P., & Metcalfe, J. S. (1984). A theoretical approach to the construction of technological output indicators. *Research Policy, 13*(3), 141-151.

Saxenian, A. (1994). *Regional advantage. Culture and competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press.

Sceats, N. (1987). Scientists down the tube. *New Zealand Financial Review, 6*(17), 34.

Scellato, G. (2006). Patents, firm size and financial constraints: an empirical analysis for a panel of Italian manufacturing firms *Cambridge Journal of Economics, 31*, 55-76.

Scherer, F. M. (1965a). Firm size, market structure, opportunity, and the output of patent inventions. *The American Economic Review, 55*(5), 1097-1125.

Scherer, F. M. (1965b). Size of firm, oligopoly, and research: A comment. *The Canadian Journal of Economics and Political Science, 31*(2), 256-266.

Scherer, F. M. (1967). Research and development resource allocation under rivalry. *The Quarterly Journal of Economics, 81*(3), 359-394.

Schmiedeberg, C. (2008). Complementarities of innovation activities: An empirical analysis of the German manufacturing sector. *Research Policy, 37*, 1492-1503.

Schmookler, J. (1950). The interpretation of patent statistics. *Journal of the Patent Office Society, 32* (2), 123-146.

Schmookler, J. (1953). Patent application statistics as an index of inventive activity. *Journal of the Patent Office Society, 35*(7), 539-550.

Schmookler, J. (1954). The level of inventive activity. *Review of Economics and Statistics, 36*(2), 183-190.

Schmookler, J. (1966). *Invention and economic growth*. Cambridge: Harvard University Press.

Schumpeter, J. A. (1934). *The theory of economic development* Cambridge: Harvard University Press.

Schumpeter, J. A. (1942). *Capitalism, socialism and democracy*. New York: Harper and Row.

Sedgley, N., & Elmslie, B. (2004). The geographic concentration of knowledge: Scale, agglomeration, and congestion in innovation across U.S. states. *International Regional Science Review, 27*, 111-137.

Shepard, H. A. (1967). Innovation-resisting and innovation-producing organisations. *Journal of Business 40*(4), 470-477.

Siegel, S., & Kaemmerer, W. (1978). Measuring the perceived support for innovation in organisations *Journal of Applied Psychology, 63*(5), 553-562.

Siggelkow, N. (2007). Persuasion with case studies. *Academy of Management Journal, 50*(1), 20-24.

Slater, S. F., & Narver, J. C. (1995). Market orientation and the learning organisation *Journal of Marketing, 59*(3), 63-74.

Smith, A. E., & Humphreys, M. S. (2006). Evaluation of unsupervised semantic mapping of natural language with Leximancer concept mapping. *Behavior Research Methods, 38*(2), 262-279.

Solow, R. M. (1956). A contribution to the theory of economic growth. *The Quarterly Journal of Economics, 70*(1), 65-94.

Song, X. M., & Montoya-Weiss, M. M. (1998). Critical development activities for really new versus incremental products. *Journal of Product Innovation Management, 15*(2), 124-135.

Sorensen, J. B., & Stuart, T. E. (2000). Aging, obsolescence, and organisational innovation. *Administrative Science Quarterly, 45*(1), 81-112.

Souitaris, V. (2002). Technological trajectories as moderators of firm-level determinants of innovation. *Research Policy, 31*, 877-898.

Srholec, M. (2010). A multilevel approach to geography of innovation. *Regional Studies, 44*, forthcoming

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.

Statistics New Zealand. (2007). *Innovation in New Zealand 2005*. Wellington: Statistics New Zealand.

Statistics New Zealand. (2012a). *International travel and migration: July 2012*. Wellington Statistics New Zealand.

Statistics New Zealand. (2012b). *New Zealand business demography statistics (Structural): at February 2012*. Wellington: Statistics New Zealand.

Sternberg, R. (1996). Government R&D expenditure and space: Empirical evidence from five advanced industrial economies. *Research Policy, 25*(5), 741-758.

Sternberg, R., & Arndt, O. (2001). The firm or the region: What determines the innovation behavior of european firms? *Economic Geography, 77*(4), 364-382.

Stock, G. N., Greis, N. P., & Fischer, W. A. (2001). Absorptive capacity and new product development. *Journal of High Technology Management Research 12*, 77-91.

Stokey, N. L. (1995). R&D and economic growth. *Review of Economic Studies, 62*, 469-489.

Subramanian, A. (1996). Innovativeness: Redefining the concept. *Journal of Engineering and Technology Management, 13*, 223-243.

Swan, J. A., & Newell, S. (1995). The role of professional associations in technology diffusion. *Organisation Studies, 16*, 846-873.

The European Communities. (2000). Innovation and SMEs, *European Commission,* . Luxembourg.

The New Zealand Treasury. (2008). *Putting productivity first.* Wellington: New Zealand Treasury Productivity Paper 08/01.

The New Zealand Treasury. (2010). *New Zealand economic and financial overview 2010.* Wellington: The New Zealand Treasury.

Thompson, V. A. (1965). Bureaucracy and innovation. *Administrative Science Quarterly, 10*(1), 1-20.

Tingvall, P. G., & Poldahl, A. (2006). Is there really an inverted U-shape relation between competition and innovation? . *Economics of Innovation and New Technology, 15*(2), 101-118.

Tinnesand, B. (1973). *Towards a general theory of innovation.* University of Wisconsin, Madison, WI.

Todtling, F., Lehner, P., & Kaufmann, A. (2009). Do different types of innovation rely on specific kinds of knowledge interactions? *Technovation, 29*, 59-71.

Trott, P. (1998). *Innovation management and new product development* London: Pitman Publishing.

Tsai, K.-H. (2009). Collaborative networks and product innovation performance: Toward a contingency perspective. *Research Policy, 38*(765-778).

Tsai, K.-H., & Hsieh, M.-H. (2009). How different types of partners influence innovative product sales: Does technological capacity matter? *Journal of Business Research, 62*(12), 1321-1328.

Tsai, K.-H., & Wang, J.-C. (2009). External technology sourcing and innovation performance in LMT sectors: An analysis based on the Taiwanese Technological Innovation Survey. *Research Policy, 38*, 518-526.

Tushman, M. L., & Anderson, P. (1986). Technological discontinuities and organisational environments. *Administrative Science Quarterly, 31*(3), 439-465.

Udwadia, F. E. (1990). Creativity and innovation in organisations. *Technological Forecasting and Social Change, 38*(1), 66.
Usher, A. P. (1954). *A history of mechanical inventions*. Cambridge: Harvard University Press.
Vaivio, J. (2008). Qualitative management accounting research: rationale, pitfalls and potential. *Qualitative Research in Accounting and Management, 5*(1), 64-86.
Veugelers, R., & Cassiman, B. (1999). Make and buy in innovation strategies: evidence from Belgian manufacturing firms. *Research Policy, 28*, 63-80.
von Hippel, E. (1988). *The sources of innovation*. New York: Oxford University Press.
Weber, R. P. (1990). *Basic content analysis* (2nd ed.). Newbury Park, Calif: Sage.
Weterings, A., & Boschma, R. (2009). Does spatial proximity to customers matter for innovative performance? Evidence from the Dutch software sector. *Research Policy, 38*, 746-755.
Whiting, R. H. (2008). New Zealand chartered accountants' working/family strategies and consequences for career success. *Pacific Accounting Review, 20*(2), 111-137.
Worley, J. S. (1961). Industrial research and the new competition. *The Journal of Political Economy, 69*(2), 183-186.
Yin, R. K. (1981). The case study crisis: some answers. *Administrative Science Quarterly, 26*(1), 58-65.
Yin, R. K. (2003). *Case study research: Design and methods* (third ed.). Newbury Park: Sage Publications.
Zhang, J., Hoenig, S., Benedetto, A. D., Lancioni, R. A., & Phatak, A. (2009). What contributes to the enhanced use of customer, competition and technology knowledge for product innovation performance? A survey of multinational industrial companies' subsidiaries operating in China. *Industrial Marketing Management, 38*, 207-218.