

**Productivity: New Zealand's Economic Imperative – identifying  
key factors of the global success of New Zealand's  
Biotechnology sector.**

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**A thesis submitted to Auckland University of Technology in partial  
fulfilment of the requirements for the degree of Master of Policy Studies  
(MPS)**

**2011**

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## **Attestation of Authorship**

“I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the qualification of any other degree or diploma of a university or any other institution of higher learning, except where due acknowledgement is made in the acknowledgements.”

Signed by:

Adam Claude Paterson

## Acknowledgements

The completion of this thesis is the culmination of several years' work that has involved periods of personal growth and periods of personal challenges. The myriad experiences that I have gained from my time at Auckland University of Technology over several years have all played a role in shaping the production of this thesis. However, apart from the role that the institutional setting has played in generating this thesis, it is above all other aspects, about the people who have carried me from the start to the end of this journey. For without these beautiful people, this journey would have never reached its conclusion. There are many people who participate in my life that deserve my acknowledgment for this work. They know who they are, and I thank them wholeheartedly. In particular the following people have been the difference between not completing and completion.

Firstly, I would like to acknowledge the efforts and significantly the talents of my supervisor Dr. Oksana Opara. Words fail to express how significant your patience, level of understanding and notable words of encouragement have meant to me and the degree to which they contributed to successfully completing this work. To my partner Paul a thousand expressions of my love in thanks and appreciation for you being you, for accepting me as I am, and for showing me the faith you have in my abilities. You have been my best ever gift since the day we met. To my friend Sabrina, I now share this achievement in no small part thanks to you. To my dearly loved and much missed niece Carrie in New York. I remember our time together every day. The opportunity to be fortunate enough to visit you, spend time with you, is one of the main reasons I do what I do. To my beloved Nana Nicholls, I miss you and thank you for giving me strength when I thought all was lost. To Les, I hope you are having fun, know that you are missed and loved. Lastly, I dedicate this thesis to my Mum who regardless of circumstances is always there, always. Someone, somewhere was taking care of us you see – it was not my time, “not you too, please not you too”. It was not my time. I love you Mum.

## **Ethical Approval**

Ethics approval from AUT University Ethics Committee (AUTEC) was granted on 17<sup>th</sup> October, 2007. The Ethics Application Reference number was 07 / 167.

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## **Abstract**

Evidence suggests that New Zealand suffers from low levels of productivity stemming, in part, from low national productivity, undermined by weaker levels of productivity in some of New Zealand's key industry sectors. However, there is a lack of research on how to respond to these challenges based on analysis of a successful industry sector experiencing strong growth based on high levels of productivity.

This study focuses on New Zealand's biotechnology sector which has demonstrated strong productivity performance over the last two decades. This thesis examines the theoretical approaches and frameworks in relation to productivity and that of its determinants by focusing on New Zealand's productivity performance in comparison with Australia, Finland and Ireland.

The aim is to identify and critically analyse the key factors that influenced, how and in what ways, high productivity in the biotech sector has been achieved. The study's participants included public and private sector experts who have been involved in the decision-making and policy formation process regarding productivity and/or biotechnology in New Zealand.

The study found that New Zealand's relative labour and multifactor productivity performance is low compared to Australia, Finland and Ireland, whilst capital services productivity is equal to or higher. New Zealand's biotech sector has achieved high productivity based on a range of factors which include partnerships between industry and government, long-term strategic development and planning, centralisation of sector representation, leveraging country-specific advantages and by the sector being globally orientated. This study contributes to the scholarship on productivity by identifying the ways public policy could play a formative role in shaping effective interventions in response to challenges New Zealand experiences in order to seek improvements in its productivity performance.

## Chapter One: Introduction

Productivity is increasingly being viewed as the key determinant (influence) in achieving higher living standards in economies across the globe.. Concepts of productivity and the role it plays in economic growth are being actively applied by developing, emerging and developed economies. One of the challenges facing developed economies is how to ensure economic prosperity continues beyond periods of medium - high growth. This had become a dominant topic in economic, academic and political policy discourse prior to the advent of the Global Financial Crisis (GFC). Notwithstanding the significant challenges the GFC has created for advanced economies this topic was and remains of specific interest to New Zealand because of historically lower growth performance when compared to Organisation of Economic Co-operation and Development (OECD) members. Contemporary academic investigation primarily focuses on New Zealand's weaker levels of productivity growth in explaining weaker economic performance. The reasons for this focus are due to the role that productivity plays in economic growth.

This thesis will focus on the role that productivity plays in industry growth, based on New Zealand's biotechnology sector. This will be achieved by applying comparative analysis between New Zealand's productivity performance and that of Australia, Finland and Ireland. The importance of identifying the factors that have contributed to industry growth in resource based industries is evident from some other developed economies that share in a general way New Zealand's characteristics, such as Finland and Australia. In addition, Finland and Australia also share human capital and economic characteristics with New Zealand, and this is where Ireland fits in to this study. A review of recent literature on New Zealand's productivity performance reveals several crucial factors.

Measurement of productivity and its determinants is an area of considerable debate among scholars, as well as, within institutions whose responsibilities include national statistical and monetary and fiscal policy formation. Comprehensive and accurate measurement that is of sufficient quality to be comparable is cited by Drew (2007), Statistics New Zealand (2007b) and The

Treasury (2008) among several other authors as critical when assessing an economy's relative growth performance. In New Zealand the main issue is the absence of effective measurement of the services sector (SNZ, 2011b). The role that industry measurement plays in productivity analysis remains an issue in the global productivity context, including for New Zealand. In response, there has been a shift to review, edit and align industry measurement techniques to improve compatibility with the International Standard Industry Classification (ISIC) system used by and advocated by the OECD (OECD, 2011). In addition to the programmes aimed at streamlining standards of industry classification, there have been efforts to produce variants of ISIC that is acquiescent to the specificities of their respective economies. For example, in Australasia the Australia and New Zealand Standard Industry Classification system (ANSIC) is used and in the United States and Canada the North American Industry Classification Standard (NAICS) system is used (SNZ, 2011b). These movements in the growth and application of measurement techniques are broad attempts to avoid statistically significant fluctuations and unnecessary divergences that occur when comparing different national accounts and economic indicators such as productivity.

Whether national and sub-national productivity statistics are sufficiently reliable when comparing relative performance between economies remains an area of contestable divergence among scholars. Parham & Roberts (2004) argue that potentially the uptake and statistical treatment of ICT services and investment could be a factor in New Zealand's capital deepening gap compared with Australia.

Tansey (2005b) argues from an Irish perspective (prior to the GFC) that understanding the factors influencing national productivity performance and its sources (diversity of contributing industry sectors) is of paramount importance to sustaining economic growth within the context of rapid economic expansion as was the case in Ireland during the mid-late 1990's until 2008 when the full economic impacts of the GFC was felt. Van Ark (2006) in a study conducted on behalf of the Australian Productivity Commission (APC) argues that effective, consistent and well articulated measurement criteria is crucial for comparative studies to be founded upon valid methodological instruments. The aim, Van Ark

(2006) suggests is for coverage and methodological issues to dissipate from policy improvements. A consensus seems to commonly exist across the literature, however there are specific cases of disagreement.

Davis and Ewing (2004) argued that although measuring differences in productivity is fraught with difficulty including methodological and measurement issues the main basis of the difference between New Zealand and Australia's recent growth performance have to do with lower levels of business research and development and capital investment, as well as, New Zealand having achieved near full employment had negative effects upon the labour productivity measure. Such views need to be carefully applied as the GFC has placed significant stress on national accounts in ways few predicted. Therefore, although Davis and Ewing's (2004) views were common it now looks less relevant being that (a) New Zealand's unemployment rate has returned to near historically average levels whilst (b) Australia's unemployment rate has decreased to levels below that of New Zealand, again historically significant for Australia. The New Zealand level of labour force participation is dominated by involvement of women (supporting the high labour force participation rate) in low wage jobs (OECD, 2010a).

For that reason, can the level of high employment be as significant as Davis and Ewing (2004) suggest when Australia has continued to experience growth even with historically low levels of unemployment? (prior to the recent environmental disasters in Queensland and Victoria). New Zealand's labour participation rate has out performed that of Australia so it may be that having such a high level of participation in employment is a more influential factor than employment is. Changes in the environment such as those brought by the GFC and the recent natural disasters (including the Christchurch Earthquakes) are reminders how vulnerable policies are to external shocks no matter how robust the planning, design and projections are thought to be. Moreover, Douglas (2006) and Drew (2007) argue that it is not advantageous to be comparing an economy to the rest of the world without comprehensive industry data (which capture the vast majority of sectors that contribute to economic activity in any given economy). A key issue for New Zealand is that it is a low wage economy and that there is a substitution of capital for labour (Drew, 2007). Differences

exist in all economies and these can actively influence the tone and depth of economic data-sets/indicators, or at the very least influence the data in ways that may interrupt the transparent flow of data from collection to publication. Such measured data-sets are crucial in determining relative success, identifying issues, responding to threats and taking advantage of opportunities. Next, we briefly discuss the relevance of activity undertaken in New Zealand in areas that are not captured by Statistics New Zealand when compiling economic data for measurement, aiding comparative analysis.

Analysis of New Zealand's comparative economic performance started several decades ago and it remains a feature of New Zealand's evolving economic maturity. Forming part of this discussion are the numerous examples of productivity occurring in various spheres of life (Do It Yourself (DIY), Community engagement, Maori concepts of Whanau Ora, indigenous and immigrant models of activity, elective pursuits i.e. crafts, art, entertainment) in which economic activity takes place.

In New Zealand it remains a truism that the country's productivity cannot be measured in terms of Gross National Product (GDP) when so much wealth is generated by spare-time activity (Pope, 1982, p. 10).

However, activities such as these fall outside industry classification categories and as such are not included in productivity statistics. Although, it is rather obvious why some of this activity is not included (expressions of hobbies and personal interest, too complex to measure, does not automatically generate a financial transaction) perhaps the question of whether these be included needs to be asked and answered. Alternatively, should an investigation reveal that these activities should not be included in national statistics for economic use – studies that focus on elective and/or volunteer and/or unpaid work could potentially be leveraged to examine the levels of productivity within this space in an attempt to seek improvements from work-based productivity. Equally, competing economies will also have aspects of personal economic activity that is either; (1) not included, or (2) included but clustered under various industry sectors and/or classifications, or (3) included and transparent; with the latter resulting in (case of New Zealand) the distortion of relative economic strengths

when compared to competing economies (in the absence of comprehensive measurement of all industry sectors). Measurement issues are paramount for there to be in-depth, accurate examination, but are only part of the challenge in better understanding productivity performance.

Based on recent evidence measured-sector labour productivity in New Zealand is a source of weakness according to Boven and Skilling (2005), OECD (2007c) when compared to Australia, Finland and Ireland (prior to the GFC). It is interesting to note that New Zealand's average measured-sector labour productivity between 1990 to 2008 was 2.2%. Australia's for the same period averaged 2.3% per annum, hence the Australian experience is relatively the same. This then raises the following questions: how and in what ways, has Australia been able to increase the size and wealth of its economy being that this specific productivity determinant is similar; and, although there are several other factors to consider in determining economic growth, why has New Zealand's growth in GDP per capita slowed considering labour productivity is approximately equal. Based on evidence from their respective studies Douglas (2006), Drew (2007), and Boven, Bidois and Harland (2010) argue that historically, New Zealand's labour productivity is lower because sustained periods of capital shallowing have occurred, especially in the private sector.

The issue of capital investment into the productive functions of business is related to New Zealand's labour/capital ratio when measuring productivity performance. Hall & Casey (2006) argue this is due to capital inputs being lower than labour inputs. An outcome of the Employment Contracts Act (1991) being introduced was that firms substituted labour for capital due to the costs of labour decreasing. The effects of this means that New Zealand firms have been more willing to take on additional capacity of labour (Hazledine & Quiggin, 2006; Grimes, 2009) – over the injection and application of capital for plant, human capital and process enhancements. It would not be accurate to suggest that this is because firms value increases in labour over capital (Key, 2010a). This is one of the reasons why in 2007 the official unemployment rate of 3.4% was at historical lows (OECD, 2007d). This divergence between capital and labour illustrates part of the reason why New Zealand's capital-labour ratio has been heavily one-sided in favour of the labour quotient. This has been driven by more

efficient labour market absorption dynamics, with an increase in less-skilled and low-productivity workers being incorporated into the labour force than has happened in competing advanced economies, particularly Australia (Parnham & Roberts, 2004; McLellan, 2004) and also compared with Finland and Ireland. The marginal productivity of labour is the wage rate and with higher numbers of less skilled workers gaining employment the outcome has been a further deterioration in New Zealand's capital to labour ratio.

A crucial element in understanding New Zealand's comparative productivity performance is analysing the exporting sector. Boven & Skilling (2005) argue that the exporting sector is performing below potential due to low-value goods and services contributing the majority of export trade, however this view is open to critique as when currency and commodity price-based fluctuations are taken into account the actual realised values are strong, based on increasing volumes and since the GFC this has continued and for some key exports such as dairy products commodity prices have accelerated in global trading markets. However, in 2003, the divergence in the value of goods and services exports, indexed to 1971 between New Zealand with the rest of the world was a staggering 66% (Boven & Skilling, 2005).

This is often characterised as a 'Boom and Bust' cycle for which the New Zealand economy is renowned for experiencing. New Zealand's business cycle remains largely driven by primary product price cycles (e.g. milk, beef, timber) which are determined by world commodity markets. This is an important reality that needs to be recognised when examining the performance of New Zealand's export sector. In an ever-increasing globalised market, with rapid commercialisation and development of competing economies, it is not necessarily a disadvantage for the economy to be heavily specialised in one sector. Successful New Zealand firms according to Drew (2007), Fabling (2007), Gaynor (2007), and Heather (2010) are increasingly seeking international opportunities including outsourcing labour intensive operations, such as manufacturing bases, to cost competitive locations influenced in large part to the increasingly over-valued, volatile and fluctuating exchange rate combined with tightening labour market conditions. The impact and effects of the recent GFC have further influenced the need for firms to be as focused as

ever on reducing costs and maintaining market share in a deteriorating labour market. The GFC also provides an opportunity for New Zealand businesses whilst growth in markets is static to incorporate new methods and/or technologies for improving firm productivity to better examine innovation, research and development investments and the benefits they provide.

Overall New Zealand's total economy productivity performance has consistently been characterised as poor (Parham & Roberts, 2004; Rowe, 2005 ;Van Ark, 2006; SNZ, 2007b; OECD, 2007c; Peart, 2009;). In comparison to OECD competitor economies such as Finland and Ireland national levels of productivity remain weaker in some areas, and stable in others when compared to New Zealand's largest trading partner, Australia (Tansey, 2005; OECD, 2007c). Many studies concentrate on the negative aspects of New Zealand's productivity performance, whereas the aim of this study was to identify where productivity performance is high, identify the contributing factors to establish the reasons why. The time focus of this study is limited to the period starting in 1990 and ending in 2010. The reason for not capturing a longer timeline for this study was due to the lack of availability of sufficiently comparable productivity data for the four economies prior to 1990. In addition, modern biotechnology in New Zealand has only more recently received central government attention and assistance. Where appropriate time series for specific data sets are analysed up to 2008 at the earliest and 2010 at the latest, depending on availability.

## ***Significance***

Evidence suggests that New Zealand suffers from low levels of productivity undermined by weaker levels of productivity in some of New Zealand's key industry sectors. However, there is a lack of research on identifying the factors that contribute to productivity outcomes in high growth sectors. Therefore, this study fills this gap by examining New Zealand's biotechnology sector and associated productivity outcomes that have contributed to its global success. By identifying the key factors this study contributes to the scholarship of productivity by identifying in what ways public policy could play a formative role

in shaping effective interventions in response to challenges New Zealand experiences in order to seek improvements in its productivity performance.

Identifying the factors which have impeded growth in levels of labour productivity remains the most pertinent question facing productivity research and analysis in New Zealand. Precisely for this reason this study contributes to this conversation and debate, and provides a framework to negate the issues often associated with New Zealand's comparative labour productivity performance based on the factors that have contributed to high productivity and industry growth in New Zealand's biotech sector.

This study involves looking at how and why New Zealand's biotechnology industry has succeeded globally in achieving rapid growth in science-intensive, research-focused fields at a time when New Zealand's national productivity performance has been relatively poor.

### ***Thesis Structure***

This thesis starts with an Introduction (Chapter One) which addresses the objectives and significance of this research. This chapter includes contextual information (background) that focuses on the challenges the New Zealand economy faces when seeking to improve national productivity performance, as well as, identifying the factors that have contributed to growth in New Zealand's biotechnology sector.

Following the introduction, Chapter Two is focused on analysis of relevant literature. This chapter examines theoretical approaches and frameworks in relation to productivity and biotechnology. Chapter Three discusses what methods were employed in this study. Furthermore it explains the reasons why certain methods were chosen ranging from the epistemological approach through to the identification and eventual selection of suitable study participants. In Chapter Four key findings from the literature review with data collected through respondent interviews are critically analysed and synthesized to identify the key factors that have contributed to New Zealand's biotechnology achieving

high levels of productivity growth. Lastly, Chapter Five summarises the findings of this study and presents recommendations for further research.

## Chapter Two: Review of Literature

In examining New Zealand's productivity performance and the rapid growth of New Zealand's biotechnology sector a key aim is to better understand why productivity outcomes are considered to be poor by comparison by reviewing relevant literature. By evaluating the growth of the biotechnology industry and by examining productivity the second key aim is to identify the key factors that influence growth. In order to comprehensively analyse New Zealand's relative productivity performance three competing economies including Australia (our largest trading partner and closest economic relationship), Ireland (small, developed economy roughly the same size in population with similar numbers in tertiary education) and, Finland (highly concentrated economic strategy on high value technological products and services from a relatively poor agricultural beginning) have been selected to best guide future policy decisions based on comparative outcomes.

Australia has been selected due to proximity, historical economic similarity and close economic integration (such as CER) with New Zealand. With Australia being New Zealand's largest trading partner and a location where many New Zealand businesses operate and trade with it was deemed appropriate to compare levels of productivity in New Zealand with Australia. Another reason was the frequency of comparisons made in public policy literature and discourse on New Zealand's rate of economic growth compared with that of Australia. Ireland has been chosen as a stable, developed country whose populace exhibit many of the features of New Zealand's citizens. Ireland, much like New Zealand, is a mixed economy that generates significant volumes of exports as a percentage of GDP, along with a very large services sector that dominates the economic activity. Additionally, Ireland deliberately chose high risk economic policies in an attempt to encourage growth and this feature of Ireland's economic strategy is one that New Zealand has previously shared (albeit with differences in policy focus). Ireland has since 1998 until 2007 attracted huge volumes of foreign direct investment (Tansey, 2005b; Czarnitzki & O'Byrnes, 2007). In New Zealand much of the policy decisions were focused on the absorption of labour and the expansion of the private sectors. As with Ireland,

Finland has been selected for some of the same reasons – small, rapid economic development occurring in a relatively short space of time. However, unlike Ireland, Australia or New Zealand – Finland was unique in so far as it implemented an economic strategy that was heavily focused on the ICT and high-tech sectors. Ireland, Finland and New Zealand and to a lesser extent Australia have all experienced either a minor (New Zealand) or dramatic (Ireland, Finland) decline in productivity since the advent of the Global Financial Crisis (GFC) which has exposed recent strategic decision-making to substantial critique. The selection of comparative economies was purposeful and targeted.

### *Chapter Outline*

The chapter starts with critical analysis of the different aspects of productivity including multi-factor (MFP), labour and capital productivity. Next, productivity measurement literature is examined to establish whether it is significant in painting a complete picture of national productivity analyses and what this means for an economy. Comparative productivity performance is reviewed next by contrasting New Zealand's productivity performance with that of Australia, Ireland and Finland. The purpose is to identify the factors that have contributed to productivity whilst aiming to establish how and in what ways national (macro-level) strategic decision-making contributes to changes in productivity. Following this, analysis of literature continues to determine what challenges lie ahead for improving New Zealand's productivity performance. Identification of the prospects for improving productivity performance is summarised next, before discussion shifts to reviewing literature on New Zealand's biotechnology sector by examining its rapid growth trajectory.

The second section titled "Why Biotechnology?" focuses on analysing New Zealand's biotechnology sector. The purpose is to establish how and in what ways biotechnology is significant to enabling an enhanced understanding of New Zealand's future economic potential. By analysing rapid growth that has been achieved the aim is to create a link between industry success, New Zealand as a location, and potential ways of improving industry productivity performance for the economy as a whole. This is followed by a brief description of what biotechnology is, identifying what role biotechnology plays in New

Zealand's economy over time. Next, we examine how strong of a relationship between productivity and biotechnology exists, based on sectoral evidence. Analysis then shifts to focus on opportunities for the biotechnology sector and identification of the challenges.

The purpose of this is to establish a clear understanding of biotechnology literature, whilst learning important lessons and to ascertain the factors that have influenced change in practice. This is followed by a brief discussion on bioethics, specifically New Zealand's bioethics regulatory body 'Toi Taiao' and the role it played supporting the basis of science intensive and research focused decisions taking into account ethical, environmental, Treaty of Waitangi, and Maori Whanau Ora concepts underpinning New Zealand's science-based industries (including the biotechnology sector). Included is the decision by the New Zealand Government in 2009 to disband Toi Taiao. This section is completed with concluding arguments on what the literature identified as the factors that influence productivity growth and the growth of the biotechnology industry. Discussion now shifts to examining relevant literature covering the different aspects of productivity including MFP, labour and capital.

### ***Productivity: labour, capital and multifactor (MFP)***

Productivity is a ratio of the volume measure of output to a volume measure of input (SNZ, 2011b). Explained in more detail productivity is the ratio of output to one or more inputs used such as labour, land (human, financial and physical resources) and capital and technology (investment - plant, machinery and equipment) in the production of goods and services. Analysis of productivity measurements illustrate how efficient the output/input quotient is. Growth in productivity means that a nation can produce more output from the same amount of input (Tansey, 2005; SNZ, 2007a). Productivity is categorised in three ways. First, labour productivity is the quantity of output produced by a given quantity of labour input. Second, capital productivity is the quantity of output produced by a given quantity of capital input (Diewert, 2004; DOL, 2004). Third, multifactor productivity (MFP) refers to the way that labour and capital are combined to produce goods and services (also referred to as total factor productivity TFP).

Considerable debate exists on whether TFP or MFP is a more enhanced tool for understanding all contributing factors when analysing productivity performance (McLellan, 2004; Oxley, 2004; SNZ, 2007c). Whereas TFP is defined as total outputs divided by total inputs, MFP considers serendipitous elements, thus is broader and not reliant solely on statistical data. MFP is a strong determinant of Per Capita Incomes. Increases in Per Capita incomes can be achieved when countries effectively utilise economies of scale in comparative advantage industry, encourage and support technical diffusion and knowledge acquisition alongside the adoption of best practice methods to obtain increases in productivity (Van Ark, 2006). Equipped with an understanding of what productivity is, let us focus on distinctions between labour, capital and MFP productivity.

Statistics New Zealand (2011b) produces three measures of productivity growth: Labour, Capital and Multifactor (MFP). According to SNZ (2011b) growth in the three measures is explained as:

Labour productivity growth reflects the change in the amount of output per hour paid; Capital productivity growth shows how a change in the volume of assets, such as buildings, machinery, computers and IT, and land, affect output growth; Multifactor productivity growth refers to the contribution of changing management processes and technology towards output growth. It represents the growth in output that cannot be attributed to either labour or capital input. (p. 32-35).

In addition, productivity measures can be either single or multifactor. Single factor relates to a measure of output to a single measure of input, whereas multifactor relates to a measure of output to a number of inputs (SNZ, 2007a). Labour and capital productivity are single (or partial) factor productivity measures; they show productivity in terms of that particular input i.e. labour participation or educational attainment by human capital (Oxley, 2004). MFP on the other hand is growth that cannot be attributed to capital or labour, such as technological change or improvements in knowledge acquisition, implementation and production methods and processes (McLellan, 2004; Parham & Roberts, 2004). Therefore, labour and capital productivity is

quantifiable from a single attribute, whereas MFP requires analysis of refinements and innovations not necessarily bound within the process of production. With these distinctions understood, next we focus on analysis of the determinants of productivity.

Determinants of productivity include primary input growth and various other factors according to Diewert (2004) and Tansey (2005). As already noted, input growth consists of labour and capital inputs and together with MFP these elements combined is what are required for increasing levels of productivity growth. Capital inputs consist of human capital, being labour, and technological capital including the adoption of new technologies (Cypher & Dietz, 2004; Davis & Ewing, 2004). An example, according to Oxley (2004) of increasing capital inputs is when educational attainment by secondary and tertiary graduates increases. This provides skilled labour into the work force, which in turn strengthens the innovation capabilities and knowledge acquisition of firms, strengthening potential increases in productivity (DOL, 2004). Labour inputs also consist of numbers in employment and the level of unemployment, as well as, participation levels identifying how effective a labour utilisation model is in ensuring an effective labour market (McLellan, 2004; Abhayaratna & Lattimore, 2006; SNZ, 2007b).

In addition, according to McDowell, Thom, Frank, & Bernanke (2006) and Douglas (2006) the growth of primary inputs, the main factor that explains output growth, is an increase in MFP of the economy. This means something other than capital investment and numbers employed may be significant to gaining productivity increases. Therefore, MFP is the upward shift in the private sector aggregate production function (Diewert, 2004; Dolman, Parham & Zheng, 2007). Strategy, institutional performance and relevant policy fit for purpose within the economic context of a country are seen as crucial determinants of productivity growth rates (OECD, 2007c; Drew, 2007). This means that countries have the ability to effectively improve levels of productivity, but such goals are dependent on the performance of major industry uptake of new knowledge and advanced processes, investment in technology efficiencies and engaging international networks to support best practice implementation. Utilising country specific competitive advantages according to Hall and Scobie

(2006) and Drew (2007) is another important attribute. Discussion now shifts to the role of determinants in productivity.

The key issues around MFP encompass industry rates of innovation, investment of capital (both human and technological) into the production functions of the business and the efficient adaptation rates of new technology and knowledge by labour (Parham & Roberts, 2004; Tansey, 2005; Dolman *et al.* 2007). The evidence suggests that these factors enhance the future productivity capabilities of business. Where business successfully merges existing processes with new ways of thinking on how to achieve greater efficiency, growth in productivity is sustainably higher (Boven & Skilling, 2005). According to DOL (2004), firm level productivity requires education about the importance of accurate measurement, as well as, substantial increases in understanding by management and staff of the benefits gained from productivity growth. Indeed, the issues of educating industry, business and people on what productivity is, how it works and what it can mean to stakeholders is a core theme throughout much of the literature reviewed. Moreover, productivity remains misunderstood at the national policy level according to Tansey (2005) and Kavanagh & Doyle (2007).

This problem persists in many countries with those who successfully navigate understanding the productivity dilemma are the ones who will benefit most. MFP is closely connected to capital-labour ratio, underpinning the nexus of productivity growth (Diewert, 2004; McDowell *et al.* 2006). There are two dominant perspectives pertaining to the question of human capital in the productivity debate according to Oxley (2004) and Drew (2007). First, human capital is an ordinary input in production. Second, human capital is seen as the primary source of innovation, education and knowledge creation. Both are necessary arguments to discuss if we are to understand all the likely effects. Oxley (2004) suggests any shift in the educational composition of the labour force plays a facilitating role in achieving economic growth – providing opportunity potential. Conversely, focusing too much attention on educational attainment of human capital misses out some crucial elements, such as intrinsic knowledge of the human being. This highlights the limitation of placing the

significance of human capital on educational achievement alone, in isolation from other significant factors.

Labour productivity is determined by the ability of human capital to work according to sets of skills required to perform a job satisfactorily. However, it is not only the function of the labour but also the capability of labour to learn, develop and assimilate new technology, innovations and knowledge that provide productivity advances that economies continue to be in specific need of (McLellan, 2004; Parham & Roberts, 2004; OECD, 2007b). As already noted, a major determinant of rising Per Capita incomes is MFP. Investments play a facilitating role for MFP. Capital and labour inputs in public sector institutions such as health, education and training provides capacity, strengthening MFP potential (Pilat, 2004). Efficient institutional performance and quality policy formation combined with effective strategy in the long run is a key factor according to Tansey (2005). An efficient business environment, providing smart, growth-supporting policies (Davis & Ewing, 2004; OECD, 2007c), enhances enterprise and industry activity.

Investments in infrastructure including transport and telecommunications are increasingly being seen as crucial to ensuring sustainable economic development, underpinning productivity performance. Whether, these investments actively enhance MFP potential is still widely debated in the literature, however evidence is emerging (Douglas, 2006; Drew, 2007; Kavanagh & Doyle, 2007) that infrastructure constraints can negatively affect the productive abilities of industry. Logistical bottlenecks, such as ports or rail networks being inadequate for the transfer of goods are an example. Moreover, effectively adopting international best practice models for strategic planning and policy guidance is now understood to contribute to productivity (Boven & Skilling, 2005; Drew, 2007). Discussion now shifts to analysis of the relationship between productivity and economic growth.

In a comprehensive study articulating the role of productivity in advancing Ireland's living standards, Tansey (2005) views productivity as the main determinant to achieve increases in quality of life. Much of the productivity literature focuses on MFP due to the fact when this is measured and monitored

– it paints a relative picture of how well an economy is performing in terms of its productive efficiency with respect to available resources (Diewert, 2004; Douglas, 2006). The ability to accurately measure increases in the efficiency of production enables better understanding of an economy's strengths and weaknesses, identifying relative comparative advantages (Hall & Casey, 2006). Enhancing the capacity and utility of sectors where comparative advantages exist – assists in improving the macroeconomic conditions in which increasing production is situated (Tansey, 2005). For many economies such as New Zealand, Australia, Finland and Ireland the goal of increasing standards of living and quality of life have become national imperatives (Forfas, 2006; Fallow, 2006; Loosely, 2007). Discussion now shifts to analysing the significance of measurement in productivity analysis, and the ways in which measurement supports the efficacy of public policy.

### ***Significance of measurement in productivity analysis***

The key objectives of productivity measurement according to Statistics New Zealand (2011) include:

providing an indicator of living standards (assuming that productivity increases are matched by wage increases); tracing the effect of technological change; assessing the economy's underlying productivity capacity; enabling international comparisons of productivity; and, enabling assessment of policies, programmes, or economic events over time. (p. 2).

Whether measurement is of comparable quantity and quality is of vital importance to productivity analysis, as briefly discussed in Chapter 1. In specific areas of productivity analysis - measurement uncertainty exists throughout the literature. Not only is it uncertainty with regard to the reliable ways in which analysis can be applied to measurement of productivity, it also brings a divergence of conceptual thinking on what matters in the pursuit of comprehensive measurement. Contentious aspects include the role and determinants of human capital - technological diffusion, labour productivity and MFP (Cypher & Dietz, 2004; Statistics Finland, 2006; SNZ, 2007b). It is clear that there are competing schools of thought when investigating human capital and as such these schools differ in how they perceive the function and role of

human capital. Therefore, divergence of opinion among productivity researchers is a challenge that must be considered when attempting to collect accurate, reliable and comparatively flexible data on levels of productivity. In addition, the different theoretical approaches applied to analysing components of labour productivity, and the levels therein, illustrate how the determinants of labour productivity is another widely debated determinant (Fallow & Dann, 2006; Dolman, Parham & Zheng, 2007). With measurement uncertainty existing within both theoretical and conceptual spaces, there are challenges that lie ahead for ensuring measurement in productivity analysis is accurate and useful for policy and industry equally. These challenges are discussed in-depth below.

For productivity analysis between economies to be effective and reliable productivity measurement needs to be consistent and comparable as possible. Measurement uncertainty acts as a barrier to assuming productivity data is comparable in terms of its sources, area of coverage and composition. However, these issues are surmountable when seeking comparable productivity statistics. Uniformity with comparative data analysis is derived not only from differences in measurement techniques, but also from how 'effective' sectors are measured nationally. According to the OECD (2007c) and the Treasury (2008) productivity measurement issues can be found in the non-measured sectors of New Zealand's economy, affecting the quality of the total economy productivity statistics (i.e. MFP). The issue is how accurate MFP measurement has been in capturing the scale, density and depth of this activity.

Parham & Roberts (2004) and Drew (2007) argue that some countries are less successful in attaining comprehensive data in relation to hard to measure sectors than others. Analysis of non-measured sectors of an economy is commonly weaker than measurements of labour productivity (McLellan, 2004; Douglas, 2006). This is a crucial point in terms of whether countries can accurately place themselves relative to other countries. If measurement of labour productivity is more definitive then what role does MFP measurement play in comparative studies? An argument put forward by McLellan (2004) whose paper examined New Zealand's economic (and productivity) performance suggests that with MFP capturing all economic activity that contributes to annual GDP that sits outside labour and capital productivity MFP

is less well-defined and therefore is a weaker point of comparison than that of labour or capital. This view assists in identifying one of the reasons why comparative productivity research depends upon a consensus when confronting issues to improve the quality of data within divergent measurement experiences.

In general there has been a reduction in measurement divergence between those of New Zealand and other economies (SNZ, 2011b). However, there is a lot of potential for measurement difference in productivity estimates. For example, Statistics New Zealand uses value added as its measure of industry output, while some economies use gross output when measuring output. In addition, for any given industry, the practical method of measuring output will differ, depending on structure of the economy, and the availability of data sources among others. Statistics New Zealand uses paid hours as the default unit of labour input, while most other economies use hours actually worked. There can be significant differences in the levels of hours paid and hours worked (for example, sick leave, annual leave, unpaid time will all create differences). However, growth rates in paid hours are very similar to growth rates in hours worked, particularly in the long term. The decision to use paid hours in New Zealand was mainly based on the ability of the paid hour's data sources to provide a longer time series, and more accurate industry detail. Statistics New Zealand also uses productive capital stock to proxy movement in the flow of capital services, while Australia uses net capital stock. When compared to Australia, New Zealand uses a different method for aggregating asset level productive capital stock movements up to the industry level. There are further examples of where New Zealand specifically chooses to use determinants of productivity in different ways when measuring levels compared to other economies. The examples cited are the key differences, thus highlight the significance of measurement in productivity analysis – most especially when using these statistics as a source of comparison.

Understanding the issue of variances in measurement is an important part of productivity analysis. Significantly, comprehensive data analysis of the non-measured sectors of an economy needs to be comprehensive to give an enhanced picture of total economic performance. Tansey (2005) and Drew

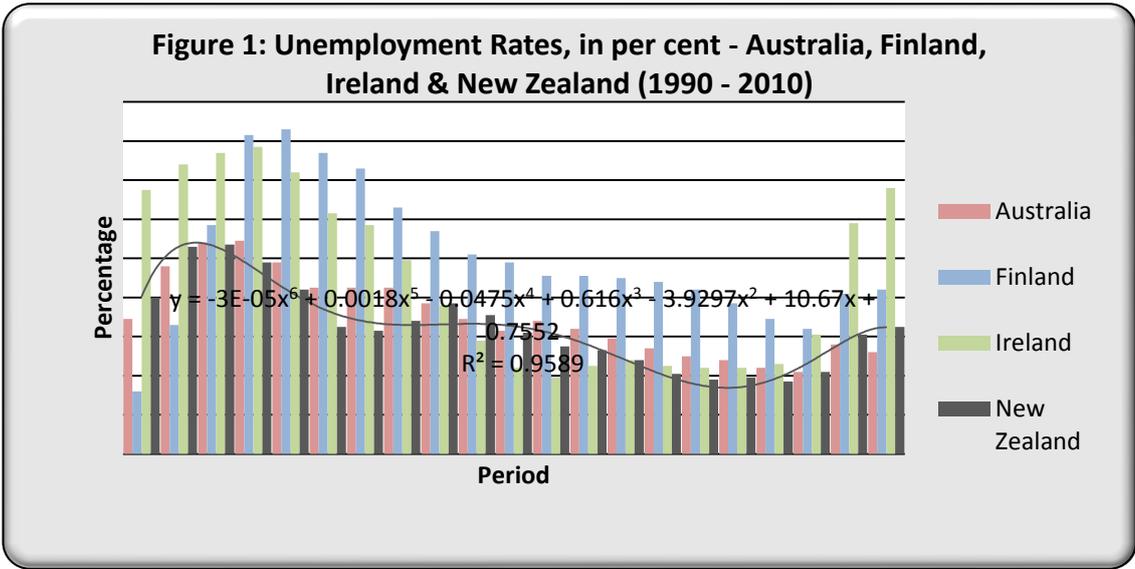
(2007) note that measurement issues exist in non-market activities such as the public sector, but also in the services sector, where measurement by definition might be narrower than techniques employed in manufacturing, telecommunications and trade. In order to achieve greater coverage and depth of data gathering – analysis and research of sectors need to look to international markets for models of best practice (OECD, 2007c). One example, where overseas experience is sought to strengthen industry data collection is how Statistics New Zealand evaluated the way it investigates and assesses hard to measure industry sectors (SNZ, 2007a).

This process has resulted in the adoption of changes that are aimed at reducing measurement divergence between New Zealand's productivity estimates and those of other economies (SNZ, 2011b). For example, on the industry level the Bioscience Survey (2009) replaces the previous Biotechnology Survey and was published using the new version of ANZSIC (2006) whereas the productivity statistics are still published using the old version of ANSIC (1996). Under ANZSIC96, the 'professional, scientific and technical services' firms will mainly be in the business services industry. 'Manufacturing and processing' will be in either the manufacturing industry, or the electricity, gas and water industry. The detail of these changes and the potential impacts are discussed in detail in section two of the literature review. Statistics Finland (2006) is another example where measurement of productivity is under-going change to mitigate the challenges and uncertainty that divergent measurement techniques create. Due to methodology of measurement differing between states, all-comparative analysis needs to be understood in light of possible divergence. Changing measurement techniques to suit the current economic environment becomes an important task for analysis of any economy. Understanding the caveats of measurement of data allows us to now ask what the review of productivity literature tells us about the New Zealand experience in relation to Australia, Finland and Ireland.

***Productivity performance: New Zealand compared to Australia, Finland and Ireland (timeframe: 1990 – 2010)***

Improving New Zealand's productivity growth is a key part of the economic puzzle if New Zealand is to holistically achieve stronger levels of economic growth and move into the top half of OECD wealthy nations (Fallow & Dann, 2006). Since 2001 key economic indicators including labour market indices (unemployment, and workforce participation), gross domestic product (GDP) and GDP per capita have achieved periods of significant improvement according to OECD (2007c) and Statistics New Zealand and New Zealand Treasury (2010). These improvements have assisted in providing stable macroeconomic foundations for sustained productivity growth (OECD, 2010d). However, the recent GFC has resulted in a series of external shocks causing rapid deterioration in New Zealand's economic indicators placing downward pressure on the current account balance and causing a sharp reduction in the Government's general financial balance. Several significant examples are outlined below. For example, in 2007 New Zealand's official unemployment rate reached 3.7% a 30 year historical low (SNZ, 2010).

By comparison the unemployment rate in 2007 for Australia was 4.4%, for Ireland 4.6% and for Finland was 6.9% (OECD, 2009). What this means is that in 2007 more New Zealanders were working comparatively to those of the other economies. As noted previously this comparative advantage in labour market dynamics illustrates how effective the New Zealand economy has been in securing labour relative to capital. However, due to the affects from the GFC on the global economy, specifically the lack of availability of capital (credit) combined with a sharp reduction in domestic demand (Davies, 2009) - over the preceding 3 years to 2010 the unemployment rate had risen to 7.1% (sitting above the historical average of 6.4%), (see Figure 1: Unemployment Rates). The percentage of the labour force unemployed during 2010 in Australia was 6.3%, for Ireland it was 14%, and for Finland it was 9.7% (OECD, 2011). Once again, although New Zealand's economy has been negatively affected by these external shocks, the labour market is still behaving in ways that contributes to acquiring labour at a rate faster than most of our key competitors.



Source: OECD (2011).

The impacts from the unemployment rate increasing on the workforce participation rate in New Zealand has been negative with the level of participation of those aged 15 – 64 years declining from 69% in the December quarter of 2008 to 67.9% in the December quarter of 2010 (DOL, 2011), (see Table 1: Workforce Participation Rates). Notwithstanding this New Zealand continues to enjoy one of the highest workforce participation rates in the OECD as the table below illustrates (all ages, all persons). High workforce participation has been a consistent feature of the New Zealand economic experience and as such is an area of comparative success when compared with the workforce participation rates of those aged 15 – 64 years in Australia (65.9%), Ireland (61.3%) and Finland (64.6%) for 2010. What is striking based on New Zealand’s high participation labour rate and with a low wage economy is that increasing participation in work may, in fact, cause negative consequences for productivity. This analysis is based on the assumption that higher productivity labour are already employed, whilst lower productivity labour are (re)entering the labour force. Levels of productivity generated by the numbers of New Zealanders working - reflected in the very high participation rates do not seem to contribute to the generation of growth. Rather, it can be argued it may actually cause deterioration in the effectiveness of inputs that determine productivity. .

**Table 1: Workforce Participation Rate (All Persons), in per cent - Australia, Finland, Ireland, New Zealand and OECD Average (1990 - 2009).**

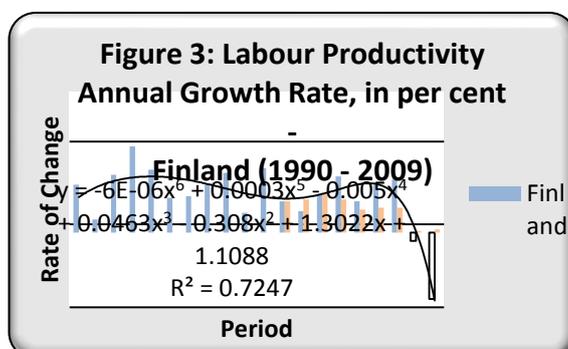
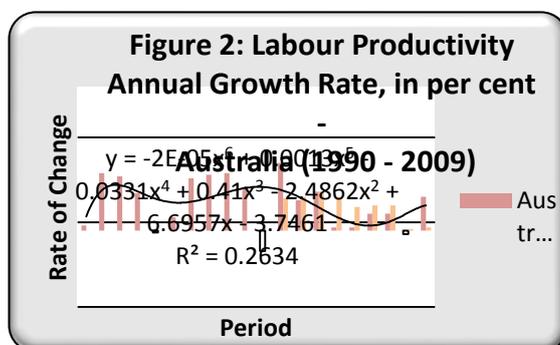
<b>Country</b>	<b>Average Rate (entire period)</b>	<b>Lowest Rate/Year</b>	<b>Growth for Period</b>	<b>Highest Rate/Year</b>
Australia	75.50	74.39 / 1990	3.95	78.34 / 2009
Finland	75.10	73.12 / 1994	4.65	77.77 / 1990
Ireland	67.58	61.67 / 1992	12.45	74.12 / 2007
New Zealand	76.99	73.67 / 1992	7.09	80.76 / 2008
OECD Countries (Average)	72.07	71.29 / 1993	2.13	73.42 / 2008
	<b>Average Rate (entire period)</b>		<b>Growth for Period</b>	
Gap between New Zealand and AUS	1.49		3.14	
Gap between New Zealand and FIN	1.89		2.44	
Gap between New Zealand and IRE	9.41		-5.36	
Gap between New Zealand and OECD	4.92		4.96	

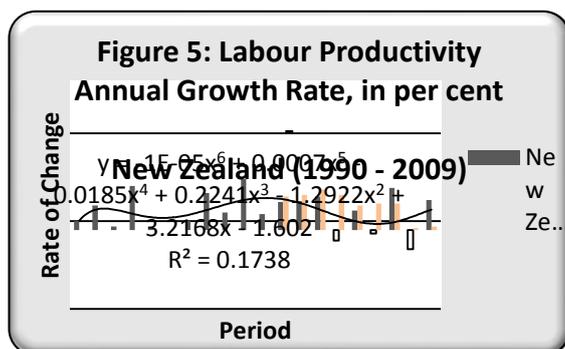
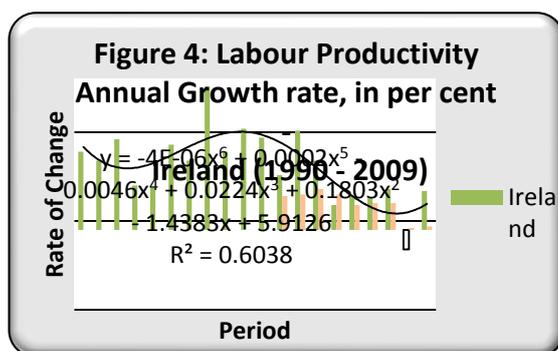
Source: OECD (2011).

The data presented in Table 1 above reveals that New Zealand's relative growth in levels of workforce participation over the 20 year study period has been the second most robust, after Ireland of the four economies analysed. Furthermore, due to New Zealand's workforce participation rate being consistently higher for a majority of the timeline it is plausible to suggest that New Zealand's labour market dynamics have contributed to the numbers working, that is, it actively and effectively enables New Zealander's to acquire work. Participation rates increased in part due to the Employment Contracts Act (1991) which was designed to reduce market imperfections. What actually happened was that the mobility of labour dramatically increased – influencing the adsorption of labour, whilst there was a corresponding decline in hourly earnings, resulting in a decline in per capita incomes. This highlights how the macro structure of the New Zealand economy incorporating monetary and fiscal policy and the functions on the micro level (labour market) are focused on employment to a higher degree than that of our competitors (Perry, 2007). In

addition, what this data tells us in combination with the literature is that a high percentage of New Zealanders work and work for long hours compared to Australia, Finland and Ireland. Yet, this does not support productivity growth. Therefore, it can be argued that labour market reform in New Zealand has influenced firm's use of labour that has led to a decline in levels of labour productivity due to high participation rates of low productivity workers, which explains why New Zealand's relative labour productivity performance is lower than that of the other three economies. New Zealand's specific productivity performance experiences are explored next by examining productivity growth in New Zealand compared with the productivity performances of Australia, Finland and Ireland.

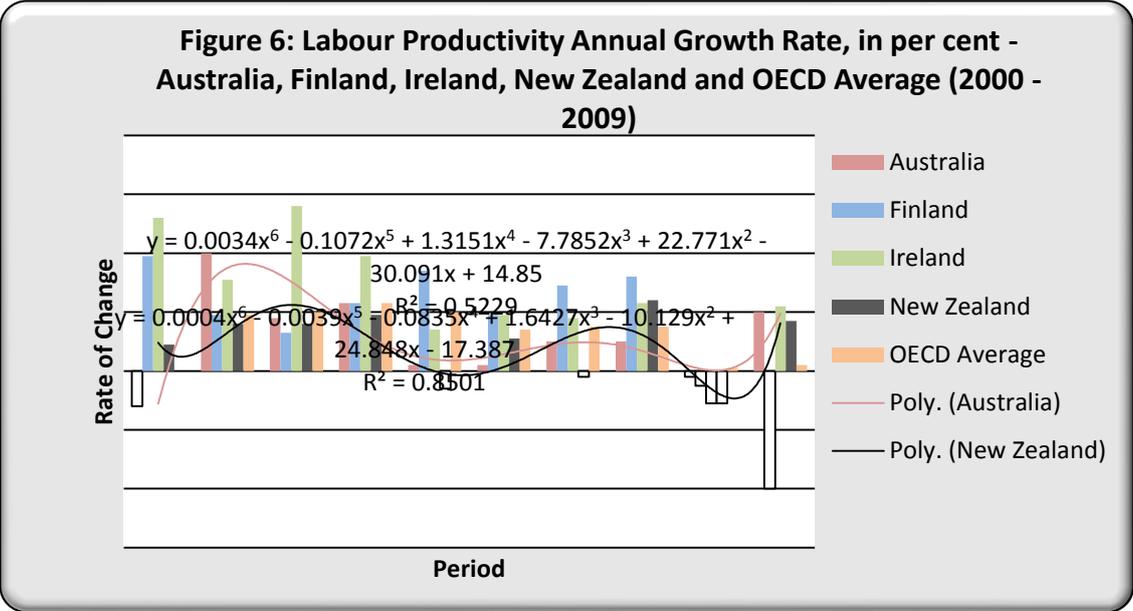
Contemporary academic investigation primarily focuses on New Zealand's weaker levels of productivity growth, specifically labour and MFP growth. Figures 2-5: Annual Rate of Growth in Labour Productivity show that New Zealand's relative Labour and MFP productivity performance has lagged that of Australia, and been meagre compared to Finland and Ireland up until the GFC in 2008.





Source: OECD (2011).

Figure 3 displaying labour productivity for Finland clearly illustrates that there was a sharp decline in 2008 and 2009 at the time of the GFC. This occurred due to a rapid rise in the number of unemployed combined with a reduction in work-place conditions for labour, the primary factor being much lower earnings per worker. The single largest contributor to this decrease in labour productivity was the collapse of Finland's Information, Communications and Technology (ICT) sector and with it the loss of previously productive and highly paid workers (OECD, 2012d). Focusing on the period from 1990 to 2008 New Zealand's average annual percentage rate of change in labour productivity growth was 1%, whereas Australia's average rate was 1.7%, Finland's was 2.4% and Ireland's was 3.7% (OECD, 2010). These figures reveal that over this 19 year period New Zealand was experiencing consistently weaker levels of labour productivity growth compared to that achieved by the comparative economies. However, if the period is shortened to the more recent period of 2000-2009 the divergence in productivity levels changes (See Figure 6: Rate of Growth in Labour Productivity 2000-2009). For the period 2000-2009 the average annual labour productivity growth for New Zealand was 1.1%, and for Australia was 1%, for Finland was 2%, and lastly Ireland experienced 2.7% over the same period (OECD, 2010).



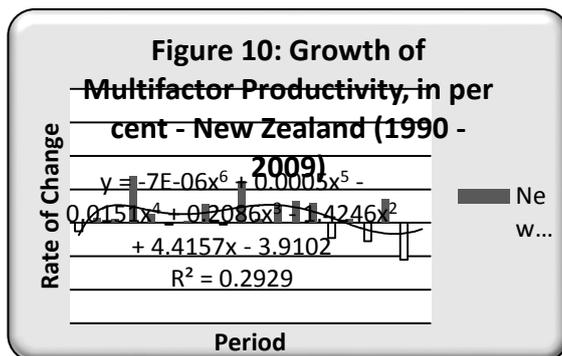
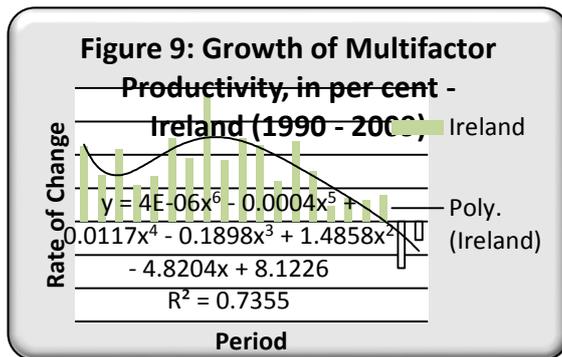
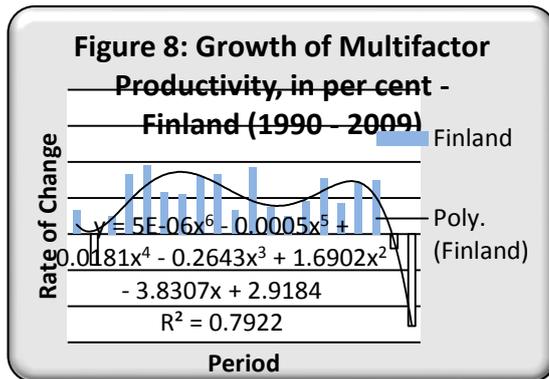
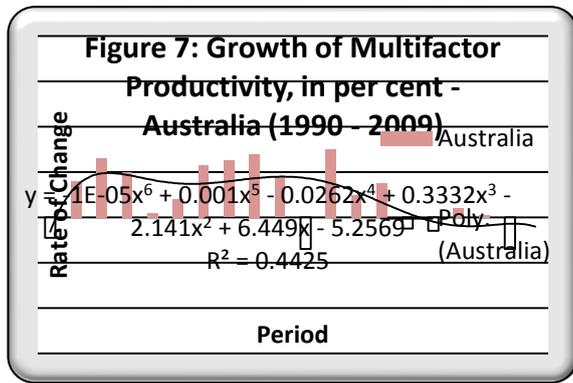
Source: OECD (2011).

Therefore, New Zealand’s average annual labour productivity rate has been weaker than that of Australia, Ireland and Finland over the period 1990-2008, and remains weaker than Ireland and Finland’s rate over the more recent period 2000-2008, however was slightly greater than that achieved in Australia. However, the difference in the level of labour productivity has (in isolation of other factors) stabilised meaning that even though the gap between New Zealand’s labour productivity and those of other economies has reduced overall during the 2000-2008 period compared to 1990-2008, the effective rate of labour productivity has only marginally increased by 0.1%. Nevertheless, the reasons why were not immediately clear. SNZ (2011a) has recently released statistics for 2010 showing that there has been a rapid increase in labour productivity.

This data shows that labour productivity in the market economy rose 3.7% in the year ended March 31, 2010. The reasons why this rapid increase has happened are explained below. Persistently higher unemployment since 2009 has meant that younger and lower-skilled workers have had less opportunity to find work or have been more frequently laid off, whereas highly skilled workers have either found and/or retained employment with additional workplace demands on their labour/knowledge/skills. What this data tells us is that: (a) it

confirms the view that weaker New Zealand's productivity performance had been influenced by previously high levels of employment; (b) explains why New Zealand's labour-capital ratio had been biased towards labour over capital; (c) the efficacy of New Zealand's labour market in providing employment to all workers has come at a cost as the preferences for labour expose New Zealand businesses to less effective workplace strategies to improve productivity, leveraged with a smaller ratio of capital for investment activity. Significantly, total output declined (1%) from the previous year (impact of recession and absence of growth in domestic demand) with capital productivity continuing to decline for the 7<sup>th</sup> successive year (SNZ, 2010a). Therefore, even though New Zealand's rate of labour productivity has shifted from low levels to higher levels along with unemployment rising, there has still yet to be sufficient capital deepening occurring. One argument for why this is the case is that New Zealand firms are typically, small, do not engage with research and development, or invest in capital when labour is more flexible and cheaper. With no corresponding upsurge in capital productivity this suggests that New Zealand firms will continue to lack sufficient flexibility that capital can also bring when responding to external shocks, have inadequate levels of capital resourcing for research and development that increasing levels of capital investment in plant, machinery and processes provide. Focus now shifts to determining whether a similar divergent experience exists in New Zealand's comparative MFP performance.

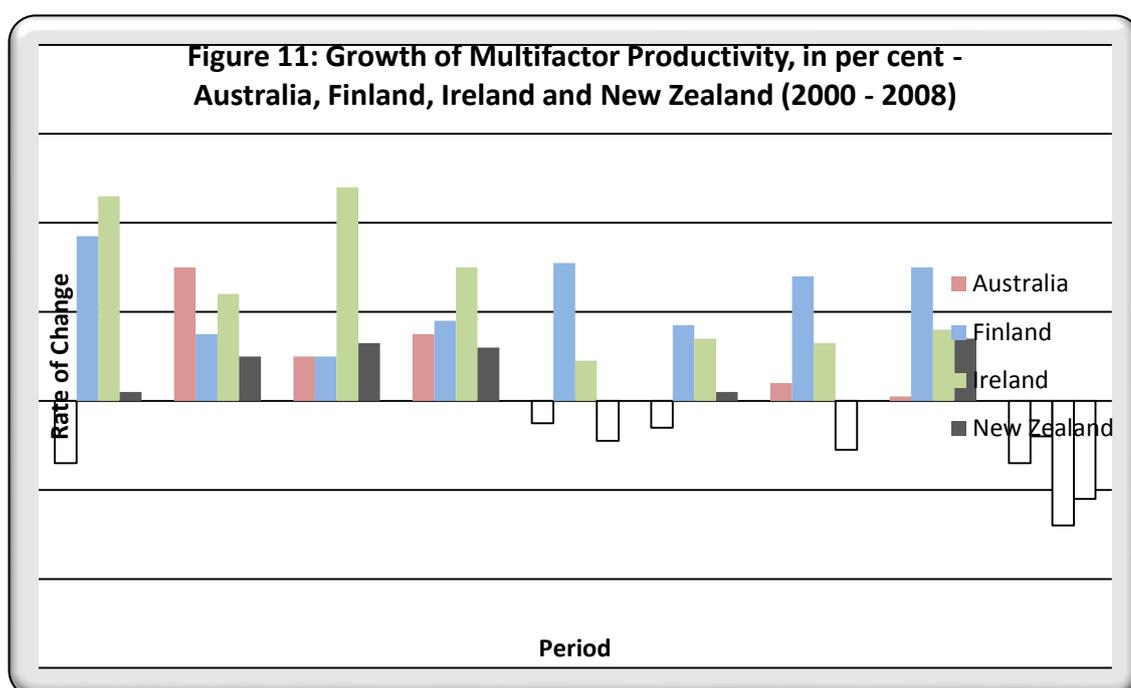
McLellan (2004) reviewed the published extracts of economic commentators over the last 40 years and identified that one element has been a recurring theme - New Zealand's weak MFP. Extracting MFP statistics data from the OECD (2010) database for the period 1990-2009 reveals that New Zealand has experienced an MFP average percentage growth rate of 0.41% (See Figures 7-10: Rate of MFP Growth 1990-2009). This compares with average MFP growth rates over the same period of 0.93% for Australia, 1.98% for Finland and 3.1% for Ireland (OECD, 2010).



Source: OECD (2011).

This data clearly illustrates the weaker average level of MFP occurring in New Zealand compared to levels found in competing economies. Of specific interest is the apparent volatility of MFP growth in New Zealand during the period. The literature revealed, as these figures highlight, that productivity determinants are

volatile. Unlike, the stability (albeit at low levels) of labour productivity growth experienced as mentioned previously - New Zealand has experienced more lower MFP minimums through this period, whilst experiencing only brief MFP growth increases; yet the band in which MFP can be measured is overall 0.1% greater than that of Australia. In an attempt to reveal whether there are any changes to the patterns emerging, the focus has been shortened once again to the period 2000-2008. The average rate of MFP in New Zealand for this period was 0.12% a figure far lower than the figure over the longer period (See Figure 11: Rate of MFP Growth 2000-2008).



Source: OECD (2011).

By comparison Australia's average MFP growth rate during the period 2000-2008 was 0.25%, Finland's rate was 1.8% and Ireland's rate was 1.9% (OECD, 2010). Therefore, for the period 2000-2008 New Zealand's productivity performance for Labour and Multifactor grew at a slightly faster rate than that of Australia. However, if the period of focus is expanded to 1990-2008, there is reversal of relative productivity performance. This means that New Zealand's productivity performance was outperformed for a significant period during 1990-2008 by productivity growth in Australia, and that New Zealand managed to reverse this trend with a slightly better MFP performance from 2000. However, SNZ (2011) productivity figures for 2010 show that MFP increased by 1.5%

from a year earlier, thus similarly with labour productivity the recession and impacts of the GFC have meant that there has been a sharp reduction in the inputs – whilst maintaining levels of output (with some areas of growth). The result is that New Zealand's relative productivity performance has significantly improved from 2009 to 2010 due to high productivity labour being employed first, together with a decline in overall numbers of people employed

According to Parham *et al.* (2004), various influences are significant in explaining growth divergences between economies. For example, Rowe (2005) and Boven and Skilling (2005) argue that New Zealand adopts new technology well, however capital investment in advanced technologies is weak compared with the other economies. There have been high rates in New Zealand of a strong acceleration in uptake in Information, Communication Technology (ICT) as also occurred in Australia during the 1990 – 2000 (DOL, 2004; Oxley, 2004). Of concern to New Zealand's productivity outlook is if there was an absence of a pickup in ICT investment and if it was part of a larger picture in which New Zealand is falling behind based on levels of investment in technology and human capital. However, as presented in Figure 17 investment in ICT has been aggressive compared with all three other economies when the 20 year period is analysed. Though New Zealand adopts new technology well, knowledge adoption is poor in comparison to the OECD average (Davis & Ewing, 2004).

As noted earlier, technological diffusion and acquisition of knowledge are crucial determinants of successful MFP growth (Carlaw & Oxley, 2008). This is because where new knowledge is successfully acquired and adopted in practice it can lead to productivity gains or gains in efficiency. The result is creating more value from the same amount of inputs, thus drives up levels of productivity. Kneller (2007) whose research compiled a series of essays from Irish and international economists highlights how Ireland and Finland have experienced strong labour and MFP growth (see Figures 3, 4, 5 and 6) due to greater capital intensity in high-end technology sectors maintaining strong export volumes. The experience in New Zealand has been different. Diewert (2004) and O'Sullivan (2006) suggest that the productivity gap between New Zealand and the rest is evenly divided between the rate of capital deepening and the rate of MFP growth. Differences in capital markets partly explain why this is so, with

one reason being the introduction of compulsory superannuation schemes in Australia during the 1990's. There has been no equivalent experience historically in New Zealand. The recent Kiwisaver Super scheme development is a voluntarist approach whose fundamental aim is for workers to pre-fund their financial needs for retirement and to create similar wealth creating effects for the broader economy (Boven, Bidois & Harland, 2010). The differences with Australia are widespread, but these arguments constitute the key factors contained within productivity literature. Ireland prior to 2007, by comparison has experienced large volumes of FDI investment from predominantly American multi-national computing, ICT and pharmaceutical enterprises (Tansey, 2005; Czarnitzki & O'Byrnes, 2007). This has greatly accelerated the means by which domestic capital supply is available for investment in firm-level productivity determinants. The GFC has decimated the employment and workforce participation rates in Ireland (see Figures 1 and 2), which is resulting in an exodus of predominantly younger emigrants overseas (FinFacts Ireland, 2011). However, Ireland is still maintaining strong export volumes of value-added goods and services, thus although the current financial account position of the Irish Government has been devastated, the private sector (excluding property services, construction, retail) is continuing to perform strongly (OECD, 2010e).

Finland's productivity performance is characterized by the high-end technology and ICT sectors creating world-leading research and development centres as well as aggressive value added global enterprises (OECD, 2007a). More recently, Finland has also experienced external shocks from the GFC on its economy (OECD, 2010d). Finland has not had to manage a banking sector crisis like what Ireland has experienced, therefore its public finances remain stable, nonetheless Finland's leading technology sectors have struggled to adapt to the changing paradigm in personal consumer technology devices. Due to this Finnish exports have declined relatively consistently since 2007 (OECD, 2010d). With the exception of agriculture (Hall & Scobie, 2007), where productivity performance is strong, there are few equivalent value-added sectors in New Zealand that competes as successfully as those present within the Irish and Finnish contexts. Putting relative productivity performances into context allows discussion to shift focus on productivity specifically in the

Australian, Irish and Finnish contexts in an attempt to identify lessons for the New Zealand model.

Since Australia is a relatively small economy, distant from large markets, it relies heavily on overseas technology, as does New Zealand. The advantage Australia has is the sheer scale of the mineral resources sector and its valuable contribution to capital accumulation and export growth. Existing empirical studies have not established a clear relationship between foreign Research & Development (R&D) and Australia's productivity performance. While it could be expected that foreign R&D would have a strong, positive impact on Australia's productivity growth, some studies find a negative relationship between the two variables (Dolman *et al.* 2007). However, domestic R&D activities have created opportunities for Australian business, specifically those who export via public-private partnerships with institutions such as the CSIRO (Pilat, 2004). Business related R&D in New Zealand constitutes one fifth of the OECD average, with the public sector overcompensating by conducting two-thirds of all R&D activity (McLellan, 2004; Drew, 2007). This is due to the small size of the vast majority of New Zealand firms. Even though this is not a surprise, it is a cause for concern. As without effective, commercialised R&D being undertaken there is little incentive for innovation.

The outcome is less effective industry related R&D. By contrast, the transformation of the Irish economy has been made possible by the combination of several factors. First, with Irish GDP tripling in size since 1985 combined with a near eight-fold increase in export volumes the two dominant features characteristic of the turnaround have been productivity growth and employment expansion. Second, rapid investments from foreign entities taking advantage of the low corporate tax rates have dramatically influenced productivity (OECD, 2007b). In the four dominant manufacturing sectors (Software; Chemicals; Computers and Instrument Engineering and Electrical machinery and Equipment) productivity increased by the rate of 134% during the 1997-2003 period (Kneller, 2007). Therefore, this has been hugely significant to Ireland's productivity growth as combined these foreign owned led sectors contribute 30% to Ireland's total value added goods and services. Providing access to free tertiary education has also encouraged greater skills

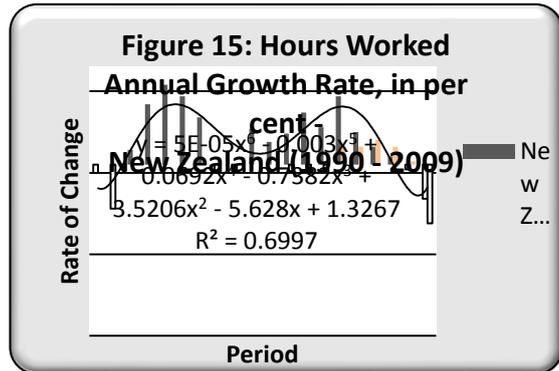
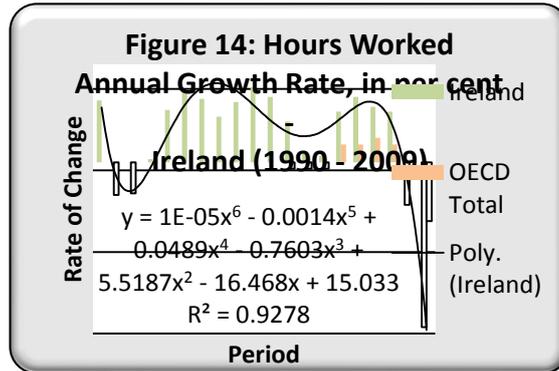
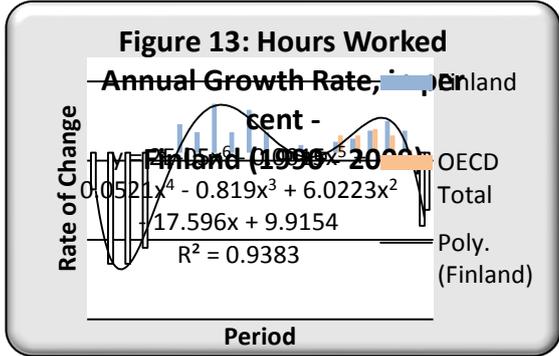
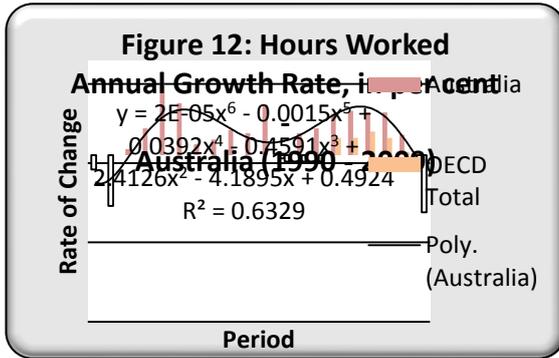
acquisition and the growth of the human capital (Ferreira & Vanhoudt, 2004). Interestingly, sectors without FDI investment have performed much less impressively and have experienced similar productivity rates to those of New Zealand. For example, the remainder of the manufacturing sector in Ireland raised productivity by only 18.3% over the same period (Tansey, 2005). The aggressive promotion of FDI investment into New Zealand in the absence of sufficient domestic capital may be advantageous to lifting productivity.

Finland has successfully navigated the economic challenges of being a small economy vulnerable to external influences, steadily rising to become one of the best performing economies in the OECD (OECD, 2007a). Finland's productivity growth follows a similar trend to that of Ireland for much the same reasons (Bank of Finland, 2007) although the rates of growth have been lower than that of Ireland. Figures 4 and 9 (pp. 37 and 40) show how high productivity gains, sustained over time improve economic prosperity via increased rates of improvements in standards of living. Export led growth has characterised the Finnish productivity experience, in a similar fashion to that of Ireland with high capital investment (especially in the private sector) in R&D activities, underpinning export led growth strategies. Even though New Zealand's economy can be characterised as open to trade and investment, free market orientated, transparent and comparatively free from regulatory burdens on business (OECD, 2007c; OECD, 2010; Statistics New Zealand and New Zealand Treasury, 2010), indeed more so than the other economies, these structural efficiencies cannot create higher value-added premiums from commodity based exports. Indeed, New Zealand has the design fundamentals of a first world economy in place however it is not performing as well as can be expected. One possible answer that is frequently cited in relevant literature is the identification of and subsequent resolution to imbalances in the economy.

Major characteristics of the New Zealand economy since 1990 can be identified as: steady rise in negative terms of trade (exceeding 8% of GDP in New Zealand for 2008 and exceeding 5% of GDP for several of the past 10 years); consistent improvement in labour market outcomes even with the external shocks experienced from the GFC (labour market has started to recover, though remains weak); weak levels of growth (when compared to rates of CPI)

in average wage/salary take home incomes; lower rates of personal taxation from successive Government tax cuts (combined with an increase in consumption tax i.e. GST); commodity based exports have risen steadily as have the prices paid for them on the global market; and, comparatively high rates of small-medium size businesses owned and operated (Dalziel & Peetz, 2008; Boven, Bidois & Harland, 2010; Key, 2010b; OECD, 2010d). Lower Reserve Bank of New Zealand (official cash rate) and mortgage interest rates have been the result of the impacts caused by the GFC. Although in 2007 inflationary pressures, driven in part by a resilient housing market and credit-fuelled consumer led consumption, meant that there were calls for the Government to mitigate inflationary pressures by alternative mechanisms other than official cash interest rates, these concerns have reduced markedly.

Instead, previous concerns have been replaced with concerns in multiple areas: the collapse of multiple financial institutions and the loss of investors' capital; the GFC and the external shocks it produced that have affected the ability of the New Zealand economy to function uninterrupted; increasing unemployment and under-employment; the historically high currency exchange rate and the associated high rates of fluctuation (impacting upon businesses being able to accurately forecast future financing costs), and the rising numbers of New Zealanders emigrating to Australia (Van Ark, 2006; The Treasury, 2008; Statistics New Zealand, 2010). In addition to new risks, there have also been specific successes. Labour mobility and rates of participation are success stories for a small, commodity based export economy such as New Zealand (OECD, 2007c), but once again these attributes are not enough to substantively increase productivity levels. Indeed, some argue (McLellan, 2004; Oxley, 2004) that New Zealand has been too successful in having more people in paid work, working longer hours with this negatively affected the resulting productivity statistics (See Figures 12-15: Growth in Hours Worked).



Source: OECD (2011).

Unemployment was at historic lows during the 2006-2007 periods and the total numbers of people dependent on social welfare had dramatically decreased (SNZ, 2007a). Many comparative studies point out that New Zealand's business

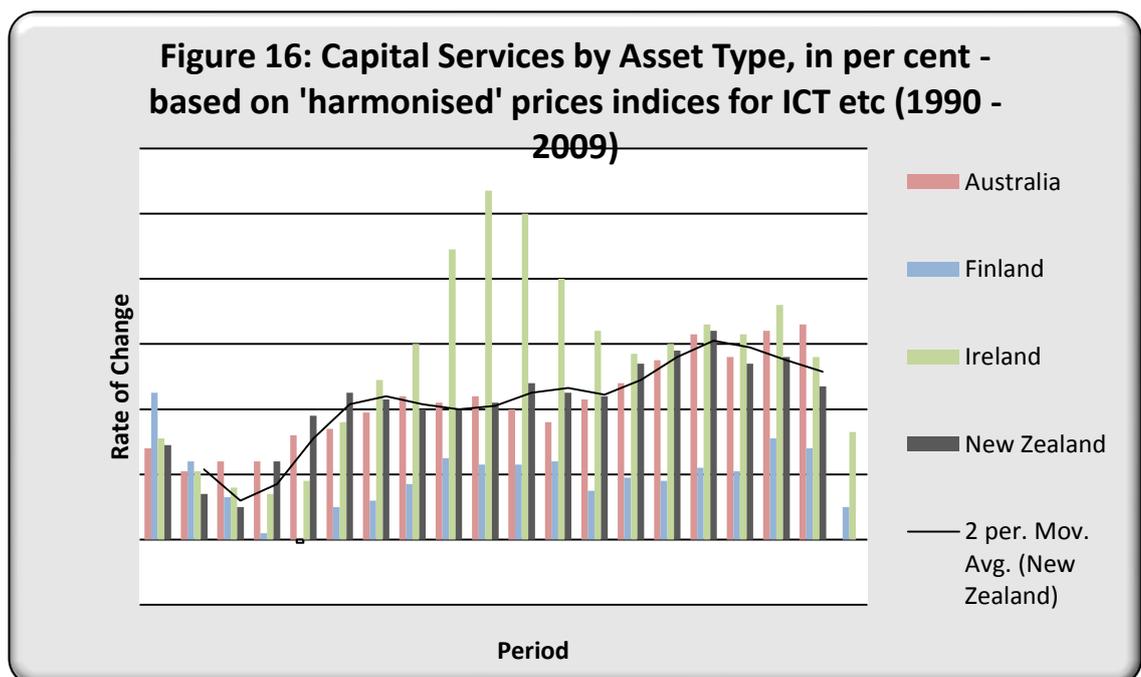
environment and compliance hurdles and tax burdens are rated positively by international business leaders (Hall & Casey, 2006; OECD, 2007c; SNZ, 2010).

The New Zealand economy suffers from a low wage, low skills equilibrium according to Dr Colm McLaughlin (NZPA, 2007). He further suggests a lack of consensus on industrial relations issues and significant ideological divisions are not conducive to attempts to improve the productivity performance of New Zealand's workplace environment. Dr Colm McLaughlin, a New Zealander based at Cambridge's Centre for Business Research in the United Kingdom, recently interviewed 50 union and business leaders, civil servants and academics in New Zealand and Ireland. Dr McLaughlin's research uncovered that there is deep-seated resentment between workers, unions and employer bodies (NZPA, 2007). This may be a result from the changes made to workplace regulation stemming from the introduction of the Employment Contracts Act (1991). Dr McLaughlin is not alone in suggesting this view. Perry (2007) whose research "Ignoring the Evidence: Comments on the Debate on Antipodean Neoliberal Workplace Reform and Labour Productivity" argues that the unintended consequences of replacing collective bargaining with individual contracts has had a perverse effect on employment relations. Furthermore, Hazledine and Quiggin (2006) argue that the levels of trust required for comprehensive debate on workplace reform has suffered from a lack of consultation with workers, thus Dr McLaughlin's argument of resentment between the parties should not be surprising.

According to Dr McLaughlin (2007), a similar attempt in Ireland to pursue a social partnership approach achieved only partial success, "Ultimately, constraint mechanisms will be needed to bring about the sort of long-term, deeply embedded institutional change envisioned in New Zealand's social democratic model" (p. 1). The business community has been critical of what might be called the failed policies of the present (Fallow, 2007). Therefore, even if there was a national agreement on discussing workplace regulation between representatives of workers and representatives of employers was to take place there is no certainty that this would lead to improvements in either the relationship or productivity performance. Notwithstanding the challenges in establishing a body of enquiry to examine employment regulations in New

Zealand, major changes are needed to achieve a sustainable base for continuous improvements in labour productivity in New Zealand with the authors cited above arguing changes may be necessary. The focus of the discussion now shifts to examining the levels of growth achieved in Australia, Finland, Ireland and New Zealand in capital services by asset type, that is, the level of capital (plant, machinery and technology etc.) investment growth occurring in each economy.

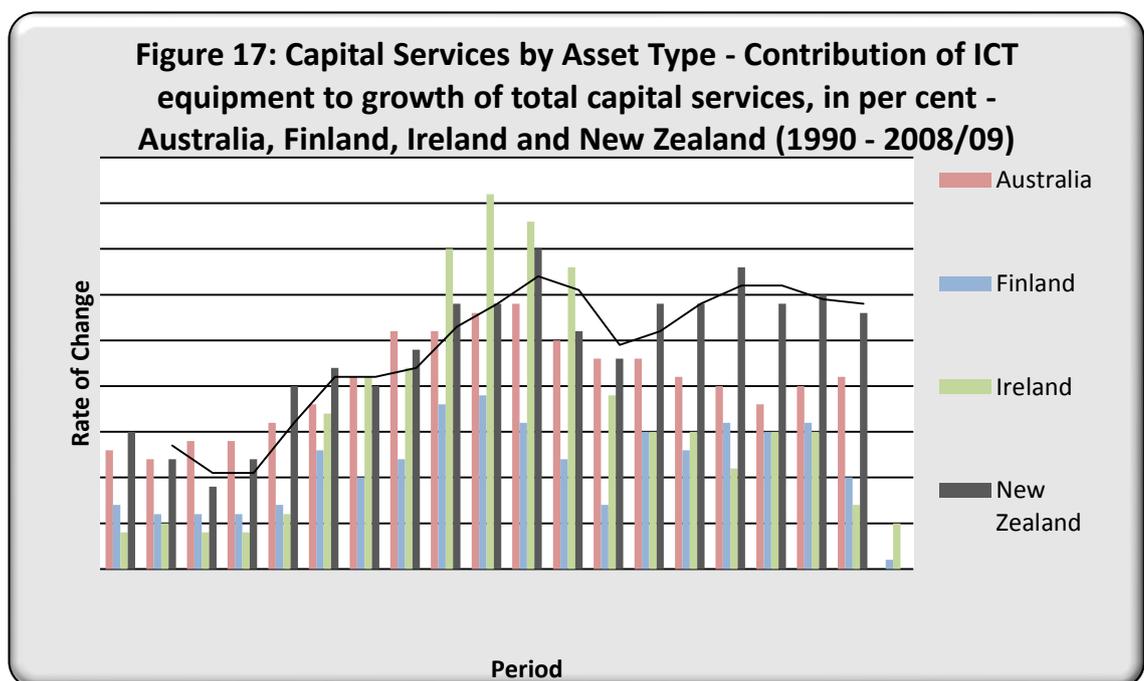
The data presented in Figure 16 measures the level of growth in capital services based on harmonised prices indices for ICT and other capital service asset types between 1990 and 2009. It is important to note that the data for Australia and New Zealand is restricted to the year 2008, whereas the data for Finland and Ireland was available for the entire period.



Source: OECD (2011).

This data reveals that the New Zealand economy has experienced an almost identical pattern of capital services growth with Australia during this period. It can be argued based on this evidence that New Zealand does not suffer from a lack of capital growth in investment into businesses to the degree that is commonly cited in the relevant literature. Based on this empirical evidence the reason for New Zealand's higher labour to capital ratio is further exposed and

highlights the fact that New Zealand is a low wage economy. Finland, on the other hand has experienced much lower levels of capital service investment in business when compared with Australia, Ireland or New Zealand. Whereas Ireland businesses experienced a surge in capital services investment during the four year period between 1998 and 2002, which was almost 100% greater than that achieved in the other economies. The impact of the GFC is also evident in the data with deterioration in the levels of growth achieved in New Zealand, Finland and Ireland. Australia was the only economy to improve the level of total capital services growth in 2008.



Source: OECD (2011).

Figure 17 presents data that is specified to the contribution of ICT equipment to growth in total capital services, that is, what influence has ICT equipment investment had over growth in the capital services of business in this studies four economies. It is clear that the New Zealand economy experienced periods of significant growth in the contribution of ICT to growth in total capital services between 1992 and 2000, which mirrors the experience of the other economies cited, albeit to varying degrees of growth attainment. More importantly for the period 2001 – 2008 New Zealand’s level of ICT contribution to growth has remained consistent with minor fluctuations. This highlights that New Zealand’s relative growth in total capital services attributed to ICT investment has been

superior to that achieved by Australia, Finland and Ireland. However, as Figure 16 shows New Zealand's level of overall growth in capital services has been similar to the other economies. It is rational then to argue that the role ICT has had in contributing to growth in capital service investment has been higher for New Zealand than for Australia, Finland and Ireland as identified in the literature (Matheson & Oxley, 2007; Engelbrecht & Xayavong, 2007).

### ***The challenges ahead for New Zealand: improving productivity performance***

The challenges New Zealand faces improving economic productivity performance relative to the productivity performances of Australia, Finland and Ireland are significant. Prior to the impacts from the GFC in early 2008 Ireland, Finland and New Zealand and to a lesser degree Australia were all experiencing declining rates of productivity growth as evident from the review of relevant literature on each economy (Fortas, 2006; Statistics Finland, 2007; Dolman *et al.* 2007). However, since the GFC the rate of decline has rapidly increased for Ireland and Finland, and continued to decline to a lesser degree for Australia and New Zealand. For example, in 2007 New Zealand (OECD, 2011) experienced annual labour productivity growth of 2.6% which was a significant 1.6% more annual growth achieved than that of Australia (1%) (See Figure 6: Annual Labour Productivity Growth 2000 - 2009). Finland continued to enjoy impressive growth rates with 3.2% improvement in labour productivity, whilst Ireland experienced annual growth of 2.7%. However, the figures for 2008 clearly illustrate the severity of the impacts from the GFC on the global economy, specifically the economies of advanced countries, including all four countries cited in this study. For example, New Zealand went from growth in annual labour productivity of 2.6% in 2007 to a decline of -0.8% in 2008. Australia went from 1% growth in 2007 to a decline of -0.2% for 2008 – illustrating how insulated the Australian economy was from some of the effects of the GFC.

However, Ireland and Finland went from high growth rates in 2007 to declines of -0.5% respectively for 2008, although not as steep of a decline as New Zealand's rate of -0.8%, it does represent a more significant deterioration in the rates of annual labour productivity over the two year period. For the year 2009 with the exception of Finland (OECD, 2011) there was a sharp correction in each countries annual labour productivity figures. New Zealand returned to growth with an increase of 1.7%, Australia responded more strongly with an increase of 2.1%, whilst Ireland was the economy to experience the most dramatic shift (once again) with an increase of 2.7%. Finland experienced a further deterioration with a decline of -3.6% thus for the years 2008 and 2009 Finland's annual labour productivity growth rate declined by a significant -4.1%.

An area of convergence regarding common experiences (until late 2008) could be found in the shift of dominance from export led growth to domestic consumption led growth. This was a distinctive feature of all the countries incorporated into this study, albeit to a lesser degree for Finland which has maintained strong export growth in comparison (OECD, 2007a). However, since 2009 this picture has reversed. Once the full effects of the GFC were felt by advanced economies in 2009, these economies once again were characterised by export led growth, with domestic consumption declining (OECD, 2010a; OECD, 2010b; OECD, 2010c; OECD, 2010d). As part of an on-going programme that delivers working papers on the challenges and ways in which New Zealand can achieve greater economic prosperity, the New Zealand Institute produced the report "A goal is not a strategy" (2010) which outlines some of the reasons why New Zealand has failed to achieve the same level of economic growth As Australia. Drivers of GDP per capita (growth) according to report authors Boven, Bidois and Harland (2010) are: comparative level of GDP per capita; GDP per worker; Government expenditure as % of GDP; labour force participation; and, private economy labour productivity per hour all calculated in New Zealand dollars (NZ\$). GDP per capita growth is used by economists as a measure of relative economic prosperity.

In addition, exports, debt and the current account play significant roles in growing the economy, and as has been discussed previously, the low value of New Zealand's exports, combined with a high private sector debt (the vast

majority being bank mortgage lending) and a worsening current account deficit, it is clear that serious challenges remain to New Zealand achieving higher rates of economic growth (Boven, Bidois & Harland, 2010). Understanding how the dynamic aspects of productivity growth have changed over time in conjunction with changes in the composition of the economy that affects all economies can inform the debate. Rather than the current situation being a catalyst for urgent structural change of the economy as happened in the preceding economic reform period, it is important to realise that the initial factors that gave rise to New Zealand's economic recovery from the early 1990's cannot be replicated. Certain policy developments such as the introduction of the Employment Relations Act (1994) resulted in higher labour participation rates, rapidly lowering New Zealand's unemployment rate, underpinning one of the reasons why our MFP and capital-labour ratio growth has lagged (Oxley, 2004). Looking back, the structural changes between the 1991 – 1998 periods lifted our labour and MFP productivity rates (Pilat, 2004; OECD, 2007c), albeit from relatively depressed points. However, New Zealand has recently experienced lower than average historical productivity growth. These results will be not enough to increase GDP per capita and therefore, materially improve living standards. There has been some discussion in New Zealand (Boven & Skilling, 2005) about how Ireland is used as a model on which to base our economic aspirations. Some arguments focus on Ireland receiving substantial European Union (EU) subsidies after joining (Tansey, 2005), suggesting without this added investment New Zealand could not be in a position to experience the same degree of growth. However, this misses out how effective the New Zealand economy was transformed at a time when Ireland was starting to experience its own turn around.

In the New Zealand context the relatively small and mobile population and isolation may continue to limit growth potential. As yet there is no consensus of the role of proximity to markets and size of the domestic market among the research scholars (Drew, 2007). Certainly one could argue that had New Zealand been in the geographical location of Ireland and Finland – the opportunity for growth would have been greater.

Characteristic of the New Zealand productivity experience, increased government funding has been provided to address the historical deficits in asset and services provision, which occurred during the periods of higher productivity growth during the 1990's. This continues to be a conundrum for New Zealand. These incremental increases in infrastructure spending have limited impact on productivity improvements as the changes are providing for current capacity utilisation, rather than forecasted future potential. Australia, Finland and Ireland are facing the same challenges New Zealand faces including domestic led consumption fuelled by consumer spending, an ageing population and dwindling supply of human capital due to low levels of unemployment. The difference is, when facing these challenges the attributes of their economic environment such as exporting resilience, deeper capital markets and greater levels of FDI and R&D activity will ensure they are better positioned than New Zealand to deal with endogenous and exogenous pressures.

### ***Prospects: improving New Zealand's productivity performance***

The ability of New Zealand's economy to substantively improve the productivity performances of the three key measures, labour, capital and multifactor is being severely challenged by the impacts of the GFC, the possible double-dip recession, and the significant interruption and associated human, environmental and financial costs of Christchurch's September 2010, and February 2011 earthquakes. Based on the review of recent literature a number of specific challenges have been identified. First, accounting for measurement issues and where possible overcoming uncertainty relating to differences between methods applied from which productivity data is sourced (significance of measurement in productivity analysis). Second, historical/comparative studies consistently point to a weaker level of labour productivity in New Zealand (low labour productivity growth has weakened New Zealand's relative economic performance since 1990). Third, the proportion of value added goods and services being exported from New Zealand are low in relation to the three other economies cited in this study (facilitating the transition from commodity based exports to high-tech products and services). Also, creating and sustaining a greater number and concentration of innovative high-end technological exporting entities aligned with Crown Research Institutes (CRIs) is of critical importance to the longer-

term productivity performance of the New Zealand economy (providing critical mass). The reason why this is so important is because innovation is not occurring in many of New Zealand businesses due to their small size. For larger firms that do conduct R&D many benefits can come from the scientific capabilities of the CRIs and from fostering a collaborative environment where science and research aids in the commercialisation of services and products to market.

The ways in which these can all be durably achieved is less well understood than the identification of the issues themselves. However, it is important to recognise that there is increasing awareness of the challenges the New Zealand economy, industry and government face. A snapshot of competing arguments include; a reduction in corporate tax rates to compete for global FDI, increasing R&D tax incentives and strengthening the awareness and transfer of knowledge of best practice models to New Zealand businesses for localised implementation are some of the more pragmatic arguments. The New Zealand Government has adopted these measures as facilitating stronger growth in the Budget of May, 2010. The focus now shifts away from literature on productivity to literature analysing New Zealand's biotechnology sector. New Zealand's biotechnology sector was selected due to it being a rapidly expanding industry, from which New Zealand is able to leverage competitive advantages, where growth had been a key feature of the sector's recent history. It was deemed to be a good fit from which key factors aimed at increasing productivity growth across all three measures could reliability be identified.

### ***Why biotechnology?***

Biotechnology is often described as an industry, but it goes further than simply being one sector of an economy. Biotechnology is a diverse and complex sector spanning high yielding grass through to medical nanotechnologies. Biotechnology both contributes to and influences many other parts of our economy and society (MoRST, 2003a). New Zealand's economy was built upon an exceptional ability to add value to agricultural products by applying technological and biological knowledge. Modern biotechnology goes further with rapid changes in the scale and significance of Biotechnology to New Zealand's

economy. For example in 2005, a brief economic snapshot of biotechnology in New Zealand showed that expenditure on biotechnology totalled more than \$640 million (represents a 20% increase from 2004); with biotechnology contributing between \$300-400 million per year to the New Zealand economy via the primary sector; with export revenue from Biotech organisations increasing 30% in a single year (2004/2005); with biotechnology organisations employing 2,200 people across New Zealand, in 126 private and public sector entities. The majority of growth has come from the private sector, consistent with a vibrant industry in strong growth mode. In addition, in 2008 there were 10 New Zealand biotechnology companies listed on the New Zealand Stock Exchange (NZX), with four of these also listed on the Australian Stock Exchange (ASX), (SNZ, 2006; NZBio, NZTE & MoRST., 2006; Boalch, 2008). In 2009, SNZ published the first Bioscience Survey: 2009.

Biotechnology is an important piece of New Zealand's economic and technological future (MoRST, 2003b; Boalch, 2008; Hickson, 2008) because it allows for the preservation of New Zealand's unique natural environment, whilst providing ways to seek increased, high quality production from existing resources via innovative processes based on scientific research and development (Boven, 2009a). Boven (2009b) has written several papers for the New Zealand Institute focused on lifting New Zealand's economic performance through structural and policy change. Boven has also evaluated the role of New Zealand's ecosystems in obtaining higher value, sustainable growth founded on the competitive advantages that agricultural legacy provide.

Investing in the biotechnology sector also provides serendipitous benefits to growth in collective knowledge on the ways in which higher growth can be achieved. This is because biotechnology allows for an increase in the epistemological understanding of the natural environment and societies relationship with it; uncovering opportunities and identifying previously unknown or unfounded comparative advantages when science, research and technology attempts to answer contemporary questions i.e. medical technologies, nanotechnologies, Ag-Bio (Coyle & Fairweather, 2005; Cronin, 2008). This has been supported by the active collaboration that has characterised the rise of biotechnology as a future-watch industry for New Zealand between government,

crown research institutes, industry representative bodies, biotechnology firms and scientists.

In addition, biotechnology is an important piece of New Zealand's economic and technological future because it enables new innovations to emerge by encouraging scientific and academic endeavour in the field of Biotech, applying innovative research approaches borne out of the biotechnology discovery process, that would otherwise not be realised according to Watson, Boland, Burns, Conder, Davenport, Gluckman, Goldson, Hayne, Lancashire, Saunders & Tallon (2008) who published a document 'A science manifesto for New Zealand' representing the views of New Zealand's preeminent scientific body the Royal Society of New Zealand. It is interesting to note that part of the basis of Ireland's and Finland's economic growth since 1990 has been the focus of government, business and industry on attracting and investing in science-intensive, technology or biotechnology driven product and service development by large-scale multinational firms (Tansey, 2005b). Moreover, in the field of biotechnology New Zealand is well positioned to leverage advantages from the growing interest and application of such technologies when seeking to find solutions/remedies for existing issues (Eady, 2008; Hickson, 2008; Hindmarsh & Du Plessis, 2008). Furthermore, biotechnology investment and growth creates a rich mix of interdependent economic and technological conditions required to support sustainable productivity growth built on New Zealand's comparative country-specific advantages (MoRST, 2003a; Nimmagadda & Prasad, 2003) including; high level biotech research, science and technology activities; creating and maintaining global network relationships adding value via knowledge acquisition to pre-existing capabilities; intellectual property recognition, protection and ownership; academic linkages to support the growth of human and capital investment in research and science.

Atapattu (2008) presented a paper at NZBio's 2008 Conference titled 'The Grass is Always Greener over the Septic Tank' and argues that growing the sector is less about what is missing, or the advantages other markets have, rather, it is about leveraging the strength's that exists organically or by way of history and adds that it takes time to build critical mass, capacity and resilience in science intensive industries such as biotechnology. With increased

investment and focus on New Zealand's biotechnology sector one of the benefits is that it builds capacity among ancillary industries including biomedical i.e. clinical trials, gene technology – dissipating reliance on international expertise, whilst strengthening New Zealand's own towards creating a cultural climate of research, science and technology endeavour in existing and new areas of investigation (Boalch, 2008).

The points above underscore the continuing significance of New Zealand developing innovative ways of producing more value-added goods and services from its country-specific advantages when applying research, science and technology to the field of biotechnology (Kaye-Blake, 2006). So how has biotechnology become a significant emerging industry in New Zealand? Two forces were critical in the development of the biotechnology sector. One was the historical legacy provided by the agricultural sector. Biotechnology today has large and wide-ranging effects on such diverse areas as health care, environmental protection, farming sustainability and bio security. The biomedical sector is one of the fastest growing biotechnology areas in New Zealand (NZBio, NZTE & MoRST, 2006).

Considering the range of activities that come under the heading biotechnology it is clear that New Zealand has the opportunity to create value, not just in biomedicine or agri- biotechnology, but in a host of associated areas. Additionally, the New Zealand scientific community is perceived to have an excellent reputation in science, agriculture, horticulture, forestry and marine sciences (MoRST, 2003a; Watson et al. 2008). For example, Chaturvedi's (2005) paper 'Evolving a National System of Biotechnology Innovation' argues that Singapore is well-placed to benefit from a systemic, vertically hierarchical national policy focus on leveraging the scientific community's strengths by aligning industry capability, supported by government financial incentives and regulatory certainty. Chaturvedi's view of building a national science, research and technology system, encouraging the development of critical mass in significant industry sectors is a model very similar to New Zealand's that started with the merger of NZBA (New Zealand Biotechnologists Association) who represented scientists and Biotenz (represented biotech firms) into NZBio in late 2003 (MoRST, 2004). In addition, comprehensive sector strategy documents

such as 'New Zealand Biotechnology Strategy – a foundation for development with care', once again with the vital support provided by Government allowed for the sector to consolidate and communicate with government and other stakeholders in ways which had not been done before.

These changes have served as a firm foundation on which to bring about changes in related industries and within the wider primary sector. Biotechnology offers capacity building and innovative research and development opportunities for all primary sectors (Eady, 2008; Trought, 2008). Building on world-class medical research, industry can tap into a huge global market for pharmaceutical and biomedical products (Savage, 2008), in a similar way to what Ireland has achieved more recently.

### ***What is biotechnology?***

Biotechnology is a term for a group of technologies that are based on applying biological processes to solve problems and make products (MoRST, 2003a). And, biotechnology is the use of biological components (occurring in nature) for ends that are medical, industrial and economic. Humans have harnessed biotechnology for centuries, but the term biotechnology is new and only recently has it become more widely used (RSNZ, 2003). Over time, change occurs differently, and this is true for biotechnology. Statistics New Zealand (2010) defines biotechnology as “the application of science and technology to living organisms as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services” (p. 11). The definition above is supported and used by the OECD and many of the country members including New Zealand, Australia, Ireland and Finland.

Traditionally, biotechnologies include fermentation applications such as beer, cheese bread-making and cosmetics, as well as animal and plant breeding techniques (Oliver, 2000). The term modern biotechnology is used to describe recent research and applications that relate to molecular and cellular biology (Thacker, 2005). It includes a range of techniques from microbiology and biochemistry through to gene technology. Genetic engineering (GE) and

biotechnology are often viewed as the same thing (MoRST, 2003b), however biotechnology is not limited to GE.

However, GE is based on the modification of genetic material, and is only one aspect of gene technology, which is itself a specific sub-set of modern biotechnology. Therefore, GE is one example of the fields of biotechnology. Modern biotechnology encompasses many of New Zealand’s leading industry sectors and includes; livestock, horticulture, dairy, forestry, marine, wine, medicine, natural products and the environment (Atapattu, 2008). Using a marketing term, these collectively translate into brand ‘New Zealand’, underpinning the tourism and exporting sectors. Examples of biotechnology fields and areas of application (categorised into related groups) that are used in New Zealand (MoRST, 2003a; SNZ, 2010d; NZBio et al., 2006) are listed in Appendix 5: Fields of Biotechnology.

The diversity of these different biotechnology fields presents New Zealand with several economic, technological, social and ecological opportunities. To that end, an independent review of the New Zealand biotechnology sector commissioned by biopharmaceutical consultants The Channel Group (TCG) identified nine important biotech sectors offering high potential for further development in New Zealand (MoRST, 2003a). This study saw TCG conduct a comprehensive audit of New Zealand’s biotechnology industry incorporating the tracking of biotech activities from inception to pre-production, and by analysing the ways in which country specific-advantages could be leveraged further with the use and application of biotech processes. The nine biotechnology sectors identified as offering future potential that is suited to New Zealand’s strengths (realised and potential) and include:

**Table 3: The Biotech Nine: Areas of New Zealand Specialisation**

Agricultural Biotechnology	Bioactives
Biomanufacturing	Biopharmaceuticals
Clinical Trials and Research	Industrial and Environmental
Marine	Nutraceuticals
Transgenic Animals	

Sources: MoRST (2003a); MoRST (2003b); SNZ (2010).

For example, Auckland University has a dedicated department focused solely on pharmaceutical clinical trials and research, supported by academia, funded by multinational and domestic pharmaceutical businesses (Cronin, 2008). The wider scientific community in New Zealand has a reputation for holding excellent expertise in land-based research and development, formed upon the legacy provided by agricultural experiences. The nine sectors above constitute the biotech areas where New Zealand's biotechnology sector has capacity, expertise, scale, intensification and either competitive and/or comparative advantages that are supported by comparatively robust, regulatory frameworks and standards (MoRST, 2003a). Underpinning New Zealand's advantage in these areas are world-leading scientists and researchers in both the private and public sectors (especially in the CRIs). With biotechnology forecast to play a critical role in New Zealand's scientific, research and economic (productivity) future, identifying the key aspects that define the relationship between productivity and biotechnology becomes increasingly important.

### ***Relationship: productivity and biotechnology in New Zealand***

The relationship between productivity and biotechnology is perhaps not immediately obvious to many. How, and in what ways, could these two theoretical concepts have a relationship? The biotechnology process involves researchers, scientists, product developers, clinicians, and farmers among other vocations having questions first and foremost, questions they seek answers to. The pursuit of answers can be motivated by the needs of business and/or the needs of the person or both simultaneously. The premise for seeking answers is often driven by opportunities for advances, such as; improvement in quality of life (biomedical research); increased efficacy when treating a specific disease (medical technologies); how to yield more production from finite land-based resources (ag-bio), without undermining the quality of future produce; understanding how intrinsic processes that exist within molecules and cells could be beneficial for plant immunity against environmental threats (molecular biology). The common driver among all these fields is progress.

Productivity analysis is centred on measuring units to determine whether there has been growth or decline in either the inputs or outputs (labour, capital) – or in the use of technology or acquired knowledge as is that case with MFP (SNZ, 2011). As already mentioned biotechnology activities are centred upon seeking answers to problems, and/or by discovering entirely new processes, organisms or technologies for example, when seeking improvements in human longevity through to oil-eating micro-organisms such as the disbursements used recently in the Gulf of Mexico (Deepwater Horizon Oil Rig) oil disaster. The parallel is that where productivity analysis seeks to improve the performance of something by analysing the use of inputs creating a particular outcome, biotechnology seeks to find answers to current problems with innovation and applies new and emerging technologies in new ways for current and importantly new issues. The Biotech sector is ultimately looking for new profitable products and processes.

On one hand biotechnology as an industry has been an example of high productivity in terms of securing growth from the same level of inputs (SNZ, 2010), on the other hand the nature of output via new biotech processes and technologies effectively with success has potential flow on effects influencing the productivity performance in other areas of industry within the New Zealand economy. In addition, investing both capital and human capital into the production functions of a business and/or research entity illustrates how inter-related biotechnology and productivity are. Indeed, what biotechnology offers, productivity analysis may assist in maximising. Alternatively, what biotechnology creates, productivity assists in perfecting. With productivity being how efficient the allocation of resources has been in order to obtain the desired results, without increases in the set of resources used - biotechnology becomes a natural part of this process. The role productivity can play in achieving growth does have some limitations. Because, its emphasis is on the utility of resources used in production which is easily displayed in numbers i.e. time, weight, inputs, outputs, use of resources – it cannot and should not be applied to unique and complex, specifically human and/or animal industries such as the health, education, military or sport which constitute the majority sectors within the non-measured sector (SNZ, 2010d). More complex is the task of understanding the nature, quality and degree of interaction that exists within the relationship and this is the focus of this chapter.

Identifying, and contextualising the issues that feature in this relationship is crucial to fulfilling the aims of this study. Biotechnology is a growth sector in the New Zealand economy (Duft, 2008; SNZ, 2010). Moreover, Biotechnology is a major growth industry worldwide (Caples, 2008; Chen, 2008), centred on developed economies and increasingly on emerging economies. According to Carroll (2008) who presented a paper at the 2008 annual NZBio Conference argued that China is rapidly becoming more cognisant of the tangible (economic, social, technological and ecological) benefits that biotech can provide – most especially when land-based competitive advantages and/or other related comparative advantages such as nanotechnology specialisation are present.

For New Zealand, what holds vast potential is that the country has the right mix of core ingredients that makes its biotechnology industry significant in securing New Zealand's longer term economic future (Cooke, 2002; Boalch, 2008). Relationships are often constructed in environments that have entrenched push and pull factors and the relationship between biotechnology and productivity is no different. Productivity is an economic frame on which to assess the effectiveness of production although it can relegate human considerations into economic parcels. Although this seems undesirable, as previously mentioned, it can also have merit.

Because biotechnology is still an emerging industry, albeit one New Zealand has developed quickly, productivity was not originally a key concern as the industry was in infancy/start up phase (NZ Venture Fund, 2008). Economic considerations (outside of the potential economic benefits) have become the focus more so as time has passed. This is because prior to an emerging industry becoming economically viable the primary goal is to ensure the environment is conducive to developing the industry, having the right mix of ingredients to be sufficiently supportive of the industry gaining in size in order to be efficient in the use of existing resources. Biotechnology in New Zealand has moved away from ideas only (implementation) and is now focused on activities and outcomes (research and science capability building) including successfully bringing commercialised products and services borne out of a biotechnology

process to market (NZTE, 2006; MoRST, 2007; NZ Venture Fund, 2008; SNZ, 2010).

### ***Biotechnology: opportunities and challenges***

There are vast opportunities to be gained from biotechnology in New Zealand. This includes opportunities that are economic, social, technological, cultural and environmental. Some require new technology, processes and capital and talent. For others, they require changes in taxation such as those announced in the May, 2008 budget re R&D tax breaks (PWC, 2008). It is important to note when analysing opportunities for biotechnology that one size does not fit all. Watson et al. (2008) who are the National Science Panel of the Royal Society of New Zealand (RSNZ) argue in 'A Science Manifesto' their vision:

New Zealand needs a science system that is a visible contributor to the nation's wellbeing; one that is practised with energy and passion; one that attracts the best students. Our vision is for science to be central to the New Zealand identity in the same way that sport is already and the creative arts are becoming. We want to hear our nation's leaders speak about our 'smart country' the problems we solve and the opportunities we create through science. (p. 2).

Several authors (MoRST, 2004; Boyes, 2008; Nicol, 2008 & Trought, 2008) argue that educating the public and business about biotechnology and what it can offer is a critical part of building New Zealand's research, science and technology cultural capability. Furthermore, according to Boyes (2008) & Trought (2008) the effective dissemination of success stories in biotechnology is required to increase generic knowledge of and appreciation for New Zealand biotechnology activities and what they create. Indeed, encouraging shifts in cultural perceptions of the value of research, science and technology (R&ST) to New Zealand are a common theme throughout the literature. Sharing the potential of what biotech can bring to benefit the New Zealand economy requires opportunity and risk identification whilst being effective in mitigating challenges and threats (Ministry for the Environment, 2002; RSNZ, 2003). Opportunity lies in building increased public knowledge of the strengths and successes the biotech industry achieves for New Zealand (Boyes, 2008). Challenges relate to finding ways to achieve enhanced understanding of

biotech, whilst developing methods to ensure greater public appreciation is sustained over the long-term.

Since, the government launched the Growth and Innovation Framework (GIF) in 2001, a series of changes has occurred in New Zealand's biotech sector (MoRST, 2003b). As part of GIF, biotechnology was identified as one of New Zealand's growth industries. Part of the changes created a more centralised approach to industry coordination. In addition, the establishment of a new industry body e.g. NZBio - brought together parties that were previously working independently. The effects of these changes enabled the biotech sector to collaborate and contribute to the New Zealand Biotechnology Strategy in a cohesive and unified way. It also makes connecting government and industry easier as there were fewer key players to be included into policy and strategic development (Boalch, 2008; Clarkson, 2008). In addition, securing the mandate of the biotech industry by working with representative bodies that adequately reflected a majority of research bodies and business entities was a critical element in building industry coordination. Therefore, the next opportunity is to attract further investment (Duft, 2008b), increase human capital participation in science and technology within the education system to provide a reliable and suitably skilled future workforce (Watson et al. 2008; Nicol, 2008), and to better educate and involve the public more often in understanding how biotechnology influences their lives every day and what this means for the future.

Challenges facing research, science and technology entities and government include; access to sufficient capital, continual improvement of the quality of regulatory environment, staff retention and recruitment, issues of critical mass, levels of offshore endeavour – pathways to global markets, industry connectedness and cohesiveness and continuing government support (NZBio et al.). However, there is a divergence of opinion between local and global players. New Zealand biotech firms report access to funds and talent as more challenging than international entities (MoRST, 2003a). The reasons for this are due to specific challenges, and although these are of concern globally, they are felt more acutely in New Zealand's smaller economy and open labour market. They are - a skilled labour shortage, near-full employment, historically high work force participation rates and fierce global competition for skilled talent. Add to

this the attraction offshore holds for New Zealanders due to a range of factors including increased professional challenge, higher earnings, and opportunities that larger markets provide and this puts pressure on New Zealand industry. This in turn, influences productivity in the short term (Drew, 2007). When these conditions are present, increased investment of capital and technology into business to replace the loss of human capital often occurs in developed economies. However, although when compared historically the capital inputs into business have improved over the last two years in New Zealand there has not been sufficient investment to mitigate the skills shortage conundrum. In fact, a sizable re-investment of capital into business would be required to offset these factors (Perry, 2007).

As already mentioned the biotech industry in New Zealand has benefited from a series of structural and systemic changes to achieve greater coordination and improve critical mass (MoRST, 2004; NZBio, 2008). However, even with these improvements, critical mass continues to be seen as a key challenge for many stakeholders in the sector according to SNZ (2006) & MoRST (2006). This suggests that even with high industry growth, complimentary institutional changes and significant government assistance improving the business environment for biotech, industry frustration about the slower than envisaged pace of critical mass building in the sector remains – notwithstanding that the Fifth Labour Government budget in 2008 and the Fifth National Government budget's of 2009 and 2010 brought favourable legislative, regulatory and taxation changes to the industry (PWC, 2008; Hickson, 2008). The basis of this argument is in acknowledging that the industry is still waiting for a 'breakthrough' story of a New Zealand biotech firm leading the world in bringing new products and processes to market.

Watson et al. (2006) suggest the adoption of a ten point programme for the recovery of science in New Zealand. This is an interesting statement, as no other authors expressed such dire sentiments on the state of research, science and technology in New Zealand. However, being that this group is so esteemed, their concerns raise warnings about the nature and investment of science in New Zealand. Of the ten points, four are of particular importance in successfully navigating the challenges ahead. They are: developing a national science

strategy; improve the path to commercialisation; promote science across the entire education system; and, build national recognition of the public value of science. A national science strategy could assist in determining the science needs of New Zealand, whilst identifying gaps in the sector that could yield benefits. Having science conducted, that is both rigorous and robust is good, but without established pathways to commercialisation being available, much of this significant activity does not end up reaching new markets. Indeed, a major challenge for biotech in New Zealand is to enable science, research and technology activities to be adaptable for commercial markets.

One area of innovation in New Zealand's approach to biotechnology sector strategy was the establishment of a Bioethics Council 'Toi te Taiao'. This expert panel of ethicists, scientists, philosophers and cultural representatives served as a statutory body charged with incorporating the inclusivity of a Maori worldview and regards for New Zealander's values when dealing with new scientific frontiers made possible by biotech endeavour. The reason why this has been included as part of the discussion is that bioethics plays an increasingly important role in protecting the social and cultural impacts from emerging technologies, especially in the field of biotech.

### ***Bioethics: inclusivity of Maori worldview and regards for New Zealanders values***

Toi te Taiao (2008a) describes bioethics as:

Bioethics is the study of the ethical, social, legal, philosophical and other related issues arising from the biological sciences and in health care. (p. 6).

The programme of industry and government actions focused on biotechnology stemming from GIF also includes the creation of Toi te Taiao (the Bioethics Council) in 2002. The aim is to improve New Zealand's understanding of the cultural, ethical and spiritual aspects of biotechnology (Toi te Taiao, 2008a). The Royal Commission on Genetic Modification in 2002 recommended the establishment of an independent body. Toi te Taiao advises the government on biotechnology matters. It deals with matters relating to biotechnology by

adequately incorporating aspects of cultural, ethical and spiritual dimensions as per consultation received by the Royal Commission (Ministry for the Environment, 2002).

Toi te Taiao acts as an expert, independent body, whose role is to inform and guide public debate on biotechnology and related issues. It is important to note that Toi te Taiao is an advisory body with no statutory powers. Part of the mandate afforded Toi te Taiao is the role of ensuring biotechnology has regard for New Zealanders values. Being that the council is responsible for informing public debate on biotechnology in New Zealand, having the terms of reference (TOR) reflect it in this way is not unusual. However, what is interesting is the importance placed on recognising Te ao Maori (the traditional Maori world view) and Toi te Taiao (the place where the sphere of the spiritual and natural worlds meet) when considering biotechnology issues (Toi te Taiao, 2007). Within Toi te Taiao, lays the Maori working group.

This group is responsible for delivering a greater understanding of how biotechnology poses potential problems for tikanga Maori (Maori culture), along with assessing how knowledgeable Maori policy-makers, ethicists, researchers and lawyers are of biotechnology as an industry. Biotechnology is controversial in several areas irrespective of culture; most notably regarding GE and GMO, Transgenics / cloning and tissue engineering among others (NZBio et al. 2006). However, what is not been well understood is what is of specific concern to Maori and the significance of ensuring that the views of Maori on biotechnology are voiced and responded to, where-ever possible. The traditional Maori worldview sees the natural world and humanities relationship with it differently to the majority New Zealand European population and the inclusion of this unique world view is constructive to ensuring biotechnology has a culturally acceptable, sustainable and secure future in New Zealand for all (Toi te Taiao, 2007).

In 2009, the New Zealand Government disestablished the Bioethics Council (Toi te Taiao, 2009). The Government claimed that the role and focus of Toi te Taiao was a duplication of existing oversight that exists among other consultative bodies. An independent review of the council found, no other body

in government had the broad range and deliberative focus of the Bioethics Council (Toi te Taiao, 2009). Thus, members of Toi te Taiao rejected the Governments justifications for disestablishing the council, and encouraged the Government to actively pursue consultation with New Zealanders on such significant matters. It is plausible then to consider with growth in biotech, a rise in the number of products and services reaching market via biotech processes/technologies (increasingly complex, green-fields areas of research) undertaken in the name of progress, the issues will remain therefore it will be increasingly likely that Toi te Taiao's former role will become more significant in time.

### ***Biotechnology Industry reports***

The majority of industry reports available on Biotechnology in New Zealand are now produced by the Ministry of Science and Innovation (MSI), NZBio and Statistics New Zealand. The majority of these reports were written under the Ministry of Research, Science and Technology (MoRST) prior to its merger with the Foundation for Research, Science and Technology into MSI (MSI, 2011). MSI, funds a broad range of research into the sector, as well as, facilitating sector wide collaborations. However, being that MSI has only recently been established (February 1, 2011) there has not been much publication on whether this merger serves the interests of the industry except to note NZBio CEO Bronwyn Dilley praised the Governments renewed focus on leveraging further gains from continued support of the sector, therefore it would seem that NZBio was supportive of this change (NZBio, 2010a).

NZBio publishes a series of industry reports, newsletters and holds seminar events including the annual NZBio conference viewed as the sentinel biotechnology gathering in Australasia, and some argue in the Pacific Rim (Boalch, 2008). The conference attracts many leading experts on biotechnology and several successful biotech entities are in attendance from around the world. NZBio represents over 88% of all biotech entities in New Zealand and has successfully increased the profile of biotechnology in New Zealand (NZBio, 2010a). In addition, Science New Zealand is the body that represents all Crown Research Institute's (CRIs) and collectively these CRIs conduct a significant

proportion of R&ST activity in New Zealand (NZBio et al. 2006). All relevant literature investigating biotech sectors highlight biotechnology as a growth industry globally. Equally, those which feature a focus on New Zealand highlight potential benefits that can be gained from Biotechnology.

**Table 2: New Zealand Bioscience Surveys 1999 – 2009**

	1998/1999 Biotechnology Survey	% Change from last survey	2005 Biotechnology Survey	% Change from last survey	2007 Biotechnology Survey	% Change from last survey	2009 Bioscience Survey
<b>Sector Characteristics</b>							
Number of Active Organisations in Biotechnology	180	-25%	135	22.26%	168	62.92%	267 (213)**
Number of Core Organisations	<i>not available</i>		<i>not available</i>		<i>not available</i>		108
Number of Employee's (number)	2,727	-9.64%	2,464		<i>under review</i>		<i>not available</i>
<b>Financial Information</b>							
Total Income (financial year)*	\$475 million	70.73%	\$811 million		<i>under review</i>	-26.10%	\$351 million^
Total Expenditure (in the two years to 30th June financial year)	\$405 million	58.51%	\$642 million		<i>under review</i>	-39.26%	\$246 million^
Export Revenue (financial year)	<i>not available</i>		<i>not available</i>		<i>not available</i>		\$167 million^
<b>Use of Biotechnologies</b>							
Technologies used at R&D Stage (%)	38%	73.68%	66%	76.31%	67%	47.37%	56%
Related Patents (granted)	59	220%	189	281.35%	225	416.95%	305
Most common area of application	Environmental		Environmental (28.9%)		Environmental (32%)		Innovative Foods and Human Nutrition (50% of core orgs)
Most active use by Region	<i>not available</i>		<i>not available</i>		Auckland (21%), Upper South Island Region (17%)		Auckland and Northland (22%), Upper South Island Region (19%)

**Table Key:**

\* Includes public and private organisations (total)

\*\* 213 fit the scope of the previous biotechnology survey

^ figures from 108 'core' organisations only

Base Year is 1998/1999 for rate of change percentages

Under Review: Income, expenditure, exports and staff figures not published from 2007 survey. Further investigation has been undertaken to better understand issues and their impact on financial and employment measures of biotechnology activity.

Not available: data not collected during survey period

Source: SNZ (2001; 2006; 2007a; 2010d)

The data presented in this table reveals that the focus of the data being collected has clearly shifted away from measuring quantity to measuring quality. Thus, the change in data over time reflects the changes occurring strategically in the sector, that is, the shift away from counting to valuing outcomes attained. This is discussed in-depth in the findings and discussion chapter. The sector has been a key stakeholder in developing the industry strategy in partnership with government 'New Zealand Biotechnology Strategy – a foundation for development with care' and subsequent ancillary reports 'Growing the Biotechnology Sector in New Zealand: A Framework for Action' and 'Implementing the Biotechnology's Taskforces Recommendations' and the 'New Zealand Biotechnology Industry Growth Report' (MoRST, 2003a; MoRST, 2003b; MoRST, 2004; NZBio, NZTE & MoRST, 2006, MSI, 2011). Following on from these formative documents on the future directions of the sector, SNZ has published a series of Biotechnology Surveys since 1998/1999 (SNZ, 2011). The most recent survey was called the Bioscience Survey 2009 and expanded upon the previous Biotechnology Surveys from 1998/1999, 2004, 2005 and 2007 (SNZ, 2010). Biotechnology is seen by all authors as an area where New Zealand can leverage further comparative advantages from our unique country-specific factors (Drew, 2007; NZBio, 2008; Atapattu, 2008, Duft, 2008b).

New Zealand's exports, balance of trade, foreign exchange earnings and Gross Domestic Product (GDP) growth are closely connected to how well the agriculture, livestock, horticulture, viticulture and marine sectors perform. All these sectors depend on the quality of New Zealand's natural environment to succeed over the long-term. Much of New Zealand's economic wealth since European settlement has been acquired from selling products and services that have come from the land or sea, based on innovative and entrepreneurial use of existing tools. This is one of the reasons why biotechnology holds significant potential for economic growth in New Zealand. Biotechnology is, put simply, the continuation of doing many of the same activities that have always been done – however with new technology applied, knowledge invested and research (best practice) raising the level of innovation made possible. There is acknowledgement among some studies of the cultural challenges faced by the sector in securing the public's confidence, when seeking to achieve growth (Boyes, 2008; Trought, 2008; Nicol, 2008).

Since the late 1980's New Zealand's economy experienced significant changes, most notably in areas of trade, employment, social welfare, finance, competition and property (McLellan, 2004). The impact of these changes continues to influence the public discourse about where, how and what New Zealand needs to do in order to grow the economy and become a wealthier society. This highlights the challenge Toi te Taiao faced and that of any replacement body whose responsibility is to improve dissemination of biotechnology and related issues to the public and hear the views of the public in return so that these views, where appropriate, can inform sector guidelines and formative policy. The biotechnology sector requires capital, human capital investment as well as a transparent, well-understood compliance system and regulatory structure in order to grow (Fabling, 2007). Since 2001, New Zealand's biotech sector has grown rapidly and is now the leading sector re levels of productivity in New Zealand. This is the reason why biotechnology was chosen for this study.

Specific issues that concern the biotechnology sector according to SNZ (2010) are: access to capital (the most pressing) followed by in no specific order; access to talent, building critical mass, improving commercialisation pathways, reducing compliance costs, improving collaboration with international partners, seeking refinement of R&ST taxation, developing collaborative partnerships with government, harmonisation with Australian and international regulatory standards (p. 5). Additionally, of primary concern to Watson et al. (2006), Fabling (2007) and Nicol (2008) is the declining numbers of students enrolling in and graduating from science and technology courses compared to increasing numbers of graduates coming through other faculties such as humanities, law and commerce. They suggest along with a programme of cultural education on the opportunities that biotech offers New Zealand, and with communicating successes more often to the public, that dedicated programmes be invested into the education sector to improve the uptake of science and technology courses by students. Indeed, the falling participation rates in science and technology are not unique to New Zealand.

The OCED (2007d) notes that New Zealand is not alone in experiencing shifts away from traditional education subjects such as science and mathematics.

Several developed economies are now trying to respond to similar shifts. Watson et al. believes New Zealand must respond now, as the risk of leaving later will mean that New Zealand gets left behind and ultimately sectors such as biotechnology will suffer. Without the trained human capital to contribute to and enhance the industry, there is little opportunity that New Zealand biotech's growth will be sustainable without being able to attract global talent with inducements.

The decline in enrolments of science and technology graduates risks exposing the biotechnology and other science related industries to a worsened skills and labour shortage. Of equal significance according to the literature is establishing industry partners i.e. collaboration with government and international networks. Boalch (2008) views the relationship between New Zealand Trade and Enterprise (NZTE), a government agency, and biotech entities as one of collaboration with dual aims of creating vertical growth and enabling technology growth. PWC (2008) similarly sees the government's role managing the compliance costs environment is a collaborative one, when parties are engaged and open to risk-sharing through mixed use of cost sharing – such as the New Zealand governments R&D tax credits that were introduced in the 2008/09 tax year. This strengthens government support of research, science and technology activities among biotech entities, public and private. Therefore, it could be argued the creation of MSI in 2010, along with the disestablishment of Toi te Taiao, may be specific attempts to streamline the broad national governance offered to the industry from Government.

### ***Conclusion: productivity and biotechnology in New Zealand***

Overall, the literature demonstrates New Zealand's lower productivity growth rates compared to Australia, Ireland and Finland since 1990 is due to the impacts of measurement uncertainty and the affects from inter-country comparisons, a lack of sufficient capital investment by industry into research, science and technology (with Government performing the lead role in the absence of industry), and the low levels of research and development capabilities of business. Combined with a strong, resilient and competitive labour market the impacts are significant.

One impact of these weaknesses is that less capital is left over (due to high numbers of labour) to invest in innovation and research and development. Research shows this results in lower labour productivity growth as the more people employed without significant business growth equals lower productivity. There is an insufficient understanding of the value of capital investment in improving the growth trajectory of business via knowledge acquisition, innovation and introduction of advanced technologies most critically in the private sector. Recent evidence suggests increases in capital investment in private business have started to occur, though not at the levels required for consistent growth, and since this data was published the impacts of the GFC have potentially harmed this rebound (OECD, 2011). New Zealand has been incredibly successful in providing work for its people – what is needed now is an increase in the value associated with innovative technology driven capital investment into the growth aspects of core business; secondary and tertiary education pathways require streamlining to become focused on ensuring durable cross-over between the different stages of education, providing a greater degree of consistency and subject evolution; recent experiences in regards to economic reforms and wholesale changes to society may impact on levels of risk taking, limiting how intelligently new opportunities are pursued.

Biotechnology is one of New Zealand's fastest growing, and most productive industry sectors contributing to the economy. In part, this has been built upon the New Zealand scientific communities exceptional ability to leverage commodities, processes and research on New Zealand's unique country-specific factors in the agricultural sector. For example, the creation of the tearless onion (Eady, 2008) is one innovation which has come directly from a history of agricultural expertise and the application of new scientific knowledge, in collaboration. Whilst, many industries in New Zealand lack sufficient levels of capital investment, biotechnology has proven that if the right set of fundamental conditions are in place, along with accurate assessment of industry structure, focus, strengths and threats investment can be attracted from both domestic and international entities. Biotechnology has seen substantial increases in venture capital investment. These combined with government assistance in the areas of

agency promotion and support (NZTE) and reductions in compliance costs, such as the R&D tax credits, continue to support the sector.

Confidence, or a lack thereof, permeates the literature as an issue that needs addressing. Communicating effectively to the public on what biotechnology is, what it offers, what it needs and why it's important is another area of much debate. There is a lack of consensus of what is required to improve productivity in New Zealand and similarly on how to ensure research, science and technology enjoys stronger participation in society as both are co-dependant on one another. By contrasting different author's views on issues they relate primarily to productivity analysis – a minority of authors believe tax is a major facilitator of economic growth, and therefore is singled out as a key factor, whilst the majority of authors espouse tax as one element among many to enhance growth fundamentals in an economy. For biotechnology, author consensus was present for most of the debate about what issues were key to securing a solid growth performance for the biotechnology industry. Where it diverged was on what issues were of sentinel importance and how these need to be addressed. Watson et al. viewed key changes in all aspects of science activity in New Zealand – including; industry structure, compliance, education rates, commercialisation pathways and investment as well as government in lowering regulatory and taxation burdens. This contrasted with a majority of authors that viewed the same issues, in different ways. Gaps in research is harder to quantify as there was an abundance of research to source in both fields, and large quantities of it has been produced by experts in their respective fields. For productivity, Statistics New Zealand's programme of extending the measurement of productivity analyses across more industry sectors as well as improving the quality of measurement techniques illustrates one area of quality improvement, constituting a gap, albeit one that has been identified.

Productivity in New Zealand has been lower among its comparative trading partners over the last 10 years for a range of reasons. Evidence, suggests the key reason is New Zealand's successful labour market ensuring strong employment growth at the expense of capital investment growth. New Zealand's biotechnology industry contains highly productive activities, thus represents one of New Zealand's strongest growth industries. It appears that many, though not

all, of the answers required to improve New Zealand's productivity in other industry sectors such as manufacturing and ICT are to be found in evaluating the biotechnology industry. Understanding how and in what ways it has succeeded in building an internationally competitive, respected and vibrant sector in New Zealand that enjoys high productivity growth provides valuable insights that can be utilised with potentially positive results.

## **Chapter Three: Methodology**

### ***Introduction***

Generally, a common feature of Social Science research is to hold an interest in exploring the ideas and perceptions of key actors in specific environments (Corbetta, 2003). The reasons are for the researcher, and by implication the scholastic community, to gain insights and information that may otherwise not be well understood, or in some cases, hidden (Fitz & Halpin, 1994). Particular attention is given to identifying what has taken place (or taking place), exploring how it happened, where it occurred, and who was involved and why. This involves in-depth discussion which is a core tenet of qualitative research (Silverman & Marvasti, 2008). For this study the focus was on collecting opinions from the key actors who are involved in establishing the framework and setting the pace of analysis regarding productivity and biotechnology in the New Zealand context. The purpose of the study was to identify and critically analyse the factors contributing to the biotechnology industry productivity performance in New Zealand. Part of the research approach was to establish what was learned from senior professionals who are considered to be 'elite' about what they saw as the factors that have influenced – how, and in what ways, productivity is understood. The aim of identifying the critical factors which contribute to enhance utilisation of or increases (growth) in productivity has been achieved by exploring key themes that emerged from the secondary data analysis alongside the primary data collection from participant interviews.

These themes are identified in the data analysis section and then analysed in the findings and discussion section. The aim was to corroborate or not, challenge or not the findings found within the literature review and to substantiate views of the respondents', based on empirical evidence. Once comparative analysis was completed the findings were related back to the original intention of the study to identify a range of factors that are proven to be conducive to increasing productivity. This study incorporates analysis of secondary data, constituting the literature review. Secondary data was selected because the aim of this study was to identify key input factors that have contributed to growth of New Zealand's biotech sector, which according to

Phillips (1998) and Wolfer (2007) cannot be achieved with interviewing alone. This included: academic peer-reviewed journal articles; technical research reports; comparative statistical data by the Organisation for Economic Co-Operation and Development (OECD); public and private institutional reports; industry sector strategies; economic, industry and mass media commentator's articles; expert presentations and analysis; including works from authors who specialise in productivity and/or biotechnology research (Skilling, 2001; Kerr, 2003; Tansey, 2005b; Cronin, 2008; Adams, 2010; OECD, 2010). To assist in contextualising the secondary data, this study employed interviews with respondents' as its primary data collection method (refer to Appendix 3: Indicative Interview Questions). This was conducted with public and private sector experts whose roles, work and responsibilities focus on the analysis of productivity and/or evaluation of the biotechnology industry, or significantly both. Further, the aim of primary data collection was to capture the ideas and perceptions of those who are responsible for design and implementation of policy initiatives in these fields.

### ***Research Design***

This study was conducted using an interpretative approach that employed a mixed method for collecting data, incorporating the use of a literature review and in-depth interviews. A qualitative approach was considered most appropriate (Neuman, 2006; Silverman & Marvasti, 2008) as this study set out to identify and better understand the ideas and perceptions of key actors who contribute to productivity and biotechnology analysis, discourse and policy in New Zealand.

The mixed method approach (Wolfer, 2007) employed the use of primary and secondary methods of data collection. Respondent interviews, the primary data collection method, provided richness of data and uniqueness of insights that were evaluated and contrasted with findings of the literature review (Phillips, 1998; Corbetta, 2003). Fitz and Halpin (1994) conducted educational research on elite settings and define an elite environment as 'institutional locations in which national policy is devised and translated into directives' (p. 34). Interviews are commonly justified as an effective data gathering tool in terms of the

uniqueness of the data they provide and the theoretical implications which they entail (Phillips, 1998). Personal interviewing is seen as essential for providing data which is unavailable in secondary literature, thus providing a distinctive methodological tool (Aberbach & Rockman, 2002).

### ***Recruitment Methods***

With the primary data collection method being face to face interviews the focus was securing relevant study participants who formed part of the decision-making and policy formation process regarding productivity and/or biotechnology. Gaining the participation of specific participants, relevant to the topics discussed was critical to ensuring that the data collected and perspectives of those involved were both appropriate and valuable. This was essential to the aims of the study. In addition, there was potential for the study participants' respective expertise to cross-over into related areas (Phillips, 1998), providing rich insights into emerging and/or new areas. In order to gain reliable, valid and quality insights this was deemed a constructive method to employ for this study. Access to 'elite' settings is one of the most cited challenges to having the opportunity to conduct research with study participants (Aberbach & Rockman, 2002) and this along with other significant challenges are discussed in more detail below.

The challenges facing research involving the participation of senior professionals' starts with how does a researcher draw sufficient attention to the merits of their study, given the limited opportunity of time when making first contact? This can only happen once identification on who, where would best serve the aims of the study has been made (Aberbach & Rockman, 2002). For this study identification was relatively straight forward as the literature review had been completed. With appropriate participants being narrowly defined to senior managers who contributed to relevant government policy and industry strategy this also assisted in the identification process. During the process of searching for relevant literature, certain identities and institutions/organisations kept coming to the fore and this combined with the researcher's own intrinsic knowledge of the public service assisted in the identification of relevant professionals. However, it was not only literature that assisted in identifying

them. Having an understanding of the key institutions whose functions directly influence and/or impact upon industry policy and strategy, and being aware of the organisational structures helped guide the choice of study participants.

One of the advantages of employing a mixed-method design for data collection enabled the research to cover a broad range of relevant sources prior to conducting the interviews (Silverman & Marvasti, 2008). The selection of participants was based on a number of factors. These included: what institution they worked for; their workplace role and level of authority and therefore likely extent of influence; and, what their key operational and/or organisation responsibilities were. Additionally, where participants had produced written material directly related to the topics covered in the study, their selection was made obvious. All these factors need to be considered when determining whether a participant's selection is appropriate for a study. Once senior professionals were identified and chosen to participate the next challenge was to make direct contact with them, asking them to consider the study, and to participate.

The issues regarding access to and the time availability of senior professionals are well-documented in social research methods text and academic articles (Phillips, 1998; Woliver, 2002; Neuman, 2006). The degree of direct access a researcher is able to obtain is crucial (Wolfer, 2007). One benefit of seeking the participation of high profile professionals is that they stand out – typically they have public profiles which expose their professional identities to the wider community. This is dependent on the nature of their work and what institution they work for. For this study being able to make direct contact without having to navigate through layers of executive and/or personal assistants was relatively simple and problem free. These gatekeepers are often cited as being a challenge for the contemporary researcher in their pursuit of 'elite' based research (Aberbach & Rockman, 2002; Neuman, 2006). It is worth mentioning that the absence of such challenges for 'elite' based research strongly suggests that the New Zealand context is different from other environments in this way. When making contact for this study an email invitation was sent directly to the invited person in question, with a summary of the study's aims and considerations. Attached to this email was a participant information sheet and

consent form (refer to Appendix 2: Participant Information Sheet and Consent Form).

For those that responded and agreed to seek more information the general reply was one of interest and willingness to take part. Unexpectedly, when and where invited professionals thought they were not able to participate, they assisted the process by identifying a person in their team or institution who they believed would match the study's aims. This snowball sampling effect is discussed in the sampling section.

Phillips (1998) and Bogner, Littig and Menz (2009) suggest that when interviewing senior professionals a researcher needs to exercise discretion. This is primarily due to the public profile of the participant in question. For the purposes of this study all potential and actual participants were guaranteed that their confidentiality would be protected (refer to Appendix 2: Participant Information Sheet). To disclose or not disclose participant identities (Neuman, 2006) was not considered a concern by the respondents themselves during the interview process. The participants were open and articulate on several areas of discussion. Indeed, one participant went so far to share with the researcher an as yet unpublished research on related topics. This highlights the genuine willingness of the respondents to enter into in-depth discussions on matters of importance, at times focusing on their own work, irrespective of challenges posed by time. The timeline for the recruitment of participants took three weeks for the first five - from the initial invitations. For the sixth and final participant it took a further three weeks, resulting in six weeks in total.

The interviewing took place in the last six months of 2007 and as such there were some participants who were forthcoming on what the prospects regarding change post the 2008 general election might be. This included what they perceived to be the likely implications for both the area of their focus and their respective institutions. It is important to note that not all participants were forthcoming, hence declined the invitation to make comment. This experience highlights the need to tread carefully when soliciting opinions from professionals when their professional role is to design, implement, manage and report on Government strategy (Bogner, Littig & Menz, 2009).

During the process of gaining ethics approval the researcher encountered an issue on whether it was considered appropriate to disclose the identities of participants. It became clear that the issue of whether to identify the respondents could become problematic (Woliver, 2002; Bogner, Littig & Menz, 2009). The issue was not straight forward, illustrating the small scale environment of the New Zealand context. So even though the New Zealand environment made it easier to access and spend time with respondents in 'elite' settings, it also increased the risk of exposure of the participants. Therefore, the resolution was swift (explained in detail in the Ethics Section). The identities of those participating were to be protected. Significantly, this experience raised the possibility to the researcher that when senior professionals are interviewed within small populations certain methodological considerations apply.

The chosen recruitment methods relied upon identification of key productivity stakeholders. As previously mentioned the participants were in fields highly relevant to the aims of this study. The invitees that responded were categorised into three groups; those who accepted; those who referred to other participants, and those who declined. One further group was formed, not as respondents, but for those who did not reply to the researcher's invitations. A total of four groups were created to assist in organising the variety of responses and non-responses.

In total, ten invitations were sent out. The original aim was to have a minimum of six participants. This is a high ratio of expected success and it was understood by the researcher as being rather ambitious. However, before the success rate could be substantiated - there were significant challenges. Due to technical difficulties the invitations sent out to the initial invitees were corrupted. The email invitations that had the correct documents attached, now had unrelated documents attached. As previously mentioned these were meant to include the Participant Information Sheet and Consent Form, however they included a private email of the researcher unrelated to the study. Preparation for the impact of unforeseen issues had been considered and consisted of a contingency plan. Before the invitations were sent out to invitees, the invitation email and attached documents were sent to the researcher's academic

supervisor's email and an external email address to test the reliability of the emails and the attachments. Both tests proved to be successful. It was then assumed, wrongly, that there would be no technological issues. Unfortunately, testing the email first did not prevent the eventual corruption of the attached files. Subsequently, initial invitees received a document relating to subject matter that was irrelevant to the aims of this study. Clearly, this was frustrating and incredibly embarrassing. Immediate action was required to correct what opportunity was left to secure participants. A follow up email was immediately sent from a different computer, apologising for the error, and it did contain the right documents for the invitees to peruse. Of those who did respond to the initial email, all were very empathetic about receiving the first email. One invitee went on to disclose that he himself had had that experience on more than one occasion. Of the initial batch of respondents, three accepted. Two encouraged me to speak with specific colleagues and referred the invite onto them.

The outcome of this process was that invitees were open to the possibility of participating, depending on where they felt their relative strengths were. Their involvement can be characterised as being very approachable. Indeed, they were amicable to both the researcher and the study. In the cases where they felt they were not able to participate, they proactively referred the invite on to others. At the conclusion of one interview the participant introduced the researcher to another party, employed by a different organisation whose role oversees research, science and technology activity across several government funded entities within New Zealand. A teleconference interview was subsequently organised and proved to be insightful and valuable to the findings of this study. Another issue was encountered once the early interviews had been carried out. One of the interviews was not able to be retrieved successfully for the purpose of transcribing, thus a second follow up interview was arranged, which the participant kindly, and graciously accepted. Of the two referrals received by the researcher and followed up with, both accepted.

In summary, from the total number of eleven professionals invited to take part in this research including the participant via snowballed introductions as mentioned above, six accepted the invitation to participate, and two declined. The final three were placed into the group of non-responses. For the three who

did not respond, a further two emails were sent to encourage their participation at later dates. There were no further email responses. Phone calls were made to their workplace contact numbers and/or to their respective executive assistants asking for confirmation regarding receipt of invitation, and to solicit their feedback. No further potential participants were reached with no responses forthcoming. Therefore, the eventual response rate was six participants from eleven invitations, which was sufficient in terms of the response rate and eagerness of those contacted to take part.

## **Sample**

The advantages of starting the sampling process with judgemental sampling is that the sample can incorporate participants from relevant areas of focus (Corbetta, 2003). The sample of this study is targeted, specifically aimed at ensuring the participation of elites whose work/research focus is productivity, biotechnology and institutional policy. Therefore, once the judgemental sampling was conducted and evaluated, establishing within what areas, and at what levels participants should be chosen from – purposive sampling was employed as the main method in the selection of suitable specific participants (Neuman, 2006). Since negotiating access to specialist public and private institutions is cited in scholarly literature (Aberbach & Rockman, 2002; Corbetta, 2003) as challenging snowball sampling was employed to compliment purposive sampling if and when the researcher was referred to other relevant parties by initial participants, as already mentioned. Referrals were actively encouraged by the researcher. Access was granted by all gatekeepers to the point of being actively encouraged by some. The only challenge encountered was filtering what assistants were stating via initial email correspondence, within the contextual realities of the environment in which they were operating.

The aim was for a minimum of six participants to be interviewed, which was achieved, albeit from a larger invitation group of eleven professionals compared to ten as originally intended. The maximum number of participants envisaged prior to invitations being sent out was ten. In the end the participants who had responded and were interviewed were senior executive Government public servants and an industry representative. Of those who did not respond, these

invitees were all mass media commentators who produce opinion pieces on their specific areas of expertise relevant to the study. Therefore, the impact was that the interviews were not representative of mass media perspectives. This is discussed further in the limitations section. The sampling approach applied included both judgemental and snowball sampling. How these techniques were used in this study is discussed in more detail below.

Of the six participants the researcher interviewed - three were employed in the public sector, and two in state owned enterprises (SOEs). Of these five, one held a senior position with the Ministry of Economic Development (MED). As a government department MED is responsible for ensuring New Zealand is an attractive place in which to do business, and for business, as well as, “foster economic development and deliver prosperity to all New Zealanders” according to its mission statement (MED, 2010). Policy formation and implementation, and research on economic development all play an essential role within MEDs mandate incorporating a specific focus, amongst others, on lifting productivity and prosperity (MED, 2010). The participants’ role as a senior economist yields considerable influence on economic development policy, hence the decision to interview them for this study. Of particular importance is that their role provides them with an audience with Government Ministers. Their role is also to act as a source of advice for government, especially in areas of specialisation.

Another participant also held a senior public servant position, however this time with the Ministry of Science, Research and Technology (MoRST). This government department is responsible for developing research, science and technology policies (MoRST, 2010). MoRST’s major outcome, as stated on its website, is, “getting measurable benefits from New Zealand’s investment in research, science and technology”. The biotechnology sector is research dependent, science intensive and technology driven (MoRST, 2003b). Specifically, this participant’s responsibilities included emerging technologies, hence the relevance of interviewing this elite within this Ministry. MoRST is also the department that has collaborated with industry to produce several key New Zealand biotechnology industry publications covering; taskforce reports; industry sector strategies; industry evaluation report cards and over the horizon

discussion documents (MoRST, 2003a; MoRST, 2003b; MoRST, 2004 and MoRST, 2007).

The third participant from the public service works with New Zealand Trade and Enterprise (NZTE). NZTE describes itself as, “the New Zealand Government’s national economic development agency” according to its website (NZTE, 2010). NZTE targets nine growth industries, identified from the work done for the Growth and Innovation Framework (GIF) under the previous government (NZTE, 2010). Biotechnology is one of these industries. Therefore, it was considered pertinent to interview a senior member of NZTE when determining what the global successes were for New Zealand biotechnology in an attempt to better understand the sector’s role in New Zealand’s future economic development and productivity performance.

The fourth participant had recently conducted research on New Zealand’s productivity performance and published an article outlining the findings. When the literature review was being conducted this article appeared in searches. Once read, it was deemed fitting to invite this author as a participant in this study. This participant worked at the Reserve Bank of New Zealand (RBNZ) and was therefore a representative from a central government agency. This participant’s work programme consisted of research focused on productivity in the New Zealand context, with analysis on the comparative performance. Therefore, their participation was critical for some of the aspirations of this study to be met. The fifth participant and last public service and/or SOE employee interviewed in this study was employed at Science New Zealand. Science New Zealand is an umbrella organisation representing New Zealand’s eight Crown Research Institutes (CRIs). New Zealand’s CRIs are world renowned for; advances in certain fields of scientific discovery i.e. Agricultural-Bio; expertise excellence in highly specialised areas i.e. cloning breeding livestock; and, for creating products and services to enhance the leveraging of comparative advantages from New Zealand’s country-specific factors (Drew, 2007; Boalch, 2008; Atapattu, 2008; Cronin, 2008). Like all previous participants, this professional held a senior position and had a wealth of experience and intrinsic knowledge of how the science, research and technology sector operates in the New Zealand context.

The sixth and final participant held a senior role with New Zealand's key biotechnology industry body, NZBio. It is important to note that this participant was the only one not to be employed by a government department and/or SOE. NZBio is a membership body that represents, serves and advocates on behalf of biotechnology entities and enterprises across New Zealand (NZBio, 2010). NZBio states on its website, "NZBIO is the national peak body representing the bioscience based industries in New Zealand. We have a broad range of members engaged in a number of different activities, and strong connections into regional and national networks" (NZBio, 2010). NZBio is responsible for supporting, leveraging and connecting biotech businesses with local and increasingly offshore opportunities. The organisations wider role is to speak to government on the issues and concerns, needs and aspirations of the sector.

All participants were asked to identify other key contributors to the growth of the biotechnology sector who they felt should be interviewed. Once relationships were established with invitees who accepted, snowballing assisted in data collection by providing contact details of other significant participants, enhancing the scope of the study. The relationship between judgmental and snowball sampling is one that plays a continuing role in selecting relevant samples (Neuman, 2006; Wolfer, 2007). Once judgmental sampling has been used effectively, snowballing continues and develops the sample in an equally powerful direction, with the same high level of reliability and validity (Aberbach & Rockman, 2002). The crucial element was that the researcher closely followed the advice of the participants when appropriate. The key stakeholders were invited to participate in the interview process, providing rigour to the analysis of factors.

### ***Ethical Issues***

A Participation Information Sheet (PIS) and Consent Form were provided to each participant who accepted the invitation. It clarified for the participant why they were selected for this study (refer to Appendix 2: Participant Information Sheet and Appendix 3: Consent Form). This included exhibiting some or all of the following professional attributes: expert or elite profile; previous or current

research and analysis of productivity; analysis and knowledge of biotechnology; responsibility for industry sector strategy and growth; position as an economist, academic and policy maker on economic and structural issues relating to research, science and technology, productivity and/or biotechnology. Furthermore, some were selected after the researcher was referred to them by other respondents, who felt their participation was warranted to achieve the aims of the study.

The interviews were tape recorded and transcribed by transcribers. Initially, the time afforded for each transcript to be transcribed was one week, but for the first five interviews this was an insufficient amount of time. Woliver (2002) suggests that the content of an elite interview is often complex and full of specific jargon which can be challenging for transcribers who are not familiar with the area of study. The researcher learnt that exceptions, although explicit, are never pre-determined, thus allowances need to be made for sufficient time. Phillips (1998) meanwhile cautions using transcribers who are not fully cognisant of the subject matter. This can expose the data to unintended risks, including the ability of the transcriber to become confused thus, potentially harming the consistency of the transcripts. It eventually took three weeks for each interview to be transcribed through to completion.

Overall, the researcher found that the accuracy of the transcribing to be sound, with minor areas of improvement required. The researcher was thankful that the transcribers had been open to discuss the likelihood of hard to decipher statements and where this occurred it was agreed that a question mark symbol would be used. Aberbach and Rockman (2002) encourage such discussions prior to the transcribing to iron-out any preconceived assumptions between the transcriber and researcher. This proved to be very helpful. The use of question marks assisted when reviewing the transcripts, that a review of that paragraph was required by re-listening to the tape to ensure accuracy. Once this process was completed over two months the audio tapes, which were numbered according to the sequence in which the interview was undertaken, were provided to the Academic Supervisor for secure on-site University storage as per ethics approval requirements. It is important to note that no participants contacted the researcher, the academic supervisor or the AUT Ethics

Committee to critique the study's aims, their participation, and the interviewing style of the researcher or any consequential time delay in proofing transcript content.

All participants provided permission for the interview to be audio taped. Once the formal introductions were completed the researcher acknowledged to the participant that the interview would from then on be recorded. For the two teleconference interviews the participants were advised before the recording was started. Each participant's transcribed texts were sent to them on completion, prior to data analysis, to seek their permission and confirmation of the content. Participants were reminded that their participation remains voluntary at this time. Furthermore, participants were reminded that they are entitled to amend, delete and/or refuse to provide their permission for inclusion of their transcripts in the report at any time, including withdrawing from the study altogether.

Although several authors (Phillips, 1998; Aberbach & Rockman, 2002; Woliver, 2002; Neuman, 2006; Wolfer, 2007) caution researchers of the challenges interviewing respondents in 'elite' settings can pose both in terms of dealing with alpha-personalities, control of access to privileged information and their potential dissatisfaction at a researcher not being adequately prepared, there were no such issues experienced during this study. Indeed, the researcher was asked on one occasion to provide a copy of his background preparatory work to one participant for their consideration to establish whether they may be a suitable fit for future employment prospects. This was highly rewarding as an experience. It provided confidence and reinforcement to the researcher that he was on track to produce research of high quality and high value to the sectors in question. The face to face interviews were conducted in order to gather data from a range of perspectives, with each participant holding a common interest in their respective area of expertise. The range of perspectives in this study covers those of economists, researchers, communications and civil service managers. Additionally, these perspectives were expanded further taking into account the various institutions (differing purposes and functions) that the elites worked for. The researcher negotiated with each individual the level and details of their involvement and established a written agreement, in the form of the Consent

Form and PIS pertaining to access, disclosure, and control of information. Participant privacy has been protected as each individual who participated was made aware via the Consent Form and Participation Information Sheet that their participation in this study was completely voluntary. Each individual's involvement in the elite interviews, including data collected during the process could only be disclosed with their permission. Their identity will not be disclosed at any time as previously discussed. The researcher coded each transcript in sequential order "participant one, two..." of the interviews conducted. This approach ensured that the individuals' privacy, public and institutional profiles and professional considerations were protected when taking part in the interview process.

### ***Data Collection***

Data was collected by employing two methods. Conducting elite interviews, constituted the primary data collection method with relevant experts in their respective fields. This was supplemented by an extensive literature review, constituting the secondary data collection method. Domestic air travel was required on two separate occasions to secure and conduct face to face interviews. Prior to each and every interview an indicative question list (refer to Appendix 4: Indicative Interview Questions, version 3) was constructed to guide the researcher and provide structure to the interview process for both parties. For the indicative interview questions to be relevant and specific to the person being interviewed the questions were altered when necessary to ensure efficacy of information yielded. Four participants were asked questions from the original indicative question list. One other participant was asked questions from a second version which was changed to reflect the different capabilities and focus of the person being interviewed. Finally, the last participant was asked questions from a third version, based again, on their respective capabilities and workplace responsibilities. It is important to note that in all six interviews, respondents were encouraged to expand on subjects that they deemed pertinent to the discussion. Equally, the researcher on more than one occasion expanded and added questions to the list during the interview process to support where the discussion was at times heading.

The participating professionals constitute the key actors directly involved in the biotech sectors and/or productivity analysis, hence held desired information (Aberbach & Rockman, 2002). Therefore, emphasis was placed on ensuring that the questions posed were valid (as mentioned above). However, there were some general contextualising questions (Wolfer, 2007) posed to establish an understanding between the researcher and participant. Phillips (1998) advocates being considerate to both the subject matter and the time of the participant by being targeted with the enquiries and propositions. This was as important to gain quality insights as it was to respect the capacities of the participants being interviewed.

As part of the interview experience it was interesting to discover how relaxed the respondents were before, during and after the interviews. Furthermore, the participants were not very formal in their approach during the interview which assisted the researcher in being comfortable to ask probing questions where appropriate. The experience of interacting with senior professionals in 'elite' settings was highly rewarding and provided reinforcement on the context and focus of the study. The respondents were attentive, helpful, passionate, and were open to alternative views. From what was observed during the research process there did not seem to be any element of 'elitism' as a cultural construct among the participants whatsoever. This experience therefore challenges (Phillips, 1998; Aberbach & Rockman, 2002; Corbetta, 2003) much of the international-based literature regarding techniques for mitigating issues when interviewing in 'elite' settings. It is reflective of the relative ease with which research can be conducted using senior professionals in New Zealand, as well as, a lack of distinctive class systems (McLennan, Ryan & Spoonley, 2000; Borofsky, 2000).

Other aspects experienced during this study while interviewing senior professionals in New Zealand included how considerate and supportive they were of research by students on areas of mutual interest. This is especially satisfying when one considers their positions of power. Significant attention within social methods text is given to warning of the negative impacts of power dynamics when interviewing senior professionals (Fitz & Halpin, 1994; Phillips, 1998). Methodology authors outline several different techniques to mitigate

them (Woliver, 2002). However, none of these potential pitfalls from working with senior professionals in 'elite' settings occurred during this study. It could be assumed that professional environments in smaller societies like New Zealand may provide additional freedoms when researching senior professionals in 'elite' settings that may not be present elsewhere. Alternatively it could mean that the focus of this study was of a sufficient standard to attract the relevant professionals to it. More likely the meaning that could be associated with these experiences is that it was a combination of both of the factors identified above which allowed for ease of interaction between researcher and participants.

Two of the participants in particular shared views on certain topics that challenged the commonly held perspective, and at first this was somewhat unsettling during the interview process partly, because this was unexpected and it did cause some apprehension within the researcher. Additionally, it was because it felt like their critiques were attacking the views posed in the questions. However, it transpired that the respondent simply held dissenting views that stood apart in specific areas from those of the majority, including those amongst the authors of relevant literature. As part of this learning process, the notion that professionals in 'elite' settings are just as different from one another, even in related fields of enquiry, was an interesting and significant discovery. This experience is summed up particularly well by the quotes expressed below. In an interview with Edward Said, Borofsky (2000) solicits views on the role of the intellectual and Said argues:

There is a difference between a professional and an intellectual. An intellectual answers the demands of [their] conscience but also a public cause relating to justice or injustice. (p. 443).

One interesting outcome from the interviews is appreciating that 'elites' are a concept defined by their relative professional status/expertise in society, and that they exhibit the same degree of divergence from one another as many other groups in society. Additionally, individual members of an 'elite' setting do not fit one mould. For example some are public service professionals, having a wealth of context specific experience which partly identifies them as being 'elite'. For others, they might be leaders in their respective field – offering quite a different set of experiences to that of the public service professional. The

distinction quoted below aptly creates a space where these differences are made clear.

Said as interviewed by Borofsky (2000) also states:

The intellectual has to be independent .... I separate myself from intellectuals who think their role is to advise power. My conception of an intellectual is that of a dissenter, that of somebody who speaks the truth to power, is opposed to it in some way, is independent from it. (p. 449).

The respondents' knowledge, opinions and recommendations were analysed, critiqued and compared with those of other participants to help identify key themes within the data. The purpose of treating the data in this way was to identify the factors that contribute to productivity growth, whilst ensuring these assertions are cited with relevant evidence (Wolfer, 2007). All of this study's participants as previously discussed play a role in policy formation or economic commentary and analysis of research, science and technology activity, productivity and/or biotechnology in New Zealand. The second significant reason elite interviewing was chosen was to solicit qualified insights into the complexities of the productivity paradigm in biotechnology, the industry itself, and productivity as an area of investigation (Neuman, 2006).

Time was a critical factor to consider when interviewing professionals in an 'elite' setting according to much of the literature referenced (Phillips, 1998; Wolfer, 2007). The length of time for interviews ranged depending on the levels of participation and disclosure of information forthcoming from participants. All interviews ranged in time between thirty minutes up to one hour. The shortest interview ran for less than thirty five minutes. This was the second interview of the participant whose voice was not audible to produce transcripts from the first interview. Effective time management of the interviews was significant to preserving the relationship between researcher and participant (Aberbach & Rockman, 2002).

However, the respondents themselves were for the most part active and willing participants and often drove the pace and length of the interviews, guided by prompting of the researcher when necessary. Two teleconference interviews

were conducted. The first one was due to the participant being based overseas. With the face to face introduction of the last participant occurring late in the study with the participant based in Wellington a teleconference was arranged for pragmatic purposes. The remaining four interviews were face to face.

This study employs a series of critically sound questions (see Appendix 4: Indicative Interview Questions) that explore, analyse and evaluate productivity in the New Zealand context and within the biotechnology sector. Questions were designed to encourage the respondents to express their view of what factors challenged and/or threatened industry growth, including broader aspects of economic growth influencing productivity and industry performance. Moreover, some questions sought their views on the quality and quantity of government involvement when supporting strategic industry growth relating to the biotechnology experience and industry sectors more generally.

### ***Data Analysis***

Once transcribing was completed, data was coded thematically. The basis for coding the data thematically stems from the grounded theory that underpins the epistemological foundations of this study (Neuman, 2006). Descriptive thematic analysis was employed to identify and analyse themes (Wolfer, 2007). Descriptive thematic analysis provided opportunities to compare and contrast data given by each participant. Themes were allocated based on the subject matter and level of enquiry of each response to a specific question (Corbetta, 2003). These themes were then revised and classified into sub-themes where and when required. This was done by identifying any divergence (Aberbach & Rockman, 2002) within the data or alternatively the opening of a new focus within the data. Themes and sub-themes were tabled into a matrix format to aid the researcher in a visual, mind map form during analysis and discussion.

Following on from this analysis of the common themes present within the data was conducted to identify possible divergent themes. Where divergent themes (Wolfer, 2007) were present – evaluation of the factors contributing to differences was conducted to illustrate why divergence occurred and to establish reasons why. Essentially, the aim was to contextualise the reasons

why this would have occurred (Neuman, 2006). This included contrasting secondary data with interview data to corroborate or undermine stated arguments and to establish understandings of key themes that permeated the literature and interview transcripts. It pinpointed, detailed observations and commonly held views of the factors that the participants believed were significant to productivity growth.

Convergent themes illustrated by the data were easily identifiable by using descriptive thematic analysis based within grounded theory. Equally, the separation and analysis of divergent themes provided clarity to the convergent themes by way of elimination (Corbetta, 2003; Neuman, 2006). When allocating themes, common key words derived from the interviews were divided into groups. Groups were separated into sub-groups allowing for divergent data to be represented in isolation from commonalities. The benefit of doing this - is the reader can more easily identify the main issues, where there are common themes and where distinctive views present themselves (Bryman, 2008). In analysing data, key words, themes were highlighted reflecting participant's convergent and divergent views of factors influencing productivity and contributing to the biotechnology industries growth success. Analysis and discussion on convergent and divergent themes will be covered in detail in the following findings chapter.

As part of this process all interview transcripts were printed, cut out and ready to be placed under the relevant findings and discussion headings, as determined by the findings from the literature review and the interviews. The headings were placed on the walls first. This was followed by relevant sections of the transcripts placed under each heading. It is important to note that this was done in a locked, coded university office; hence security and anonymity were protected at all times. This process provided the opportunity to peruse the content in full prior to cut outs and consider which parts went where, and why. This also assisted the researcher by being able to view the transcripts and headings of the findings and discussion chapter as one piece of work.

## ***Reliability***

The main goal regarding reliability of this study was for the research approach and methodology to be transferable for future research, and to successfully ensure rigour and quality. A mix of methodological and theoretical tools was implemented. This study is a mixed-method, interpretative process based on grounded theory using a constructionism framework. As part of the research approach it was important to contextualise the epistemological foundations of this study as an iterative process. To assist this process at the beginning of the study the researcher's intrinsic biases were well identified and discussed with the academic supervisor. This enabled the creation of shared meaning in understanding the approach and techniques used (Bryman, 2008). The result was for an improved understanding between the researcher and the supervisor on how related issues were identified and incorporated to help guide the development of research. By doing this the research conducted was more rigorous - improving the quality of the study's findings and recommendations. A key learning aim for the researcher was providing consistency of argument and analysis related directly to the study's original aims.

Triangulation entails (Bryman, 2008) the use of more than one source or method in the study of the social world. The purpose of using a triangulation of methods was to support the study's aim of identifying the factors that contribute to increasing productivity. For this study this related to using both primary and secondary methods of data collection. Triangulation was considered a robust research tool as it is better to look at something from several angles (constituting the key stakeholders) than to look at it only one way (Neuman, 2006). It is widely considered (Corbetta, 2003; Bryman, 2008) to provide a study with fullness, the result being that this study is more comprehensive, by encapsulating a variety of perspectives on a particular topic.

For this study the institutional variety of the participants and the inclusion of a participant whose membership body represents the biotechnology sector assisted in capturing a wide range of pertinent perspectives.

Selecting qualitative techniques allowed a sequential mixing of the styles. Secondary data collection first, followed and supported by primary data collection. The aim was to improve the quality and depth of findings, thus supporting the identification of useful outputs and durable recommendations. Secondary data contributed to situating the data collected from the interviews in the wider epistemological context. One example was the consideration of wider literature on the ideological warfare taking place in vertical power spheres within New Zealand on economic development. Initially, it was considered that the articles and analysis of these tensions would provide a socio-political viewpoint for analysis and purpose of the research. However, once discussed with the academic supervisor and on further reflection it was deemed irrelevant when the stated aims and goals were considered. The result was that the study remained focused on exactly what it was set out to achieve namely the identification of factors that contribute to productivity growth.

The realisation that in order for this study to be considered of sufficient quality (Corbetta, 2003; Wolfer, 2007) it was a requirement to better cognitively appreciate the confines of a thesis project lead to a series of reflective moments during the research process. Recognition of the development of theoretical concepts and research foci over time is the best way according to Neuman (2006) of achieving the researcher's qualitative reliability credentials was helpful when undertaking this study. Discussion will now shift to the relationship between reliability and validity. Immediately following this the focus shifts to a section on validity in qualitative research and its use in this study.

Social research methods literature (Wolfer, 2002; Corbetta, 2003; Bryman, 2008) argue that "reliability is necessary for validity and is easier to achieve than validity" (Neuman, 2006, p.171). The questions employed for this study's interviews were open-ended, targeted and informed from the analysis of secondary data collected, limiting impacts of ambiguity and divergence from the study's aims (refer to Appendix 4: Initial Indicative Questions). The desired result is that the conclusions of this study be valid covering divergence from initial expectations to convergence with other sources (Ratcliff, 1995).

## ***Validity***

For the purposes of this study validity is viewed as, "...a contingent construct, inescapably grounded in the processes and intentions of particular research methodologies and projects" (Golafshani, 2003, p. 602). Recognising the value of adhering to the core principal 'to be truthful' is also paramount when we discuss validity (Neuman, 2006). The basis of conducting qualitative research, via an interpretative approach was to add to the researcher's knowledge and application of qualitative methods in practice. Additionally, by acknowledging and analysing what the researcher's perception of validity was during this study the associated learning was being able to better recognise the role that trustworthiness plays in determining the value and quality of the research undertaken. Trustworthiness implies that the methods are explicit and clearly defined as tools designed to perform in unison to produce replicable methods for use in future research, such as in this study for interviewing elites in the New Zealand context.

The use of triangulation strengthens this study by combining methods (Golafshani, 2003). By selecting an interpretative process the aim was for the evaluation mechanisms in this study to limit intrinsic bias from the researcher and more broadly control the influence of biases within the sample. Trustworthiness is seen as being able to capture honest and balanced accounts of the area of focus, adding to the truthfulness of the narratives explored (Bryman, 2008). Selecting a wealth of literature on the key subject matters and on closely related subjects (where relevant) combined with elite interviews of those who have a high degree of control and influence in the area of focus enabled the research scope to be comprehensive. Additionally, this meant that the data collected was pertinent in preserving truthfulness within a qualitative framework. The researcher was careful to represent the views collected in their entirety where-ever appropriate within the findings and discussion chapter. Accurately portraying the views gathered is critical for qualitative research, especially when using an interpretative approach and this was maintained throughout the study.

## ***Limitations***

The limitations of this study include the timeframe of enquiry. It starts from 1990 and continues through until 2009. It was considered appropriate to limit the timeframe to a period where relevant data existed concerning the topics of this study. Indeed, it was also considered important to recognise the significant events occurring over the timeline of the subjects being investigated (productivity and biotechnology). Some of the data-sets used in this research are limited to between the years of 1990 and 2007. However, where and when possible data-sets including the years 2008 and 2009 were actively sought. The aim was to ensure that this study was contemporary as possible considering the contemporary nature of both fields of enquiry.

The focus of investigation is on productivity in the New Zealand context. With particular emphasis on the biotechnology sector specifically identifying the factors that have contributed to growth of the sector.

Limitations also relate to the sample of the participants interviewed. As has been previously discussed there are five public servants and state employees and one representative from industry. The reason why leaders of biotech companies were not included in this study's sample was because the policy framework to plan for the sector was government sponsored in conjunction with industry.

Additionally, the sector is directly supported by the entities of the participants outlined in the sample section. Moreover, biotechnology is an industry which has attracted a significant portion of successive governments' attention in the pursuit of economic development opportunities. However, including the views and experiences of biotechnology companies and also those of stakeholders in CRIs not present in this study would provide additional and possibly new insights for future research.

## ***Summary***

This study used an interpretative process based on grounded theory using a constructionist framework that employed mixed-method data collection. The primary method of data collection employed was elite interviews with key stakeholders on productivity and/or biotechnology in the New Zealand context. The secondary data collection method was conducting a literature review of relevant articles, research reports and opinion pieces relating to the topics of enquiry focused on, but not limited to New Zealand. Triangulation was employed to gain insights from a range of institutional perspectives, incorporating the view of one industry representative. Recruitment methods consisted of the identification of the main players in the productivity discourse and policy formation process in New Zealand. This was also the case for the biotechnology sector. Judgemental, purposive and snowball sampling techniques were employed in this study to identify and capture a variety of key actors. A descriptive thematic analysis was used to analyse the data collected and themes were separated into sub-themes. Coding of data was done on the basis of the emergent themes as well as anonymous coding of the interview transcripts to protect the identity of the participants. Reliability was focused on transferability and ease of which future research could be done by replicating many of the methods employed in this study, especially when interviewing elites in the New Zealand context. Validity centred on the perceived trustworthiness of the ways in which the methods were organised and how well the researcher appreciated the subtle differences in how they were used.

## **Chapter Four: Findings and Discussion**

### ***Introduction***

In this chapter major findings will be presented and discussed to identify the factors that have contributed to industry growth and high levels of productivity in New Zealand's biotechnology sector. The key focus is to establish what factors, supported by empirical and theoretical evidence, influence industry productivity in New Zealand. Discussion will be based on the literature review and interviews. Each section within this chapter starts by explaining the findings that are pertinent to this study's aims. Discussion of the findings is followed by critical analysis before focus shifts to the next section.

Where applicable any divergence and conflict between arguments, justified with evidence, are expanded upon to explore the meaning and phenomenological aspects inherent within the competition of perspectives. Identification and acknowledgement of gaps within the area of focus are highlighted and elaborated on to draw attention to their absence. Discussion includes whether these gaps have a marginal or influential role in determining the efficacy of the factors identified that contribute to industry productivity growth. The aim is to closely examine the key factors that influence productivity growth within New Zealand's biotechnology sector.

### ***Contextualising Productivity***

Productivity is increasingly being viewed as a method of analysis and measurement that assists economic policy development (APC, 2010). Productivity analysis is increasingly used as an effective tool when evaluating the relative merits of specific economic policy (Davis & Ewing, 2004). This provides decision-makers and policy advisors with an in-depth assessment of the utilisation and weighting given to specific inputs and outputs (endogenous and exogenous). This is achieved by capturing where-ever practically possible 'comprehensive measurement' of the determinants of productivity to provide the data on which assessments and evaluations depend.

Within the contemporary globalised paradigm productivity has multiple uses (Matheson & Oxley, 2007). It is used widely as an economic assessment (evaluation) tool; a methods technique for the measurement of economic, technological and human capital data; and, determining the rate and mix at which resources are used in the production of goods and services. Productivity is also used as a measurement method for time management, prioritisation technique for logistics, and for individual self-development to improve the organisation of and application of one's productive skill set (Tansey, 2005a). These uses occur across a range of contexts including, though not limited to; public policy, consultancy, business, economics, technology, and in several academic disciplines. Moreover, the efficacy of productivity is evident at the micro (business/organisation), macro (industry/national) and global levels. This highlights how significant and widespread the multiple uses of productivity and it's generation of value has become.

There is an increasing body of evidence from research analysing New Zealand's national productivity performance that points to New Zealand experiencing comparatively weaker levels of productivity than that of its key trading partners (Engelbrecht & McLellan, 2002; Cypher & Dietz, 2004; Drew, 2007; Boven, 2009a). Australia, Ireland and Finland are cited as economies where productivity gains have enabled higher economic growth to be created and maintained over recent periods than has been the case with New Zealand (Van Ark, 2006). Several governments including liberal western-democracies (New Zealand, Australia, Ireland and Finland), emerging market economies (Vietnam) and the emerging economic giants referred to as BRICS (Brazil, Russia, India, China and South Africa) are investing significant time and resources into productivity research, analysis and public policy formation (Ferreira & Vanhoudt, 2004; Hazledine & Quiggin, 2006; Abhayaratna & Lattimore, 2006; Castles, Curtin & Vowles, 2006; Bank of Finland, 2007). The reasons for undertaking these investments are as diverse as the nations. Each of the economies cited above feature aspects of productivity in their economic development planning (Van Ark, 2006). Often, though not exclusively, this is achieved by conducting an in-depth analysis assessment of what factors are required to create, maintain and develop the right mix of conditions and

resource allocation to provide for increased economic development (Cypher & Dietz, 2004). How durable and effective such undertakings are - can be assessed in an evaluation of the outcomes (planned and serendipitous).

Depending on the policy, “views” espoused is sometimes promoted irrespective of whether the proposed economic reforms and associated theory is grounded sufficiently in the (New Zealand) context. One example is the approval in May’s 2010 Budget for the increasing of the rates at which taxation thresholds kick in (limiting the exposure of income to taxation, most especially at the higher end of the income thresholds) and increasing consumption tax as a proxy to re-balance domestic led growth based on consumption to export led growth based on trade (Key, 2010). The most obvious effect of this change will be that those who earn less will pay a greater share of the economy’s total consumer spend (less if you earn \$70,000 per annum or higher), and more significantly an even higher proportion of their more limited income on the higher consumption taxes (Collins, 2010). Brash (2001) and Kerr (2003) suggest that because New Zealand now enjoys an open, mobile labour market the potential for growth is greater. This perspective relies on the notion that a small (lacking an economy of scale), remote (proximity) economy such as New Zealand’s owes its future economic prosperity to agents of economic change. Such a view illustrates the degree to which public policy has been driven principally by ideological preference in New Zealand. This is critical when we seek to better understand how and in what ways such legislative events have shaped the tone and depth of economic development in New Zealand today.

Australia’s economy where successive governments chose to implement less radical labour market and social sector reforms, at a slower pace of intervention, grew more consistently, and during specific periods more strongly (Oxley, 2004; Abhayaratna & Lattimore, 2006). Also, collective representation and union involvement is still a key feature of the Australian labour market. There are many who argue that the effect of this is that there is a greater consensus between employers and workers in Australia than is the case in New Zealand (Davis & Ewing, 2004; Parham & Roberts, 2004; Hazledine & Quiggin, 2006; Perry, 2006; Perry, 2007). These perspectives, based on both anecdotal and empirical evidence, are important when we consider labour productivity as

one of the key determinants of productivity, which is discussed at length in the following sections.

Australia's increasing economic growth trend and sustained collective representation in some industries continues today, albeit in slightly moderated form (Dolman, Parham & Zheng, 2007). This is not to say that had the ECA (1991) not occurred New Zealand would have grown at the same speed or consistency experienced by Australia. Rather, what this experience and associated data reveals is that the choices successive governments made between the periods from 1990 to 1996 (indeed at any time regarding questions of policy validity) may have hindered New Zealand's ability to pursue growth in the same way that its competitors have. A low wage environment, like New Zealand, does seem to impact on productivity outcomes.. It also directly influences the nature and tempo of the relationship between industry and labour.

A key aspect from the literature is the importance of focusing on consistency. This can be achieved by grounding policy within an acute awareness of place, in which it is intended to serve (Neuman, 2006). The result can be an increase in the quality of outcomes from policy that should for all intent and purposes be, fit for purpose (current and forecast over the lifetime of the policy). For development programmes to be conducive to growth - planned changes need to recognise and respect the environment in which they will exist (McLellan, 2004; MED, 2007b). Cognisance of having an insightful, implicit knowledge of the environment in practice is crucial to creating a process where relevance, consistency and malleability feature. Although these examples of various countries exist in diverse contexts they all share the experience of increasingly using productivity in their policy tool-kits. One example is where Australia established the world's first productivity commission government agency. The key purpose of Australia's Productivity Commission is expressed below:

The Productivity Commission is the Australian Government's independent research and advisory body on a range of economic, social and environmental issues affecting the welfare of Australians. Its role, expressed simply, is to help governments make better policies in the long term interest of the Australian community.... As its name implies, the Commission's focus is on ways of achieving a

more productive economy - the key to higher living standards. As an advisory body, its influence depends on the power of its arguments and the efficacy of its public processes (APC, 2010).

The key features of this mission statement are: “independent research and advisory body” - ensuring accountability to key stakeholders (Government and Industry) by limiting the influence of interests from entities sitting outside the parameters of the commission; “make better policies in the long term interest of the Australian community” – representing the fact that although successive governments and industry leaders will hold their own specific preferences and biases the core aim must endure, thus is built to withstand the perilous nature of national politics. Finally, “its influence depends on the power of its arguments and the efficacy of its public processes” sums up the immensely difficult task ahead: balancing the needs of those in power with the needs of those whom the commission is intended to serve, whilst maintaining rigorous and robust methods for engaging with, listening to and serving the Australian public (APC, 2010). In late 2010, New Zealand’s Productivity Commission was established (NZPC, 2011). The New Zealand Productivity Commission is very similar to that of Australia in some key ways. It appears that the New Zealand commission’s purpose, which reflects the same areas of focus, is more simply expressed than that of the APC as outlined below.

The principal purpose of the Commission is to provide advice to the Government on improving productivity in a way that is directed to supporting the overall well-being of New Zealanders, having regard to a wide range of communities of interest and population groups in New Zealand society (NZPC, 2011).

Another similarity that can be drawn from the information made available is that the APC seems to be bipartisan in its discourse and series of work programmes, with the NZPC exhibiting the same characteristics. This is of critical importance to ensure that an independent crown entity is able to exercise its role free of government intervention and intrusion, as intended.

There is a wealth of academic discourse (Diewert & Lawrence, 1999; Mawson, Carlaw & McLellan, 2003; McLellan, 2004; Kavanagh & Doyle, 2007; Matheson & Oxley, 2007), scientific research (MoRST, 2007; MED, 2007a) and economic thought (Kerr, 2003; Oxley, 2004; Tansey, 2005a; OECD, 2010; O’Sullivan,

2010) available regarding productivity in international literature. Some, such as Brash (2001) exhibit divergent perspectives compared to Perry (2007) on the role that productivity can play in economic development. Significantly, a majority of ideological clashes based on competing worldviews contest the reasons why New Zealand's economic outcomes are of a particular kind (Hossain & Chung, 1999; Brash, 2001; Perry, 2007) rather than dissent from productivity as an effective tool. A prime example is how legislative events since 1990 have had either a supportive or destructive influence on the role that productivity perform in securing economic growth (Diewert, 2004). There is however, sufficient evidence to deduce that there is general consensus of arguments in specific areas. This point is elaborated on further in this chapter in section 'It's a question of what we envisage'.

### ***Productivity and its contribution***

In their pursuit of economic growth governments, industry and business are employing an ever-increasing range of investigative tools in their respective quests for rigor in research (Davies, 2009). This is a common occurrence amongst disciplines in an attempt to better understand the role and impacts that specific factors have in creating conditions conducive to the aims of research as is the case with this study. In the case of economics this relates to recession, sustainability and growth phenomena (Cypher & Dietz, 2004). Defining productivity as with any multiple-use term is fraught with subjective interpretation, and this was evident from the literature review findings (Wolfer, 2007). What became clear during the literature review was that there was a high degree of divergence among authors on how they defined aspects of productivity (Lange, 2006; Perry, 2006; Van Ark, 2006; Schreyer, 2007). In particular, authors who had depth of experience in economics were more assured of their definition and the reasons behind it (Tansey, 2005a; Procter, 2008). Interestingly, although they were more certain, they were also more deeply critical of the permutations involved in defining productivity.

...it starts getting very slippery because you know what measurement of both outputs and inputs is difficult right and we also get into the issue of how inputs are priced...  
(Participant C)

In responding to the question of how productivity can be defined, this respondent chose to highlight the potential dangers associated with all-encompassing definitions, and by doing so, was cautious about how and in what ways a researcher can define abstract terms, as well as being wary of drawing conclusions based on assumptions not explicit within data. This cautious view, was shared by one other respondent and highlights the issues surrounding the measurement of determinants of productivity – both for researchers, those being interviewed, and for statistical data collection by national agencies, i.e. Statistics New Zealand. These issues are discussed at length in the section Productivity Performance. This respondent continues by explaining the conditions required when defining productivity.

...so on a strict sort of productivity point of view we, you typically assume that the world price of the outputs we are producing are constant over time...  
(Participant C)

Interestingly, this respondent's discussion is based, partly, on the implicit assumption that price stability acts as the foundation on which further analyses rely.

...but if it's the case say for example we're taking the dairy sector you know where you can get massive increases and raw prices the amount of, even the amount being produced per person or per unit of capital is constant over time...  
(Participant C)

By citing New Zealand's dominant 'dairy' industry as an example where fluctuating global commodity prices impacts upon price stability, the respondent is acknowledging that price stability is not always possible, though advantageous for analysis to be reflective of the productivity picture. In addition, the point being made is that price instability does not discount the possibility that units of production per worker or units of capital are often "constant over time". Thus, price stability and the rate of inputs and outputs over time can be mutually exclusive.

...the price we're seeing in world markets those increasing over time that in a sense is a productivity gain because it's implying an increase in income occurring to New Zealand for that fixed unit or resource...but be aware that there are a lot of wrinkles around it.  
(Participant C)

The implication is that where income increases (stemming from price volatility), that gain can be characterised as a productivity gain, when in reality no actual productivity increase need have happened for this result to occur. Interestingly, this discussion previewed this respondent's maxim of productivity (see quote below). Apart from how data is affected by limitations in how productivity growth is measured - these comments illustrate one of the many divergent perspectives in contemporary economics. Whilst there are different theoretical perspectives researchers can choose from, often, their views are related to the perspectives of those from their chosen school of economic thought. Such views can easily stem from their professional development experiences and exposure to specific environments where particular views reign. This type of influence was noticeable for some respondents when conducting the interviews, but for others it was less clear whether one could characterise their comments based on any theoretical view of economics. Caution was applied when asking the participants about their definition of productivity. Only respondents who had responsibility for and/or input into the national policy on productivity were asked.

Output per hour worked, real output per hour worked.  
(Participant D)

The definition above can be characterised as a 'text book' economic definition of productivity, thus matching the majority of definitions to emerge from the literature review, and can be closely related to the role and the entity this respondent worked for. Productivity is defined according to Statistics New Zealand (2011b) as the ratio of output to one or more inputs used in production (p. 5). Inputs involve a mixed use of resources (including labour, land) and capital (machinery, technology, knowledge) depending on requirements (McLellan, 2004). Next, the definition below is the previous respondent's maxim of productivity as previously discussed.

...my definition of productivity is the standard economic definition, it's the amount of output generated for the fixed level of inputs so increase in productivity is when you have output increasing over time for a fixed level of inputs.  
(Participant C)

Although, as the respondent states this definition is “the standard economic definition” it is clear that value is being placed equally on quantity and time, whereas the first definition was purely theoretical. Both definitions were typical of the majority of views identified in the literature on how productivity is defined by economists. For the final two participants, a slightly different question was asked. The reason for treating the participants differently had to do with their respective fields of expertise.

In the next two cases the respondents were employed in science-intensive industry, thus were not economists per se and as such the questions were reformulated to account for their respective responsibilities. Therefore, for the final two participants they were asked for their understanding, from an institutional perspective, of (a) sectoral productivity, (b) business productivity and (c) national productivity.

...you might have gathered, from the B.I.G. (Biotechnology Growth Report) report where sectoral productivity lies and I think it's probably been covered by Participant A & B. My understanding is that, although with Biotech we are becoming more advanced in other areas, so not to stay with Bio but with medical technologies and healthcare, human health applications. So those are growing.  
(Participant E)

What is clear from this response is that this participant's idea of what constitutes productivity is starkly different to that of the previous respondents'. Unlike the definitions cited earlier that were theoretical and academic in nature, this definition was more focused on the practical (productive) advances that come from the use of biotechnology. The respondent goes further, by acknowledging that perhaps the initial answer given was not a reflection of the response being sought.

National productivity, I don't know? Is it a comparison question...I probably couldn't give you a really crystal clear answer on that, certainly on the last one anyway.  
(Participant E)

This response was entirely appropriate and was in accordance with the intrinsic knowledge and experience of the participant in the biotechnology sector. The last part of the question was included to assess whether the researchers initial hesitation on asking the participant the original question was appropriate. Similarly, the next respondent's definition focused on the use of productivity as a phrase, citing relevant evidence to support this view.

Productivity is the big catch phrase and I think people are latching on to it now and beginning to understand the importance, particularly because New Zealand has the third highest rate of work in the OECD.  
(Participant F)

The quote above best illustrates how productivity has become a common feature in popular discourse regarding economic growth and development (The Treasury, 2008). It is interesting that this participant cited the uptake in productivity analysis as being related to the comparatively high level of hours worked by New Zealander workers. This view is shared by several authors identified in the literature review (McLellan, 2004; Pilat, 2004). Three out of six participants reported that their understanding of productivity concentrated on how efficient production processes were in resource utilisation. These responses are emblematic of the respective fields the respondents work in. For example, where a participant had expertise in macro-economics, then the answer was more concise and reflected their answer as an economic formula such as Participant D. There was substantial consensus with this view from the relevant literature on how productivity is defined as an economic concept (Diewert, 2004; Tansey, 2005b; SNZ, 2007b; Borley, 2008; Boven, 2010). However, there was a wide range of interpretations on what can be considered key components of productivity and this is discussed at length in the following section.

## ***Determinants of productivity: labour, capital and multi-factor***

There are three key determinants of productivity. They are labour, capital and multi-factor productivity (Diewert, 2004; Drew, 2007; Engelbrecht & Xayavong, 2007). All three are widely accepted as constituting the main aspects of the productivity process. Productivity, as an outcome, is widely understood to assist analysis when examining rises and falls in GDP per capita (Parham & Roberts, 2004; Schreyer, 2007; SNZ, 2007b). Where productivity is strong, GDP per capita tends to be high. Conversely, where productivity is weak, GDP per capita is often lower.

This sets the bar high in terms of introducing in new methods for achieving similar growth periods into the future. This 'developed' view assumes that when the data is collected these one dimensional markers were resting on a point that most accurately displayed the productivity capacity of the country in question. What is missed and considered significant according to Douglas (2006) and Czarnitzki & O'Byrnes (2007) is the quality, scale and value of the base (when, how and why) of production. Representing these characteristics supports underpinning enduring trends of economic growth that at times precede data collection assisting in contextualising the productivity performance over time. Gaining an accurate picture of change over time is critical in determining what factors work well and what factors harm the process in securing sustained growth (Fox, Kohli & Warren, 2002).

Determinants of productivity are complex and interrelated with one another. One example is human capital. This is influenced by education policy in the early childhood, primary, secondary and tertiary sectors; employment law, regulation and avenues available for redress and mediation; role of the rule of law, including jurisprudence and judicial process; immigration law; natural endowment, age, health and well-being of working-age population; and, the quality of labour used to resource the sector (Oxley, 2004). Defining what determinants work well where is fraught with interpretative limitations, including potential ideological bias stemming in part from a person's worldview. Even though there is agreement on the value of productivity as a concept to analyse

economic performance in an attempt to improve outcomes, there are numerous debates on what factors are considered key influences on productivity determinants (Cypher & Dietz, 2004; DOL, 2004; Douglas, 2006; Engelbrecht & Xayavong, 2007; Boven, 2009b). Discussion now shifts to specifically focus on what factors influence each of the three key determinants of productivity starting with labour productivity.

As already mentioned productivity consists of three key determinants – Labour, Capital and Multi-factor productivity (MFP) (Davis & Ewing, 2004; Drew, 2007). There are two versions of the third determinant present in the relevant literature (Diewert, 2004). MFP is also known as total-factor productivity (TFP). For the purposes of this study MFP was considered more appropriate as it incorporates serendipitous factors into analysis and evaluation (Pilat, 2004). Therefore, it is expected to represent a more detailed, defined picture of productivity than that of TFP. The challenges of productivity measurement and the impacts of using MFP versus TFP are discussed in-depth in the section impacts, issues and significance of measurement in productivity analysis. The perspectives of the respondents' were solicited asking what facets, if known, of productivity determinants i.e. capital, labour or multi-factor productivity (MFP) are most critical to ensuring New Zealand's biotech sector is productive and why? Once again, this question was limited to the four participants who had implicit knowledge of industry growth and productivity.

Also in terms of the Biotech sectors productivity, obviously clearly it's a strength and its high, obviously it's probably a mixture of multi-factor productivity through capital and labour but is there any one aspect of productivity...that could be a signifier to its strength for Biotech...

(Participant B)

It is important to emphasize three findings here. Firstly, the literature review identified that labour productivity is the most significant determinant in isolation from any other. However, in the case of New Zealand it has been found that New Zealand's relatively low labour productivity and lack of capital intensity in the productive functions of business both rely upon multifactor productivity growth to a greater extent than the comparable countries.

So, I'm a bit hard pressed to answer that question. The industry is characterised by high investment and labour and it does actually produce and manufacture a great deal at the moment so I guess an awful lot of the productivity is revolving around the use of high wage workers.

(Participant B)

The quote above underlines how reliant the sector is on highly skilled professionals which in turn become a factor in playing a determining role in increasing productivity growth. As was previously identified in the literature review human capital and the associated costs and challenges were influential in developing New Zealand's biotech sector. This respondent's view highlights again how labour is seen to hold a strong influence over productivity, both as a determinant and as a resource. This perspective characterises the view that New Zealand experiences quite an uneven labour to capital ratio as identified from the literature review.

...the vast majority of expense that I see from biotech companies goes into research, either their own staff, or subcontracting research from universities and CRIs and of course the Universities and CRIs provide a capital incentive and so forth so I haven't seen a huge investment in capital and relatively small investment in plant and manufacturing and so far relatively little investment in production of goods.

(Participant B)

The emphasis here is on the need for growth in the commercialisation of goods which suggests that the industry, according to this participant, needs to shift into the production phase and build upon the lessons and successes gained from research and development phases. As discussed in-depth in chapter two a majority of discussion and analysis (Davis & Ewing, 2004; Fallow & Dann, 2006; Hazledine & Quiggin, 2006; O'Sullivan, 2006; Sautet, 2006; Fallow, 2007; Gaynor, 2007; Drew, 2007; Perry, 2006; Maida, 2009; Kelly, 2010) in the literature review focuses on the role labour productivity plays in the New Zealand economy.

A majority of the literature on New Zealand's productivity performance focuses on labour productivity growth being lower than that of its trading partners and is one of the most cited reasons why New Zealand has failed to achieve the same level of growth, especially in per capita terms than that of Australia, Finland and

Ireland (Perry, 2006; Gaynor, 2007). Several authors (DOL, 2004; Tansey, 2005b; Douglas, 2006; Dolman, Parham & Zheng, 2007) cited labour as being the most crucial determinant of productivity. Discussion now shifts to identifying the factors.

First, labour productivity is the foundation on which capital and multi-factor depend upon (Davis & Ewing, 2004). Without labour there would not be a need for the use of capital or the requirement of multi-factor analysis. This is because labour is the cornerstone of production. Without it, production could not exist. Second, labour productivity peers into the process of how labour uses and applies resources in the production of products, services and systems (Diewert, 2004). Moreover, labour serves as the key component for the physical production of everything (limited to the concept of human production). Third, labour is the force behind conceptualisation of design, creativity and innovation and is vital in maintaining the processes and technology put in place to support the production through all its various stages. Furthermore, without labour there would be no business model, system, process that would currently survive its absence.

The advent of virtual-based, completely automated technologies are growing in significance and autonomy, however they do not yet provide complete self-sustaining abilities that enable them to survive and respond to changes as required without human intervention and participation. The role of labour market developments are discussed next in an attempt to better understand how, and in what ways, these developments impact on and hold influence over labour productivity. Labour market developments have a major influence over labour productivity (Parham & Roberts, 2004). As mentioned, the impact of employment legislation has intensely defined the structure and style of workplace agreements between individuals and employers (Perry, 2006). Considerable debate exists on whether changes such as the ECA (1991) have had positive or negative impacts on labour productivity between 1991 and 2009. The data indicates that there was no longitudinal increase in labour productivity stemming either directly or indirectly from these changes (see Figures 3-6: Annual Rate of Growth in Labour Productivity).

As part of the discussion in an attempt to draw respondent views on what determinant of productivity i.e. labour, capital, or multifactor plays the more significant role in growth one respondent in particular had this to offer.

Between capital labour and multifactor – well, in some sense you know the economy, people doing growth accounting work, economists etc. you know right down in production function distinguish between these elements that's a useful analytical device but you need to be clear that you know there are interdependencies between all these things...

(Participant C)

By the 'economy' this respondent is meaning everything outside of capital and labour, covered by multifactor productivity or alternatively a combination of all three, therefore none in isolation from one another. That is, the interconnectedness of productivity determinants is where real value can lie. Focusing on identifying the 'one' may lead to incomplete findings or enable one dimensional conclusions to be drawn. The respondent continues explaining to clarify their position.

...and in a sense MFP is just a measurement issue itself in the sense that you're not capturing all the quality dimensions to do with capital and labour so in some sense I can't really say what is the most important because they're so intertwined.

(Participant C)

Being that MFP is meant to capture all shifts in productivity that cannot be attributed to either labour or capital, it is fair and accurate to say that currently MFP is "just a measurement issue itself" (Schreyer, 2007). Labour and capital productivity are contextualised within finite parameters including hours worked per hour and human capital costs or levels of employment and investment in technological capital such as plant and machinery (SNZ, 2010a) – thus, are measureable and therefore protected from contamination from the more variable MFP environments. MFP is meant to capture all other significant inputs across many environments (regulatory, practice and theoretical), hence the challenge is to be able to judge or evaluate MFP on the same basis as labour or capital productivity. The participant continues in response to the question – which, if any, of three productivity determinants matter the most, and why?

I mean at its most fundamental level it must be labour which matters the most right which you can see in a cross country basis you know countries in which you have really low rates of participation of populations and even primary school education, very low levels of productivity generally speaking as you move to economies where you get increasing portion of the population going to secondary schools and on to universities you tend to see higher productivity.  
(Participant C)

According to this respondent labour plays the key role, with specific emphasis placed on human capital, whilst MFP is cast aside as it reflects the void around labour and capital, rather than signifying distinctive factors as labour and capital do. Several authors identified in the literature review cited MFP as being the key productivity definition when seeking to assess growth performance; however they did not articulate the way to increase the quality of measurement for MFP. Equally, the participant's point that MFP is in itself a measurement issue is an interesting one.

This participant's answer provides an opportunity to discuss whether higher productivity is determined by constant levels of productivity or significant shifts in productivity (Van Ark, 2006). The four economies Australia, Finland, Ireland and New Zealand share the characteristic of higher productivity being determined by constant levels of productivity over a similar period of time (i.e. development). As defined earlier, MFP is the reporting of productivity data from sectors of the economy that have not been derived from labour and/or capital when building a framework to assess productivity of a national economy. With environmental factors combining with market conditions influencing MFP at any given time, MFP is less well defined, thus it is harder to quantify compared to labour and capital and this was well established in the literature (Tansey, 2005b; Drew, 2007; SNZ, 2010b). The literature review identified that although there is common understanding among authors of what productivity is, there is less certainty about which determinants of productivity are most influential, hence the need to seek responses to this question from relevant participants. With productivity determinants playing a formative and influential role in productivity analysis, discussion now focuses on the relationship between productivity and economic growth.

## ***New Zealand's macro-economic productivity performance (timeframe: 1990 to 2010)***

...so that leads you do think well okay maybe there are other things going on and in particular there is fairly good evidence that we 'suffer' from a low level of capital so maybe that is more obvious place to look in NZ...

(Participant C)

Capital shallowing has been a major challenge in New Zealand since opening up the economy to global free-trade in commodities (Boven & Skilling, 2005). As previously noted in the literature review not only has there been firm level bias towards investing labour over capital in the majority of organisations, whilst recognised as a significant issue with regards to improving productivity the associated absence of focus on design and planning to affect change over the long term remains a political and economic challenge (DOL, 2004; Drew, 2007). This can be explained as a simple economic prediction given costs (wages v rents) and productivity. They choose on the basis of costs or production technologies.

New Zealand has more companies succeeding in overseas markets than ever before (O'Sullivan, 2010). A key distinction between these companies and those which continue to absorb labour over capital is that they have navigated the transition from local business model to sector competitive model to transnational risk-taking model (Parham & Roberts, 2004; Tansey, 2005b; Engelbrecht & Xayavong, 2007; Boven, 2009b).

This view is supported by findings that identify New Zealand's domestic capital supply as low compared to several major trading partners (Boven, Bidois & Harland, 2010). Higher MFP growth should lead to higher growth in the capital-labour ratio, according to Diewert (2004) because higher MFP growth results in more rapid increases in the marginal product of capital inducing greater capital accumulation. However, New Zealand has experienced lower growth in the capital-labour ratio, despite having similar MFP growth relative to Australia (this is discussed in depth in the section 'lessons learned from New Zealand's

comparative productivity performance with Australia, Ireland and Finland (timeframe: 1990 to 2010)'.

One of the key findings to emerge from the literature review is how mobile and unrestrictive New Zealand's labour market dynamics are (McLellan, 2004). The respondent highlights this point below when continuing their analysis of New Zealand's productivity performance and the barriers to improvement.

...and most indicators of NZ's labour product and market regulations are fairly liberal so there's no obvious impediments for why that capital accumulation is not taking place so that's when it starts getting interesting, well what is it that is there?  
(Participant C)

An argument which the discussion above raises is that if labour market conditions are comparatively so free and mobile does this not then suggest that this acts as a disincentive to capital investment in business (Procter, 2008; New Zealand Treasury, 2008; Hickey, 2010). If the respondent's view espoused above was taken to its logical conclusion there seems to be no significant impediments to improving capital accumulation. Yet, the challenge of capital supply remains. How influential is the absence of economy of scale in this analysis?

Is it a factor of us having a relatively small population being far away from market?  
(Participant C)

Questions of proximity and the market limitations of having a small population have persisted over several decades as some of the possible reasons why New Zealand, counter to neo-liberal economic logic, has not benefited more from the reforms made in pursuit of liberalisation and wealth (Hossain & Chung, 1999; Fabling, 2007; McCann, 2009). There have been studies including 'Measurement of Public Sector Output and Productivity' by Douglas (2006) and 'New Zealand's productivity performance and prospects' by Drew (2007) among others that have identified that New Zealand may be less affected by proximity to major markets than is commonly perceived. Technological advancements in transport (shipping, air freight), communications (satellite, broadband), logistics and distribution and just in time manufacturing processes and systems have all

lessened the impact of proximity on small trading nations like New Zealand (Drew, 2007; OECD, 2009). This is also the experience, as noted earlier in the literature review for the much larger economy of Australia, and to a lesser degree for the smaller, yet still comparatively successful economies of Finland and Ireland (OECD, 2010b; OECD, 2010d; OECD, 2010e). This respondent notes it as part of their systematic discussion on what factors are acting as barriers to increasing productivity. One major issue is that New Zealand's local markets are too small to achieve economies of scale in trailing new products. Also, New Zealand's economy is dominated by the services sector (non-traded, government) where productivity, though not well measured, is likely to be low (Douglas, 2006). The discussion now shifts to New Zealand's comparative advantages.

...so maybe it's a factor of us you know the basic comparative advantages we have in agriculture, maybe it's a measurement issue again that we a lot of the manufacturing we've done is in niche products services where maybe they're not measuring the true value added from that.  
(Participant C)

Potential issues stemming from the way activity and processes are measured are highlighted again as one possible reason, in a similar way to how these issues were explored in several of the studies covered in the literature review, why New Zealand continues to experience challenges from its comparative productivity performance (SNZ, 2007b).

There's a lot of, you know, interesting work still to be done on that area to tease it out.  
(Participant C)

This statement from the respondent is one of the reasons why this study (including the research focus and parameters) were chosen, and also one of the primary reasons for qualitative research methodologies to be employed. It is clear from the wealth of literature found together with narratives gained from the interviews why significant policy focus continues to be applied on New Zealand's productivity performance. This work is set to continue and develop in new ways with the establishment of the Government funded 'Productivity Commission' (NZPC, 2011). The substantive reasons for the weaker

productivity performance continue to be debated whilst specific issues are raised again and again. Diewert (2004), McLellan (2004) and Hall & Scobie (2006) argue it is a symptom of lower levels of capital investment into business, when compared to higher levels of labour investment. Whereas Boven & Skilling (2005) and Davis and Ewing (2004) argue it is due to political bias towards New Zealand's labour market model (both of which are arguing on the same issue, just from different starting positions). The OECD (2007a) argues that it is a combination of both issues that has resulted in poor productivity performance. Getting people into work and increasing the labour quotient, rather than providing the means by which business can be more productive remains a possible continuing weakness in New Zealand's economic strategy (OECD, 2009). The comparative deficiency of investing capital and/or technology outside of ICT as revealed in chapter two as required by industry has demonstrated that when New Zealand enjoyed historically high levels of employment and low levels of unemployment, relative productivity remained at a level that only matched that of Australia, and except for the recent impacts of the GFC on Finland and Ireland, remained significantly weaker during the period 1990 – 2010 (see Figures 2-11, 16-17: annual labour productivity, MFP, and capital services productivity). If this is combined with an exhaustive Reserve Bank of New Zealand fiscal policy aimed to dampen inflationary pressures, in an attempt to respond to New Zealander's appetite for property ownership the narrow band of growth achieved is more easily understood. Discussion now shifts to analyse and critique the role that measurement issues play in comparative productivity performance debates.

***Lessons learned from New Zealand's comparative productivity performance with Australia, Ireland and Finland (timeframe: 1990 to 2010)***

A prolonged period of poor performance with low revenue growth and rising social expectations will ultimately undermine the fiscal position and lead to macro instability. This is the story of Uruguay (McLellan, 2004). This message is often used to inform the debate around the economic aspirations of New Zealand as a nation. Such narratives are normally promoted by politicians and business leaders in equal measure. This forms part of a rationale that argues

that unless radical, broad-based structural reforms are made urgently then Uruguay's experience could become New Zealand's reality (Brash, 2001; Kerr, 2003). Based on the experiences of economic decline and reform in New Zealand, such a view is of direct relevance to New Zealand during the 1970 – 1988 periods. Beyond that, New Zealand has experienced severe economic challenges, but not to the same degree than what happened previously.

When comparative studies have been done on the dimensions of cost (wages, regulation, taxes, price of land) weaker economies (New Zealand, Australia) were more cost competitive than comparators (Ireland and Finland). Thus, cost competitiveness alone is not enough, and certainly does not seem to be a sustainable model as witnessed by the evolving development of the Chinese and Indian economies (Davis & Ewing, 2004; Hall & Casey, 2006).

So why did New Zealand experience lower growth in the capital-labour ratio despite having similar MFP growth relative to Australia. One possible reason why New Zealand's capital-labour ratio was lower is owing to factors that impede capital flows into New Zealand (Parham & Roberts, 2004). However, based on the findings discussed previously this possible reason is hard to sustain due to two features. The New Zealand economy does not suffer from a lack of capital availability sourced from overseas. New Zealand's private sector (including households) accounts for close to three quarters of overseas debt liability, with the Government holding the remainder (OECD, 2011). Another feature, as mentioned earlier, is the type of investment being attracted to New Zealand has been overtly biased towards consumer debt accumulation, rather than investment in the productive functions of businesses. A further possibility is that the evolution in the relative price of labour to capital (a measure of the relative cost to firms of sourcing from output growth from labour versus capital) evolved differently in New Zealand than in Australia, Ireland and Finland (Davis & Ewing, 2004; Fabling, 2007).

When the relative price of labour to capital increases, firms will tend to source more of their output growth from capital rather than labour, and vice versa (Tansey, 2005a). This has been New Zealand's case where firms have increased levels of labour as it is cheaper than capital investment. The role of

the Employment Contracts Act (1991) where labour costs fell by 22% between 1992 and 1996, a four year period affecting a reduction in labour cost of nearly a quarter, underscores part of the reasons why labour has been the preferred choice of firms seeking output growth (Hazledine & Quiggin, 2006).

In Australia labour costs did not decrease to the extent that occurred in New Zealand, therefore capital was still able to be accumulated without it costing more than the relative costs of labour (Davis & Ewing, 2004; Perry, 2006; Dolman, Parham & Zheng, 2007). This partly explains why Australia did not manage to achieve as low a rate of unemployment from 1990 – 2007 as New Zealand. Interestingly, since late 2007 Australia's unemployment rate has declined to historically low levels decreasing to levels below that of New Zealand, whilst New Zealand's has returned to near average trend levels, increasing to levels above Australia. As the labour market continues to tighten, relative prices are likely to move back in favour of more output growth being sourced from capital as opposed to labour input. More recently, as cited by participant C in particular, New Zealand experienced stronger growth in business investment from late 2005 to early 2008 resulting in New Zealand experiencing capital deepening over the period (SNZ, 2011a).

A sizable portion of the literature contained analysis on New Zealand's comparative productivity performance. The interview extracts below support the findings from the review of literature that New Zealand's comparable productivity performance has been weaker than that of trading partners and fellow OECD member economies (albeit to a lesser degree than has been commonly espoused by specific interest groups in New Zealand).

But then you put NZ in the group of OECD countries, typically you find that our labour quality, this in terms is measured as labour as education attainment is pretty good yet our labour productivity levels are lower...

(Participant C)

As previously discussed in chapter two, there is increasing evidence to suggest that the higher educational attainment achieved means the relative potential for an improved productivity performance increases (Oxley, 2004). This participant is articulating the same view. The obvious question is how can significant

improvements in educational attainment in New Zealand since 1990 not result in a more improved labour productivity performance relative to that of Australia, Ireland and Finland in 2010? Part of the answer lies in the efforts of these respective economies to improve the educational attainment of their respective populations as successfully, if not more successfully, than that of New Zealand (Oxley, 2004; Douglas, 2006; Kavanagh & Doyle, 2007; Statistics New Zealand & New Zealand Treasury, 2010; Statistics Finland, 2011).

### ***The impacts, issues and significance of measurement in productivity analysis: how to respond to institutional, global divergence***

A major theme to emerge from the literature review is the significance of measurement to productivity performance. Accuracy and quality of measurement are cited by Tansey (2005a) and Drew (2007) as being critical elements to ensure reliable productivity statistics, on which analysis relies. In addition, economic and industry planning and strategy also rely heavily on the efficacy of measurement methods, thus measurement is of critical importance to the study of productivity (Engelbrecht & Xayavong, 2007; Bekaert, Harvey & Lundblad, 2011). The following extracts illustrate the dominant public policy views on the role that measurement plays in identifying, contrasting and examining relative, as well as, in a comparative context productivity performance of an economy.

...summary of that paper was that essentially...picked the evidence that NZ's productivity levels are low relative to a lot of other OECD countries is fairly compelling...  
(Participant C)

The evidence of New Zealand experiencing low levels of productivity relative to many OECD economies is persuasive based on a research paper seeking to evaluate New Zealand's productivity performance conducted by this respondent. This evidential opinion once compared with the major findings of the literature review that found that New Zealand, in some specific cases (time period co-dependent), has experienced lower levels of labour, capital and MFP productivity compared to Australia, Ireland and Finland (Davis & Ewing, 2004;

Kavanagh & Doyle, 2007; Dolman, Parham & Zheng, 2007) as the literature review revealed. However, there remains no consensus among key stakeholders on the reasons why this weaker performance persists.

...the more important issue which is productivity growth rates appear relative to OECD countries that's where there is a bit more disagreement...

(Participant C)

This perspective focuses on the divergence of factors considered influential among researchers and policy analysts as to whether productivity growth rates appear relative to OECD economies. That is, are the data sets on which further analysis rely and the methodologies applied consistent to afford confidence that such comparative findings are sufficiently reliable? This view brings into line findings from the literature review in chapter two, whether the complexities related to ensuring a convergence of methodological considerations will continue to impact the efficacy of productivity statistics, until such questions are comprehensively resolved (MED, 2007a; New Zealand Treasury, 2008).

...traditional way of measuring productivity is simply aggregate GDP divided by aggregate labour employed in the economy over time suggests a pretty weak labour productivity growth...

(Participant C)

Productivity performance is significantly determined by the methodology of measurement and based on the traditional method for calculating labour productivity; New Zealand's performance has been weak relative to that of several OECD economies, including Australia, Ireland and Finland. However, whilst recognising that issues remain, Statistics New Zealand (SNZ, 2011b), have already embarked on a programme of measurement alignment with best practice (OECD standards), that will provide greater depth, coverage and scale of productivity data with the aim to positively influence the quality of New Zealand's productivity statistics.

...when you start digging into that and this is essentially what stats NZ have done to try and come up with official measures and when you actually look at the measured sector which is going to get good independent measures in inputs and outputs actually are getting more and more comforting in the productivity growth picture.

(Participant C)

In the literature review it was identified that productivity measures cover two distinct areas of the economy; measured and non-measured sectors (SNZ, 2007c). The discussion focused on how measures covering both sectors were critically important to assessing relative productivity performance, on which comparative analysis depends. The extract above clearly argues that planned improvements by SNZ (some of which are now complete) have had a qualitative impact on productivity measures, and more significantly on New Zealand's relative performance stemming from these improvements (SNZ, 2010a). Growth, according to this respondent, is occurring and the scale of growth may be greater than previously envisaged. This highlights the critical role that measurement plays in relative productivity performance. Next, the participant was asked, notwithstanding the discussion already provided, how important is the quality of figures and the accuracy of data collection and representation, how important is it, how vital?

I think it is very important, as I had mentioned and particularly because in NZ like a lot of OECD countries the fastest growing sectors in the economy are the servicing sectors and that's the sectors where traditionally it's the statistical agencies have had the most trouble measuring productivity...

(Participant C)

The challenge of enabling quality measurement of the services sector formed part of Statistics New Zealand productivity programme (SNZ, 2011). With increasing reliance internationally on quality, detailed and comprehensive measurement over quantity measurement, New Zealand faces two unique challenges; first, adopting best practice methods of measurement that align at a minimum to OECD standards; ensuring that where-ever possible those used by New Zealand's significant trading partners are at the very least reliably compatible with New Zealand's system, and if not, adopting the same methods and analysis of measurement (Drew, 2007). Second, how to effectively respond to the rapidly expanding influence of the services sector on the national economy, and by extension New Zealand's relative productivity performance. It is problematic that Statistics New Zealand has to respond to the combined forces of alignment with best practice and to effectively account for shifts in the

size of expanding sectors. However, it clearly also creates an opportunity to affect change by seeking improvements when responding to both issues. Arguments presented in the literature review seek to achieve the same level of consistency (OECD, 2009; Statistics New Zealand & New Zealand Treasury, 2010). Several authors, including Tansey (2005b) and Van Ark (2006) argue it is crucial that these improvements are made and that work focused on issues surrounding measurement is evaluated over time. Indeed, this view is shared by Statistics New Zealand (SNZ, 2011b). The tangible benefits to New Zealand productivity research, and associated policy initiatives are that such improvements will provide certainty in the sectors most affected, especially measurement dependent industry and Government, whilst refining with a higher degree of clarity New Zealand's relative position globally to its competitors. The result is that the 'picture' of New Zealand's productivity performance will be enhanced and more critically will be more reliable.

...if you've got an economy where the services sector is growing faster than the non-services sector that's a NZ case the service sector is growing relatively faster in NZ than in a lot of other countries then that could lead to a substantive source of bias.  
(Participant C)

Bias in measurement methods distorts data, which skews results, thus provides a pre-determined picture driven by subjective ideals, rather than accurately represent the real rate of activity of growth or decline (Erosa, Koreshkova & Restuccia, 2010). The respondent is acknowledging how problematic this would be if realised. Building on from the findings found in the review of literature this view is an additional consideration not discovered in the literature, thus now becomes an important consideration when seeking to identify the factors that have enabled New Zealand's biotechnology sector to succeed globally. .

If you look at the measured sector statistics, productivity growth has been slowing over the last 6 or 7 years.  
(Participant C)

Between 1999 and 2006 productivity growth did slow, however this, not unlike periods before it, was due to levels of unemployment falling to the lowest level in 34 years (NZPA, 2007) combined with a sharp increase in the growth of annual hours worked (see Figures 6, 11 and 16). When this is combined with

the literature review findings (Maida, 2009; SNZ, 2011b) that New Zealand's labour productivity rate has suffered from a bias towards the adoption of labour over capital (irrespective of capital availability) it is logical that labour productivity sitting underneath measured sector statistics (with capital and MFP) has not experienced strong growth – limiting the growth achieved in the measured sector.

In contrast, in the latest, the very latest statistics, productivity growth seems to have picked up.  
(Participant C)

For the years 2007, and 2009 national level productivity statistics achieved growth; however for the year 2008 there was a sharp decline from the impacts of the GFC (Davies, 2009; Banks, 2010) as noted in the literature review and from the collapse of financial institutions undermining investor and capital market confidence (Banks, 2010). Therefore rates of economic activity were exposed to severe shocks (one external and the other internal) together amounting to weaker performance across a wide range of measures (Davies, 2009). The GFC and financial institution collapses were both partly related to the rapid decline in credit availability worldwide, stemming from the sub-prime mortgage lending scandal and the exposure to bad credit in poorly performing institutions.

However, this is not entirely clear because these statistics are not for the measured sector, but for the whole of the economy including the part that is not well measured.  
(Participant C)

Discussion on how the measured sector has performed, as this respondent argues, is limited by the measurement challenges that persist. Therefore to provide quality and detailed measurement of the 'measured' sector remains a challenge for Statistics New Zealand.

Part of the reason for that slowdown in measured sector productivity is that we have absorbed into the labour force the people that were previously unemployed. So it is partly a good news story.  
(Participant D)

As recently discussed – this respondent is arguing that the bias towards labour has meant that more New Zealanders are working than would have been, had the labour market dynamics not shifted. Successive Governments, especially those that have sought to redefine the style and tone of employment relations away from freedom of representation, fairness and equity to mobility and individual responsibility have it could be argued succeeded in ensuring more New Zealanders enter the labour force (Perry, 2006). However, the costs associated with creating mobility in the labour market (perhaps not immediately obvious during the periods of reform) are now better understood.

However, it's not quite as simple as that because the participation rate has risen in part because women are being absorbed into the labour force as well. And you can think of any number of reasons why the slowdown may have occurred...  
(Participant D)

The rate of labour force participation (see Figure 2: Workforce Participation Rates) achieved in New Zealand during the period from 1995 through to 2009 has clearly outperformed that achieved by Australia, Ireland and Finland. 1995 was the year that many of the labour market reforms were fully implemented by the National Government. Within this data, there are figures that demonstrate that New Zealand has been more successful in women entering into the labour force (DOL, 2011). This is partly explained by successive Governments taking a position on social support for women who give birth. Prior to the introduction of the Paid Parental Leave Scheme established under the 4<sup>th</sup> Labour Government, sponsored by the Alliance in coalition with Labour in 2002 (Perry, 2006), women had three choices. Stay at home and be supported by a working partner and receive no social welfare support; not re-enter the labour force (without a partner) and receive the Domestic Purposes Benefit (DPB); or, return to work, but pay more costs associated with early childhood care. The introduction of the Paid Parental Scheme alleviated some of the financial pressures on working mothers, thus helped ensure that New Zealand's labour force participation growth rate was maintained and this is evident from the data presented when New Zealand is compared with Australia, Ireland and Finland from 2002 until 2009. Australia's rate improved due, in part, to the introduction of a Paid Parental Scheme as reflected in the data (NFAW, 2011).

As noted earlier, Statistics New Zealand's (SNZ) programme of reviewing measuring techniques, scope of data collection and processes to assess the productivity pattern in the non-measured sectors, as well as improve the quality of measures in the measured sector is aimed to improve productivity data in New Zealand (SNZ, 2011b). The views gained from the interviews demonstrate the convergence of opinion in regards to the role that measurement plays in determining accurate (actual) productivity performance. It is important to note that productivity measurement is a growing area of research and analysis globally, therefore New Zealand is not alone in coming in terms with issues and challenges of analysis and measurement in the study of productivity.

Discussion now shifts to participants views on the key issues, challenges and opportunities the biotechnology sector faces in New Zealand.

### ***Biotechnology: New Zealand's future global industry?***

The biotech sector has received significant state resources since 2000 in the form of government investment in the sector, primarily because Biotechnology being one of the three future growth sectors for New Zealand identified via the Knowledge Wave Conference and subsequent GIF framework (MoRST, 2004). The views of respondents were sought to identify the reasons why biotech was considered such a significant opportunity to New Zealand in securing the future and what factors contribute to growing New Zealand's economy.

Let me set some context more generally, to start with. From a biotech perspective, New Zealand has a recognised global position and strength in the field of Ag-bio before you reference them, that is really based on probably the last 150 years of very solid agricultural performance...  
(Participant A)

New Zealand's biotech sector has forged a strong brand globally that is in part built upon the agricultural legacy inherited from the farming pioneers, botanists and scientists who have provided the raw materials required to build a biotech sector (MoRST, 2003a).

...and it's just an embedded component of the New Zealand economy which has gained in productivity across our agriculture sector year upon year and whilst we are now in the field of so called

modern biotech, biotechnology has been part of that journey right from the outset...  
(Participant A)

Although, biotech is often perceived to be a new phenomenon it actually has been a feature of the New Zealand environment for over 150 years. The farming and science sectors have been savvy in the ways innovation, knowledge and data has been captured and then subsequently applied (NZTE, 2006). Of critical importance is the long term view the key personnel in the sector took when determining that there could potentially be future benefits stemming from new ways of using existing resources at different levels of data (cell, animal, environmental).

...we have been pretty smart in the way that we have rigorously collected some pretty important animal genetic data sets over the last 30-40 years in particular and it's extremely difficult to replicate that kind of knowledge based dataset quickly...  
(Participant A)

Smart application and use of technology has become a hallmark feature of New Zealand's agricultural sector and is the reason why it is world-renowned (SNZ, 2007a). This leads into the discussion focused on the comparative advantages New Zealand has that come directly from the historical legacy preserved by relevant authorities, most especially the CRI network now branded as Science New Zealand (NZBio, 2010). One of the findings discovered in the literature review was how biotechnology has been a feature of the New Zealand industry, and the economy since the 1900's (Marsh, 2002; MoRST, 2003a).

...the one that intrigues me most of all is the way that we've seen quite some sophistication in the definition of biotechnology in New Zealand where it's not just all about Ag-bio, but increasingly about the area of human health and nutrition and obviously the area of industrial biotechnology.  
(Participant A)

Universities, CRIs and biotech organisations relative expertise in the fields of human health and nutrition are on the increase with many of the inputs necessary for this growth coming directly from biotechnology (NZBio, 2009). Fields of biotech research and activity in New Zealand are growing and those that are forecast to play an influential role in New Zealand's economic

development are listed in detail in Table 3. The respondent is drawing attention to the process of development that has occurred within the sectors that produce and/or utilise aspects of biotech outputs in the work they do. Taking the discussion further, the respondent ties his view together by highlighting the areas where New Zealand conceivably has competitive advantages.

...many of those biotech application domains draw quite substantively on our Ag-bio heritage so we are seeing increasingly smart evidence of companies and research groups using knowledge base they have built up from Ag-bio domain and applying it in other application areas and we can look at it from a high end human therapeutic application areas where New Zealand Ag-bio advantages are coming through.  
(Participant A)

What is highlighted here is that there is now a change occurring that shifts the sector away from a predominantly research and development phase into a phase of application and commercialisation. Drawing on the findings in the literature review it is clear that modern biotech has been limited to science intensive activity in New Zealand until recently.

### ***Significance of biotechnology sector growth to New Zealand's productivity debate***

Unlike productivity comparisons, biotechnology is more than inputs, outputs, outcomes, analysis and interpretation of statistics and measures. These are valuable, but without also understanding the uniqueness and strength of New Zealand's country-specific advantages comparing the biotechnology industry with another would be limited. The analysis of interview data presented outline a range of reasons why biotechnology is a growth industry for New Zealand, giving historical insights into the development of New Zealand's Ag-Bio sector. Participants were asked "Several studies over a number of years have identified and analysed how New Zealand has been successful in utilising New Zealand's comparative advantages, based on country-specific factors such as agricultural land-based production and expertise in Ag/Biotech science and research & development; what factors in your opinion will contribute to our economy's

ability to leverage further, sustainable advantages from unique New Zealand factors? Why?”

Throughout 2006, NZBio had a fulltime policy person who has gone on his OE, so we were sorry to see him go but one of the big pieces of work that he did was to help us to lobby for changes to tax policy so that was implemented. And we met when that was implemented, that was a really big one for the industry and it was a lot of the behind the scenes work for us so its stuff that um of course there is more that we would like to see...

(Participant E)

As previously discussed, the biotechnology sector has been a feature of the New Zealand industrial landscape for approximately 150 years (NZBio, 2010a). However, it was not until 2001 that government became firmly focused on the potential of the biotech sector in ways that had not occurred earlier. GIF ensured that biotech's status and New Zealanders awareness of the sector was increased to levels not previously seen. Having a national discussion on what it is that collectively is envisaged for New Zealand was a crucial element to rising biotechnologies profile as of significant importance to the future.

...think company share options was another area that might be looked at again so employees could have been able to take a share in the company, which incentivizes productivity. I think that's a model that is probably used in other countries but we don't do it here yet so those were two of the big issues. We got through the R & D tax credits, so they were and became live in April this year so it's very new. The devil will be in the detail...

(Participant E)

### ***Leveraging country-specific factors via comparative and first-mover advantage(s)***

The literature review revealed that there is a strong view among authors of the potential benefits that biotechnology affords New Zealand, specifically benefits that provide comparative advantage. These are based mainly on country-specific factors that are well established and have been utilized in trade between New Zealand and the rest of the world. The country-specific factors range from physical resources through to research activity to innovative

endeavour. These elements combined provide opportunities for the biotech sector to leverage growth from existing strengths.

...and we have advantage in terms of a lot of underpinning research and raw data from which we can gain further productivity increases ahead of our competitors and I guess in terms of agricultural competitors the ones that we need to watch out for most closely exist in South America.

(Participant A)

This view identifies the critical role that research and data can now play in new ways when seeking to increase growth, and to support the expansion of the biotech sector within New Zealand whilst aimed at building critical mass and commercial success in the global marketplace.

...geographical country specific advantages that New Zealand can offer from an agricultural-biotech perspective really fall into the isolation factors where New Zealand is disease free in terms of class A disease pathogens so that's quite a unique advantage.

(Participant A)

Geographical location has historically been cited as a key reason why New Zealand has not enjoyed growth similar to that of Australia, Finland and Ireland due to issues of proximity. Whereas, this respondent is arguing that in terms of protecting and preserving valuable comparative strengths, geographical isolation is to New Zealand's economic and environmental advantage.

So there are some fundamental advantages that New Zealand has.

(Participant A)

Based on this respondent's argument, isolation from other significant land masses (proximity) performs a very different role for the biotech sector in New Zealand, one that is protective and ensures uniqueness is preserved, whereas for productivity, as mentioned earlier, it may play a different, less constructive role (Coyle & Fairweather, 2005; Hindmarsh & Du Plessis, 2008; McCann, 2009).

I know Australia has certain disease free status as do a number of south American countries but the volume of certain liquid that surround New Zealand does provide quite a nice barrier against in

which to regulate the flows of disease vectors in and out of the country so that's a barrier that will not be eroded overnight.  
(Participant A)

New Zealand's island status located in the world's largest mass of water offers barriers to external threats which are unlikely to be overcome in the foreseeable future. Not only is this a strength from which value can be protected, this is also one of the key reasons why New Zealand has significant opportunities in biotechnology. Therefore, proximity is less of a factor in determining poor productivity performance with respect to biotechnology than has historically been perceived and by extension may play a more constructive role in New Zealand's future economic growth.

...many of those biotech application domains draw quite substantively on our Ag-bio heritage so we are seeing increasingly smart evidence of companies and research groups using knowledge base they have built up from Ag-bio domain and applying it in other application areas and we can look at it from a high end human therapeutic application areas where New Zealand Ag-bio advantages are coming through.  
(Participant A)

The sector has achieved a degree of critical mass from which research entities and businesses are now able to leverage. What is happening now is that the early work done in the lab, based on high levels of expertise together with quality data sets, is growth in innovation and development of new methods of creating products, processes, knowledge and science derived technological advancements. There are several excellent examples of biotech companies successfully navigating the transition from the start-up phase into the production phase (Kaye-Blake, 2006; Savage, 2008a; NZBio, 2008; Boven, 2009b). What is of crucial importance is that the development continuum keeps growing and develops carefully over time.

Yes, there is a continuum and we need to evolve.  
(Participant A)

The evolution of biotech research in New Zealand now features international collaborations built upon the intellectual property and breakthrough science successes of skilled professionals. However, as highlighted in the literature

review the challenge of reaching an evolving consensus on where to next remains.

I think we need to do more work in the engineering and processing side of things, so at the moment we are working off our biological knowledge, and that's all very well at discovery phase. But, there is a lot of knowledge that we have around processing and engineering and plant design and that sort of stuff that we have acquired as part of the dairy industry in particular and fermentation expertise and so forth, which I think we need to leverage into Biotech.  
(Participant B)

Since these views were collected there are now examples of successful biotech companies reaching into new areas that have not been achieved before now. For example, according to NZBio (2008) biotech organisations Anzamune & Biopacific Ventures have successfully leveraged New Zealand specific advantages in the collaborative sheep genome project, which drew worldwide attention to the project results and to the increasingly innovative and ground-breaking New Zealand research and science community. Equally, New Zealand biotech organisations involved in human health and nutrition fields have successfully created, tested and commercialised new technologies (NZBio, 2009). This has been achieved by the organisations ability to identify and build collaborative partnerships with global stakeholders in the industry, whilst also attracting investment capital to facilitate the entry into market.

You can see the beginning of that using the pharmaceuticals building new plants and some other stuff, but we need to – I think, and that's where the – all the discovery work is fine but it's not really productive in the long-term and so we need to move out into processing and application side of things more.  
(Participant B)

The challenge for the sector has been to effectively move from the discovery phase into the processing phase, from which the production phase can follow. There is evidence of this shift occurring, proving that the biotech sector can play a significant role in partly determining the strength of New Zealand's future economic growth. One of the key findings is that New Zealand's comparative advantages in agriculture and related fields continue to play a vital role in securing future economic prosperity, as much as they have contributed to this in the past, it seems likely that it will continue into the future. This process of

successfully leveraging further sustainable increases in biotechnology underpins the sectors role in increasing productivity and economic growth. One of the key themes to emerge from the review of literature was how biotechnology is a global industry. The extracts below support this view and lead the discussion on to how New Zealand can secure advantages from global networking in the fields of biotechnology.

Biotech has always been an international market. So Biotech has always been an international industry.  
(Participant B)

The increased dependence of trading economies, such as New Zealand, on the global market has meant that economies have needed to better identify where comparative advantage lies. For New Zealand the biotech sector can provide specific advantages based on the view expressed here that biotechnology is an international industry. This allows New Zealand biotech companies to target their products and services to the more lucrative global markets. A constant view expressed in many of the studies cited in the literature review argue that one of the reasons why New Zealand has suffered from low productivity and comparatively lower rates of economic growth is due to the localised view adopted by the majority of New Zealand businesses that seek mainly to service the local market rather than taking increased risks by entering into overseas markets. It is debatable whether this is a purposeful aim of business or rather a lack of international focus and aspiration. There has also been a significant cost from this behaviour. The development of new technology, processes and products and services have predominantly been created on the needs of the domestic market, and have not taken into account the needs of overseas markets. This has meant that New Zealand businesses have had a poor record of successful ventures in overseas markets.

...Biotech is expensive to develop products and New Zealand is a very small market so that the New Zealand Biotechnology market, except in a few niche areas around Ag-bio, nearly all our companies are looking offshore for their markets and that's just a fact of life. So that means Biotech right from the word go has an international focus.  
(Participant B)

It could be argued that with the biotech market being international in nature this 'fact of life' is of timely benefit to New Zealand's rates of productivity growth, underpinning industry sector growth.

Now how the success of the companies contributes to building that I think forming international links requires a quid pro quo, no-one is going to link with you unless you're providing something in return...  
(Participant B)

NZBio and NZTE extend considerable resources to identifying, marketing and building new international relationships for biotech companies. This is a key characteristic of the sector and this will be expanded upon in the section Acting as one: how best to engage global networks.

...what New Zealand is offering is a high level of innovation, a high level of education and research investment, particular strengths in niche areas, and you know obviously the standout agricultural food sort of areas – so we are offering all that to the offshore market and they're picking up.  
(Participant B)

The confluence of factors assisting the growth of the biotech sector is well illustrated in this respondent's views. Government investment directly into the sector, such as capital, technology, expertise, time and policy is enabling the sector to reach beyond its initial potential more rapidly than would have occurred without this support. Indirect government investment into human capital development (education and funding of science research), and the assistance and guidance various government agencies have provided to support sectoral development have also protected the strengths of the sector from external threats to a greater degree than those in other significant industries including ICT, Tourism and Manufacturing.

Seeing investments through inventions in Nestle in New Zealand's specialist areas, we are seeing investment in drug development from Australian investment capital.  
(Participant B)

Human health and nutrition research in New Zealand is attracting flows of predominantly Australian venture capitalist funds during a time of limited capital availability globally. That is, at a time when credit is in limited supply and is

heavily focused on specific projects and models it is noteworthy that New Zealand's biotech sector is attracting investment from risk-seeking investment bodies.

You know in some ways New Zealand is being seen as sort of virgin territory for people to come and look for ideas. Because we are just that much outside the mainstream. The mainstream has been fairly picked over, people make the effort to come here, they try new things and I think that has been born out in practice. So yeah, unless you have a successful Biotech industry that's making a difference, then the international community aren't going to be interested.  
(Participant B)

Interestingly, the New Zealand market of ideas is appealing to overseas investors because of the uniqueness of innovation and research being done according to the view expressed above. The same argument was identified in the literature review where New Zealand was seen as an attractive place to invest because of specific strengths New Zealand has. These include political stability, financial and trade openness and the quality of the regulatory environment. New Zealand is also seen as a relatively new market ripe for investing – highlighting the quid pro quo mentioned earlier.

Well when I have listened to people who have been involved in the sector a lot longer than I have, right from when we used to spray whey as a waste product onto paddocks and farming or agriculture was looked at as a sunset industry at one point in our history and I think there's been a real turn around in that and people started to realize that by applying science to what was considered waste products we could actually be making money out of them and policy, I think farm government policy is reflecting that, what's backing agriculture once again and the launch of the Fast Forward fund is a really important signal.  
(Participant E).

This respondent emphasises the journey that New Zealand's biotech sector has taken and argues that the role of the early adopters especially of Ag-bio in New Zealand is where this journey started. With government policy reflecting what is occurring in the development of the sector has meant that the sector has grown in size and depth rapidly since the GIF framework was launched in 2001. With the sector transitioning from the discovery phase to process phase and increasingly into the production and commercialisation phase there remains

considerable opportunity for high industry growth and crucially for New Zealand's economy high productivity growth stemming from these investments.

### ***Building critical mass: quality of resource, capital and policy allocations***

An argument put forward by Parham & Roberts (2004) is that New Zealand does not necessarily have to devote a high percentage of its resources to primary research and development (i.e. the creation of new products and processes). It need only have easy access to the sources of new knowledge. It should also be noted that expending resources on the development of new products is not necessarily productive. There are costs associated with expenditures on developing new products and processes that New Zealand is not well suited to absorb with the fixed costs of such endeavours typically too high and benefits being too low (Parham & Roberts, 2004). As part of this discussion, it is important to mention that it is widely reported that New Zealand adopts new technology well, however new knowledge poorly (Engelbrecht & Xayavong, 2007). Moreover, New Zealand rates poorly on the most significant indicator, private sector funded research and development (MoRST, 2007).

One benefit that we find as government working with the Biotech sector in New Zealand – we are talking at both a research end and at a industry and commercialisation end is that all the active players that we are working with are immediately talking and thinking about global value chains, global partnerships because they recognise Biotechnology has such a high degree of innovation content at the core.

(Participant A)

With the majority of stakeholders in the biotech sector holding the big-picture view by focusing on the global environment, linking with states, organisations and people with a high degree of specialisation in complimentary fields of biotechnology it is clear that this is one of the key reasons why the sector continues to perform strongly. This is of especially important considering the risk-adverse global environment currently of public and private business.

They have to think on a global scale and that unquestionably brings productivity advantages in terms of sharing IP, sharing ideas, just

sharing understanding about the way that key global markets are operating...  
(Participant A)

By operating in a context where the market is global the biotech sector provides unique advantages to New Zealand. Based on the evidence above where New Zealand has traditionally adopted new knowledge poorly the biotech sector can play a facilitating role in improving the methods of how industry interconnect across borders and into new markets.

...so from an organisational perspective we do not have to encourage companies to think beyond national borders in the way that they are looking to develop their research or their products or service lines, they are already thinking in that space because of the very nature of Biotechnology so the whole international, global market factor is absolutely key.  
(Participant A)

The experience of the biotech sector provides other New Zealand industry with another significant advantage. Based on the findings selected from several authors identified in the literature a commonly espoused view on the 'state' of the challenges facing New Zealand when pursuing economic growth is the lack of globally focused industry. That is, based on the continued global success of New Zealand's biotech sector, and the valuable contribution the sector plays in New Zealand's relative productivity performance – there needs to be greater emphasis and resources invested into the strategic view of industry to persuade and assist re-orientating short and long term goals into globally focused frameworks.

But, not to say that we don't have a role in further raising the profile of New Zealand's Biotech sector internationally and we do that and we are seeing quite a sophistication and the interesting conversation around New Zealand competency, with companies already thinking in that space.  
(Participant A)

Public and private sector agencies responsible for supporting New Zealand enterprises in global markets have a critical role to play, most especially at the beginning of new market ventures. This respondent is highlighting the significance of that role whilst acknowledging that this work needs to continue

and adapt to the evolving needs of particular industry. Part of this responsibility will depend on at what stage an industry is at in development or with overseas ventures with the need for policy settings to be reflective of the changing environment of global business.

### ***Pathways forward: industry organisation, co-ordination continuum***

It is important to recognise the starting point of the pathway selected for biotechnology in New Zealand to contextualise this discussion. As previously discussed biotechnology has been in use in New Zealand for a long time. The application and sophistication of modern biotech has emerged more recently since the early 1990's. The significance and value of the sector, based on uniquely New Zealand advantages attracted the close attention of both industry (agriculture, science and research) and that of government. This developed out of the Knowledge Wave Conference that involved professionals across disciplines. Following this was the creation of the Growth and Innovation Framework (GIF). The end result was the development and publication of the 'New Zealand Biotechnology Strategy' published in 2003.

The Knowledge Wave Conference and that's something that people quite often refer to as the time when it was pre growth and innovation framework. So that came out of the knowledge based conference...  
(Participant E)

Government, with the participation of industry leaders and policy specialists identified the need of bringing together previously disparate elements of science, research, technology, industry and government in New Zealand to identify the sectors that would most likely play a significant role in New Zealand's future economic growth. Biotechnology was identified as one of three sectors that would be crucial to achieving future growth, based on comparative advantages. The other two industries were Creative Arts and Information Communications Technology (ICT). Discussion proceeds now with a focus on how the biotech sector was organised prior to changes identified from the Knowledge Wave Conference and GIF being implemented.

At that time, there were a couple of different organizations; there was the NZBA, the New Zealand Biotechnologists Association which was a group representing individual scientists namely and there was also an organization which I contracted to for communications group, called Biotenz and that was supposedly to represent the company side of Biotech industry in NZ.  
(Participant E)

What is clear from this discussion is how separated industry grouping and representation was prior to the adoption of the recommendations contained within the strategy. This remains a feature of some industry in New Zealand in the ways that they structurally organise responsibility and roles. Based on the success of specific New Zealand industry operating globally it can be argued that the centralisation and co-ordination of industry is a crucial factor in determining industry sustainability and overseas market success.

It was quite early days I think and it was um I guess early days; the model perhaps, had not been refined in terms of benefits to members and so on. Part of the growth and innovation framework, well the NZ biotech strategy and the task force sort of fell out of that, I guess or grew from that and one of the task force points said that we should form a single organization to represent the sector and that involved the merging of the NZBA and Biotenz to form a single structure and that was NZBio.  
(Participant E)

One of the core features of New Zealand's biotechnology sector has been the in-depth involvement of all stakeholders in evaluating the strengths, weaknesses, threats and opportunities of the sector prior to creating a strategic vision that accounts for these elements whilst achieving the goals identified that are of benefit to organisations operating in the sector. Of critical importance to the health of the sector has been the consistent approach and range of efforts invested in the sector by consecutive Governments.

We also do a lot of work in the coordination of this sector so government funds NZBio through NZTE and ourselves do a lot of work in coordinating sector making sure that the regulations are balanced and reassuring the public and allowing innovation, that's a very key balancing act particularly after the royal commission so we've been doing a lot of work in that and I think from my perspective we've done a reasonably good job but a lot of other people I'm sure would feel there's a lot more that we could do.  
(Participant B)

Not only is biotech naturally an internationally focused sector, it is also a sector that works closely with Government, State Owned Enterprises (SOEs), Science New Zealand research entities with regional and local organisations all contributing to the strategic planning of the sector. Therefore, the sector is interconnected and actively communicates with each other and from this has come a series of successful industry organisation and co-ordination developments that continues to serve it well.

I think the key things for growth has been the funding in the RS and T has been the history of the research that we've got to build on and in terms of industry success a lot of that has come down to the coordination provided by NZBio and NZTE the coordination and the networking the ability to find offshore staff all of that is kind of soft stuff has been tremendously successful in the Biotech industry.  
(Participant B)

The view on the importance of building on the history of experience New Zealand holds is also cited often among the relevant literature. Combined with resource support and leadership from government has enabled the sector to achieve high growth, over a short period of time, whilst leveraging New Zealand specific advantages, to be referred to as country-specific factors. The type of support from government has also been important. Not only have consecutive governments provided support to the sector within New Zealand, increasingly their support extends to biotech entities entering, negotiating and developing markets in overseas economies. Therefore, biotech organisations have not had to jump into the unknown by solely relying on organisational resources when taking on such risks.

We were lucky that we started NZBio, well when NZBio was formed from the two existing agencies they had pretty much complete coverage the industry was relatively young there was a lot of government interest and therefore a lot of government money at the time and so NZBio was clearly placed as the lead organisation and that has not been true in a lot of the other sectors.  
(Participant B)

A core feature of the biotech sector today is how well represented it is by the lead organisation NZBio. NZBio is the pre-eminent biotechnology industry organisation, representing the vast majority of biotech enterprises. Leading on from this discussion, whilst identifying factors that have influenced the global

success of New Zealand's biotech sector discussion now shifts to focus on evaluating the role that strategic thinking, industry planning, development and evaluation plays in industry growth.

### ***Strategic thinking: industry planning, development and evaluation***

As part of the process of identifying which factors have been key to the global success of New Zealand's biotech sector the role of strategic planning is now discussed in-depth. The respondents were asked to what degree, or rather how important has the strategic decision making, thinking and planning been in terms of the success achieved.

I would say yes, but clearly I am biased from the seat that I occupy. But, if I try and give a neutral answer here – I came into New Zealand about five years ago from the United Kingdom with relatively minimal background in the Biotech field to date, but a strong background in the area of technology transfer. And, I was fortunate enough to be given the opportunity to work with the early formed Biotechnology Taskforce, and in fact I was asked to assemble the report from that taskforce which gave me clearly a good understanding of all the movers and shakers and the thinking taking place. And, the Taskforce, I presume, are you familiar with that particular report ... Task Force report issued in May 2003...  
(Participant A)

Referring to the 'New Zealand Biotechnology Strategy – a foundation for development with care' this respondent is highlighting the role they played in producing this report. This view is elaborated further below on the thinking behind the decisions made in respect to the sector.

It's very much set out a body of thinking around the need for strategic alignments and vision between the Government and industry.  
(Participant A)

The value of conceptual thinking on the issues that are of most significance to sector sustainably and growth is a feature of biotech's success. Industry, especially science/research intensive sectors are exposed to high cost factors that limit the degree of opportunities for growth, thus the government has played a critically important role in providing support during the periods when the sector

has needed it most. Although the contribution from government remains significant and enduring today – simply because the industry relies upon ancillary sectors that are expensive, it is likely that the ratio of government support to industry investment will slowly dissipate over time. This process will develop further once the commercial, as well as, global financial partnership successes reach a critical mass.

And it set out in fact a ten year vision at the time and it benchmarked some of its thinking about some similar strategies that other nations had put in place where Biotechnology was seen as a key growth sector for the future. Lots of countries and investing heavily, but it provided an opportunity to get close alignment between as I say different sections of industry, across those three broad spheres I was talking about earlier in terms of industrial, human health and Ag-bio/science.

(Participant A)

The New Zealand Biotechnology Strategy was formed not only from local history, experience and knowledge it was also formed from other nations industry growth strategies on which specific aspects were based. This contribution is a feature of a best practice approach that utilizes fit for purpose policy. That is, the authors were cognisant of the challenges that local industry face in competing in global markets thus ensured that competitor nations thinking and directions were incorporated where necessary, based on the respective success achieved.

It allowed conversation and research alignment from a number of key CRIs it brought many different Government departments to the table at the same point, including implementation agencies such as NZTE and to bring some collective thinking together and to recognise the role of Biotech can play both as an enabling technology as well as a vertical contribution to the New Zealand economy in its own right...

(Participant A)

By bringing all interested parties together the taskforce was able to capture the views and concerns of each stakeholder, whilst government provided much of the necessary support required to sustain this activity. Effectively, this taskforce was able to achieve what the government system was unable to achieve, without the taskforces determined focus and agreed parameters of investigation. This is notable as government departments and agencies,

however independent and removed are intended to be a collective when responding to whole of business or industry need, and yet, this is clearly not always the case. Governments employ a wide range of tools to co-ordinate people and organisations in ways that are not possible otherwise by creating or establishing commissions, taskforces, working groups and in the most severe of cases, royal commissions. These groupings of senior leaders in appropriate fields work well in parliamentary democracies such as New Zealand providing depth of enquiry, breadth of relevant sources and most critical of all, time. However, government and industry, and therefore citizens would benefit in more sustained ways based on increasing quality if government could effectively organise its disparate parts more often, rather than relying on special bodies established for a single purpose. It could also be argued that this is not an effective use of New Zealand's limited resources. The views of how effective this document and the strategy it promoted were are discussed below.

I think was essential in terms of setting that strategic framework and a good 95% of the recommendations made have all been actioned either by Government, by industry directly and many through joint actions.  
(Participant A)

The development of a strategic framework is a commonly cited factor in determining industry growth and creating the conditions necessary for improving productivity performance in the literature. With a majority of the recommendations having been adopted by all interested parties, where appropriate – rather than mainly by one group, this is reflective of the degree and depth of co-ordination and organisation present in the biotech sector across stakeholders. Interestingly the fact that the vast majority of recommendations were adopted suggests that many of these recommendations were of sufficient quality to enable high levels of productivity and sector growth to be achieved since implementation.

So I think it really has been quite instrumental in accelerating the growth and the position of the New Zealand Biotech sector, and there is unquestionably growth that has occurred over the last 4 years.  
(Participant A)

Strategic thinking generates idea creation among other benefits which often leads to enhanced performance of an organisation, industry or economy. This process requires a high degree of comprehensive, accurate and detailed information from which informed decisions can be made. Due to the collaboration of all significant stakeholders having input into the strategic direction of New Zealand's biotech sector the sector has gone from strength to strength. That is not to say that there are no challenges and risks remaining to the future growth of the sector. These include New Zealand's macro-economic conditions, political stability and continued commitment, global economic growth in both developed and developing markets and the on-going preservation and protection of New Zealand's natural environments and those of neighbouring economies (i.e. climate change).

But, one has to be mindful of the natural time scales that operate in a heavily science driven innovation field such as Biotech. It does take time and it does take capital and it does take some bright thinking, so we have not completed the strategy as yet, and indeed there is growing conversation at the moment between industry and Government led by NZBio that the timing to reconstitute the taskforce in some way, shape or form ...  
(Participant A)

Time is of critical importance to changing the trajectory of New Zealand's biotech sector. Time is cited in the literature as having considerable influence over the eventual and continued success and efficacy of the sector's strategic development and direction. The view expressed here also highlights how there is a need for strategies/programmes to be consistently monitored, reviewed and evaluated in order to ensure relative appropriateness in changing environments so that intended aims are enduring. Identifying the factors present in strategic thinking that provide vision and responsive policy to the changing environments of industry, science, research and technology sectors allows the discussion to evaluate the value of collaboration between industry stakeholders.

***Holding hands: Collaborative partnerships between industry, research institutions and government***

The relevance of size of Government is commonly cited as a possible reason why some economies perform better than others (Brash, 2001; Kerr, 2003; Pilat 2004). Finland (along with Denmark, Norway and Sweden) has the dubious distinction as having the largest government sectors in the world. In Finland this accounts for approximately 47% of GDP per annum (McLellan, 2004). On the other hand, Ireland has a lower ratio of government spending, and prior to the GFC appeared to do well both in terms of productivity and economic growth. Following the recent experiences of countries like Ireland and Finland who were severely exposed to the threats posed by the global financial system (whose risk were at higher levels than that of Australia and New Zealand) size of government arguments are now known to play a role in determining growth, but not necessarily the ways that had been previously perceived. Identified and discussed in the literature review it is the quality of spending that counts, not necessarily who spends it (Tansey, 2005b; Douglas, 2006). Furthermore, New Zealand's national social contract is able to be more consistently reflected in quality spending by Government (charged with the responsibility to represent the people, for the people) than by business (who traditionally are responsible for business stakeholders) alone, building an arc between the aspirations and needs of all citizens irrespective of degree of involvement. This also ensures that the benefits that come from such investment are more broadly distributed among the local population via a combination of government and industry spending. With this in mind some interventions seem to work well in some circumstances, whereas in other circumstances the same interventions are problematic (Fabling, 2007). This brings us to the interventions below.

When the government funds education and R&D, as the New Zealand government does, it has to make a choice...I think there is, there are occasions when the government should be quite explicitly thinking of which sectors it should be focusing on and fast forward is an objective example.

(Participant D)

Fast Forward refers to the proposal from the Fifth Labour Government in their last term that identified where and to what value government and private investment (in partnership) were to invest significant contributions in the fields of science, research and technology, including biotechnology. The fund was never established due to the National Party winning the 2008 election. However, the

fundamental components of this proposal have been to varying degrees advocated by the Fifth National Government in its first term, albeit in lesser form (specifically with regard to financial incentives and overall capital contribution). The New Zealand Government has recently produced a defined strategy for the research, science and technology sectors in the document 'Igniting Potential: New Zealand's Science and Innovation Pathway' (MoRST, 2010). Where the focus of the Fifth Labour Government had been on incentivising the process of commercialisation of products, services and knowledge with capital investment, this strategic document seeks similar aims in the long term, but by implementing a mix of structural reforms, capital investment and centralisation of activity.

I'll have to give you my paper, just writing a draft, an occasional paper on how I think about economic growth and in there I've got a quote by Stiglitz which I use in that paper. He points out that in a sense the government cannot help but have an industry policy and cannot help but have a vision of how the economy should develop.  
(Participant D)

The literature reveals that there is considerable debate on whether governments, like New Zealand's, should 'pick winners' or adopt a different form of strategic 'talent' identification. Here emphasis - drawn from the recent writing of Stiglitz *et al.* (2009) - is placed on the effective role government can play in fostering industry and national economic growth. As to whether picking winners is 'the' answer, they had this to say.

But is much more a case of working with the market and it is not a case of picking winners. So, there's a sense in which the government cannot avoid choosing and there's a sense in which it will do better if it does choose.  
(Participant D)

Picking winners is not the answer according to this respondent. Rather, they argue that what it is about is the ability to work effectively with the market, that is, both the organisations serving the market, the needs of the consumers within the market, and the needs and requirements of the sector involved.

One of the examples I give in my paper is that it's unlikely that the ports of Auckland, the three ports in Auckland are going to take into account the cost of infrastructure the government has to provide to access those ports when they choose how they compete with each other.

(Participant D)

This practical example emphasises how government spending on infrastructure is not often factored into organisations analysis of their relative strengths or weaknesses compared with competitors when surveying the environment. What this highlights is that significant amounts of government expenditure are viewed as government responsibility solely by many businesses and industry, thus are absent from assessments made on relative competitiveness. Being that the biotech sector is firmly connected, at multiple levels with several government agencies, including the executive of government, it has been able to factor in government spending on relevant infrastructure (however seemingly removed) into its strategic thinking and development. The outcome is that biotech is more aware of changing priorities and therefore is more successful in responding or adapting to changes made by government. It can be argued that this would be of significant benefit to some New Zealand industries if they were to adopt this as part of industry behaviour. The respondent was then asked to share their view on what other government initiatives and policy developments play a constructive role in increasing growth in the biotech sector and in productivity.

...a review of the literature on the impact of tax credits and in my view, the balance of evidence suggest firstly, that tax credits increase R & D and secondly, that increased R & D leads to increased productivity.

(Participant D)

Whilst there is a debate on the efficacy of tax credits in supporting growth in the literature, this respondent's view is clear; tax credits increase research and development from which levels of productivity are increased. Although there are no current proposals from government to extend tax credits to the biotech sector, it needs to remain part of the tools that government can use to improve the environment of science intensive, research driven sectors in the economy. The discussion now returns to focusing on whether 'picking winners' is good practice by government when seeking to increase sectoral growth.

Well, this is a debate I have with Participant F on a fairly regular basis actually and I think at the moment...certainly the government is for all intents and purposes focusing its financial assistance on areas that have been shown to be a good growth area for us...my personal question about that is really should we just be picking winners and focusing on people who have shown or given money to the same things all the time, this is my personal view or should we be casting the net a bit wider and taking a chance on some of the newer technologies.

(Participant E)

This respondent's view raises interesting questions regarding the choices government make in support of industry. Part of their argument is that there may be an opportunity cost of solely 'picking winners' as higher risk investments may suffer from a lack of government attention and resources prior to evidence becoming available to substantiate any proposal's viability or potential for relative success. Equally, the margins at which success can be identified will be narrowly defined by the convergent characteristics of chosen 'winners' with outliers unable to benefit. One of the findings identified from the literature reveal that Ireland and Finland in particular have successfully leveraged comparative advantages from specialising in certain industries, which had been successful in attracting overseas talent and investment. However, what is better understood since the GFC in 2008 is that this had perverse effects on the resilience of their economies to external shocks, not previously foreseen. Equally, Australia's economic success story is starting to fragment with the economy exhibiting features of a two speed economy, one based on resource mineral extraction and export, the other on declining sales and negative growth of the much larger services sector. There are valuable lessons that New Zealand can take from these findings when evaluating 'picking winners'.

Participants were asked next "To what degree is the success and international collaboration of the Biotechnology sector been based on how the industry has structured itself via voluntary and government regulated frameworks?" This question was chosen to solicit participants' views on whether critical mass was a factor in achieving growth in biotechnology.

Well there two parts to the answer I think. The industry structure, so let me wind back a stage. One benefit that we find as government

working with the Biotech sector in New Zealand – we are talking at both a research end and at a industry and commercialisation end is that all the active players that we are working with are immediately talking and thinking about global value chains, global partnerships because they recognise Biotechnology has such a high degree of innovation content at the core.  
(Participant A)

As already identified earlier a key behaviour that characterises biotech stakeholders is their focus on global environments. This includes connecting with global value chains and partnerships. With biotech using innovation at its core stakeholders understand the importance of looking beyond the immediate horizon, reaching out across borders into areas that hold valuable complementary strengths that are in the interests of biotech leaders, organisations and more broadly the sector. This behaviour is a common feature of science intensive, research-led sectors, which includes biotech. Although this intrinsic behaviour is not related directly to the structure of the sector this view is expressed in biotech frameworks that promote international relationships, joint ventures and connecting with global biotech environments and stakeholders.

The second part of my answer would really relate to your question in terms of industry structure. There was a very deliberate move, I guess four years ago, when the Biotechnology taskforce put forward its body of thinking about the future of the New Zealand Biotech sector to form one consolidated, national Biotechnology organisation, NZBio.  
(Participant A)

The decisive move by industry, business and government to bring together various elements of the sector under one umbrella organisation, NZBio, created effective industry representation firstly to government and secondly to international biotech environments. The creation of NZBio is widely regarded by the sector as being influential in advocating the interests of biotech organisations, whilst enabling international entities to access and work with a single body. This has provided significant representation and networking opportunities that continue to build today.

NZBio represents de facto the national face of the biotech sector in New Zealand. And, it's always of benefit when going out into the international market place to be able to profile a strong national body that has got a high percentage of membership. I think if you look

across at all the number of Biotech players in New Zealand in the industry or research groups, NZBio, their membership accounts probably between 80% and 90%; they certainly represent the sector. (Participant A)

The global environment is best served by single industry representative organisations where membership is comprehensive. New Zealand and Australia are two economies where single organisations represent the sector globally. This has specific advantages as identified from the literature review. It simplifies the access point to the local industry for interested parties. Relationships with government are often present and accessible, allowing for a greater degree of certainty as to the possibilities discussed, and the likelihood of plans coming to fruition. The most valuable contribution single body industry representation provides is that the sector is perceived by others as united, working as one, and seen to be pursuing the same strategic goals based on a shared vision.

But it means that there are many advantages that NZBio can offer back into the sector in terms of key learning's or key international high net worth speakers that come into New Zealand where they quickly run symposium or forum and if we look at the growing success NZBio has engineered around the conferences that they have been running certainly over the last three years and they run these conferences in Auckland, I think the last conference must have been back in March 2007, they had around 600+ delegates, maybe 1,000 delegates come through the conference itself, and quite a large contingent came from overseas to just interact and learn more. (Participant A).

The process existing between NZBio and all stakeholders is not limited to representation and being united. It also provides an in-depth communication channel between both groups of players. This is significant as knowledge, relationships, technology and intellectual property can be disseminated, examined, and considered more efficiently via a two-way feedback process. NZBio organises with the sector an internationally recognised annual conference where a significant proportion of delegates and presenters are international operators. The respondent elaborates on his experience gained from participating at a recent NZBio conference.

As a matter of fact I had an interesting experience...we were hosting a group of Biotechnology companies and research groups from the state of Iowa we had been doing some stuff with Iowa on and off over

the last couple of years they have bought about 10 individuals down from the state to participate in the conference and some further network meetings for the remainder of the week. We hosted them on a Sunday evening and arrived in New Zealand, we knew most of them beforehand, and we had taken them out to a restaurant in Auckland and quite coincidentally it was the restaurant that a Canadian delegation had chosen, who were also down, and again we know them all, but they were also down for the NZBio Conference and I stood back from the restaurant at one point and two thirds of the restaurant were filled with international delegates who had come specifically through to understand and learn more about the New Zealand Biotech sector and that was because of NZBio and because of the structures that they have put in place and because of the quality of conference and the calibre of speakers and I mean it's a long way to come down to New Zealand and it represents a big time investment and it represents a big cost investment for there are other international delegates from other countries who have come all that way – it's a direct reflection of what NZBio has put in place.  
(Participant A)

The experience shared above offers valuable lessons for other New Zealand industry sectors. Effective industry representation matters when operating in global markets in fields that are driven by research, science and technology. Once established with a high percentage of opt in from organisations operating in the sector as contributing members, the next step is to scan the global market space for leaders in their fields (if not already identified). As cited above, the quality of people and processes and systems are what is required for consistent, sustainable growth to be achieved from a constant level of inputs. Economies of scale matter and critical mass as they play an important role in growing market share however these processes need to be well established early on as part of the scoping exercise and discovery phase for sector re-organisation. Government can play a key role in organising industry by providing specific support that includes strategic planning and co-ordination. This view is expanded on in the respondent extract below.

...I mean a lot of government work has gone in into the area in producing strategies. As a bureaucrat it would be nice to think that these have made a huge difference. On balance you know clearly it's the major impact of the government has been the funding of research on science and technology we fund and awful lot of research in the area and that's had a big flow on the productivity gain so that would be our biggest contribution.  
(Participant B)

The impacts on productivity can be significant with increased levels stemming from active government involvement in industry development. A predominant feature of global biotech environments is the central supporting role national and state governments play in resourcing sector planning. This contribution from government directly increases the levels of productivity occurring due to biotech organisations being less involved with the 'big picture' challenges, although their voices are heard and represented via NZBio to government and beyond. The benefit of this process is that the organisations are able to focus more on specialisation gained from research and development, and less time attempting to establish global connections and partnerships. However, when they do seek to pursue these objectives, central government and associated agencies provide some of the necessary tools to make this happen. Furthermore, when industry can rely on a sentinel industry agency, such as NZBio to assist in knowledge dissemination and acquisition, the benefits that come from collaboration and coordination among members using NZBio as a conduit is enhanced. The extracts below further develop how the role of a representative industry agency can increase industry coordination and identifies what benefits it can bring to industry success.

So that was late 2003. There was an AGM in about September of that year; sort of a wrap up of those two organizations and not quite the birth of NZBio but it was a start. They recruited a CEO and that was Brian Ward and it kicked off really in early 2004, I think...so I would say GIF and the Biotech strategy were really sentential to us.  
(Participant E)

Again, this view highlights the influential role that the Knowledge Wave Conference that produced GIF has been in uniting the sector, eliminating overlap, this increasing the effectiveness of sector co-ordination and networks. Although, the biotechnology sector is served well by the industry body, there remain notable gaps in the membership, especially large New Zealand multi-national enterprises (MNEs).

Certainly I think that we are possibly reaching the upper limits of where we could be but there are some notable gaps in our membership and they would be some of the larger companies like, Fisher and Paykel Healthcare who attend a lot of our medical technology events, come to our conference so would love to be involved but haven't actually joined. And Fonterra would be another

example of a large organization that is active in the sector and certainly attends our events but haven't become financial members.  
(Participant E)

The membership of NZBio has 'notable' gaps as the respondent identifies above. Even though the membership is near 90% of all organisations involved in biotech and bio related activity, several of the largest bio active entities have chosen not to be full members. This is a threat for the sector in the future. The risks of MNE's not opting in as fully participating members reduces sector opportunities that would come from full participation with NZBio and their members. It can be argued that the reasons for large globally operating New Zealand biotech businesses to remain independent are driven by views that are concerned with commercial sensitivity and protection of intellectual property, or possibly risks associated with losing human capital. It is fair to argue that these organisations have fully-funded a high percentage of their own research and development costs, as well as, ventures into new markets without the degree of support now offered by government in collaboration with NZBio that is made available to members. Therefore, it is not unreasonable to assume that these businesses see the changes in the development of the sector as positive and helpful, though not necessarily to their business model at this stage. It is in the best interests for the continued productivity growth and growth in the sector as a whole for these challenges to be overcome and better understood. If significantly sized organisations remain on the periphery some opportunities are unlikely to be maximised.

### ***Acting as one: how best to engage global networks***

Identified in the literature review as a key reason why New Zealand's biotech sector is performing strongly is due to the effective role NZBio has played in representing the views and needs of the sector with government and overseas partners. Furthermore, the performance of NZBio since its inception has been warmly received by members and government. Within the literature a common theme was the need for industry sectors that seek to operate globally fundamentally require effective and ensuring representation. This is because it is more likely to attract the attention of key global players along with international investors being used to 'whole of sector' lobbying and

representation from major industry sectors. With government representation also being present this provides investors with confidence that the structure, function and public sector support for the industry is real and tangible. One of the reasons why acting as one is crucial to industry growth is due to the benefits that come from seeking to identify, maintain and preserve networks globally. Discussed below is how significant the expansion of global networks has been in the success of New Zealand's biotech sector.

Absolutely that's just it the nature of the industry is such that it must network. It's not going to work unless it has international links because we are really too small to make a difference in Biotech on our own.

(Participant D)

Once again, the view expressed here argues the nature of biotech industry plays a formative role in the relative success achieved thus far. The argument that the nature of the industry is partly responsible for the success achieved is a constant theme to emerge from the literature and respondent interviews. Of equal importance is the reality that the New Zealand biotech sector and market are too small for them to constructively leverage growth on a significant scale without relying on established global networks.

I think that international collaboration is recognized as an important part of the successes of the industry and there are some structures in place to foster that and the Australia/NZ bio partnering fund would be an important one to mention. New Zealanders, due to our geographical isolation and our pragmatic nature we are willing to travel and also look for ways in which we can work with other people. So, the Biotech industry is a reasonably well networked one, internationally.

(Participant E)

With international networking being a common feature among biotech sectors it is interesting that this respondent also argues that New Zealanders, culturally speaking, are willing to travel far and willing to work with a range of people. There was no specific evidence of this identified in the literature, however it raises an interesting cultural characteristic that needs to be explored more fully in related future research.

I've just returned from an annual conference in San Diego this year, which is held in the States every year in different cities and that's a place where you'll get nearly 20,000 or nearly 22,000 people all listening to presentations, doing business partnering, networking with each other in a formal way. Certainly the amount of business that is done by having that face-to-face aspect is significant and there would be some key examples in the way that works, likely, at IRL, one of the Crown Research Institutes based at Gracefield which is Lower Hutt. Some of the drug development work they've been involved with has been a direct result of having their case scientists meet in an informal way with international counterparts...  
(Participant E)

With New Zealand being a small market for industry it lacks critical mass in certain ways. One of these ways relates to issues in regards to a lack of density, of limited market opportunities and distance from significant markets. These issues are illustrated above in the respondent's extract which highlights the need for New Zealand based science, research and technology professionals to travel and attend major industry conferences. The face to face business discussed and conducted at these events can be lucrative, thus are an important element in creating and maintaining global industry networks.

Overseas experiences can also promote New Zealand's biotech sector to people working in the sector and related sectors, which can result in professionals deciding to visit and/or stay and work. This is of specific importance to science intensive, research dependent industry as although New Zealand has significant talent in these fields, new people bring new ideas and these combined with their prior experiences offer valuable contributions to the ways in which organisations and the sector more generally operate.

Malaghan would be another good example they've got a lot of international imports working on their team.  
(Participant E)

The contribution and role of human capital in New Zealand's biotech sector is discussed in-depth in the section nurturing human capital: producing, attracting and securing global talent.

## ***Counting the Costs: access to and availability of funding, capital market development and risk-taking***

A common theme to emerge from the literature is how New Zealand's productivity performance has partly been determined by the limited investment of capital into the productive functions of business. Labour investment has been the preferred mode of choice for business, based on the ease of which labour is sourced from the highly effective labour market model in place. This is why New Zealand experiences a high labour to capital ratio in business investment. In this section discussion focuses on findings identifying the reasons why capital investment is a concern to stakeholders in the economy.

...but in saying that you know where capital is freely mobile, NZ has no problems of attracting financing for investment in NZ that's you know in fact why we've got such a larger current account deficit right...

(Participant C)

New Zealand economy has, not unlike many of its developed economy peers, become overly reliant on foreign direct investment, and more problematically, overseas lines of credit to fuel property, lifestyle and income requirements (Gaynor, 2007; Key, 2010). No greater evidence need be cited to support this respondent's view that capital has been freely and widely available to spur specific investments (often debt accumulation) in targeted areas (Hickey, 2010). However, this view does not account for the dichotomy of access to capital in New Zealand. Whilst capital has been (and continues at lower levels since the GFC) freely available from external sources this is mainly targeted at domestic consumers (most especially for property) rather than towards business investment where it is most valuable to influencing levels of productivity (McCann, 2009). The cost of relying on external capital to the extent that it often replaces a lack of domestic capital available has seen capital deepening in New Zealand change in 2006 from 'improving' to 'static' in 2008 and in some areas to 'worsening' by 2010 according to (SNZ, 2010a). This helps explain why capital, although freely available, has not resulted in higher productivity occurring at the firm level to improve industry performance, and thus has failed to support sustainable increases in national productivity and therefore stronger economic

growth. Furthermore, external capital supply according to Procter (2008) and The Treasury (2010a) cannot supplant the multiplying effect from an increasing domestic capital supply. Participants were asked “One of the most cited - constant challenges facing the Biotechnology sector is access to and the availability of investment funds. Venture capital investment in Biotechnology is growing exponentially (over the past 6 years) and for example several maturing and emerging pension funds from Australia and New Zealand invest heavily in the Biotech sector. What do you believe are the attractive factors for investors when investing capital into New Zealand’s Biotech sector? What could be done to make the industry more attractive to investors?”

Well, there are a number of factors. One is the calibre of science and innovation that is taking place in the Biotech sector within New Zealand there really is invest able science and invest able product and service line development opportunities.  
(Participant A)

Calibre of science and innovation activity is also cited in the literature as a determinant of the relative success of New Zealand’s biotech sector, and more broadly science, research and technology sectors nationally. Quality activity is another factor why New Zealand’s biotechnology sector has enjoyed global success. Other significant factors are discussed below.

A number of the comparative advantages that we spoke about earlier does provide additional edge to bolster those investments decisions and we, as you’ve correctly stated, we are seeing an increase in the overall metric of investments starting to come into the sector, but there are still quite a long way to go.  
(Participant A)

Over time the sum of capital investment being invested into biotech has risen considerably. As previously mentioned the majority of funding remains sourced from the New Zealand government, however increasingly capital investment is being attracted to the sector from overseas venture capital and pension funds and among private investors seeking high-risk investment opportunities. This is a key aspect of New Zealand’s biotech sector’s success story. The rapid rise in foreign direct investment is enabling the industry to continue developing at pace, whilst providing the resource necessary to maintain the standards of quality that are the sector’s hallmark feature.

Where it gets interesting for New Zealand, we are going to cover some of the ground that I was discussing in terms of the international scene for New Zealand is a lot of the investment that comes in is designed to enable companies to grow to that next stage that often involves setting up a base of operations close to the markets that they are looking to serve. From our perspective this is a healthy dynamic because we are not going to be able to grow the scale of Biotechnology enterprise in New Zealand that can provide return to the New Zealand economy with companies solely basing all of their operation, all their R & D, all their market servicing components locked in New Zealand, that is not the way global Biotechnology markets work.

(Participant A)

Along with the need to continue attracting external and local capital into the market to grow biotech enterprises, there is also a need for the sector to embrace supportive environments globally.

...by demonstrating flexibility and understanding and many companies are of the need to operate almost as mini multi-nationals. This is the kind of dynamic and response that the investor community is looking for, so that in itself provides an attraction. Of course we have also seen the recent change in the New Zealand R & D Tax credit system and that provides quite a nice piece of additional leverage which is also a sweetener in the pot for the investment community. So it is all starting to move in the right direction...

(Participant A)

International industry investors are understood to search for particular characteristics when assessing whether a sector is viable for investment. Of specific importance is the view expressed above highlighting that certain market behaviours are known to aid the attraction of investors. Players in New Zealand's biotech sector exhibit an array of characteristics involving levels of innovation, adaptability, evidence based developments, thus investors are drawn to the sector partly on this basis. Changes that are made by government to the taxation system, normally via modifications to rates and/or capital inducements or incentives are widely reported to play a supporting role in leveraging further value from international investor consortiums.

...what New Zealand lacks at present, though I am confident it will come through are those first one or two big wins, success stories – which really show good investment returns.

(Participant A)

Within the literature a consistent theme to emerge was how New Zealand's biotech sector was now waiting, and in the view of some, relying upon a 'big win' story some notable success stories in terms of collaborations and commercialisation of products, services, processes and knowledge. This is of specific importance to the growth of the sector as this would clearly signify to the investor community, and other biotech environments – and industry more broadly that New Zealand's biotech sector has now successfully navigated through the discovery, development phases and is now entering the commercialisation (driven by market demand) phase. New Zealand's biotech sector has already had a series of 'big win' success stories during the last few years, thus it can be argued the organisational cultures and that of the sector as a whole were conducive in securing investment, which in turn enabled development of the sector at this crucial stage.

Because at the moment a number of the funds that are operating are operating closer to being an equity fund rather than a true venture capital fund. Because they are picking the lowest hanging fruit where, I am not going to say they are going to get a guaranteed return, but they are not going to get the scale of return that a true venture capitalist can enjoy from proper risk venture capital.  
(Participant A)

The distinction between equity and venture capital funds according to this respondent is that the motivation behind equity funds investment choices is different from those of venture funds. New Zealand's biotech sector is characterised by holding a long view of sector development that is high risk in nature, therefore attracting a particular type of investor who appreciate the risks and time periods involved is of crucial importance to the sustainability of sector capital resourcing outside the role that is being played by government. Attracting and maintaining the interests of venture fund capitalists is paramount to securing the continuing success of New Zealand's biotech sector. This is especially important when considering the sector has entered into a new stage of development (commercialisation). Partnerships and collaborations will assist in identifying and accessing venture fund capital and this process needs to continue and grow over time.

We are still not seeing enough, what I would call risk venture, coming into the sector. But we are seeing good capital come in so that is not to knock it at all.  
(Participant A)

One of the most constant challenges cited has been the availability for extra funds in particular venture capital investment and there is increasing evidence that this investment is growing exponentially. According to the literature and the views of respondents there are several new emerging funds from Australia, New Zealand and the United States becoming involved and this includes the Australia New Zealand Biotech Investment Fund (ANZBF). Respondents were then asked for their views on what they believe are the attractive factors for these sorts of high risk investment funds coming into this sector. Specifically, relevant respondents were asked “what’s pulling them in?”

I’d say the same as with any fund the promise of high reward for many of these. So the investment funds are seen for a relatively small investment you can buy a share of a company that can have tremendous returns, particularly the stuff that’s happening in the health area where a lot of the investment is happening people are seeing a high level of potential return now that hasn’t translated into practice yet from a New Zealand company but the potential is still there and again it’s this that a lot of the investments a lot of the opportunities offshore has picked up...  
(Participant B)

As mentioned earlier New Zealand’s biotech sector has competitive strengths in the fields of human health and nutrition and it is these fields that are attracting significant overseas investment from venture capitalists in particular. The reasons why this is so are shared from this respondent above. Capital investment has significant impact on levels of productivity, thus is a key factor that explains why New Zealand’s biotech sector has high levels of productivity at its core. Since this data was collected from respondent there is now evidence that proves that funding attracted to the sector has translated into practice for several New Zealand biotech organisations. Thus, the thinking that has driven the growth in the sector is playing a valuable role in determining future progress, built on effective knowledge of the way the global market functions and operates.

...New Zealand has had a weak capital market until relatively recently so there are a lot of opportunities around looking good opportunities around looking for capital and so that's why there's been this rise.  
(Participant B)

Flowing on from this discussion is to identify how significant the government's attempts to strengthen New Zealand's investment market and domestic investment market i.e. availability of domestic capital; the Kiwisaver national savings scheme is encouraging high levels of domestic business reinvestment in terms of capital into business as opposed to utilising the labour quotient which they've done historically overtime.

I guess that's where there's divergence of opinions around...my personal opinion is that it's not obvious to me at least that will make much of a difference at all. ...if you look at the investment rates in NZ ...we might be capital shallow but investment growth in NZ over at least the past 7 or 8 years have actually been pretty robust...  
(Participant C)

Interestingly, government intervention seeking development of capital markets is not yet proven to affect substantive change in the either the way the market operates, or influence the size of the market according to this respondent. It is well established in literature that New Zealand's capital markets are highly reliant on capital and credit from overseas, thus it is rational to assume that if the domestic capital markets were improved this could reorientate the balance between repatriation of profits flowing overseas and those remaining in the local market for reinvestment. Discussion on the challenges or misnomer of such a view continues to be discussed below.

...we don't seem to have any problem attracting foreign capital or those investments as again is reflected in that large current account balance which hasn't precipitated any sort of corrections in the currency...so it doesn't look like international investments are nervous at the scale of borrowing that we take on to fund domestic investment so if that doesn't appear to be an issue...then why should it be the case that you know setting up these sorts of domestic savings vehicles makes a difference the only to my mind of thinking the only way you could imagine that make a difference is that these savings vehicles get channelled into investment activities that wouldn't take place otherwise...  
(Participant C)

It can be argued that these savings vehicles are channelled into investment activities that would not take place otherwise is precisely why such interventions have a role to play in maximising the size and quality of the domestic capital market. Indeed, if all supplementary investment occurring from such schemes operated only in marginal areas, and in time, proved to be ineffective in growing the multiplying activity and growth of the market and of businesses involved then it is logical to be sceptical about their respective efficacy or lack thereof. However, the New Zealand Superannuation Fund and those of multiple Kiwisaver Schemes have been active investors, albeit in limited ways to date, in New Zealand entities, specifically those that were already well established in attracting investor capital based on previous market performance success. The damage caused to domestic investor confidence from the collapse of several high profile private financial institutions in New Zealand prior to and during the GFC in 2008 is evidence of the perilous effects that poor management and unethical practice can have on capital market performance. In addition, the contagion effect was so persuasive on the market that it is logical to conclude that government scrutiny and intervention does have a role to play in supporting growth of the sector. If the historical bias shown by business to investment of labour over capital in New Zealand is incorporated into the analysis it is not beyond logic to suggest that there is a very real need to encourage a shift in market behaviour.

...this is where the treasury release a piece of work on this, Allan Bollard made a speech about it a while ago sort of identifying things like when you get into things like venture capital markets or secular investment perhaps there's a home bias there that local savers will be more willing to fund that investment than overseas potentially because the monitoring cost and the principle agency problems are reduced if you can understand that sort of junk, so that ok and that might be the case I'm just saying that the jury's out.  
(Participant C)

An important finding to emerge from this passage is that there has yet to be a definitive consensus established among key stakeholders on the reasons why specific market outcomes defy policy intentions or standardised behaviour. It appears that elements of theoretical limitation, market underperformance, and elevated costs associated with close inspection could play more influential roles than has been commonly perceived. The literature identifies that the capital

investment attracted into the sector is shifting from equity to venture capital funds. Venture capital is more comprehensively funding research and development activity, including the commercialisation process.

...there is an issue about the capital markets and the availability of capital. I think there is an issue that needs to be addressed here. I was speaking to some Australian officials and they said that the depth of their capital markets has been substantially increased by the superfund here, precisely and that has reached into our own market. I think that this has some lessons for New Zealand.  
(Participant D)

The lesson for New Zealand expressed in this respondent's view is that domestic capital supply is increased when domestic fund vehicles are operating in the local environment. Private and public schemes based on individual contributions provide accumulation of capital that affords the market increased investor activity. These require the active participation of government and industry to collaborate on work-place savings schemes in particular, and as the evidence identified in the literature emphasises New Zealand's track record of contribution based savings schemes has been poor when compared to those operating in the Australian market.

So even though I wasn't involved or wasn't directly involved, I think that the Kiwisaver announcement was good, not from the perspective that private individuals aren't necessarily being rational in how much they save, but from the perspective that New Zealand has an issue with savings and therefore investment and therefore capital markets. And that applies in angel investment and venture capital and also in the stock markets - all of the equity side of the financial market. From the debt side we seem to be reasonably good.  
(Participant D).

Capital markets in New Zealand suffer from lower levels of equity than is present in Australia therefore attention should be directed to improving equity in capital markets. Increasing the level of inputs in the capital markets through greater accumulation of domestic capital can arguably lift this aspect of the way capital markets function in New Zealand. This can improve the levels of capital resourcing occurring in industry sectors, which in turn offers the organisations within sectors new opportunities to improve the productive functions of the business. This is desirable for New Zealand industry including biotech because

levels of industry productivity can be injected with increased capital which has been identified as a weakness. But, what signs are there of this process happening in the New Zealand market?

Yes. New Zealand has got good debt markets with respect to bankable investments, investments that have collateral housing is the obvious one. New Zealand's capital markets are thin with respect to investments that are not bankable in that sense, and obviously this applies to things where the Capital is intellectual rather than physical. So that moves to strengthen them are a good thing in my opinion.  
(Participant D)

More recently government policy has shifted from increasing the metric size of capital markets in New Zealand to a position of simplifying the regulation of market standards, as well as, simplifying market behaviours. Based on the view of the respondent, it is clear that the previous policy position was deemed helpful to market performance. It is yet to be seen whether this change in approach will be conducive to improving capital market development in New Zealand or whether it will have consequential impacts. Research literature, particularly research undertaken by the Department of Labour and that of some international productivity authors reveals that organisational leadership at the firm level could partially help explain why New Zealand business investment decisions are less often placing significant value on the reinvestment of profits. This might possibly be driven by a lack of exposure to the benefits of reinvesting capital. Respondents were asked for their view on why our productivity performance may be limited by the behaviours at the firm level that involve capital.

...careful because I don't think that our performance does say otherwise that was the point in my I guess that...article so that once you take into account the measurement issues the growth in productivity has been solid it's been pretty good...  
(Participant C)

This respondent published an article on New Zealand's relative productivity performance and argues rather passionately that the performance does not necessarily identify firm level capital decisions as having significant bearing on productivity activity. In addition, once measurement issues are accounted for New Zealand's relative productivity performance is solid, that is, similar to that

of many comparable OECD economies, including Australia, Finland and Ireland. Figure 17 Capital Asset by Type illustrates that the investment of capital, specifically that of ICT into business has been relatively high, even compared to the economies above. There is clear evidence based on New Zealand's comparative labour productivity performance that better utilisation of available resources has led to the practice of firm's investing in labour assets over capital assets, as further evidenced in New Zealand's high labour to capital ratio. What other reasons are there?

I mean it has tailed off in the last four to five years but the data there is very, very lumpy, you tend to see big surges in labour productivity growth following periods of strong capital accumulation which is what is happening now, and actually there is some recent revisions to GDP which revised national productivity levels but that just recently came out of the portals...

(Participant C)

As identified in Figures 2 - 6 New Zealand's productivity performance is characterised by shifts in both labour and capital productivity. Once the less well defined influence of MFP is incorporated it is not unreasonable to argue, as this respondent is, that the key reasons that will help explain why these changes are occurring are yet to be determined. Moreover, the data collected suggests a range of possibilities for New Zealand's relative productivity performance.

...the sort of picture that may perhaps show productivity slowing down or has slowed down in the past 5 or 6 years is not set in stone, when we get data in the next 1 or 2 years that might close out a bit.

(Participant C)

And, yet it seems probable based on the discussion above that the data is more likely to support the view that levels of productivity have slowed, rather than have improved. It seems incongruent to argue that the data does not reveal anything concrete, yet suggest that there might anecdotally be downward revisions occurring.

But again going back to what we were saying earlier the labour productivity levels are unambiguously low in terms of other countries and so this is the \$64 million question you know what has impeded those labour productivity levels...

(Participant C)

Identifying the factors which have impeded growth in levels of labour productivity remains the most pertinent question facing productivity research and analysis in New Zealand. Precisely for this reason this study seeks to contribute to this conversation, and provide a framework to negate the issues associated with labour productivity based on the productivity success of New Zealand's biotech sector. Respondents were then asked for views on whether they think the availability of capital for biotech industry investment is going to increase due to private and public pension plans maturing.

I'd like to say that I hope that investment, private investment in the sector would grow. One of the ideas that I've heard and this is our chairman, Jim McLean who is also the Chair of HortResearch and the deputy chair of the Foundation for Research Science and Technology, he supports the idea of perhaps listed entities for investing in the Biotech sector so through the NZ or Australian stock exchanges but to simplify the investment process for everyday investors.

(Participant E)

Diversifying capital market access opening up investment to individual investors from within the sector is one idea that has gained traction. Several New Zealand based biotech organisations are now listed on the New Zealand share market (NZX), and many are also listed on the Australian share market. This has been made possible by biotech businesses entering into commercial production and export of specialised goods, services and knowledge often in partnership with global biotech or technology entities.

So I think that's probably a model that's worked elsewhere or something that they do in Australia. I'm not sure what it's called apart from the obvious superannuation fund investments so I think that's being talked about whether it happens in the next 2 years or 5 years, who can say.

(Participant E)

As yet, there is no formal system established in New Zealand's biotech sector for professionals involved in the sector to participate in capital investment, outside of purchasing shares in publicly listed companies. It is rational to argue that such an idea could be motivated by the restriction to capital experienced by the sector. The idea is an interesting proposal and needs to remain in strategic

and long term planning decision making so that this option can be more fully explored in the future. An additional common theme to emerge from the literature is the challenges New Zealand's biotech sector has in nurturing human capital whilst competing on the global market and this is discussed in-depth next.

### ***Nurturing human capital: producing, attracting and securing global talent***

New Zealand has recently experienced a series of short, sharp external shocks that have influenced the labour market in significant ways. The economy has gone from experiencing historically low unemployment – bringing with it a skills shortage 'crisis', before sharply retracting once the effects of the GIF in 2008 became more widespread. However, one consistent feature that remained through this ebb and flow period has been the demand in science intensive, research led sectors for well trained professionals with specialised experiences in particular fields of work. Nurturing existing human capital remains an ever-present challenge for New Zealand's biotech sector. Moreover, attracting and securing global talent to work based in New Zealand is cited as a significant challenge and potential growth-limiting barrier for biotech.

I'm sure people would have told you already that we're crying out for qualified people, how NZ competes with salaries.  
(Participant E).

The findings identified in the literature emphasised how New Zealand was a small player in the global labour market, thus could not necessarily compete on cost basis alone. Another common theme to emerge from the literature was that lower cost structures were not the answer for an open, globally focused trading economy like New Zealand and although this was targeted at discussions around outsourcing of manufacturing and other labour intensive industry it is also highly relevant for discussion about human capital.

...the most important things for the success of the industry, access to talent come up pretty highly...it backs up everything people would have told you that its incredible hard to get people to stay here.

Maybe quality of life is one of the key offerings...if they want to have families this is in fact where they will come.  
(Participant E)

The retention of highly qualified staff is a challenge for most industry in New Zealand especially because the residency and immigration policies are not punitive in the sense that freedom of movement is a basic right afforded to all New Zealand residents by the Bill of Rights (MoRST, 2010a). Leaders across many industry sectors have been arguing for some time that the effects that human capital shallowing is having on industry productivity, and on retention costs is damaging and is a risk for the future. However, New Zealand produces a relatively high per capita ratio of excellently trained, experienced specialists across industry and also attracts a significant number of overseas talent to New Zealand, often on the basis of the quality of work combined with a favourable reputation as a place to work and live.

...we shouldn't overlook the access to world class health care as part of that package and that's something that people who have come here from other countries have noted and been surprised at the way our system works...that will be an important part of our quality of life offering.  
(Participant E)

The motivations for professionals to seek new opportunities around the globe are various. However, there are some basic factors that often play a role. These include quality work environments and quality of opportunity. Another factor that acts as a drawcard is the chance to work alongside experts in specific fields. Level of remuneration and associated benefits are also cited as a major factor in attracting human capital to new locations. The view being expressed above highlights the less obvious role that quality public service delivery and infrastructure plays in securing and retaining talent in New Zealand.

...increasing talent is worrisome -- at present we're able to recruit from first world nations despite the anecdotes that we are simply swapping our best and brightest into the first world and recruiting from the third world. I think that's the sum of the anecdotes, you know, are we in essence recruiting lower quality people.  
(Participant F)

Anecdotal evidence as highlighted above suggests that when the sector attracts talent from overseas the sum of this gain is negated with the consistent emigration of highly skilled New Zealanders to offshore markets. This challenge is not unique to the biotech sector. Many industries in New Zealand are faced with the same dilemma and the costs that come with it. Mixed in with rational views on the challenges of securing local talent as well as attracting global talent for industry are aspects of cultural bias and nationalist based fears. Although these characteristics are present in any economy, New Zealand can ill afford to waste rationed resources on disproving or nullifying such discourses when faced with already sizeable issues.

...internal research we've found that close to sixty per cent of our PhD recruits over the last two years have come from overseas...they're realising that they're going to be receiving less salary here, but what's disturbing for them is the change in social status between their home lands and here. Back home if you're a physicist you may be well regarded as an intellectual; your view will be sought on various things by your friends and neighbours, you know, your community, if you like.  
(Participant F)

The relative absence of recognition and respect wider New Zealand society affords scientists and researchers more generally may be changing, albeit in incremental ways. However, this creates issues with talent attracted from overseas. This view is expanded upon below.

People have less appreciation of your... intrinsic talent and value as well, talents for your contributions to their wealth and wellbeing here. Science New Zealand is intended to help redress some of that...  
(Participant F)

Removing the current incentives (e.g. PRBF) that have led to a reduction in the number of postdoctoral positions to a critically low number across many sectors according to some authors in the literature is important (Nicol, 2008). Government funding of science-intensive researchers also requires attention. This discussion leads back to the discussion earlier focused on whether 'picking winners' was a smart strategy or not. It is logical to assume that researchers who have successfully proven themselves over time to reach the highest of academic status, requires decisive action on behalf of contestable funding

bodies. Where studies succeed, reward the experts involved by funding the next research project. Where studies are not successful, withdraw financial support. One of the responsibilities that Science New Zealand is charged with is to re-orientate this limited perception within New Zealand society and this is discussed in-depth in the section 'affective communication – promoting success to the New Zealand public' on p. 164. The role that Professor Peter Gluckman is playing since 2009 as the Prime Minister's Chief Science Advisor was a response by the New Zealand Government to improve the public's understanding of science and the role that it will play in securing New Zealand's future.

Now in New Zealand there may well be an emerging internal market for talent, especially as universities receive government funded pay increases each year when CRIs do not. Now they get about twenty million dollars plus each year as a contribution to their salary rises. Universities get that direct from the government. CRIs, even though we're owned – immediately owned by the government do not get any such – we do not get any bulk funding whatsoever. We don't get any funding for specific activities such as salaries or even for facilities...  
(Participant F)

The distance from government financing support cited in not directly supporting the securing of talent into New Zealand's network of CRIs is a concern. Being that talent is one of the most often cited challenges facing New Zealand's biotech sector in pursuit of growth and innovation it could be argued that government does have a responsibility and a role to play. However, being the CRIs conduct a high percentage of research, testing and analysis for the private sector, it is probable that the government prefers that the funding obtained via these transactions between a CRI and business is used to fund staff retention and to attract talent. It also serves in the interests of the independent financial survival of the CRIs by not relying upon government funding for talent. This would be plausible if it were not for the fact that government currently funds a proportion of university based staffing costs, who exhibit many of the same output characteristics that CRIs do.

One thing which I think is true is that researchers are as much attracted as much by other competent researchers as by salary and New Zealand does have an extensive skill base in the sciences

underlying the pastoral food industries so the thinking is to pull on those strings to make it even more attractive and hopefully to make it an international centre of innovation.  
(Participant D)

Levels of comparative competence in skilled labour are cited as another influential factor in attracting and securing talent into the sector. New Zealand's country-specific advantages also, based on this view extend to the quality level of competence of skilled professionals working in the fields of biotechnology. This provides a further opportunity for New Zealand to leverage comparative advantages especially in regards to competing with economies such as Australia, Ireland and Finland whose relative educational attainment is equally impressive.

New Zealand has a large diaspora in proportion to its population, and that diaspora I think tends to be relatively skilled.  
(Participant D)

Another opportunity, which is increasingly being recognised by government and industry, is the potential for valuable networks to be created by connecting to the New Zealand Diaspora internationally. The creation of KEA and other uniquely New Zealand networks spanning the globe have shown the willingness of expatriate New Zealanders to contribute, often remotely, to the growth of New Zealand society as a whole (Boven, Bidois & Harland, 2010). This also identifies a recommendation to emerge from this study. It is imperative that such globalised cultural networks, based on quality and ideas – rather than ideals and patronage – are developed further to spur new innovation and development between relevant professionals no matter where they reside. Potentially this can provide New Zealand industry with a human capital matrix with responsibilities for promoting New Zealand science, research and innovation, and also support the expanding roles of government and industry bodies in achieving strategic goals.

***Research, science and technology: government policy, legislation and institutional performance***

Tansey (2005a) and Dalziel and Peetz (2008) suggest that policy needs to, indeed must, be representative of the realities of its existence. Where policy is contextualised within its localised environment, it is more likely to be successful in improving outcomes. Where it is not, it is less likely to be durable, and can potentially cause negative unintended consequences. An example as previously discussed is the introduction of the Employment Contracts Act (ECA) in New Zealand in 1991 which had an immediate effect of not only increasing the mobility of labour within the market (stated aim), but also suppressing wage growth causing wage deflation. Indeed, between 1992 and 1996 wage costs in New Zealand declined by 22% (Hazledine & Quiggin, 2006). Notwithstanding these changes to the labour market - productivity statistics in the measured sector over this period were marginally weaker than periods preceding it or for periods that followed (SNZ, 2007c). Labour productivity did not improve during this period, nor was there any lag in effect resulting from the change in policy to provide impetus to the notion that improvements would follow (see Figure 5). One less tangible impact of this policy, in close proximity to the economic reforms of the late 1980's, was that sections of the New Zealand public lost trust in government (McLellan, 2004; Hazledine & Quiggin, 2006).

New Zealanders that were most affected realised that "government" was no longer going to balance their financial security needs against the competing macro-economic needs to restructure and reorganise aspects of the economy in the pursuit of greater economic growth (McLennan, Ryan & Spoonley, 2000). Significantly, the architects of change did not argue that the need for reform was due to the exogenous factors of global recession, nor was it a response to overheating in the domestic labour market (Perry, 2007). To the contrary they argued that New Zealand needed urgent structural changes in the way the economy functioned so that future growth could be achieved (Perry, 2006). By design, the policy stripped away collective wage agreements - those commonly espoused and supported by union representation, and were replaced with individually negotiated contracts (Perry, 2006). Emphasis was placed on the move away from collective to individual bargaining, the onus shifting away from unions and given directly to the worker when negotiating with the employer.

Due to these changes in the labour market combined with the severe economic reforms made in the years prior to 1990 the New Zealand economy now can be characterised as exhibiting one of the most economically liberal, least unionised, mobile labour markets in the developed world (Fallow & Dann, 2006). Kerr (2003) and Brash (2001) argue that economic growth for New Zealand needs to be about boldness, vision and risk-taking. This raises the question of what New Zealanders envisage for New Zealand: can there be consensus on how we get there?

So now, you get other science organisations which might include universities or the Royal Society of New Zealand or even MORST who are able to talk about the value of science and technology and part of that is there's a cultural value in just seeking knowledge.  
(Participant F)

New Zealand societal culture is often referred to as being profoundly pragmatic and this view is fiercely defended by many New Zealanders (McLennan, Ryan & Spoonley, 2000). Also of significance to this discussion is the perception that the mass New Zealand culture is inclined to disapprove of a person who stands out from others, that is, achieves a degree of recognition than others who share similar characteristics do (often referred to as "tall poppy syndrome"). In addition, it can be argued based on anecdotal evidence that New Zealand culture also features aspects of an anti-intellectual streak (McLennan, Ryan & Spoonley, 2000). What this may mean is that areas of research, science and technology activity do not garner the attention, and possibly the respect of the public. This is an area that requires further research as these notions could inhibit growth of national economic activity via MFP performance.

It doesn't have to have a utilitarian value or even be value specific to New Zealand. Their value at universities as in the Universities Act is about advancing knowledge. Who is able to absorb that knowledge is incidental; it's not a primary matter that's dealt with in the Act.  
(Participant F)

The structure of the science and innovation sectors in New Zealand is of specific importance to the discussion of productivity performance. As highlighted in the extract above, this respondent is describing the different requirements placed on universities compared with CRIs within the broader

science and innovation sector. The result of this analysis suggests that the legislation relating to CRIs articulates a public dissemination function that is not required of universities from its related Act of parliament.

Whereas with the CRIs, the purpose is to do research of benefit to New Zealand, that's what the Crown Research Institutes Act says, and the Act also says... must transfer and disseminate that. So that's part of our purpose of Science New Zealand is building that constituency of support so that we can see investment of people's money and time and careers and study...  
(Participant F)

The challenges that Science New Zealand face in successfully performing its legislative role may be less substantial than commonly believed based on nuanced changes the government have made. Creating a public profile for the Prime Minister's Chief Science Advisor, and actively drawing more attention to the increased successes of New Zealand based scientists has raised the profile and perceived value that science and innovation are playing in securing New Zealand's future.

I think it's interesting, knowledge acquisition is one of the core tenants of raising productivity or ensuring that the – its two key parts of productivity are there in order for it to grow.  
(Participant F)

Interestingly, this respondent focuses on knowledge acquisition and the key role it plays in productivity. The literature identified that not only does the acquisition of knowledge improve levels of productivity it also increases the contribution of productivity determinants to rates of productivity. The next theme to emerge from the literature related specifically to the biotech sector is the difficulties sectors, firms and leaders have when promoting success to the New Zealand public.

### ***Affective communication: promoting success to the New Zealand public***

A factor identified in the literature as one of the challenges for future growth in the biotech sector and the growing role it can play in the economy is the

uniquely New Zealand challenge of communicating success to the public. Although this view does not in itself present any obvious barriers, several authors cite the challenges posed in the fields of research, science and technology in disseminating success to a wider local audience. As mentioned earlier Professor Peter Gluckman's role as Chief Science Advisor to the Prime Minister is part of the government's approach to affecting change in the perceptions of science in the eyes of New Zealand society. This challenge will take time as there are no clear answers in building recognition of the role that science can play in improving New Zealand's growth prospects.

New Zealand's biotech sector is particularly aware of the challenges of this issue. Several presenters at consecutive NZBio Annual Conferences have focused on how to develop affective communication strategies; it would seem, in an attempt to evolve levels of willingness of the public to better appreciate what biotech offers the economy and more directly offers to people (Boyes, 2008; Cronin, 2008). Communicating the value of research for New Zealand is part of the focus of the science and research sectors and this is actively encouraged, most especially at industry conferences. Yet, there appears to be no significant shift in the role that science, research, technology and innovation plays in the lives of the general public, outside of the improved public profile of Sir Peter Gluckman. That is, the majority of improvements benefiting the consuming public come via the import of new consumer goods and services, and rarely from within New Zealand. That is, the public would likely be interested in more substantive benefits that New Zealand's biotech sector can provide, however this relies on the industry to make these issues of relevance to their lives. Though, New Zealand's biotech sector is operating in a globalised context it can be argued that this is one reason why affectively communicating New Zealand success to the public remains a significant challenge.

### ***Over the horizon, long-term strategic planning taking account of serendipitous factors***

As has been established when identifying the factors that have influenced the global success of New Zealand's biotech sector, based on high levels of productivity, there are a number of specific factors that have enabled the sector

to develop and achieve strong growth. An important aspect of this discussion according to a majority of the literature is the need for there to be long-term strategic planning frameworks which where possible are made malleable enough to be responsive to serendipitous factors.

I would say yes...if I try and give a neutral answer here – I came into New Zealand about five years ago from the United Kingdom with relatively minimal background in the Biotech field to date, but a strong background in the area of technology transfer...I was fortunate enough to be given the opportunity to work with the early formed Biotechnology Taskforce, and in fact I was asked to...the report from that taskforce which gave me clearly a good understanding of all the movers and shakers and the thinking taking place...set out a body of thinking around the need for strategic alignments and vision between the Government and industry. And it set out in fact a ten year vision at the time and it benchmarked some of it's thinking about some similar strategies that other nations had put in place where Biotechnology was seen as a key growth sector for the future.  
(Participant A)

A significant factor that provided New Zealand's biotech industry with an appropriate sector strategy was the partial involvement in the formulating process of the experiences gained from other biotech environments globally, as well as, unrelated industry strategy development performance experiences.

Lots of countries...investing heavily, but it provided an opportunity to get close alignment between as I say different sections of industry, across those three broad spheres I was talking about earlier in terms of industrial, human health and Ag-bio/science...  
(Participant A)

Indeed, one of the defining elements of the development of New Zealand's biotech strategy was the collaboration between the government and industry. A scoping exercise where the relevant stakeholders were identified and whose views and experiences were sought as part of the objective allowed the taskforce report to reflect what was occurring in the sector, thus the needs and issues identified were a valid reflection of the sector in practice.

It allowed conversation and research alignment from a number of key CRIs it brought many different Government departments to the table at the same point, including implementation agencies such as NZTE and to bring some collective thinking together.....and to recognise the role of Biotech can play both as an enabling technology as well

as a vertical contribution to the New Zealand economy in its own right – I think was essential in terms of setting that strategic framework and a good 95% of the recommendations made have all been actioned either by Government, by industry directly and many through joint actions.

(Participant A)

As part of the sector's strategic planning another aspect which highlights the quality of thinking has been the near total adoption of taskforce recommendations, actioned firstly by the Fifth Labour Government and continued by the Fifth National Government. This brings into focus the successful lobbying of government that the biotech sector has gained and provides a model on which other industries may choose to follow. The respondent's view expressed below summarises the convergence of factors that have ensured New Zealand's biotech sector continues to successfully value over the horizon long-term strategic planning taking account of serendipitous factors in industry planning.

So I think it really has been quite instrumental in accelerating the growth and the position of the New Zealand Biotech sector, and there is unquestionably growth that has occurred over the last 4 years. But, one has to be mindful of the natural time scales that operate in a heavily science driven innovation field such as Biotech. It does take time and it does take capital and it does take some bright thinking, so we have not completed the strategy as yet, and indeed there is growing conversation at the moment between industry and Government led by NZBio that the timing to reconstitute the taskforce in some way, shape or form ...

(Participant A)

## ***Factors influencing productivity and contributing to growth in New Zealand's biotechnology sector***

This section summarises key factors identified in the literature review and gained from interviews that have influenced productivity and contributed to growth of New Zealand's biotech sector. Key findings on the determinants of productivity are summarised first.

The determinants of productivity being labour, capital and multifactor are all important to New Zealand's productivity performance with no one factor playing a more influential role in isolation from any other because all three factors are so intertwined. That is, if the focus of policy makers was to be exclusively fixed on one determinant it is likely that this would have unintended consequences on the role being played by the other two, resulting in changes that may not reflect the needs of industry nor reflect the intent of policy designed to support industry growth. This is of specific importance when considering how to improve New Zealand's relative productivity performance due to the historic focus placed upon the role of labour productivity.

Data reveals that the New Zealand economy has experienced an almost identical pattern of capital services growth between 2000 and 2008 compared with Australia. It can be argued based on this evidence that New Zealand does not suffer from a lack of capital growth in investment into businesses to the degree that is commonly cited in the relevant literature. New Zealand's relative growth in total capital services attributed to ICT investment has been superior to that achieved by Australia, Finland and Ireland. However, as Figure 16 showed New Zealand's level of overall growth in capital services has been similar to the other economies. It is rational then to argue that the role ICT has had in contributing to growth in capital service investment has been higher for New Zealand than for Australia, Finland and Ireland. However, this overreliance on ICT equipment in capital services growth invested into the productive functions of business is an area of relative weakness. It is well established in literature that New Zealand's capital markets are highly reliant on capital and credit from overseas, thus it is rational to assume that if the domestic capital markets were

improved this could reorientate the balance between repatriation of profits flowing overseas and those remaining in the local market for reinvestment.

New Zealand's relative levels of labour and multifactor productivity growth are generally lower than those achieved by Australia (labour only), Finland, and Ireland (Matheson & Oxley, 2007). Key reasons arguably are due to how New Zealand's labour market operates influencing a higher labour to capital ratio in business, as well as, entrenched industry behaviour in seeking to invest human capital before capital assets (outside of ICT) which has meant that New Zealand's labour productivity has been influenced by the number of people working more than by the quality of work being undertaken. That is, any rise in labour productivity has had to grow faster than any growth in labour market size for the labour productivity growth to be achieved. This is further influenced by the very high labour force participation rate in New Zealand which is higher than for Australia, Finland and Ireland.

Measurement of productivity remains a challenge when economies seek to evaluate relative performance. The issues associated with measuring productivity are mainly focused on two specific areas. First, the methodological approach and subsequent analysis of labour, capital and multifactor productivity activity is now less often significantly different between economies, however the differences that remain can be so nuanced that identifying the role such differences play in explaining performance is hard to qualify. Second, the scale and depth of industry measurement is a critical component of an economy being able to establish national productivity performance. In turn, industry are equally reliant on effective productivity measurement when strategic planning and evaluation occurs.

Biotechnology has always been an international industry. A key behaviour that characterises biotech stakeholders is their focus on global environments. The view expressed here argues the nature of biotech industry plays a formative role in the relative success achieved thus far. The argument that the nature of the industry is partly responsible for the success achieved is a constant theme to emerge from the literature and respondent interviews.

So there are some fundamental advantages that New Zealand has. These advantages are quality of environment, quality of education, quality of skilled professionals, depth of historical data sets and experience, political stability and quality of regulatory frameworks.

New Zealand's country-specific advantages also, based on this view extend to the quality level of competence of skilled professionals working in the fields of biotechnology. This provides a further opportunity for New Zealand to leverage comparative advantages especially in regards to competing with economies such as Australia, Ireland and Finland whose relative educational attainment is equally impressive.

As mentioned earlier New Zealand's biotech sector has competitive strengths in the fields of human health and nutrition and it is these fields that are attracting significant overseas investment from venture capitalists in particular. Capital investment has significant impact on levels of productivity, thus is a key factor that explains why New Zealand's biotech sector has high levels of productivity at its core.

The quality of human capital and processes and systems is what are required for consistent, sustainable industry growth to be achieved from a constant level of inputs based on the findings of this study. Of critical importance is the long term view the key personnel in the sector hold as evidenced by the actions of New Zealand biotech's early pioneers. This was based on the realization that by applying science to what was considered waste products New Zealand could profit out of it and agricultural specific government policy has reflected this. One of the key factors identified to support industry growth has been the funding provided for research, science and technology sectors combined with New Zealand's history of research in the field.

The significance and value of the sector, based on uniquely New Zealand advantages attracted the close attention of both industry (agriculture, science and research) and that of government. This developed out of the Knowledge Wave Conference in 2001 that involved professionals across disciplines. Following this in 2002 was the creation of the Growth and Innovation

Framework (GIF). The end result was the development and publication of the 'New Zealand Biotechnology Strategy' published in 2003 which set out a body of thinking around the need for strategic alignments and vision between the Government and industry.

A core feature of New Zealand's biotechnology sector has been the in-depth involvement of all stakeholders in evaluating the strengths, weaknesses, threats and opportunities of the sector prior to creating a strategic vision that accounts for these elements whilst achieving the goals identified that are of benefit to organisations operating in the sector. Of critical importance to the health of the sector has been the consistent approach and range of efforts invested in the sector by consecutive Governments.

Time is of critical importance to changing the trajectory of New Zealand's biotech sector. Time is cited in the literature as having considerable influence over the eventual and continued success and efficacy of the sector's strategic development and direction. This study highlights how there is a need for strategies/programmes to be consistently monitored, reviewed and evaluated in order to ensure relative appropriateness in changing environments so that intended aims are enduring.

That is, based on the continued global success of New Zealand's biotech sector, and the valuable contribution the sector plays in New Zealand's relative productivity performance – there needs to be greater emphasis and resources invested into the strategic view of industry to persuade and assist re-orientating short and long term goals into globally focused frameworks.

A significant factor that provided New Zealand's biotech industry with an appropriate sector strategy was the partial involvement in the formulating process of the experiences gained from other biotech environments globally, as well as, unrelated industry strategy development performance experiences.

As part of the sector's strategic planning another aspect which highlights the quality of thinking has been the near total adoption of the Biotechnology Taskforces recommendations, actioned by the Fifth Labour and the Fifth

National Governments. This brings into focus the successful lobbying of government that the biotech sector has gained and provides one method which other industries may choose to follow.

Not only is biotech naturally an internationally focused sector, it is also a sector that works closely with its key stakeholders including Government, State Owned Enterprises (SOEs), Science New Zealand research entities with regional and local organisations all contributing to the strategic planning of the sector. Therefore, the sector is interconnected and actively communicates with key stakeholders at different levels and from this has come a series of successful industry organisation and co-ordination developments that continues to serve it well.

This study identified that Ireland and Finland in particular have successfully leveraged comparative advantages from specialising in certain industries, which had been successful in attracting overseas talent and investment. However, what is better understood since the GFC in 2008 is that this had perverse effects on the resilience of their economies to external shocks, not previously foreseen. Equally, Australia's economic success story is starting to fragment with the economy exhibiting features of a two speed economy, one based on resource mineral extraction and export, the other on declining sales and negative growth of the much larger services sector.

Based on the evidence examined in the study New Zealand has traditionally adopted new knowledge poorly the biotech sector can play a facilitating role in improving the methods of how industry interconnect across borders and into new markets.

Being that the biotech sector is firmly connected, at multiple levels with several government agencies, including the executive arm of government, it has been able to factor in government spending on relevant infrastructure (however seemingly removed) into its strategic thinking and development. The outcome is that biotech is more aware of changing priorities and therefore is more successful in responding or adapting to changes made by government. It can

be argued that this would be of significant benefit to some New Zealand industries if they were to adopt this approach as part of industry behaviour.

The impacts on productivity can be significant with increased levels stemming from active government involvement in industry development. A predominant feature of global biotech environments is the central supporting role national and state governments play in resourcing sector planning. This contribution from government directly increases the levels of productivity occurring due to biotech organisations being less involved with the ‘big picture’ challenges, although their voices are heard and represented via NZBio to government and beyond. The benefit of this process is that the organisations are able to focus more on specialisation gained from research and development, and less time attempting to establish global connections and partnerships. However, when they do seek to pursue these objectives, central government and associated agencies provide some of the necessary tools to make this happen.

Governments employ a wide range of tools to co-ordinate people and organisations in ways that are not possible otherwise by creating or establishing commissions, taskforces, working groups and in the most severe of cases, royal commissions. These groupings of senior leaders in appropriate fields works well in parliamentary democracies such as New Zealand providing depth of enquiry, breadth of relevant sources and most critical of all, time. However, government and industry, and therefore citizens may benefit in more sustained ways based on increasing quality if government could effectively organise its disparate parts more often, rather than relying on special bodies established for a single purpose. It could also be argued that this is not an effective use of New Zealand’s limited resources. However, it does make sense to have the ‘best’ analysing particular issues and if these issues are sufficiently infrequent then it makes no sense to keep the elites on the books.

There may be an opportunity cost of solely ‘picking winners’ or identifying areas of strongest potential as higher risk investments may suffer from a lack of government attention and resources prior to evidence becoming available to substantiate any proposal’s viability or potential for relative success. Equally,

the margins at which success can be identified will be narrowly defined by the convergent characteristics of chosen 'winners' with outliers unable to benefit.

Although there are no current proposals from government to extend tax credits to the biotech sector, it needs to remain part of the tools that government can use to improve the environment of science intensive, research driven sectors in New Zealand's economy.

An important finding to emerge is that there has yet to be a definitive consensus established among key stakeholders on the reasons why specific market outcomes defy policy intentions or standardised behaviour. It appears that elements of theoretical limitation, market underperformance, and elevated costs associated could play more influential roles than has been commonly perceived.

Proximity, that is, geographical distance from markets remains a disputed factor in determining relative productivity performance.

Following the recent experiences of countries like Ireland and Finland who were severely exposed to the ebbs and flows of the global financial system (whose risk were at higher levels than that of Australia and New Zealand) size of government arguments are now known to play a role in determining growth, but not necessarily the ways that had been previously perceived. This study identifies that it is the quality of spending that counts, not necessarily who spends it. Furthermore, New Zealand's national social contract is able to be more consistently reflected in quality spending by Government (charged with the responsibility to represent the people, for the people) than by business (who traditionally are responsible to business stakeholders) alone, building an arc between the aspirations and needs of all citizens irrespective of degree of involvement.

Another common theme to emerge from this study was that lower cost structures were not the answer for an open, globally focused trading economy like New Zealand and although this was targeted at discussions around outsourcing of manufacturing and other labour intensive industry it is also highly relevant for discussion about human capital.

The costs of relying on external capital to the extent that it often replaces the lack of domestic capital available have seen levels of capital deepening in New Zealand deteriorate. This helps explain why capital, although freely available, has not resulted in higher productivity occurring at the firm level to improve industry performance, and thus has failed to support sustainable increases in national productivity and therefore stronger economic growth. Furthermore, external capital supply cannot supplant the multiplying effect from an increasing domestic capital supply, based on the knowledge that profits generated from a local business are more likely to be reinvested in the local economy, than overseas sourced capital that is often repatriated overseas (specifically those investors who operate with a short-term view). Over time the sum of capital invested into the biotech industry has risen considerably. The majority of funding remains sourced from the New Zealand government and New Zealand biotech organisations themselves, however increasingly capital investment is being attracted to the sector from overseas venture capital and pension funds and among private investors who seek high-risk investment opportunities over the long-term. This is a key aspect of New Zealand's biotech sector's success story.

The rapid rise in foreign direct investment is enabling New Zealand's biotech sector to continue developing at pace, whilst providing the resource necessary to maintain the standards of quality that are the sector's hallmark feature.

Certain market behaviours are known to aid the attraction of investors. Players in New Zealand's biotech sector exhibit an array of characteristics involving levels of innovation, adaptability, evidence based developments, thus investors are drawn to the sector partly on this basis. Changes that are made by government to the taxation system, normally via modifications to rates and/or capital inducements or incentives are widely reported to play a supporting role in leveraging further value from international investor consortiums.

This is of specific importance to the growth of the sector as this would clearly signify to the investor community, and other biotech environments – and industry more broadly that New Zealand's biotech sector has now successfully navigated through the discovery, development phases and is now entering the

commercialisation (driven by market demand) phase. New Zealand's biotech sector has already had a series of 'big win' success stories during the last few years, thus it can be argued the organisational cultures and that of the sector as a whole were conducive in securing investment, which in turn enabled development of the sector at this crucial stage.

The distinction between equity and venture capital funds is that the motivation behind equity funds investment choices is different from those of venture funds. New Zealand's biotech sector is characterised by holding a long view of sector development that is high risk in nature, therefore attracting a particular type of investor who appreciate the risks and time periods involved is of crucial importance to the sustainability of sector capital resourcing outside the role that is being played by government.

Private and public schemes based on individual contributions provide accumulation of capital that affords the market increased investor activity. These require the active participation of government and industry to collaborate on work-place savings schemes in particular, and as the evidence identified in the literature emphasises New Zealand's track record of contribution based savings schemes has been poor when compared to those operating in the Australian market.

Diversifying capital market access opening up investment to individual investors from within the sector is one idea that has gained traction. As yet, there is no formal system established in New Zealand's biotech sector for professionals involved in the sector to participate in capital investment, outside of purchasing shares in publicly listed companies. It is rational to argue that such an idea could be motivated by the restriction to capital experienced by the sector. The idea is an interesting proposal and needs to remain in strategic and long term planning decision making so that this option can be more fully explored in the future.

What is clear is how separated industry grouping and representation was prior to the adoption of the recommendations contained within the strategy. This remains a feature of some industry in New Zealand in the ways that they

structurally organise responsibility and roles. Based on the success of specific New Zealand industry operating globally it can be argued that the centralisation and co-ordination of industry is a crucial factor in determining industry sustainability and overseas market success.

With a majority of the recommendations having been adopted by all interested parties, where appropriate – rather than mainly by one group, this is reflective of the degree and depth of co-ordination and organisation present in the biotech sector across stakeholders. Interestingly the fact that the vast majority of recommendations were adopted suggests that many of these recommendations were of sufficient quality to enable high levels of productivity and sector growth to be achieved since implementation.

The decisive move by industry, business and government to bring together various elements of the sector under one umbrella organisation, NZBio, created effective industry representation firstly to government and secondly to international biotech environments. The most valuable contribution single body industry representation provides is that the sector is perceived by others as united, working as one, and seen to be pursuing the same strategic goals based on a shared vision. It also provides an in-depth communication channel between both groups of players. This is significant as knowledge, relationships, technology and intellectual property can be disseminated, examined, and considered more efficiently via a two-way feedback process.

It can be argued that the reasons for large globally operating New Zealand biotech businesses to remain independent are driven by views that are concerned with commercial sensitivity and protection of intellectual property, or possibly risks associated with losing human capital. It is fair to argue that these organisations have fully-funded a high percentage of their own research and development costs, as well as, ventures into new markets without the degree of support now offered by government in collaboration with NZBio that is made available to members. Therefore, it is not unreasonable to assume that these businesses see the changes in the development of the sector as positive and helpful, though not necessarily to their business model at this stage. It is in the best interests for the continued productivity growth and growth in the sector as a

whole for these challenges to be overcome and better understood. If significantly sized organisations remain on the periphery some opportunities are unlikely to be maximised.

This is because it is more likely to attract the attention of key global players along with international investors being used to 'whole of sector' lobbying and representation from major industry sectors. With government representation also being present this provides investors with confidence that the structure, function and public sector support for the industry is real and tangible.

Calibre of science and innovation activity is also cited in the literature as a determinant of the relative success of New Zealand's biotech sector, and more broadly science, research and technology sectors internationally. Quality activity is another factor why New Zealand's biotechnology sector has enjoyed global success.

One of the responsibilities that Science New Zealand is charged with is to re-orientate the limited perception within New Zealand society on the role of affective communication promoting success of the biotech sector to the New Zealand public. The establishment of the role Chief Science Advisor to the Prime Minister's (currently held by Sir Peter Gluckman) was a response by the New Zealand Government to improve the public's understanding of science and the role science will play in securing New Zealand's future.

The challenges that Science New Zealand face in successfully performing its legislative role may be less substantial than commonly believed based on nuanced changes the government have made. Creating a public profile for the Prime Minister's Chief Science Advisor, and actively drawing more attention to the increased successes of New Zealand based scientists has raised the profile and perceived value that science and innovation are playing in securing New Zealand's future.

New Zealand's biotech sector is particularly aware of the challenges of this issue. Several presenters at consecutive NZBio Annual Conferences have focused on how to develop affective communication strategies it would seem, in

an attempt to increase the willingness of the public to better appreciate what biotech offers the economy and to people (Boyes, 2008; Cronin, 2008). Communicating the value of research for New Zealand is often the focus of the science and research sectors and this is actively encouraged, most especially at conferences. Yet, there appears to be no significant shift in the role that science, research, technology and innovation plays in the lives of the general public. The majority of improvements benefiting the public come via the import of new consumer goods and services, and rarely from within New Zealand. Therefore, it is plausible to argue that the public would be greatly interested in the more substantive benefits that New Zealand's biotech sector can provide them, however this relies on the industry to make these issues of significant relevance to their lives. Though, New Zealand's biotech sector is operating in a globalised context it can be argued that this is one reason why affectively communicating New Zealand success to the public remains a significant challenge.

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Being that talent is one of the most often cited challenges facing New Zealand's biotech sector in pursuit of growth and innovation it could be argued that government does have a responsibility and a role to play. However, being the CRIs conduct a high percentage of research, testing and analysis for the private sector, it is probable that the government prefers that the funding obtained via these transactions between a CRI and business is used to fund staff retention and to attract talent. It also serves in the interests of the independent financial survival of the CRIs by not relying upon government funding for talent. This would be plausible if it were not for the fact that government currently funds a proportion of university based staffing costs, who exhibit many of the same output characteristics that CRIs do.

Key factors in securing talent include quality work environments and quality of opportunity which may involve working alongside experts in specific fields. Level

of remuneration and associated benefits are also cited as a major factor in attracting human capital to new locations.

## **Chapter Five: Conclusions and Recommendations**

### ***Conclusions***

New Zealand's relative productivity performance during the period 1990 – 2010 ranged from low to high when compared with the productivity performance of Australia, Finland and Ireland. Specifically, New Zealand's level of labour productivity has been lower than that achieved in the comparative economies cited in this study. New Zealand's level of capital productivity is equal to that of Australia, and superior to that experienced in Finland and Ireland. New Zealand's level of multifactor productivity has been equal to that of Australia for some of the period, but significantly lower than that achieved in Finland and Ireland. This evidence identifies that the challenge for New Zealand in increasing relative levels of productivity performance require a set of varied responses across each of the three determinants of productivity. The contribution to an economy's relative productivity performance from the measurement of productivity cannot be underestimated. That is, the process of measurement and the underlying assumptions driving the methods of measurement in an economy have considerable influence over relative productivity outcomes. This is of relevance to New Zealand's productivity performance being that its economy is a member of the OECD league of wealthy nations against which its economic performance is often measured against.

New Zealand's more substantive labour utilisation model and superior rates of labour force participation, combined with favoured capital investment in certain assets are the reasons why New Zealand's relative productivity performance has a record of achieving both high and low levels of productivity when compared to Australia, Finland and Ireland. In addition, the allocation of capital in New Zealand is not consistent with maximising productivity, or the generation of income. It is these factors that are responsible for New Zealand's low growth in per capita incomes during the period this study was focused on.

Areas where specific consensus exists based on the findings identified in the literature and interviews include: productivity performance is a determinant of

the rate of economic growth; productivity performance provides the opportunity for in-depth analysis on the quality of use of the factors underpinning economic growth; comparative productivity performance is a significant indicator (among others of less significance) in assessing whether sustained economic development is being achieved in an economy; analysis of productivity components assists in determining whether the utilisation of resources in the pursuit of growth is efficient, effective and maximised; and, how accurate and comprehensive measurement with an evaluation of inputs/outputs and outcomes play a critical role in the monitoring and evaluation of economic activity.

New Zealand's biotechnology sector is characterised by significant growth and by high levels of productivity. That is, the biotech sector is science intensive, research focused and technologically driven providing the ideal mix of conditions that ensures increasing levels of productivity occur over time. Moreover, New Zealand's biotech sector has benefited from a strong relationship with consecutive New Zealand Governments that have been broadly consistent in their respective approaches to supporting the sector in its long-term strategic development.

Leveraging country-specific advantages have contributed to the global success of New Zealand's biotech sector made possible by the over the horizon thinking of the early pioneers in ag-bio fields specifically. Attracting capital investment into the sector has been made possible by the quality of talent, activity, procedures and regulatory frameworks undertaken. Furthermore, the challenge of securing human capital talent is assisted by the globalised nature of the biotech sector, with international networks providing linkages that allow for New Zealand's biotech successful ventures to be shared with interested partners and promoted in new markets.

It is clear that New Zealand industry, based on the performance of the biotech sector, can achieve improved levels of productivity by employing a range of factors identified in this study. As what matters most for New Zealand improving its productivity performance is the quality of action.

## ***Recommendations for further research***

This study explored New Zealand's relative productivity performance compared with Australia, Finland and Ireland and examined the key factors that have contributed to New Zealand's biotech sector's growth during the period 1990 – 2010. During the identification of the factors certain areas requiring further research were revealed and warrant further investigation.

With international networking being a common feature among biotech sectors as highlighted by study respondents New Zealanders, culturally speaking, are willing to travel far and willing to work with a range of people. There was no specific evidence of this identified in the literature, however it raises an interesting cultural characteristic that needs to be explored more fully.

Another opportunity, which is increasingly being recognised by government and industry, is the potential for valuable networks to be created by connecting to the New Zealand diaspora internationally. The creation of KEA and other uniquely New Zealand networks spanning the globe have shown the willingness of expatriate New Zealanders to contribute, often remotely, to the growth (not limited to economic) of New Zealand society. This also identifies a recommendation to emerge from this study. It is imperative that such globalised cultural networks, based on quality and ideas – rather than ideals and patronage – are developed further to spur new innovation and development between relevant professionals no matter where they reside. Potentially this could provide New Zealand industry with a human capital matrix with responsibilities for promoting New Zealand science, research and innovation globally, and also support the expanding roles of government and industry bodies in achieving strategic international goals. It may also connect New Zealand industry with industry based in other locations where New Zealanders reside. If these expansions were realised it is rational to argue that this would support the changing of behaviour at the firm level in New Zealand to become more focused and dedicated to global markets.

In Australia labour costs did not decrease to the extent that occurred in New Zealand, therefore capital was still able to be accumulated without it costing

more than the relative costs of labour. This partly explains why Australia did not manage to achieve as low a rate of unemployment from 1990 – 2007 as New Zealand. Interestingly, since late 2007 Australia's unemployment rate has declined to historically low levels decreasing to levels below that of New Zealand, whilst New Zealand's has returned to near average levels, increasing to levels above Australia. Therefore, further research could examine the process of structural reform in the Australian policy context to better inform the impacts of reforms in the New Zealand policy context.

New Zealand societal culture is often referred to as being profoundly pragmatic and this view is fiercely defended by many New Zealanders. Also of significance to this discussion is the perception that the mass New Zealand culture is inclined to disapprove of a person who stands out from others, that is, achieves a higher degree of recognition than others who share similar characteristics do (often referred to as "tall poppy syndrome"). In addition, it can be argued based on anecdotal evidence that New Zealand culture also features aspects of an anti-intellectual streak. What this may mean is that areas of research, science and technology activity do not garner the attention, and possibly the respect of the public. This is an area that requires further research as these notions could inhibit growth of national economic activity via multifactor productivity performance. However, it is also important to not overestimate anecdotal findings, and to proceed with sensitivity on such matters.

Based on the empirical evidence that the level of capital investment growth in New Zealand businesses is comparatively strong the reasons for New Zealand's higher labour to capital ratio is further exposed and raises the possibility that as yet undetermined factors are still to be identified. This issue requires further investigation that may assist in clarifying the factors that are limiting the potential of industry growth in New Zealand.

Discussing productivity at the workplace from investors, employers, unions and managers to workers at all levels whilst exploring the role individuals and teams play at influencing levels of productivity within an organisation more effectively could minimise the cultural barriers that may be affecting growth. This can occur in tandem with government agencies and business mentoring programmes to

support any changes to the functions and structure of a business and the way people are currently working, leading or managing.

Promoting the value and contribution to the New Zealand public about the role productivity plays in the economy, how it works, and why it matters to economic growth (by identifying how it relates to their lives and has influence over their lifestyles) is a further area for future research.

Forced diversification of the key pillars of industry activity within the economy (i.e. dairy, wool, meat, seafood, wine and wood exports) can potentially disrupt advances in dominant sectors, thus harm the sustainability of future levels of growth. Further research may clarify where such interventions can work, and where they might undermine sustainability and growth.

The consistently changing inclusions/exclusions and focus of the Biotechnology and Bioscience surveys have improved the efficacy of measurement and the detailed accuracy of the data they provide at any given point in time, but disrupt the comparative analysis process with categories often changing with each subsequent publication. This process of refinement by Statistics New Zealand is to be commended for focusing on creating data-sets that are cognisant of shifts in best practice, but at what cost to reliable comparisons over time? These changes need to be reconciled as soon as possible to allow for consistent and valid analysis between time periods, however with a built in ability to continually monitor and evaluate performance at regular intervals.

Representative groups of business may need further support to better understand the vital economic importance of continual capital investments into the productive and innovative functions of the business and to reflect on the ways in which workflows can be improved by various methods, not only by increasing labour or ICT investment.

The re-investment ratio of businesses in the private sector in New Zealand is comparatively low by OECD standards. This is particularly of concern when we know that New Zealand firms tend to hire more labour than they invest in capital areas of input. A national industry-specific programme should be established

(initially funded by Government in the short-term) to promote decreasing the rate of publically listed company dividends so that more capital is reinvested into the productive and innovative aspects of the firm.

New Zealand's Productivity Commission could potentially conduct some of the recommended research cited in this study as part of its work programme as many of these fields do reflect the purpose and vision of the Commission.

The economies of Ireland and Finland have been negatively impacted upon by the GFC. This has resulted in severe cuts to public spending, increases in the rates of taxation and in the case of Ireland an increasing exodus of young, skilled migrants. However, the export sectors in both economies have maintained their ability to meet the demands of global markets for their products. In fact, Ireland's export volumes have increased at the same time that the Government's financial position has become untenable due to the exposure from underwriting toxic bank and institutional loans. The lessons that the New Zealand economy can learn may prove to be valuable to its future growth prospects. For example Ireland's focus on producing goods and services that the world increasingly demands has ensured that the Irish economy once again it can be argued will be in a position of relative prestige in years to come. What this means for New Zealand due to the fact that most of its dominant industries are engaged in sectors that are seeing increasing demand (i.e. food, agricultural, biotech) is that as the planet's population continues to rapidly grow the dominant exporting industries can be confident of a market for their products. The challenge lies in New Zealand's ability to leverage further, as yet, unrealised gains, value-added propositions from these goods and services in ways that have yet to be fully identified. This exercise has started, most specifically within the Crown Research Institutes, but there is a need for any blue skies research component of such studies to morph into commercialisation processes so that new products, services, process, technology and knowledge reach new markets.

The implications of Prime Minister John Key stipulating that the retirement age will not rise under his tenure, as well as, along with the Minister of Finance's assertions that this Government, although concerned with New Zealand's high

private (and increasing public) sector debt, will not introduce a capital gains tax to capture the significant proportion of capital gains in New Zealand from residential house sales is of immediate concern to affecting significant changes in New Zealand's economy. The OECD and Standard and Poor's, as well as, Moody's have all argued that implementing these policy changes to positively influence the structural arrangement of the economy are necessary, but acknowledge that these are not being heeded by government. Future research could focus on these issues and establish at what cost?

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# Appendices

- 1. Consent to Participate in Research**
- 2. Participant Information Sheet**
- 3. Preliminary Indicative Interview Questions (version 1a)**
- 4. Updated Indicative Interview Questions (version 1b)**
- 5. Fields of Biotechnology**

# Appendix 1: Consent to Participate in Research

## Consent Form



*Project title: **Productivity: New Zealand’s Economic Imperative – identifying a Model of Best Practice to sustainably increase Industry productivity based on the global success of New Zealand’s Biotechnology Sector***

*Project Supervisor: **Dr Oksana Opara***

*Researcher: **Adam Paterson***

- I have read and understood the information provided about this research project in the Information Sheet dated 4<sup>th</sup> September 2007.
- I am aware that my privacy will be protected in this study in relation to data analysis from my interview and my contribution will remain anonymous.
- I have had an opportunity to ask questions and to have them answered.
- I understand that notes will be taken during the interviews and that they will also be audio-taped and transcribed.
- I understand that I will be provided with a full transcript of my interview on completion and that the researcher will seek my permission to include the data in the study. I am aware that I can amend and/or delete any part of this data prior to sending it back with my permission to be included in the thesis.
- I understand that I may withdraw myself or any information that I have provided for this project at any time, without being disadvantaged in any way.
- If I withdraw, I understand that all relevant information including tapes and transcripts, or parts thereof, will be destroyed.
- I agree to take part in this research.
- I wish to receive a copy of the report from the research (please tick one): Yes  No

Participant’s signature:

.....

Participant’s name:

.....

Participant’s Contact Details (if appropriate):

.....  
.....

.....  
.....

Date:

**Approved by the Auckland University of Technology Ethics Committee on 17<sup>th</sup> October, 2007**

**AUTEC Reference number 07/167**

*Note: The Participant should retain a copy of this form.*

## Appendix 2: Participant Information Sheet



### **Date Information Sheet Produced:**

4<sup>th</sup> September 2007

### **Project Title**

Productivity: New Zealand's Economic Imperative – identifying a Model of Best Practice to sustainably increase industry sector productivity based on that global success of New Zealand's Biotechnology Sector.

### **An Invitation**

My name is Adam Paterson and I am currently pursuing a Master of Arts degree at Auckland University of Technology. I would like to kindly ask you for your assistance in my research project. This will involve an interview with you to discuss your views on New Zealand's Biotechnology Sector with regard to productivity. Please be advised that your participation in this research is completely voluntary and you may withdraw at any time prior to the completion of data collection.

### **What is the purpose of this research?**

The purpose of this study is to identify and critically analyse the factors contributing to the Biotechnology Sector's superior productivity performance. The aim is to construct a best practice model focused on increasing productivity in large scale, value added industry sectors in New Zealand. This Best Practice Model will draw on the opinions and suggestions of elite's in the fields of productivity and Biotechnology. This will be achieved by analysis of data collected via interviews in conjunction with analysis of recent policy developments and best practice in the Biotechnology sector. As the researcher I am concerned with exploring the ideas and values of key actors who have been involved in setting the pace and framework of analysis, research and discussion on productivity and/or Biotechnology in the New Zealand context, which has influenced its substance and the course of its progress. An additional purpose of this research study is that it allows the researcher to be awarded a Masters Degree.

### **Why was I chosen for this invitation?**

You have been selected for this study due to exhibiting some or all of the following professional attributes: your expert or elite profile; previous research and analysis of productivity; analysis and knowledge of the Biotechnology Sector; your position as an economist, academic and commentator on economic issues relating to productivity and/or Biotechnology. Furthermore, you were selected after I was referred to you as a leader of a successful Biotechnology company to provide a firm-level perspective on productivity in the Biotechnology Sector.

### **What will happen in this research?**

Data will be collected by conducting elite interviews. Each interview will take approximately 45 minutes – 1 hour and will be held at a mutually agreeable time and location. The interview will be tape recorded. The researcher will take notes. After each interview is completed the researcher will contact participants to provide transcripts of the interview to confirm the accuracy of content. Once the thesis is completed the researcher will contact each participant and send them a copy of the thesis. Participants will be informed and encouraged at all times to contact the researcher with any questions, concerns or queries throughout the length of this study.

### **What are the discomforts and risks?**

It is hoped that you will not experience any discomforts and risks while participating in this study.

**How will these discomforts and risks be alleviated?**

You will be reminded that you have the right to decline answering a question or to end the interview if you sense any discomfort at any time.

**What are the benefits?**

While there may not be any direct benefit from this research for you it is hoped that the study will be of interest to industry leaders, business owners, policy makers and economic and research institutions in the future. Furthermore, this study is valuable for the researcher, as it will allow him to be awarded with a Masters Degree.

**How will my privacy be protected?**

Prior to participating in one on one interviews, interviewee's will be required to give informed consent and will be reminded that participation is voluntary and participants may withdraw from the study at any time. Participants privacy will be protected, in terms of confidentiality, as each individual who accepts will be made aware via the Consent Form their participation in this study will be completely voluntary and significantly, anonymous. Each individuals involvement in the elite interviews, including data collected during the process can only be disclosed with their permission. Their identity will not be disclosed at any time. The researcher will code each transcript in sequential order "interviewee one, two .." of interviews conducted. This will protect the individuals privacy, public and institutional profile and professional considerations potentially at risk from taking part in the study. Once you agree to participate in the research, I will go through the information sheet again to ensure that you are aware of your right to withdraw at any time prior to the completion of data collection. Respect for the rights of participants will be applied throughout the length of the study, and during analysis of data. Non-discriminatory language will also be employed as a means to respect the rights of participants and audiences.

**What are the costs of participating in this research?**

You are expected to assign 45 minutes to 1 hour of your time for the interview.

**What opportunity do I have to consider this invitation?**

You will have approximately three weeks to consider the invitation to participate in the research.

**How do I agree to participate in this research?**

If you agree to participate please can contact me (my contact details are listed below). When we meet for the interview I will ask you to sign a consent form confirming your consent to participate in this study, and for your interview to be taped. You can withdraw from the study and any information that you have given at any time prior to the completion of data collection.

**Will I receive feedback on the results of this research?**

Yes, upon completion of the Master thesis, a copy will be available in the Auckland University of Technology library for the participant and public viewing. A copy of the thesis can be sent at any time once completed upon request.

**What do I do if I have concerns about this research?**

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, *Oksana Opara*, [oksana.opara@aut.ac.nz](mailto:oksana.opara@aut.ac.nz), 09 921 9999 Extension: 5891. Concerns regarding the conduct of the research should be notified to the Executive Secretary, AUTECH, Madeline Banda, [madeline.banda@aut.ac.nz](mailto:madeline.banda@aut.ac.nz), 921 9999 ext 8044.

**Whom do I contact for further information about this research?**

***Researcher Contact Details:***

Adam Paterson

Daytime Contact Number: (09) 357-9691

Mobile: 021-104-6597

Email: [adapat77@aut.ac.nz](mailto:adapat77@aut.ac.nz)

***Project Supervisor Contact Details:***

Dr Oksana Opara

Senior Lecturer (School of Social Sciences)

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**Approved by the Auckland University of Technology Ethics Committee on 17<sup>th</sup> October 2007, AUTEK Reference number 07/167.**

## **Appendix 3: Preliminary Indicative Interview Questions (version 1a)**

Leading opening question – introduces the topic and identifies their view

1. How do you view the notion that “productivity is increasingly perceived to be a key indicator of economic performance when assessing national or industry growth performance, and is the main source of growth necessary for governments to achieve goals of rising standards of living and/or quality of life for citizens?”

Broad challenges, non-specific, identifies factors for growth

2. Please describe in your opinion what are the most significant challenges to increasing productivity in the New Zealand context today? What key factors do you consider significant to sustainably increasing industry productivity and why?

Biotechnology and international partnerships – explicitly asks how (in what ways) to improve global reach of industry and business

4. New Zealand’s Biotechnology Sector experiences a high degree of active collaboration based on seventy five percent of collaborations involving international organisations. Please describe with this in mind – in what ways can other industry sectors enhance global connectedness and market reach starting with fewer international partnerships and relationships?

Convergent industry-level challenges: Talent and Human Capital supply

5. Please explain what role talent (defined as skilled human capital) plays in ensuring the long-run success of industry growth; how can industries overcome these challenges in the short-term whilst the labour market remains so strong?

Financing, deals, funding and capital

6. Funding remains challenging for biotechnology companies but overall trends are positive with more venture capital funds available, an increase in public offerings and the creation of the

SciTech index on the New Zealand stock exchange. What role should the government and the private sector play in funding industry growth?

## Appendix 4: Updated Indicative Interview Questions (version 1b)

1. Please describe the chronology of sentinel events which have enabled NZBio to become an effective and comprehensive industry representative of Biotech entities and organisations in New Zealand today?
2. How many companies, individuals and students as well as international organisations are members of NZBio?
3. How successful was your recent NZBio conference? What value has it produced thus far for supporting Biotechnology entities and/or the industry as a whole? What were the limitations, and why?
4. What is your understanding, from an industry body perspective, of (a) sectoral productivity, (b) business productivity and (c) national productivity?
5. What facets, if known, of productivity determinants i.e. capital, labour or total-factor productivity (TFP) are most critical to increasing productivity in New Zealand's Biotech sector and why?
6. Several studies over a number of years have identified and analysed how New Zealand has been successful in utilising our comparative advantages, based on country-specific factors such as agricultural land-based production and expertise in Ag/Biotech science and research & development; what factors in your opinion will contribute to our economies ability to leverage further, sustainable advantages from unique New Zealand factors? Why?
7. Please describe what role central Government should play in supporting, encouraging and facilitating industry productivity growth? Should central Government assistance be targeted to industry where growth potential is greatest?
8. What are your views on the budget announcements by the New Zealand Government from May 2007 and May 2008 that increase tax breaks for business conducting R & D activities, increase the availability of funding for business operations that produce land-

based products and services, increase funding for Crown Research Institute's (CRIs) to conduct science and research development, increase industry grants via the expansion of the Marsden Fund and other incentivised tax related measures for supporting the business environment? Why?

9. To what degree is the success and international collaboration of the Biotechnology sector been based on how the industry has structured itself via voluntary and government regulated frameworks?
10. How critical to the Biotechnology sectors productivity and growth performance has strategic decisions, planning and effective use of intellectual property and human talent been? Why?
11. One of the most cited - constant challenges facing the Biotechnology sector is access to and the availability of investment funds. Venture capital investment in Biotechnology is growing exponentially (over the past 6 years) and for example several maturing and emerging pension funds from Australia and New Zealand invest heavily in our Biotech sector. What do you believe are the attractive factors for investors when investing capital into New Zealand's Biotech sector? What could be done to make the industry more attractive to investors?
12. Increasingly, industry sector growth (across a number of industries) is being challenged by a lack of talent including labour and skills shortages and a very robust and competitive labour market, as well as, the cyclical increase in numbers of skilled workers emigrating offshore; how do biotechnology entities and the sector as a whole manage to (a) remain competitive against such external pull forces, (b) retain highly skilled talent (world leading Ag-Bio, Biotech scientists, researchers & biologists) when the world market for such talent is extremely lucrative? Is it a question of lifestyle and quality of living or is it something more specific to the industry itself?
13. Is there room from a policy perspective for the government via immigration and other external management related activities to more actively source and procure the talent needed or does the responsibility for this lie solely with the industry concerned or would you say it is a combination of the two – or is it more of a hybrid approach outside of the options outlined, and if so, please explain?

14. What has been the defining characteristic (s) of how the Biotech sector and specifically successful Biotechnology businesses have undertaken strategic management and organisational leadership, if at all?
  
15. Cited as one of the influential factors that has contributed to increasing productivity in the Biotechnology sector has been the breadth and quality of local, national and international partnerships that industry leaders are engaged in; what core attributes of this phenomena could be constructive in promoting international partnerships in other New Zealand industry sectors, if any, and why?

## Appendix 5: Fields of Biotechnology

### Environment fields:

- Agricultural biotechnology

Biotechnology is being used in all areas of agricultural production to improve pest control, improve yield, limit abiotic stresses such as drought and cold, and to enhance nutritional content of food.

- Marine

The scientific study of organisms in the ocean or other marine or brackish bodies of water.

### Extraction and/or replication of organically occurring processes:

- Biocomputing

Is the artificial replication of organically occurring processes used for biocomputer-based computing.

- Biopharmaceuticals

Is the indirect extraction from a native biological source for therapeutic or diagnostic purposes.

- Biomanufacturing

The process of managing the manufacturing process of bio-derived products over its life-cycle.

- Nutraceuticals

Is a food or food product that provides health and medical benefits, including the prevention and treatment of disease.

- Bioactives

A material is considered bioactive if it has effect on any cell tissue in the human body.

### Pharmacology:

- Pharmacogenomics

Branch of pharmacology that deals with the influence of genetic variation on drug response in patients.

### Medical technologies:

- Gene Therapy

Technique for correcting defective genes which are responsible for disease development.

- Genetic Screening

Involves the direct examination of the DNA molecule – used to test for genetic disorders.

- Regenerative medicine

Process of creating living, functional tissues to repair or replace tissue or organ function due to damage, or congenital defects.

- Medical genetics

Speciality of medicine that involves diagnosis and management of hereditary disorders.

- New eugenics

Seeks both to minimize congenital disorder, and enhance capacity, traditional eugenic goals and relies more on reproductives than on selective breeding charts to achieve its aims.

#### Recognition Technology:

- Biometrics

Consists of methods for uniquely recognizing humans based upon on one or more intrinsic physical or behavioural trait.

#### Study of Molecules:

- Molecular biology

Deals with the molecular basis of biological activity.

- Bioinformatics

Bioinformatics is the field of application of statistics and computer science to the field of molecular biology.

#### Genetic Engineering:

- Genetically modified (GM) foods

Are foods derived from genetically modified organisms (GMO).

- Transgenics

Transgenic organisms, a subset of GMOs, are organisms that have inserted DNA that originated from a different species.

### Study of Proteins:

- Genomics

Discipline in genetics concerning the study of the genomes of organisms.

- Proteomics

Large scale study of proteins, particularly their structures and functions.

- Structural genomics

Seeks to describe the 3-dimensional structure of every protein encoded by a given genome.

### Manipulating Matter:

Study of manipulating matter on the atomic and molecular scale:

Nanotechnology

Sources: MoRST (2003b; 2003a), SNZ (2010).