

Growing more innovative and productive Kiwi firms

Symposium transcript

The New Zealand Productivity Symposium
Tuesday, 1 December 2015
Intercontinental Hotel, Wellington, New Zealand



Welcome message from the Productivity Hub Board

From the Symposium programme

Welcome to the 2015 Productivity Symposium: Growing more innovative and productive Kiwi firms

We like to think that Kiwis are an innovative bunch. Give us some no. 8 fencing wire and see what we come up with. We're proud of the fact that, among other things, we invented instant coffee and were the first to use whistles in sports games.

Yet Kiwi firms are good at some aspects of innovation but not so good at others. This is why the Productivity Hub Board – the New Zealand Productivity Commission, the Ministry of Business, Innovation & Employment, Statistics New Zealand and the Treasury – teamed up with Motu Economic and Public Policy Research to see what the rich firm-level data Statistics New Zealand puts together – from tax records, patenting and trademark filings, and the Business Operations Survey – tell us about innovative activity.

This is also why we are holding this symposium on Growing more innovative and productive Kiwi firms. This symposium will cover:

- How the longitudinal business database (LBD) could help us better understand innovation and business performance;
- The latest international thinking on innovation and productivity; and
- The design of R&D support schemes and government interventions to support innovation in New Zealand and around the world.

We will hear from four international speakers: Professor Eric Bartelsman, Professor Bronwyn Hall, Professor Beth Webster and Sir David Ramsden. We will also hear from nine domestic speakers, including Professor Shaun Hendy, Professor Kaj Storbacka and Professor Adam Jaffe. Time will be set aside for question and answer sessions with the speakers.

The Productivity Hub Board would like to thank these speakers, along with the people working behind the scenes, for giving their time to take part in and help with this conference. The Hub Board would also like to thank the sponsors – whose support means that an event of this calibre can be provided without charge to attendees.

Finally, the Hub Board would like to thank the organisations who have supported the Hub throughout the year. The Productivity Commission has funded the Hub Secretariat as well as regularly hosting Hub events. Statistics New Zealand has helped with accessing and using the LBD. Motu has worked closely with Hub agencies to help build capacity to use micro-data, and the New Zealand Initiative and Professor Norman Gemmill, the Victoria University of Wellington Chair in Public Finance, have also helped with events and research.

Note: This transcript of the 2015 symposium was prepared by the Productivity Commission. It contains material from the original programme, a summary of key points, the full transcript of each session, and the presenters' slides at the end.

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Overview

The Productivity Hub held a symposium on *Growing more innovative and productive Kiwi firms* on 1 December 2015 at the Intercontinental Hotel, Wellington. Around 130 people attended including keynote speakers from Australia, the Netherlands, the United Kingdom and the United States. This summary of the symposium has been prepared by the Productivity Commission. It describes some key take-outs from the symposium, and summarises the keynote addresses by the four international speakers.

Key take-outs

Background

New Zealand has had a relatively poor productivity performance over many years. A crucial question is whether low levels, or the wrong types, of innovation among New Zealand firms could be partly to blame. If so, what explains this and how could the situation be improved?

At the Productivity Hub's 2013 symposium, **Alain de Serres** of the OECD highlighted the importance of investments in knowledge-based capital for productivity. Knowledge-based capital encompasses a wide range of assets, including computerised information, intellectual property and economic competencies (such as management capability). He pointed to indications that New Zealand firms on average under-invest in this type of capital. For example, he estimated New Zealand's low investment in business R&D and other forms of knowledge-based capital could explain up to 40% of our productivity gap vis-à-vis a number of other OECD countries (de Serres, Yashiro & Boulhol, 2014).

...while New Zealanders characterise ourselves as strong in ingenuity and innovation – the no. 8 fencing wire attitude and all that – the economy-wide evidence for this claim is mixed.

This important role of knowledge-based capital in explaining New Zealand's poor productivity performance was reflected in the Forward Looking Agenda for Research (FLARE) published by the Productivity Hub Board (Nolan, 2014). The goal of FLARE was to aid in the coordination and collaboration of productivity research in New Zealand. Consistent with the work of de Serres, Yashiro and Boulhol (2014), FLARE highlighted that while New Zealanders characterise ourselves as strong in ingenuity and innovation – the no. 8 fencing wire attitude and all that – the economy-wide evidence for this claim is mixed.

As part of the research programme outlined in FLARE, the Productivity Hub Board entered into a multi-year research partnership with Motu Economic and Public Policy Research to make use of New Zealand's powerful Longitudinal Business Database (LBD), which brings together a broad range of data at the firm level (Fabling & Sanderson, 2016). Among many other uses, these data provide valuable insights into the innovative activity of New Zealand firms, including the characteristics of innovating firms and the effectiveness of government interventions aimed at lifting innovative performance (eg, Wakeman & Le, 2015; Jaffe & Le, 2015).

The 2015 Productivity Symposium focused on questions around the innovative performance of Kiwi firms, the link between innovation and productivity and the role of government in supporting innovation. These topics clearly matter for the future of productivity in New Zealand and are areas in which government policies and institutions play key roles. The symposium also provided a chance to draw on some of the firm-level work being undertaken using the LBD and to showcase the ways in which economic research can help inform policy choices.

The topic areas covered in the 2015 Productivity Symposium were also of international interest, as evidenced by the Hub's ability to attract top international scholars, not only to speak at the symposium, but to also take part in meetings scheduled around the symposium with officials and business groups in Wellington and Auckland.

This international interest comes as no surprise given the important debates now taking place between "technology optimists" and "pessimists" on the permanence of the global productivity slowdown and the predictions of massive disruptions to existing business models and jobs from ICT-based innovation (OECD, 2015). The significance of these international

debates is why **Sir David Ramsden**, drawing on the UK's Productivity Plan, described lifting productivity as no less than "the challenge of our time."

What will make Kiwis better off in 2030?

... "what we're trying to think about as a country and as a government is to make Kiwis better off. [...] So what can we do that will make Kiwis better off in 2030?"

A good starting point for a discussion on innovation is the potential impact on future standards of living. As **Professor Adam Jaffe** said: "what we're trying to think about as a country and as a government is to make Kiwis better off. [...] So what can we do that will make Kiwis better off in 2030?"

The concern is, as **Gabriel Makhoul** noted, while New Zealand has good policy settings, immense natural capital, a skilled and energetic workforce and a reputation for innovation and agility in business, we suffer from persistently low productivity growth compared with other countries. This translates into a lower ability to grow our living standards.

Further, as **Murray Sherwin** said in his closing remarks, while our productivity challenges have been "pretty well tramped over" at the macro level, this story "struggles to explain why New Zealand is 30% or so behind where others are and where we'd like to be, despite the quality of our institutions. What it tells us is that we

need to be looking for a more finely-granulated examination of our performance and what shapes it, in order to develop the effective policy responses required.”

...“meeting the challenge of improved productivity is a task that we all have to face up to, public or private sector, big or small firms. If we had all the answers I wouldn’t be here speaking to you today. We need to share experiences, build agile and resourceful innovation, promote its diffusion, deepen our international connections and make sure we use all of New Zealand’s diversity of talent and ideas.”

Defining a problem is the easy bit. The bigger challenge is in developing and implementing an effective policy response. We should not forget, as Sir David Ramsden noted, the importance of institutions. And, as Gabriel Makhoul went on to say, “meeting the challenge of improved productivity is a task that we all have to face up to, public or private sector, big or small firms. If we had all the answers I wouldn’t be here speaking to you today. We need to share experiences, build agile and resourceful innovation, promote its diffusion, deepen our international connections and make sure we use all of New Zealand’s diversity of talent and ideas.”

The increasingly important role of intangibles

...intangible assets have become much more important relative to physical assets in explaining productivity growth.

Looking “under the bonnet” for what drives productivity in the modern knowledge economy, a group of assets loosely termed “intangibles” is regarded as increasingly important. In particular, recent research highlights the importance of firms’ investment in knowledge-based capital (KBC) as increasingly important in facilitating innovation and driving productivity gains.

KBC includes intangible assets that can be broadly classified into: computerised information, intellectual property and economic competencies. Specific examples include networks, databases, software, patents and firm know-how such as management capability. Although measuring these types of assets is difficult, in some countries where such measures exist (which does not include New Zealand), KBC has become much more important than physical capital in explaining productivity growth.

Once a firm has successfully invested in KBC, these assets are typically non-rival in production, meaning they can be used by multiple users at a very low marginal cost without reducing their basic usefulness. KBC is also often only partially excludable, meaning that its productive capability can spill over beyond its place of creation.

...patents per capita grow with city size. Larger cities also have denser networks of innovators, and more diverse and more novel portfolios of technological capabilities.

Because KBC is non-rival, it can give rise to increasing returns to scale – an important property that makes ideas and knowledge key engines of growth in 21st century economies. These scale effects sometimes take the form of agglomeration economies that underlie the higher productivity found in large cities.

Professor Shaun Hendy's research on patents indicates that patents per capita grow with city size. Larger cities can also have denser networks of innovators, and more diverse and more novel portfolios of technological capabilities. Given scale effects, open innovation and networks of innovators are becoming increasingly important. Networks bring together the skills and capabilities to support complex innovations, and support the combination of technologies in novel ways.

Firms investing in intangibles face uncertain productivity and profit outcomes.

At the firm level, the outcomes from investing in KBC can differ in important ways to those associated with more traditional assets such as machinery and equipment. Firms investing in intangibles face uncertain productivity and profit outcomes. Productivity and profits can become increasingly variable across firms, with a great likelihood of “winners” making very high returns and dominating markets. So as KBC continues to grow in importance as a factor

of production, there will likely be associated trends in the importance of scale, “winner takes all” markets, and increasing variance across firm-level outcomes (output, employment, profit and productivity).

On average across firms, the returns to investing in KBC such as innovation could be close to zero and statistically insignificant as successes and failures cancel each other out. But returns could still be significantly positive for the industry and economy as a whole if resources move to the successful firms. This shows the importance of the reallocation of resources from stagnant firms to dynamic firms. The extent to which this happens varies a lot across countries, showing the need for a flexible environment that facilitates these resource shifts.

The increasing importance of KBC also means that the share of national income accruing to labour and “traditional capital” decline relative to their historical averages. Investment in traditional capital may also appear sluggish because ICT and intangibles often enable better utilisation of existing physical assets and so be “capital saving”.

R&D and innovation

Innovation policy often focuses on raising firms' expenditure on R&D. R&D is relatively easy to measure, and so appears most frequently in international comparisons. R&D is also an important part of the innovation process for firms in large parts of the economy. For example, R&D expenditure dominates overall expenditure on innovation by New Zealand businesses in both the primary and manufacturing sectors, where R&D spending is around 80% of overall innovation expenditure. Furthermore, R&D is important not only for high-productivity firms that work to push out the global technological frontier but also for laggard firms as they try to move up towards the frontier.

...business expenditure on R&D (BERD) is low as a percentage of GDP and relative to population. New Zealand is ranked 31st in the OECD index of BERD, which places it right at the low end... historically New Zealand has had a relatively low share of its production in R&D-intensive industries, and has engaged in less R&D-intensive activities within those industries.

In New Zealand, business expenditure on R&D (BERD) is low as a percentage of GDP and relative to population. New Zealand is ranked 31st in the OECD index of BERD, which places it right at the low end. There are several explanations for this. The large share of small firms in New Zealand and relatively low R&D intensity in our larger firms partly explains New Zealand's low R&D figures relative to other countries. Moreover, historically New Zealand has had a relatively low share of its production in R&D-intensive industries, and has engaged in less R&D-intensive activities within those industries.

...“New Zealand’s level of business R&D is low. You can explain it away: firm size, sectoral composition of the economy and so on, but that’s quite different from [...] thinking about where we would like to be over time.”

Nevertheless, as **Dr Peter Crabtree** noted, “New Zealand’s level of business R&D is low. You can explain it away: firm size, sectoral composition of the economy and so on, but that’s quite different from [...] thinking about where we would like to be over time.” If we want a structural shift in the economy, he asked, how do we achieve that? “To what extent does it evolve out of what you’ve already done? To what extent does it evolve out of things that you are going to be surprised about and so on, and to what extent are you deliberate about that, or do you essentially just create the enabling conditions for that to happen?”

As part of this drive to increase BERD, the government established Callaghan Innovation in 2013 with a mission to help increase BERD to 1% of GDP. As **Sarah Holden** from Callaghan Innovation said in her presentation, “That actually translates, all other things being equal, into getting businesses to spend an extra \$1 billion on R&D. And this is what I call ‘the billion dollar question’ for us, is how do we get businesses to do that.” As she went on: “Now, what do we do? We work closely with business. [...] We try to phrase this in a language that’s going to resonate with business. So our purpose, as we would explain it, is to help businesses succeed through technology.”

...over a 2-year period, only 2.6% of all firms introduce products new to the world, compared with 19.3% of firms that introduce products new to those firms.

Yet while lifting BERD may be helpful, it is not the whole answer to lifting innovation and productivity in New Zealand. **Dr Simon Wakeman** highlighted that innovation is a broad concept, including product, process, organisational or marketing innovation. It also includes introducing products, processes, etc. that are new to the firm, even if they are already

available elsewhere on the market. The firm-level data in New Zealand show that over a 2-year period, only 2.6% of all firms introduce products new to the world, compared with 19.3% of firms that introduce products new to those firms. Around 17% of New Zealand firms introduce process innovations, while around 22% introduce organisational and/or marketing innovations. Highlighting the fact that there is more to innovation than R&D, among New Zealand firms introducing any type of innovation, only 22% of these firms also engage in R&D.

Importantly, the significance of formal R&D in the innovation mix is particularly low among firms in the services sector – in this part of the economy R&D expenditure is only around 35% of total expenditure on innovation. With the services sector accounting for around 70% of Gross Domestic Product (GDP) (and growing), this raises questions about whether the government should do more to support forms of innovation that are not driven by R&D, such as organisational and marketing innovation, and if so then how?

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Likewise, **Professor Kaj Storbacka** argued for going beyond product innovation to also consider how firms may engage in market innovation (eg, shaping the markets for products). He contended that a strategy built on these concepts, involving R&D, collaboration, standards, skill development, regulatory changes, etc., could unlock greater use value to the benefit of a small open economy such as New Zealand. He cited Finland's StoraEnso company and the various strands that needed to be brought together to develop and market its innovative, multi-story timber buildings as a good example.

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But Professor Adam Jaffe noted, when deciding what to do as a country it is crucial to understand the extent to which BERD is low “because there are things getting in the way, as opposed to it’s low just because there’s actually not much return there.” We only want Kiwi firms “to do a billion dollars more R&D if it’s actually going to be useful. We don’t want them to do a billion dollars more R&D just so we can tell the OECD we moved up [...] in their list. That doesn’t actually make Kiwis in the year 2030 better off if the research itself hasn’t been productive.”

How does innovation affect firm productivity?

In her keynote address, **Professor Bronwyn Hall** presented an overview of what we have learned about R&D, innovation and productivity at the firm level. Historically, most research used R&D as a proxy for innovation, but as discussed earlier, that only covers certain types of firms and certain types of innovation. Since the development of the European Community Innovation Survey we have been able to look at the relationship between innovation and productivity more broadly.

...if the share of a firm's sales that is coming from new products doubles, its productivity goes up by around 20%. The amount is higher in more R&D-intensive industries and, correspondingly, lower in less R&D-intensive industries.

The international research shows, on average, that if the share of a firm's sales that is coming from new products doubles, its productivity goes up by around 20%. The amount is higher in more R&D-intensive industries and, correspondingly, lower in less R&D-intensive industries. The results with measures whether a firm innovated or not are less clear. Overall, they show a relationship between innovation and productivity, but it is not possible to pin down the magnitude or identify the effect of specific types of innovation (such as product, process, etc.).

Professor Bronwyn Hall emphasised that these results focus on "improvements within existing firms, namely, creation of new goods and services and process and organisational innovation which lead to efficiency gains." At the economy-wide level "the big mechanisms [...] are the entry of more efficient firms and the exit of less efficient firms." However, these results on the impact of innovation on firm productivity do not speak to these reallocation effects.

Dr Simon Wakeman showed recent research using the LBD to investigate whether New Zealand firms' investment in innovation leads to a subsequent rise in their productivity. Results to date indicate that innovating firms grow their output faster than non-innovators and lift their rate of multi-factor productivity (MFP) growth. Specifically, over a 3-year period, MFP growth in innovating firms is around 2-3 percentage points higher than in non-

innovating firms. Highlighting the importance of firm capability (such as management quality), the results also show that firms introducing organisational innovation experience MFP growth improvements almost as large as firms introducing product innovation.

The impact of innovation on productivity growth is largest for younger firms, especially those in the 5–10 year age group, which have growth rates 7–10 percentage points larger than non-innovating firms over 3 years. [...] In general, process innovation does not appear to be associated with increases in measured productivity. However, this may be because the productivity benefits are realised through lower prices, which will not show up in the productivity measures used in the study.

There is also some interesting variation across different types of firms. The impact of innovation on productivity growth is largest for younger firms, especially those in the 5–10 year age group, which have growth rates 7–10 percentage points larger than non-innovating firms over 3 years. Also, firms that trade more widely, either in domestic or international markets, experience higher growth following both product and organisational innovation. Among product innovators, the productivity differentials relative to non-innovators are

larger for firms that engage in R&D or get their ideas from universities, Crown Research Institutes (CRIs), etc., while for organisational innovators, they are larger among firms that get their ideas from their business environment. In general, process innovation does not appear to be associated with increases in measured productivity. However, this may be because the productivity benefits are realised through lower prices, which will not show up in the productivity measures used in the study.

ICT adoption is a key part of the innovation mix, especially for firms in the services sector. ICT-based technological change is driving higher productivity and disrupting many industries and the world is long past Robert Solow's 1987 quip that he could see computers everywhere but in the productivity numbers.

Yet Robert Gordon makes the argument that ICT-led innovation will ultimately have much weaker effects on productivity growth and human welfare than past technological revolutions (Gordon, 2012). Indeed, keynote speaker Sir David Ramsden illustrated concern over the global picture of much lower productivity growth since the Global Financial Crisis (GFC) in 2008. The question is whether this lower productivity growth is the new normal.

ICT-led innovation... will put a premium on nimble entrepreneurship, labour-market flexibility, re-training and resource reallocation.

Professor Eric Bartelsman disagrees with Gordon and puts himself firmly in the camp of the technological optimists. The power of ICT, the general purpose technology of the present age, is evident in the ways it is disrupting more, and more diverse, parts of economies. ICT-led innovation has a long way to run and will put a premium on nimble entrepreneurship, labour-market flexibility, re-training and resource reallocation. Some examples of new technologies likely to have powerful

influences are autonomous vehicles, universal programmable robots, data-driven expert systems, and the Internet of Things.

...ICT-using firms grew faster (productivity, sales, employment) and experienced a rising ICT wage premium. Wages grew 1.4% faster in ICT-intensive firms compared with non-ICT intensive firms.

Professor Eric Bartelsman's research using firm micro-sets across 14 EU countries (2000 – 2010) has found that adoption rates of ICT and intangible assets vary greatly across countries, with some countries being four or five years behind others. Rankings of ICT use across countries are remarkably highly correlated with rankings in the export of both manufactures and services. Professor Eric Bartelsman also found that ICT-using firms grew faster (productivity, sales, employment) and experienced a rising ICT wage premium. Wages grew 1.4% faster in ICT-intensive firms compared with non-ICT intensive firms.

There is a case for governments to support R&D and innovation

Much international evidence finds high rates of return to R&D in those industries for which R&D is important (eg, manufacturing). Less evidence exists on the returns to innovation more broadly, although returns are more clear-cut for product than process innovation.

As **Professor Beth Webster** noted in her remarks, because knowledge is non-rival and tends to spread through demonstration effects or communication between technical workers, innovating firms often fail to capture the full benefit of their innovations at the margin. Useful knowledge is also likely to leak to neighbours when firms engage in knowledge absorption

from external sources. Phenomena such as these are likely to result in underinvestment in knowledge (from society's viewpoint) by individual firms in a free market.

Innovators often lack cash, yet many financial institutions are unwilling to lend to them to fund investments in KBC given the high and complex risks involved and the intangible nature of the assets.

Innovators often lack cash, yet many financial institutions are unwilling to lend to them to fund investments in KBC given the high and complex risks involved and the intangible nature of the assets. This is a problem given that KBC is becoming increasingly important as a driver of productivity and income growth.

These external (spill-over) effects and financing problems motivate the case for some form of government support for R&D/innovation. This could be the creation of intellectual property rights (IPRs) but a downside is that overly strong IPRs cause inefficiency in knowledge diffusion and stifle future knowledge creation. Other forms of support to encourage firms to innovate towards a socially optimal level are dollars (to change the private benefit-cost ratio), de-risking the environment, and bringing parties together.

Three alternative schemes to deliver dollars to firms are competitive schemes (eg, contestable grants), entitlement schemes (eg, R&D tax credits) or R&D boards (eg, primary sector levies to fund industry-good research). All of these schemes have strengths and weaknesses and require careful design. Government prizes for solving important social and economic problems are another form of support worth considering.

Challenges for New Zealand

As noted above, New Zealand's relatively slow productivity growth and its consequent large gaps in productivity and income levels compared with its better-performing OECD peers is a long-standing issue that pre-dates the advent of the internet. What then are New Zealand's future prospects not only to close the gaps inherited from its past, but to prosper in the new knowledge age?

New Zealand's geography (small domestic markets and distant location) has been a significant cause of its economic underperformance going back three or four decades. Given the increasing importance of innovation, scale effects and knowledge flows in modern economic growth, these geographic features appear on the surface to be a continuing barrier to making the most of the opportunities and productivity gains that will surely be increasingly available to the world at large.

New Zealand's geography... has been a significant cause of its economic underperformance going back three or four decades.

If knowledge creation is random, and in proportion to population and existing knowledge, then New Zealand is not well placed – larger areas that are already ahead in terms of productivity and that have denser populations will grow faster.

Scale effects are even more significant in the case of knowledge-intensive goods and services because production is even more likely to be characterised by high fixed costs and low marginal costs. Many New Zealand firms struggle for scale because of a small domestic market (plus difficult internal geography). Adding to this are high international transport costs because of New Zealand's distant location. Even with

clever innovation, the returns will typically be lower (and so footloose knowledge capital may well choose to locate elsewhere). Distance is also likely to act as a barrier to the visibility of new ideas in other countries.

Fortunately, ICT is steadily reducing the costs of distance and increasing the visibility of ideas for some types of economic activity. New Zealand has a strong interest in making the most of this trend. For example, although difficult to define, by one measure New Zealand's high-tech sector is growing quite rapidly – the top 200 (by revenue) of New Zealand-founded technology companies (the TIN200) increased their revenues from \$6.2 billion in 2009 to nearly \$9 billion in 2015. Investment in R&D among the TIN200 companies appeared to increase by around 16% in the last year. That said, it is starting from a relatively low base; historically New Zealand has had a relatively low share of production in R&D-intensive industries, and engaged in less R&D in those and other industries.

Many New Zealand firms struggle for scale because of a small domestic market (plus difficult internal geography)... Fortunately, ICT is steadily reducing the costs of distance and increasing the visibility of ideas.

Research indicates that innovation outputs increase with city size and density. Auckland is New Zealand's one large city, yet it is of relatively modest size by global standards. It will need to outperform to match the output of comparable economies. One opportunity could be to make more effective use of virtual networks as an alternative to face-to-face contact to link researchers and innovators both within New Zealand and between them and those overseas.

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A tentative strategy for the difficult challenges New Zealand faces is to focus on connecting to the global knowledge frontier, not across the board, but in a small subset of the product and services space, where New Zealand could have strengths (eg, the primary sector, digital effects, health and business software etc.). The idea would be to gain scale and a rich, dense innovation ecosystem in such areas.

This approach would entail a more active role for government but it would not be picking winners at the individual firm level. Rather it would be supporting thematic platforms, with associated investments in research and information dissemination, regulation, skills and infrastructure to world-class standards.

Moreover, the government has opportunities to be an innovation leader in government services – health care (including the organisational side), social services, tax, education, transport, housing, art and leisure. Success here will at least benefit those that live in New Zealand and help make New Zealand firms that depend on these services more internationally competitive. At best, it will enable New Zealand-based entrepreneurs to sell the innovations underpinning these services to the world and increase the incomes of New Zealanders.

Against this background, Professor Adam Jaffe highlighted the need to think carefully before further subsidising R&D. This would not necessarily result in good outcomes. There could be broader reasons (eg, small firms, fragmented industries, limited management capability) for low returns to R&D and innovation in New Zealand and these need to be understood before deciding on which policies would offer the best returns.

Key points from selected presentations

The remainder of this overview briefly summarises the keynote addresses by the four international speakers, in order of appearance.

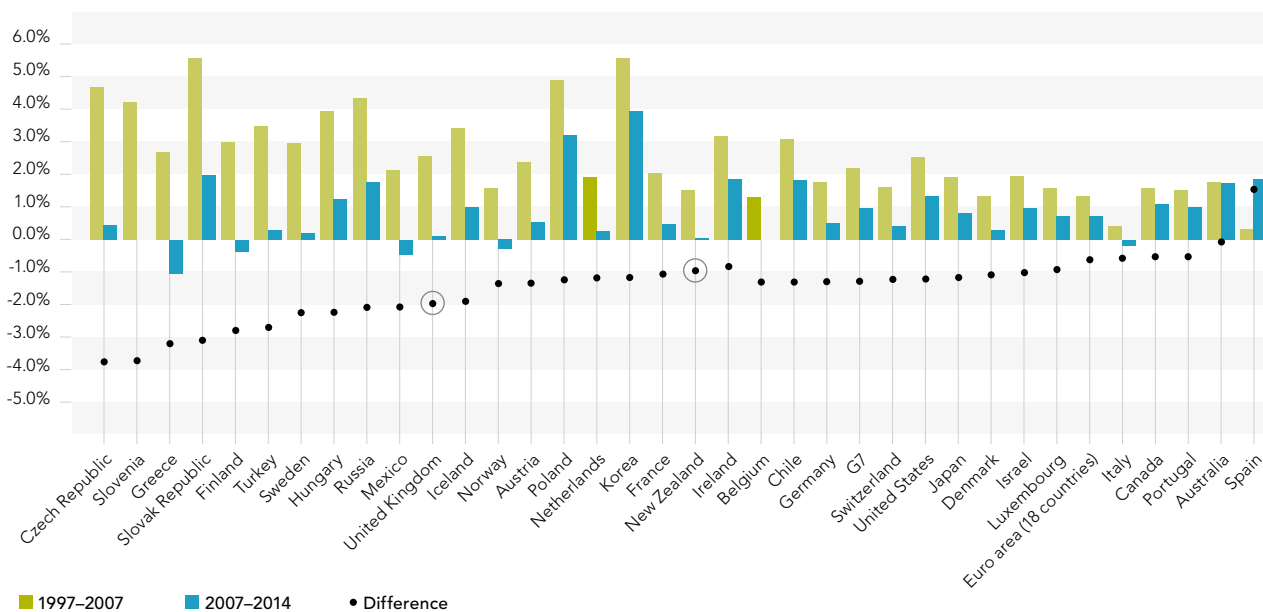
UK perspectives on productivity

Sir David Ramsden, Chief Economic Advisor at HM Treasury and Head of the UK Government Economic Service

Sir David Ramsden's presentation focused on the sharp productivity slow-down in the United Kingdom since the 2008 Global Financial Crisis (GFC), comparisons with other countries, and the policy thinking and measures taken by the United Kingdom government to try to lift productivity growth.

Many countries have experienced weak productivity growth compared to the pre-GFC period. In the UK labour productivity has been weak for several years. In 2014 the UK's productivity level was little higher than it was in 2007. The UK is not alone in experiencing declining productivity growth. Indeed, since the GFC the average productivity growth across the G7 has fallen from 1.9% in the pre-crisis decade to 0.9% since. However, while not alone in experiencing a decline, the growth in productivity in the UK over these later years was lower than in any other G7 country. In New Zealand, productivity growth post-GFC has also slowed to be close to zero. This contrasts with Australia, where there was little change in productivity growth around the GFC.

Change in average productivity growth – pre & post crisis



Source: OECD databank

There has been debate about whether the productivity slowdown in the UK is a temporary blip or a sign of things to come. As the UK Institute for Public Policy Research (Dolphin & Hatfield, 2015) has noted, there are three possibilities. The most optimistic view is that the fall in productivity growth is cyclical (reflecting the recession) and that there remains scope for significant catch-up. The most pessimistic is that there has not only been a permanent loss in the level of productivity, but productivity growth has also taken a permanent hit. A middle view is that, although the growth in productivity could return to its pre-crash rate, there has been a permanent one-off loss. If this is the case, then even with an improvement in productivity growth the level of productivity will remain below its pre-crisis trend.

...since the GFC the average labour productivity growth across the G7 has fallen by close to two-thirds.

Sorting out these different views is no simple task. One challenge relates to measurement (Bean, 2015). Productivity measurement is not just an academic exercise, as around 40% of the fall in the UK's productivity can be attributed to the professional services, finance and insurance, and information and telecommunications sectors, which are all sectors in which it is relatively difficult to measure output. Further, as former Bank of England deputy governor, Charles Bean, noted, measurement challenges also make estimates of spare capacity imprecise. This is important, as the strength of different views depends on the degree to which there is spare capacity in the UK economy. The lower the level of spare capacity, the more likely it is that the productivity loss is permanent.

...the UK Government has published a Productivity Plan built around two pillars...

In an effort to boost productivity growth, the UK Government has published a Productivity Plan built around two pillars:

- 1:** Long-term investment in human and knowledge capital, and in physical infrastructure;
- 2:** A dynamic economy (flexible fair markets, productive finance, openness and competition, resurgent cities).

Based on this recommendations have been set out in 15 areas, with key measures being:

- cutting UK corporation tax to 18%;
- setting up an independent national infrastructure commission;
- a Competition Plan to cut red tape and open up markets;
- putting higher education funding on a more sustainable footing;
- building a northern powerhouse (the northern England cities); and
- science spending and investment protected.

The Design of R&D Support Schemes

Professor Beth Webster, Centre for Transformative Innovation, Swinburne University of Technology

Professor Beth Webster reviewed the case for public subsidies for R&D, the different possible forms of support, and some pros and cons of each depending on context. She also described the characteristics of firms associated with their undertaking R&D and innovation.

Rationale for R&D subsidies

A necessary condition for using public monies to support R&D by domestic businesses is that the R&D would otherwise not be undertaken and it has benefits to third parties. Such benefits are well established. Mechanisms include the transfer of knowledge among technical workers in neighbouring firms, and the demonstration effects that occur when some firms use R&D (perhaps created by others).

...why focus only on R&D? It is not the only form of knowledge creation or diffusion. Why not support knowledge diffusion directly?

A reasonable question is why focus only on R&D? It is not the only form of knowledge creation or diffusion. Why not support knowledge diffusion directly? Professor Beth Webster suggested that you need to decide the form of support that gives the best value for money.

Another rationale is the mismatch between ideas and money. The intangibility of R&D makes it hard to value and trade. So banks are unwilling to lend due to a lack of solid collateral. Compounding this are the high risks involved, prompting high discount rates, which makes finance very expensive.

If the marginal cost of bearing risk rises with the quantum of risk, there's a good case to spread the risk of profound but very uncertain investments via government funding (Arrow & Lind, 1970).

Characteristics associated with firms undertaking R&D

Professor Beth Webster stated that it was difficult to identify causality, but associated characteristics include size, foreign ownership, ICT, a desire to go international, other forms of innovation and being in a cluster.

Already a lot of government support exists for innovation. Is there a case for more?

Policies to influence the decisions of firms to innovate

Already a lot of government support exists for innovation. Is there a case for more? Probably because social return to R&D is high and in excess of the cost (social discount rate). Three broad policy approaches: government provides dollars to change the benefit-cost ratios of firms, de-risk the environment, and bring relevant parties together (eg, the work of the US Department of Defense in bringing firms together, and firms and researchers).

Attributes of R&D support schemes

	Competitive	Entitlement	R&D Board
Total funding	Capped	Uncapped	Uncapped
Engagement	Costly; hard to discover; commercial sensitivities	Good except for SMEs (ignorant)	Not suitable without solid engagement
Project selection	Depends on skills of committee; little evidence it targets spillovers	Aligned with private benefits; bureaucratic rules	Targets intra-industry spillovers but not interindustry
Additionality	Hard to prescribe	Gross R&D ↑ less than govt transfer	Targets ex-firm activities
Payment	Often matching \$	Least generous	Can be in-kind or \$ matching
Admin costs	Expensive, 2–3 weeks work in application	Low; random audits	Fixed admin team

Dollar schemes themselves can be competitive (eg, firms compete for grants as in New Zealand), entitlement based (eg, R&D tax credits), or R&D boards (eg, primary-industry levy schemes). The table above describes some characteristics and pros and cons of these.

Generic problems with schemes include:

- changes to programmes (compounds the problem of firms not knowing about programmes, and high compliance costs);
- over-engineered requirements;
- absence of generalisable evaluations; and
- isolated, fragmented policies/programmes.

R&D, Innovation and Productivity

Professor Bronwyn Hall, University of California at Berkeley

Professor Bronwyn Hall presented an overview on what we know about R&D, innovation and productivity at the firm level, including effects on firms' output and employment growth. The evidence was largely based on Community Innovation Surveys in various countries.

What mechanisms connect innovation and productivity? Innovation results in improvements within firms, ie, new products or existing products produced more efficiently. Innovation also stimulates market dynamics, ie, the entry of more efficient, more technologically advanced firms and the exit of less efficient firms.

Firms which undertake R&D are more likely to be innovators, but plenty of innovating firms don't do R&D.

Some key conclusions: Firms which undertake R&D are more likely to be innovators, but plenty of innovating firms do not do R&D. Compared to manufacturing firms, service firms' innovation spend is more on new equipment and marketing and less on R&D. Petrin and Warzynski (2011) produced evidence on the product/process innovation distinction and find that it is real.

The impact of innovation on productivity is more difficult to estimate because of imprecise measures of innovation, but product innovation shows a robustly positive impact.

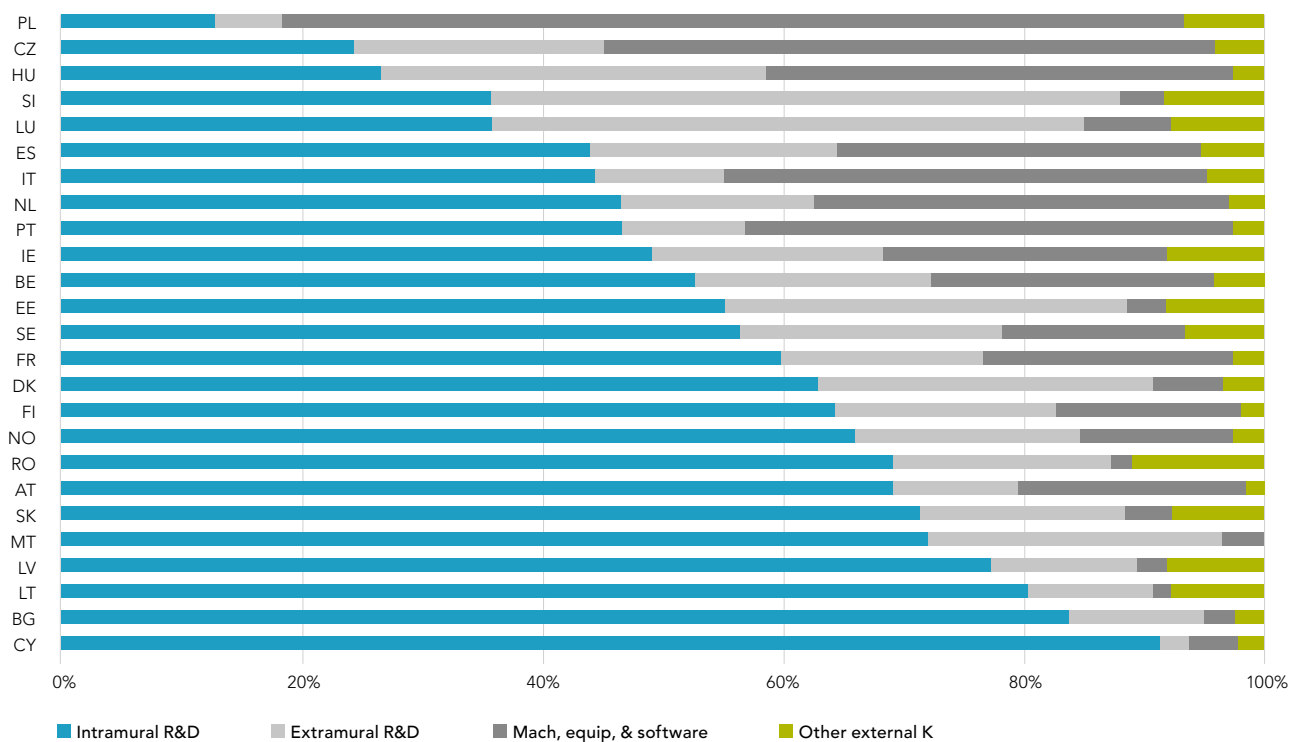
Much research has been done using the CDM (Crepon, Duguet & Mairesse, 1998) model for

over 20 countries, which confirms high rates of return to R&D. The impact of innovation on productivity is more difficult to estimate because of imprecise measures of innovation. However, product innovation shows a robustly positive impact on productivity that is larger for high-tech and knowledge-intensive firms. Patchy results for process innovation could reflect poor measurement of both productivity and process innovation.

Share of sales due to new products is a good measure of product innovation, and better than the answer to "Did you introduce a new product in the last year?" However, there is no comparably good measure for process innovation.

Product innovation unambiguously increases revenue productivity (combination of higher prices owing to higher quality and increased consumer demand) and labour demand. Process innovation will increase revenue productivity and labour demand only if consumer demand is elastic.

Data available on different types of innovation spending by firms shows wide cross-country variation:



Estimates suggest doubling innovation spending has a similar effect on multi-factor productivity (MFP) as doubling R&D. The full set of links between innovation, competition, exit/entry, and productivity growth have not yet been explored.

ICT, Innovation and Productivity Growth: Connect or Disconnect

Professor Eric Bartelsman,
Vrije Universiteit, Amsterdam

In his keynote presentation, Professor Eric Bartelsman built on what had already been said about innovation, R&D and productivity by looking ahead 30 years at what new technologies and likely impacts are coming down the track. He also offered some thoughts on what might be the implications for New Zealand as a small, island economy.

[The technological pessimists] predict average annual income growth per head is slowing to around 0.5% (incomes doubling in 100 years), the [technological optimists] believe there is no reason for it not to achieve 2.5% (incomes doubling in 30 years).

He divided his presentation into four parts:

1: Technological prospects

There has been debate between the pessimists (Gordon, 2012) and the optimists (Brynjolfsson & McAfee, 2011). The former group predict average annual income growth per head is slowing to around 0.5% (incomes doubling in 100 years), the latter group believe there is no reason for it not to achieve 2.5% (incomes doubling in 30 years).

At its core the debate is about the scope and power of ICT as a general purpose technology (GPT) to impact human wellbeing relative to previous GPTs. Professor Eric Bartelsman is in the optimists' camp, giving examples of how powerful new technologies could be: autonomous transport (Google Car), universal programmable robots, data-driven expert systems, and the Internet of Things. These technologies could lead to technological advances in areas like clean energy, sustainable land use, new materials, health (biotech), elderly care, liveable cities and countryside, education and knowledge dissemination, managing production, supply chains, and labour markets. However, they will also be highly disruptive of many existing jobs and businesses, raising many questions and challenges. They will place a premium on the ability of economies to retrain people and reallocate resources.

2: The economics of growth with intangible (knowledge-based) capital

Intangibles are typically non-rival production inputs. This implies benefits to scale, and can often lead to "winner takes all" outcomes. Firms that invest in intangibles have uncertain productivity outcomes – depending on the luck of the "draw" from the distribution. The optimal size of the firm will depend on the outcome from its investment in intangibles. Profits across firms become very skewed. While technology may have decreased the cost of firm start-ups (ie, trying something new), the probability of success has decreased.

Intangibles tend to be labour saving and can also be capital saving (eg, if we get self-driving vehicles, utilisation rates are likely to rise to 60% as opposed to 4% currently). So investment in traditional capital may look sluggish. Another effect is that income shares for labour and "traditional capital" could fall. Successful innovators earning rents could be part of the explanation.

If resources move to firms with good productivity draws, productivity will be higher... technological adoption and reallocation are critically linked.

The aggregate productivity of the economy is determined by the distribution of productivity draws across firms and by their market shares. If resources move to firms with good productivity draws, productivity will be higher. So even if innovation outcomes average to around zero across firms, reallocation means that it can still be positive for productivity in the economy as a whole. In this sense, technological adoption and reallocation are critically linked.

3: Evidence from linked firm micro-data sets across 14 EU countries, 2000–2010

...there are surprisingly large country variations in intangible investment and its effects. Is this due to policy, distance or something else?

Data include results from Community Innovation Surveys and ICT surveys. Findings include that technological penetration continues and that R&D, ICT use, innovative output, human capital intensity and productivity are correlated across firms. But there are surprisingly large country variations in intangible investment and its effects. Is this due to policy, distance or something else?

Wages grew 1.4% faster in ICT-intensive firms compared with non-ICT intensive firms. ICT-using firms grew more (output, employment, productivity) with output growth tending to be higher than employment growth in ICT-intensive firms.

There is a rising ICT wage premium. Wages grew 1.4% faster in ICT-intensive firms compared with non-ICT intensive firms. ICT-using firms grew more (output, employment, productivity) with output growth tending to be higher than employment growth in ICT-intensive firms.

The results also confirm the increase in the variability of productivity, employment and sales outcomes among firms as investment in intangibles increases. And the aggregate industry impact of intangibles is positive, even while the average firm-level impact is insignificant: ie, (re)allocation matters.

4: Connecting with New Zealand policy

So how could New Zealand harness the potential of ICT-led innovation?

New Zealand has good framework conditions but the uptake of ICT and investment in intangibles appears to be lagging. So how could New Zealand harness the potential of ICT-led innovation?

The increasing importance of ideas and KBC in modern economic growth raises concerns about the prospects for a small, distant and sparsely populated island economy. Other things being equal, new ideas will occur randomly in proportion to population and existing knowledge. Higher transport costs of trade (while acknowledging the near-zero transport costs of digital products) will mean that output is less scalable, so returns to success will be lower. Distance may also make ideas elsewhere less visible.

...[New Zealand could] take a more active policy approach by focusing on a small subset of product space comprising existing and/or emerging strengths (eg, primary sector, some software areas and digital effects).

Thinking about New Zealand has changed Professor Eric Bartelsman's view. It could be worthwhile for the country to take a more active policy approach by focusing on a small subset of the product space comprising existing and/or emerging strengths (eg, primary sector, some software areas and digital effects). The situation may call for government involvement that goes beyond standard Anglo-Saxon innovation policy by supporting specific thematic platforms and a degree of directed technical change.

Another idea is to offer prizes for innovative solutions to well-defined economic and social targets. This approach could be used, for example, in tackling current challenges in the public sector. The costs of government services in small, low-density jurisdictions tend to be high. Innovations in health, education, transport, etc. could reduce these costs, improve the competitiveness of private-sector exporters and even be exported themselves.

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Programme

9.00 – 9.15	Introduction and welcome	Gary Dunnet, Statistics New Zealand
9.15 – 10.30	Panel discussion	Sarah Holden, Callaghan Innovation Professor Kaj Storbacka, University of Auckland Professor Shaun Hendy, Auckland University
10.30 – 11.00	Morning tea	
11.00 – 11.30	Keynote address	Gabriel Makhoulf, New Zealand Treasury
11.30 – 12.00	Keynote address	Sir David Ramsden, HM Treasury
12.00 – 12.45	Lunch	
12.45 – 1.30	Keynote address	Professor Beth Webster Swinburne University of Technology
1.30 – 2.00	Discussant	Professor Adam Jaffe Motu Economic and Public Policy Research
2.00 – 2.30	Afternoon tea	
2.30 – 3.15	Keynote address	Professor Bronwyn Hall University of California at Berkeley
3.15 – 3.45	Discussant	Dr Simon Wakeman New Zealand Productivity Commission
3.45 – 4.30	Keynote address	Professor Eric Bartelsman Vrije Universiteit Amsterdam
4.30 – 5.00	Discussant	Dr Peter Crabtree Ministry of Business, Innovation & Employment
5.00 – 5.15	Closing remarks	Murray Sherwin New Zealand Productivity Commission
From 5.15 pm	Networking function	

The day will be facilitated by Dr Patrick Nolan, New Zealand Productivity Commission.

This conference is kindly supported by:



Speakers



Professor Eric Bartelsman

Professor of Economics, Vrije Universiteit Amsterdam

Professor Bartelsman has a B.S. in Economics from the Massachusetts Institute of Technology and received his PhD from Columbia University. He served as economist at the Federal Reserve Board in Washington DC, as advisor to the CPB, Netherlands, and as Head of the Economic Research Department at the Ministry of Economic Affairs in the Netherlands. In 2007 and 2008 he was a member of the Netherlands Council of Economic Advisors (REA). His research focus is on the sources of productivity growth, both from a micro and macro point of view. Bartelsman is a Fellow of the Tinbergen Institute and IZA Bonn.



Professor Bronwyn Hall

Professor of Economics, Emerita, University of California, Berkeley

Professor Hall is Emerita Professor at the University of California at Berkeley, a Research Associate of the National Bureau of Economic Research and the Institute for Fiscal Studies, London, and a Visiting Fellow at NIESR, London. She currently serves as an associate editor of the *Economics of Innovation and New Technology*, and of *Industrial and Corporate Change*. She is also a member of several advisory boards (Solvay Brussels School of Economics and Management, European Patent Office, DIW – German Institute for Economic Research). She received a B.A. in physics from Wellesley College in 1966 and a Ph.D. in economics from Stanford University in 1988.



Sir David Ramsden

Chief Economic Adviser, HM Treasury

Sir David Ramsden was appointed to the Treasury Board in June 2007 and in 2008 was appointed Chief Economic Adviser. In June 2007 he also became Joint Head of the Government Economic Service, the largest single recruiter of economists in the UK, and has been sole Head since 2010. In January 2013 he became Chair of the Treasury's Diversity Board. He is a trustee of Pro Bono Economics and is also President of the Society of Business Economists, on the Council of the Royal Economic Society and a Governor of the National Institute of Economic and Social Research. He was knighted in the 2015 New Year Honours for services to economic policy making.



Professor Beth Webster

Director of the Centre for Transformative Innovation,
Swinburne University of Technology

Professor Webster is the Director of the Centre for Transformative Innovation and an Honorary Professorial Fellow of the Melbourne Institute of Applied Economic and Social Research at the University of Melbourne. She has authored over 100 articles on the economics of innovation and firm performance and has been published in *RAND Journal of Economics*, *Review of Economics and Statistics*, *Oxford Economic Papers*, *Journal of Law & Economics* and *Cambridge Journal of Economics*. She has been appointed to a number of committees including the Lomax-Smith Base funding Review; CEDA Advisory Council; the Advisory Council for Intellectual Property; Board Member, European Policy for Intellectual Property Association; and Board Member, Asia Pacific Innovation Network.



Dr Peter Crabtree

General Manager, Science, Innovation and International, Ministry of Business, Innovation & Employment



Gabriel Makhlof

Secretary and Chief Executive, New Zealand Treasury



Gary Dunnet

Manager, National Accounts, Statistics New Zealand



Dr Patrick Nolan

Principal Advisor, New Zealand Productivity Commission



Professor Shaun Hendy

Director, Te Pūnaha Matatini



Murray Sherwin

Chair, New Zealand Productivity Commission



Sarah Holden

General Manager, External Relations, Callaghan Innovation



Professor Kaj Storbacka

Professor, Markets and Strategy, University of Auckland Business School's Graduate School of Management



Professor Adam Jaffe

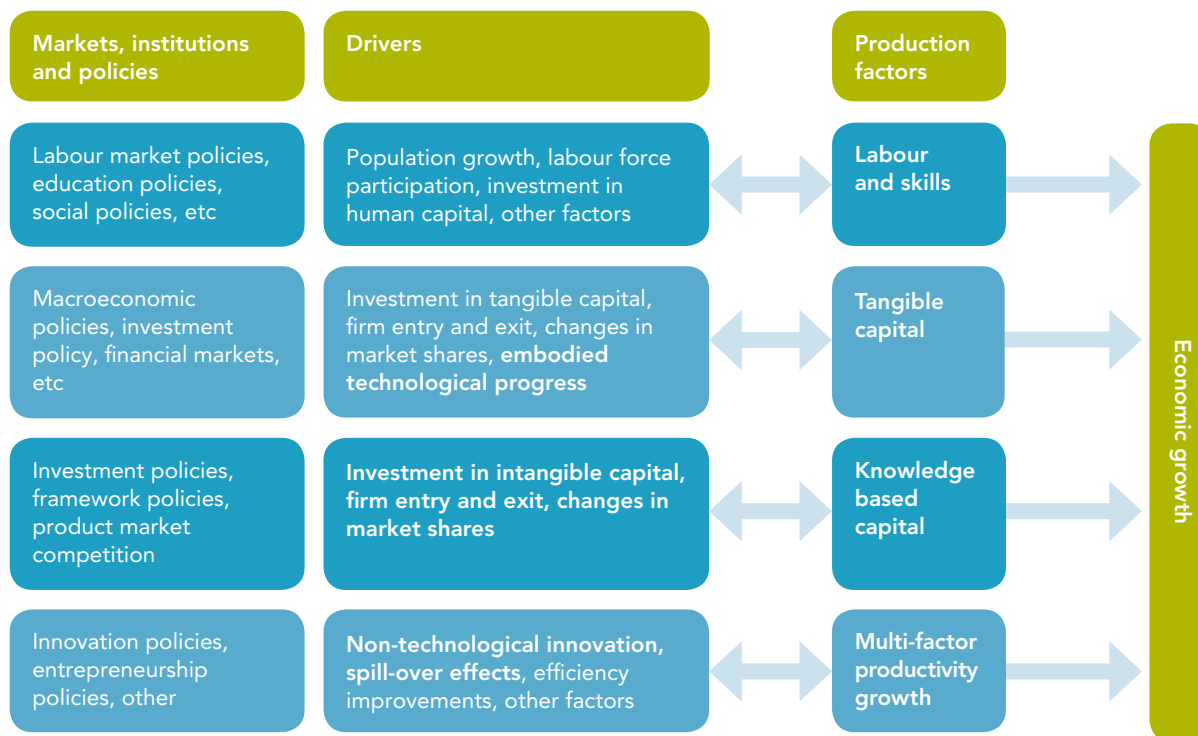
Director, Motu Economic and Public Policy Research



Dr Simon Wakeman

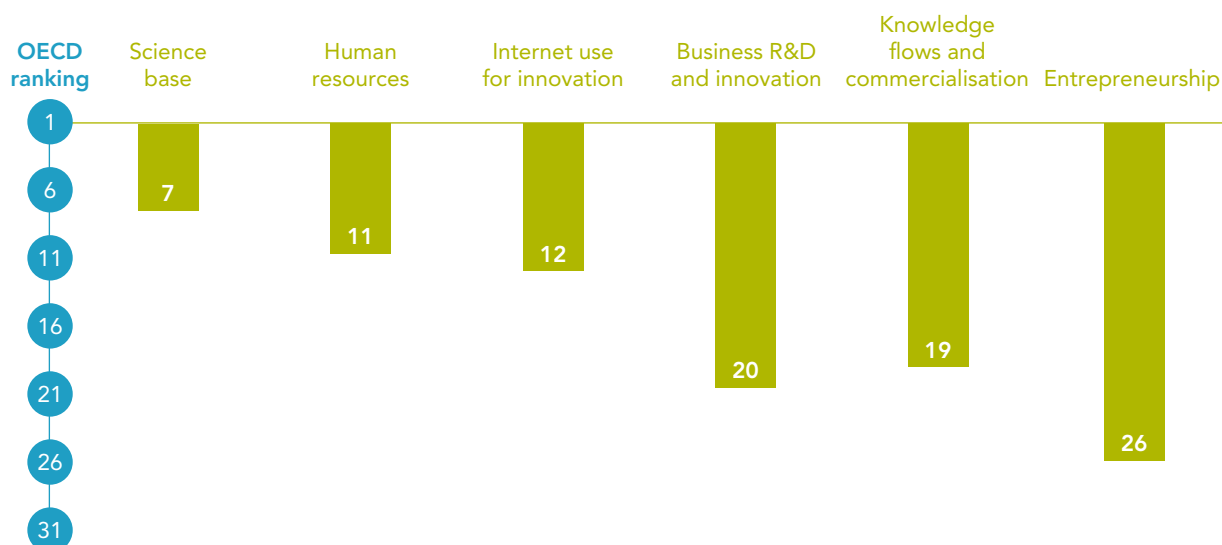
Principal Advisor, New Zealand Productivity Commission

A simplified framework to analyse economic growth



Source: OECD (2015), "The innovation imperative: Contributing to productivity, growth and well-being".

New Zealand's average ranking in top-level categories of OECD innovation indices



Source: Wakeman and Le (2015), "Measuring the innovative activity of New Zealand firms".

Welcome
and introduction

 **Bill McDonald** @connect_nz:
#whywellington #innovatenz
Wellingtons top minds gathered
to grow more innovative and
productive Kiwi firms



Patrick Nolan: Good morning everyone. There's a lot of useful bilateral discussions going on, but in order to try and keep to time I'm going to kick us off now.

We will be recording the event today to produce a transcript, so please do bear that in mind. We will have microphones that will come round when we're asking for the question and answer session, so when you're asking a question, please do identify yourself and where you're from. And also for those speakers at the top table, bear in mind that these mics, to make them live you press the green button as well.

Now we're also aiming to make today as interactive as possible; this is a working event. Luckily, the Wellington weather has cooperated and it's no longer sunny, so this is good working weather. The theme of the day is how we can grow more innovative and productive Kiwi firms. We have a hashtag there [#innovatenz], so please do feel free to tweet the event. I'll be monitoring Twitter throughout the event and any of the best tweets will get read out – so there's your chance for a little bit more glory. Please do tweet, and I look forward to reading those.

I must mention the sponsors of today. We simply couldn't do an event like this and make it free to attendees without the support of a number of sponsors. They're listed up on the slide there, as you can see, and so thank you to the sponsors. We're very grateful for your support. And I think that's just about enough in terms of housekeeping.

I'm thrilled to be able to introduce Gary Dunnet, who's going to kick us off today. Gary is the Senior Manager, National Accounts, Statistics New Zealand. He's a career official statistician with a long career at Statistics New Zealand. He's worked at the Central Statistics Office of Ireland and the Australian Bureau of Statistics and he's worked extensively in both the European and Asian international statistical area, and was recently appointed to the bureau of the OECD Working Party for National Accounts. He's also, I should say, a member of the Productivity Hub Board. So thank you, Gary, and I'm looking forward to your opening remarks.

 **NZ Productivity Comm**
@NZprocom: Gary Dunnet
@StatisticsNZ kicking off #InnovateNZ
– looking 4ward to discussing what
drives NZ productivity & growth



Welcome:

Gary Dunnet, Statistics New Zealand

Gary Dunnet: Kia ora tātou. I'm here today to both welcome you to the Symposium on behalf of Liz MacPherson, our Chief Executive and Government Statistician, but also to set the scene for the day.

Statistics New Zealand is charged with measuring the nation's performance, and as you probably know, we do this by gathering data and information on an increasingly wide range of topics.

As the world changes, we need to change as well. Last year Statistics New Zealand reassessed our longer term direction and realised that we needed to change our strategic direction and it would be fair to say we've challenged ourselves in the process. So we started with our vision which is now "to unleash the power of data to change lives". As good statisticians we set ourselves an ambitious target of doubling the value of data by 2018.

We've identified four key roles as part of delivering the value to decision makers: those of provider, enabler, innovator and steward. They will help us clarify what we need to focus on to deliver on our vision. But we remain committed to providing New Zealand's most trusted and important data and statistics.

Across government, it is recognised that there are huge opportunities of utilising integrated data to benefit New Zealand, but everyone is aware there are both risks and opportunities.

We are seeing that data and information is becoming ubiquitous and we recognise the need to take a greater outside-in view. We want to transform and innovate to be a leader of enabling the data ecosystem. Ultimately, this is about empowering New Zealanders by making it easy for them to access and use trusted data to make informed decisions. Across government, it is recognised that there are huge opportunities of utilising integrated data to benefit New Zealand, but everyone is aware there are both risks and opportunities.

The New Zealand Data Futures Forum was established to explore the potential benefits and risks of sharing, linking and using data. The key driver here is for New Zealand to treat data as a strategic asset and utilise it. However, data can't accomplish things on its own. Ultimately it is about people, relationships and particularly partnerships.

Partnerships across government and the private sector are essential for us to be successful in our work. I believe a great example of an effective partnership is the Productivity Hub and the work programme that it has established. By working in partnership we bring together areas of expertise and knowledge to create value to truly unleash the power of data for New Zealand to be truly productive.

...an increased use of data to drive innovation could deliver \$4.5 billion in benefits to New Zealand over the next five years. So what is our role in achieving this?

If we are not successful in this, we will not be successful in creating more innovative and productive Kiwi businesses. To try and bring this into perspective, there is an increasing number of reports concluding that New Zealand is not securing the potential benefits of data-driven innovation. I recently saw a report that estimated that an increased use of data to drive innovation could deliver \$4.5 billion in benefits to New Zealand over the next five years. So what is our role in achieving this?

Let me talk a little bit about the Productivity Hub and some of its achievements. The Hub's goals are fourfold.

- Firstly, connecting people to establish a community of like-minded individuals across academia, public, private and voluntary sectors with an interest in productivity research and making the best use of knowledge and the research.
- Secondly, capability development.
- Thirdly, shaping research agendas and creating opportunities to collaborate on research work.
- And finally, sharing research by providing a platform where research, data and analysis can be exchanged, for example, events such as this one. Over the last year the Productivity Hub has delivered a number of papers and hosted a number of discussion fora.

Good research needs good data. In New Zealand there are two complementary sources of data used in productivity analysis.

- Firstly, there is the official macroeconomic productivity measures for the total economy and industry for which I am responsible.
- Secondly, there is increasingly-available micro-data that enables productivity analysis at the meso and micro level.

Statistics New Zealand's longitudinal business database (LBD) is considered a world-leading, integrated data set covering New Zealand firms. Having access to firm-level data means that researchers can explore questions that aren't possible with aggregate data and look at the firm and industry impacts on productivity. Such granularity also means that policy interventions, which are generally taken at the micro level, can be better informed.

Now I'm a keen advocate for understanding what is driving productivity in the growth of New Zealand economy, especially the micro, meso, macro linkages. For the day ahead I am looking forward to gaining a greater understanding of these linkages and exploring how better to measure these. I should also note that as part of the organising committee, I know that there are many more pieces of work that could have been added to the agenda that would continue to add to the debate. With many of the authors in the room, I hope that the roundtable discussions will draw on this knowledge base that collectively each of you bring.

The presentations you're about to see are great exemplars of data used to truly influence policy. Over recent years, Statistics New Zealand has worked to improve access to data and this is certainly a priority for the organisation going forward. I think one of the greatest recent achievements has been the distribution of data lab facilities to places like the Productivity Commission, Treasury and numerous universities, but we do recognise there is still a way to go for improved access.

Now a broad outline for the day. The day starts with scene setting of the New Zealand issues and then we move on to international evidence. In particular, the first panel raises a number of questions and challenges, such as how

government and business can work together to encourage innovation, the importance of looking at markets in new ways, or so-called market innovation, and the importance of getting researchers to work across networks. This is then followed by keynote addresses from the New Zealand and UK Treasuries which link innovation and productivity back to a broader economic narrative.

The focus of the design of policy responses will then be continued by Beth Webster and Adam Jaffe who will discuss the design of R&D support schemes. Finally, Bronwyn Hall and Eric Bartelsman, along with their New Zealand discussants, will tell us where the international economic literature points us. Bronwyn and Simon Wakeman discuss the relationship between innovation and productivity among

New Zealand firms and Simon will present some new evidence from the LBD. Eric and Peter Crabtree will then talk on ICT, innovation and productivity growth before Murray Sherwin draws the day to a close with the summary of the key messages that have emerged.

In developing the day, the Productivity Hub had hoped that the conversations would take over the presentations, in that we all have an offering in the sector and that the presentations should be seen as conversation starters.

So I wish to leave you with a challenge. At the end of the day you should each try and have either one contact that you will follow up or take away an interesting data idea that you discuss in your workplace tomorrow or ponder further.

So enjoy the day. [Applause]



Discussion



Patrick Nolan: Thank you Gary. I've got just one quick question. You discussed particularly the use of micro-data and what we can actually do with the LBD now, which is quite, quite incredible. And we had a very good session on this yesterday at the Government Economics Network Conference. I guess the challenge is, how do we make it real? How do we connect to a broader audience with that sort of work?



Gary Dunnet: Well, I think one of the challenges which is facing a lot of agencies – and Statistics New Zealand is no different – is how do we communicate our data and statistics to our end users? Whether that be policy analysts or even the general user in the street. And I think what we'd have to try and do is grab some of those nuggets of information that are inside our research, and we're doing great research, but grabbing some of those nuggets and articulating them to the public.

...“so what does that mean to my plumber in Masterton?”
...through this research we've identified things like how the uptake of broadband leads to a measurable increase in productivity. And how good HR practices lower your staff turnover.

I reflect on a conversation that we were having with the Minister of Statistics where Patrick and Paul came along to talk to him about the Productivity Hub and the work around the LBD, and I was there as an official. And then the Minister in his usual way said, “so what does that mean to my plumber in Masterton?” And “what's his take-home message?” So I was able to say through this research we've identified things like how the uptake of broadband leads to a measurable increase in productivity. And how good HR practices lower your staff turnover. So that if we can get that plumber thinking well, actually, how can I take up broadband, or consider new HR practices like talking to my staff on a Monday about what they've done over the weekend. Getting that sort of understanding across to the public would be useful in our desire to grow more innovative and productive firms.



Patrick Nolan: Thank you Gary. [Applause]

Session 1

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Patrick Nolan: And now I'd like to invite our first panellists up to the stage. So, Gary, maybe if you grab a seat at the front and I will invite Sarah Holden, Kaj Storbacka and Shaun Hendy, if you could come and join us on the stage please. As Gary mentioned, our first panel discussion is in a way an agenda-setting session for the conference and it's a chance to delve into some of these issues that face the New Zealand economy.

We'll start with Sarah Holden who's the General Manager of External Relations at Callaghan Innovation. Sarah has over 20 years' international experience in economic policy with a particular interest in strengthening science and innovation systems. We'll then hear from Professor Kaj Storbacka who's Professor, Markets and Strategy at the University of Auckland Business School and Kaj's main research focuses on market and business model innovation, market shaping strategies and solution business transformation. And finally we'll hear from Professor Shaun Hendy, who I have to say is probably the only Professor of Physics in the room at the moment.

Male Participant: [Indistinct]

Patrick Nolan: I know Richard Fabling, if he's around here, he did his PhD on the sun, so it's not unheard of, I guess.

Richard Fabling: It's a long trip. [Laughter]

Patrick Nolan: Shaun is the Director of Te Pūnaha Matatini, a New Zealand Centre of Research Excellence focused on the study of complex systems and networks. So I'm very much looking forward to the presentations. We'll start with Sarah. I've asked the speakers to each speak for 15 minutes and with about two minutes to go I'll start dinging the glass, so you all have a warning.



Panel discussion 1: Sarah Holden, Callaghan Innovation

Sarah Holden: Oh great, thank you. Okay, I'm not going to provide you with any data insights. What I wanted to do was set a bit of a context for today.

I'm Sarah Holden; I'm from Callaghan Innovation. How many people here have heard of Callaghan Innovation? Okay, well, that's great. Callaghan Innovation, we're a government agency. We were set up about two years ago, going on three years now. And really the context for us being created was to try and grow the economy by having more high-tech businesses.

...economies that had a high proportion of exports coming from the high-tech sector were able to generate far greater revenue per employee.

I'm going to put a graph up here which we used in 2009 when we had some conversations with the Minister about why he should care about science. What we know about science is it's used by this thing called high-tech industry, which was not a commonly-used phrase at that time in New Zealand, and that high-tech industries were good things to have because

they created high wage jobs. And if we look at the productivity figures here, we were able to show that economies that had a high proportion of exports coming from the high-tech sector were able to generate far greater revenue per employee. The feature of New Zealand, of course, is being primarily a primary industry-based economy, with food and beverages being a very large part of our exports, these typically make quite low use of science relative to the high-tech sector. So what we were trying to say is that if we can get science being used by business, we'll have a different kind of business that will be creating greater benefits for the economy.

Now we all know about BERD. We all know that New Zealand has very low business investment in R&D and part of Callaghan Innovation's mission is to increase the level of BERD to 1%. That actually translates, all other things being equal, into getting businesses to spend an extra \$1 billion on R&D. And that is what I call "the billion dollar question" for us, is how do we get businesses to do that?

Just another figure that I wanted to put up here was, if you actually look at where our BERD comes from, for most similar, small countries it is large businesses that invest most in R&D. In New Zealand, as we know, we have relatively few very large businesses. I don't know who's from MBIE – perhaps you can give me the latest figures – but I think a few years ago we estimated there were about 11 companies with over 1,000 employees and most of those are cooperatives and most of them are in the primary sector. Whereas in other countries they have much larger companies and it is those companies that are really spending on research and development. For the majority of our companies in New Zealand, they are spending, give or take, about how we would expect them to spend compared to other equivalent countries. So that, to me, is quite revealing in terms of our challenge at Callaghan Innovation.



 **Donal Curtin** @donal_curtin:
Interesting #InnovateNZ thought
from Sarah Holden – is our
business R&D spend low because
we have few v big companies...

We've got few firms of scale. We have quite low management capability. We have relatively little competition. So we really don't have many of the factors within our economy that's going to make businesses want to invest in R&D.

Now, what do we do? We work closely with business. I said that our aim from a government perspective is to increase BERD; businesses don't care about that. What they want to know is what is it going to do for them? We try to phrase this in a language that's going to resonate with business. So our purpose, as we would explain it, is to help businesses succeed through technology. We have a big challenge with that because, as I said, most of our businesses are in the primary sector so they're not great users of technology compared to, say, the pharmaceutical industry. We've got few firms of scale. We have quite low management capability. We have relatively little competition. So we really don't have many of the factors within our economy that's going to make businesses want to invest in R&D. What we do, we try and phrase what we can do with businesses in terms of a value proposition for them: why would they want to do more with R&D? We say it will help them get their products to market faster, it will give

them a market advantage because they'll be generating cool things that no-one else is producing and basically that will be good for their bottom line. We can actually come back and test whether any of those things are true. But that's certainly what we believe is our value proposition to business.

...we're particularly interested in companies that are wanting to disrupt the market, wanting to do something creative and wanting to grow.

We're quite careful about who we choose to work with. Actually, it's quite a sobering fact: there are only between 2,000 and 3,000 companies in any given year that are doing R&D, according to our official statistics. So that's actually not a huge number of businesses. Where we believe we can add the greatest value is firstly, businesses that actually want to grow – because if you're going to invest in R&D, you need a lot of guts because it's pretty risky, so you need to have that ambition and want to grow. And also, where we believe where we can add value is where people want to do fairly high risk R&D. So they're going to need a government partner to help manage that risk – I was going to say de-risk, but it's actually more around managing that risk. So we're particularly interested in companies that are wanting to disrupt the market, wanting to do something creative and wanting to grow.

We've got the usual suite of products and you'll find this from any country. There's nothing terribly new here. Perhaps what is a bit unusual for New Zealand, because we've got so many small companies, we have a large R&D facility. Businesses can come to us and we will do their product development for them, on hire. This isn't provided by the private sector at the moment, and we believe it will help companies that don't have scale or are of not sufficient scale to have their own in-house capability,

that there probably is a value proposition for them in being able to outsource their R&D.

We can help them get access to experts. We try and connect people internationally. People want to work not with the second-best but with the best, and so we do a lot of searches for businesses to help them find who the leader is in a particular field. We do a lot of skills training so that they can manage their R&D programmes. We do a lot around business collaborations, helping businesses work together to solve a common problem, and of course the last and often the most contentious, we don't have an R&D tax credit here, but we do have R&D grants and we give out a variety of different funding through that.

Is it moving the dial in terms of their R&D investment and, actually, is it affecting their bottom line?

As I said, we've been set up since 2013 and we've been fairly busy. Does this add up to very much? That's part of the question we're trying to ask now at Callaghan – trying to understand what kind of impact we are having in firms. Is it moving the dial in terms of their R&D investment and, actually, is it affecting their bottom line?

We have some quite good anecdotes and I'll give you this example from a company called drikolor – I'm sure Rachel won't mind me sharing this with you. Rachel is a classic entrepreneur. I don't think she ever sleeps. She's full of energy and ideas. Family business in paint. And she had an idea about creating a powdered paint which you could then sell through your home furnishing retail outlets, so that people could decide, I'm buying my curtains, I'm buying my sofa – what paint colour do I want to go on my wall? So this was a whole new way of selling paint, because you could get access to different retail outlets. But to do that you had to powder the pigment and then have it stirred into a can of white paint.

Now Rachel came to us. She was just a one person show at that time, no technical expertise whatsoever in making powders, and through us we were able to make powdered pigments which can indeed be stirred into a can of paint. And she has now established commercial contracts with some of the largest home furnishing outlets around the world. So I think that was an example of where a small company with a bright idea could come to us and we could help her develop the technology to take her product to market. And of course she's had grants from us and we've helped put her in contact with the experts that she needs to grow. We have a lot of these sorts of anecdotes and you can certainly go on our website if you're interested in knowing more about that.

But just stepping back a bit and saying, well what's happening to the high-tech sector? One of the reports that's been quite interesting to us is the TIN100 [Technology Investment Network]. I presume everyone here knows the TIN100. I think when it first came out – it's just had its 11th anniversary – it was a bit like the unicorn, a bit of a mythical creature, this high-tech sector. And what the TIN100 did was put 100 companies together in a book with profiles about them saying, yeah this sector is real. These are the diversity of companies that are doing some really quite, quite amazing things which are not always intuitive to a lay audience. And I think that's been quite hard for us in terms of how we encourage government to invest more in R&D. It's hard to see and it's hard to understand the benefits of.

...the TIN100... has grown quite rapidly: nearly nine billion dollars to date... and accounts for most of our business expenditure on R&D...


What we found with the TIN100, though, is that the sector has grown quite rapidly: nearly \$9 billion to date. Probably on track to overtake the dairy sector in exports, which was a surprise. And also the TIN100, of course, accounts for most of our business expenditure on R&D and allegedly their investment is growing quite rapidly. They had a figure of 16% in the last year, although I don't know how much of that came from Xero.

...how do we measure impact, and if we're not seeing impact, what else is going on?

But for us and some of the work we've been doing looking at our own data, and indeed with the Productivity Commission, it's been much harder to draw evidence based between our set of activities and what's going on with business investment in R&D, and indeed whether that is translating into more profitable, healthy companies. And I think that's part of the question that I'd like to pose to this audience: how do we measure impact, and if we're not seeing impact, what else is going on? Just some of my observations is that we're finding in New Zealand the bigger companies – we've just been to see a larger technology company – they do quite well without government, thank you very much. It's more about what they can do for us. They've got a remarkable R&D facility. They quite like the grants, but of course most countries have either an R&D tax credit or a grant, so the grants just level the playing field and I suspect discourage them from leaving New Zealand and going elsewhere.

The smaller companies have proven quite tricky to work with. Those that use our facilities, I think, rate us quite highly, but actually we don't have that many that use our R&D facilities – maybe 200 companies in a year, and it's very difficult to get them to pay for R&D. I'd go as far as to characterise New Zealand firms, "short arms and very deep pockets". And that is tricky, because if firms aren't willing to put money on

the table, it's difficult for us to judge whether they're really going to do something with that R&D.

 **Donal Curtin** @donal_curtin:
Sarah Holden's 1st principles
#InnovateNZ point – maybe small companies don't do R&D because it doesn't pay them to?

...we know firms that invest in R&D generate more products, but actually it's not creating much profit for them.

Some of the data that we've analysed – and I think Simon's going to talk more about that as well – it's been very hard to find the impact on firms' revenue and profit. So we know firms that invest in R&D generate more products, but actually it's not creating much profit for them.

So I think that leaves me with the last question: it could be possible that actually the returns for small firms for R&D are very low and that most of the benefits are captured in spill-overs. And if that is the case, what does that mean for us as a government agency and the kind of products that we deliver?

Patrick Nolan: Thank you for your time.
Thank you Sarah. We will do a joint Q&A.



Panel discussion 2:

Professor Kaj Storbacka, University of Auckland

Kaj Storbacka: Yes, good morning. Patrick calls me Kaj. Sometimes I like that because I actually pronounce my name “Kai” and as you know kai is food in Māori and sometimes that’s a bit scary. [Laughter]

What I’m going to talk about today is about market innovation and I’m talking on behalf of Suvi Nenonen who is sitting over here too. We’re conducting research about market innovation at the moment.

...that’s maybe one of the problems in terms of making progress, that we are too focused on what other people think about us.

As you can probably hear from my accent, I’m not a Kiwi. I’m actually from Finland originally and that’s why I like the first slide which had Finland on it. I don’t know how much you know about Finland, but Finland is also a small economy and there’s a really good story that explains the characteristics of Finns very well, which I will share with you because I think it’s relevant. And it’s a story about a French

gentleman and a German gentleman and a Finn walking in the jungle. And then they found a really weird new animal that nobody had seen before, and started to discuss this and the French guy said “I wonder how this animal makes love?” [Laughter] And then the German said “I wonder how this animal functions and how can we improve it?” [Laughter] And the Finn said “I wonder what this animal thinks about me?” [Laughter]. And I think that’s what small open economies often think. Or they are very focused on what other people think about them, and that’s maybe one of the problems in terms of making progress, that we are too focused on what other people think about us.

So market innovation may be an answer to the questions Sarah posed. Our argument is that increasingly it’s not enough to just invest in R&D. It’s important to invest in R&D, but it’s not enough. You probably know that there’s lots of discussion about business model innovation at the moment. You see the Ubers and the thing going on around. We argue that that’s not enough either, on top of that you should also take a much broader view and think about how you could innovate markets. So I’m not saying either/or – I’m saying both/and. But I think that much of the R&D expenditure that we have could be much improved if we would spend some more money on market innovation. Now I’m going to also argue that market innovation is cheaper and it’s much more connected to revenue and value than R&D. So that’s going to be the premise.

 **Bill McDonald** @connect_nz:
#innovatenz @AucklandUni Market innovation is cheaper than R&D and markets are increasingly malleable

It’s important also for you maybe to note here that many of you have a more national economy view on things and we don’t. So just to make it very clear that we look at this from a firm level perspective. Our perspective is strategic management for individual firms, so there might be stuff here that feels a bit odd for you.

... the reason why we have mature markets is that people think that the market is mature and then they start to behave like it's mature and then it becomes mature.

But when we look at markets, strategic management at the moment is very much informed now by the major change going on in most societies, often driven by digitalisation and hence we are looking to other types of disciplines to understand what markets are. And increasingly the dominant view here is – as one of my colleagues said – markets are not – they become. There are no markets. Markets are because we think there are markets. So what I'm saying is that they are socially constructed. As one of my friends once said: the reason why we have mature markets is that people think that the market is mature and then they start to behave like it's mature and then it becomes mature.



So there obviously are markets out there but we have to think about that you can actually go out and shape – a socially constructed market can be reconstructed. The other really important thing as a starting point for how we view markets is that we like to look at markets as complex adaptive systems. And there's two really important ingredients in what this means, the first one being that if you start to look at complex adaptive systems you have to accept that markets again are not given. They cannot be fully planned so a really key ingredient of that would be emergence. So from an individual firm perspective one of the really key problems at the moment – that you cannot really plan, you cannot predict. So you have to somehow adapt, or be agile in adapting fast to what's going on in the market. So emergence is a key ingredient in this.

The second really important ingredient in all of this is that we also would like to challenge the idea of the value chain. That in fact value is very seldom distributed through a value chain. Value happens in a much larger system which is much more complicated than a value chain. And if you say value chain you automatically accept the idea that you define your market around product, which we don't think makes a lot of sense.

And so the basic argument here is that markets can be changed. Markets, markets are malleable and I would argue, or based on our research we would argue, that they are increasingly malleable. I'm going to talk a bit about that later on – that we are seeing that markets – all kinds of markets – are dramatically changing at the moment and I would argue that the biggest opportunity in New Zealand would actually be the primary sector and not the high-tech sector, when it comes to the malleability of markets. We've been working just recently with the primary sector and there's tonnes of really interesting things happening in that sector which could dramatically change what's going on.

These are some starting points that we build our thinking around. And now just a couple of words – what is market innovation and what is it not? Just to clarify what we're talking

about here. First of all most of businesses obviously are involved in what they call market share increase – so they try to sell more of the same stuff. Well, in our mind this is not market innovation. Here we are assuming that the market is given and the only thing that we're trying to do is to find ways to share that market. I'm not saying that you should stop doing that but I'm just saying that this is not market innovation. We don't think that market innovation is to enter a new market. Entering China – that's not market innovation in our definition here. So that's just more of the same, in a sense, because then again we're accepting that hey this market is given and we are exporting a product into a market which is given. And again, we are trying to fight for that market share.

...market innovation relates to somehow shaping what's going on in your existing market...

There are some elements in here that could be viewed as market shaping. So some companies are quite good at re-defining their business and by doing so finding new markets. That could be viewed as market innovation in a sense. But from our point of view market innovation relates to somehow shaping what's going on in your existing market, so we call that market shaping strategies; that you would actually go out and somehow look at that system that you're engaged in and then change various aspects of that so that more value can be created. Typically, we'd like to see then market level changes – not only that we get market share but the market grows. There's more profit to be shared, or more volume to be generated or something like that.

And then obviously there's one element that is very obviously market innovation, which would be that you have a new technology or innovation or whatever you have, and then you start to build a market around that. There's lots of documented evidence around that if you look

at innovation literature, so that's maybe not that dramatic.

We're interested in the two latter ones but particularly, maybe, in shaping existing markets. And if you think about what is the difference between the two to the left [increase market share; enter new markets] and two to the right [improve the current market; create a new market]? I think that really the simple key difference here is that the two to the right very often define their market around product.

I've been lately challenging people when there's a lot of talk here in New Zealand. We talk a lot about exports here in this country, and okay, this is not researched by the way – this is my personal thinking out loud. But I think that obviously exports are important, but there might be a mental blockage in using the word 'export', because automatically when we say 'export' we automatically define our market around product. We are exporting products. And automatically we end up in thinking about that our job is to get market share in a product market.

What's the problem with that? Well, I think the problem here is that if I have a product and I sell that product now to Patrick over here, what happens is then that he would pay me some money hopefully. And what happens then is we generate so-called exchange value. But the real interesting thing is that when he starts to use the stuff that I give him and create value for himself – and that's called use value. And the problem with exports is that automatically, we don't forget, but we allow us not to think about use. And I would argue that often use value is a much bigger value than exchange value.



McGuinness Institute

@McGIInstitute: Discussion on NZ focuses too much on exports; it means we focus on exchange value not use value – interesting!
#innovatenz

It's more interesting to understand how people use your product... not the product but what the product makes possible for the user.

It's more interesting to understand how people use your product. So not the product but what the product makes possible for the user. And by thinking export, we liberate ourselves from thinking about use. It becomes free on board and then you can forget it. And we all know that the big value is further up in the value chain. So hence we would need to somehow be involved in that.

I was thinking about statistics here when Sarah was introduced here. I was thinking whether statistics are measuring use value or exchange value? Yeah, statistics measure exchange value and I think that might be an institution that can be challenged, because that actually forces many companies to stick to product market definitions because that's the only thing that you can measure. And I could challenge you and I would like to say that the problem or the opportunity with use value market is that very seldom are use value markets mature. Product markets are very often mature but use value markets are not mature. So I see lots of opportunities in moving forward in the value chain and thinking about how could we get access to this use value in a different way.

The other thing which is important if you compare the stuff to the left with the stuff to the right here in the slide, is that if you look at the stuff to the right there's one big difference here. So if I open up so you can see: on the left-hand side I call this, or on the slide, it says "competitive strategy". So if you think product market share, automatically you think competitive strategy. You compete for market share. And I think that the whole notion of being focused on competitive strategy, which by the way, most small countries for some odd reason were really focused on. Finland and New Zealand

are the only countries which are completely "Porterised". All strategy is based on Porter's Competitive Strategy from the 80s – from the 80s! It's quite a long time ago.

So I'm arguing that what happens, if you want to shape the market you very seldom can do that alone. We have to enter into some sort of the shaping strategies collaboratively. So we're talking collaborative strategy not competitive strategy. We need to join forces. And due to technological change the size of the company in the future is not as important as it used to be. So if small companies can join forces we can do lots of really interesting things to shape what's going on. But that means that we need to learn to collaborate in order to make a bigger pie that we can then share. Which, by the way, then means also that then competitors will gain from this too and not only you.

The questions that we need to ask if we think about this is what can you shape and how do you do it? I don't have time now to go into details. That's what our research now is all about. I'm just going to show you two examples of this. The first one from Finland.

This is a large company. When we investigated this we found that both small companies and big companies can shape markets, but this is a big company from Scandinavia called Stora Enso, one of the biggest forest companies. What these guys have done is that they have lobbied for a long time to get legislation in Scandinavia to change so that you can build high rises out of wood. In the old days you could only build two storeys high because we used to burn the cities in Europe on a regular basis so they thought that building out of wood is not a great idea.

So they lobbied that and they got the change in the building codes so you could build high rises and then they were really happy about it but nothing happened. So they realised that it's not enough to change regulations. You have to do other things. So what they did was that they built a case around that. They framed the market to focus on residential in urban places. They chose a specific technology called cross-lighted timber, a very good product to build out of. They scoped the solutions so that

they actually built elements which are then assembled on the construction site. They took a temporary role extension so they are now actually co-builders and co-developers. They engaged with a lot of architects and engineers to get this to work in practice and they also created a standard, a wood building system in order to encourage competition, because their notion was that this market will never fly if there's only one supplier.

...[market] shaping is a multi-faceted thing. It's not something that you shape one thing and then something happens. We have to shape many things and it takes some time.

And then they went in to the industry association to change the way that the concrete guys looked at buildings and changed standards in there and obviously used media. And now they are building these very, very beautiful buildings, which actually this particular building won the prize for the most beautiful building in Finland last year – up to eight storeys high. Consumers loved these buildings because there is something special about them. When you walk in you realise that you are in a wooden building and not in a concrete building, and, there, there's some sort of feeling in that. So just to give you a notion about that [market] shaping is a multi-faceted thing. It's not something that you shape one thing and then something happens. We have to shape many things and it takes some time.

Another really good example which happens to be from New Zealand and which I particularly like is the New Zealand screw cap wine sealant initiative. How many of you know about that? Very few of you know. The reason why we see an increase in screw caps on wines at the moment is that these four guys started a movement

around that which took them only four years to change the whole industry, which – and this is, by the way, there are three Johns here, so John Forrest, John Stichbury and John Belsham and Ross Lawson. They're burying the cork in Marlborough just as a symbolic action. And they used large scale events like this and fact-based arguments that actually wine with a screw top is as good as anything else. So a capability to understand, timing and understand how to involve central actors in the market to shape this.

And finally, I'm just going to say that interestingly enough, also now many of the big management consultants are starting to understand that there's something going on here and there's a really interesting book out there called *Your Strategy Needs a Strategy*, where they are actually arguing that, that malleability is increasing and predictability is decreasing. Which means that we are going to need new types of strategies. They call them shaping strategies. And they also made a really interesting analysis of all strategy tools available for companies and what they found was that there are very little tools around the market shaping strategy at the moment. They only found four. And hence, we think that this could be something for a small open economy to be the world leader in market shaping. That's my suggestion.

Patrick Nolan: I'll introduce Shaun, but for those people standing at the back there's seats at the front, or if you'd rather stand that's fine too. Shaun.



Panel discussion 3:

Professor Shaun Hendy, University of Auckland

Shaun Hendy: Tēnā koutou katoa. I was asked to talk about the role of networks and innovation, but perhaps I'll just start by talking a little bit about our research centre at Te Pūnaha Matatini. So the literal translation of Te Pūnaha Matatini is the meeting place of many faces and that actually has two meanings for us.

The first is that we're a multi-disciplinary research institute. So we have people like me, physicists, interacting with economists, social scientists, mathematicians, computer scientists and we even have an anthropologist working in the centre.

But also we're a distributed research centre so we're one of the Government's Tertiary Education Commission-funded Centres of Research Excellence and most of these centres are distributed around the country. So we have researchers at Auckland University where I'm based, University of Waikato, Massey University, Victoria University of Wellington, Canterbury University and Otago University and then we have researchers at two non-tertiary partners: Motu Public Policy and Economics Research and Landcare Research. So we're many faces in several different ways. And we focus on a range of topics including innovation, and I guess this is what brings me here today.

Where does innovation come from? Now I realise there's a few people in the room who are

from overseas, who this won't be causing pain to, so let me explain why this is causing pain to New Zealanders in the audience.

What is it about a place; why do certain places seem to be more innovative than others?

This is the underarm bowling incident where after 100 years of cricket the Australians realised that there was nothing in the rules that said they couldn't bowl underarm. So when New Zealand was very close to winning this one day match, the Australians innovated and bowled underarm and, of course, won the game thanks to this. Now normally as New Zealanders we analyse this and put it down to defects in the moral character of Australians, but it could just be that they're more innovative than us, and indeed, when we look round the world we do see places and environments that seem to create more innovation than other places. And I guess you'd call this subject the economic geography of innovation. What is it about a place; why do certain places seem to be more innovative than others?

So that's what I'm going to talk to you a little bit about today and the role of networks in that. Okay, my publisher would be upset if I didn't throw in a shameless attempt to sell more copies of my book, *Get off the Grass*, which does cover some of this material. But actually I like using this image because there's an innovation on the cover and that's the barcode that if, when you go out and buy my book later on this afternoon, they'll scan the barcode at the cash register. And it's an instructive example. Where the barcode came from gives us a model for how innovations occur and it will be the model that I'll use today to try and understand the role of networks in innovation.

So if we look back to where the barcode came from. Well, actually the barcode was first developed by Amtrak in the United States and I'm not sure how easy that is to see, but

here's a railway wagon with a set of coloured stripes painted on the side of the railway wagon. And the idea was that Amtrak would use this to keep track of where its wagons had ended up. I guess they were losing wagons in different parts of the country and so they wanted to have some systematic way of labelling these wagons. It didn't work. They abandoned it after a couple of years. So it's an example of perhaps an invention that didn't go on to become an innovation. It didn't go on to prove itself useful.

...a large number of innovations come [about] because two ideas that themselves are not necessarily useful meet in some way and go on to produce a useful innovation.

But actually it had to wait to encounter another invention, and that was the laser. Once you put together a barcode, a set of black and white stripes, with a laser that could read that barcode, you could scatter the light off the barcode and detect the light coming back, then you suddenly had a useful invention. And at the time when the laser was invented there was really no use for it. People made it because they could and surely it's going to be something – it'll be useful. But it didn't actually have a market driver creating it either. It was only when these two things met and were combined together, put together, that we actually had a useful innovation. Okay, so that's the recombinant model of innovation. Not all innovations occur this way, but a large number of innovations come [about] because two ideas that in themselves are not necessarily useful meet in some way and go on to produce a useful innovation.

 **Bill McDonald** @connect_nz:
#innovatenz @hendysh Invention
+ Collisions thru Collaboration =
Innovation

And the entity or the social construct that we talk about when we think of the ways that ideas, inventions are meeting and interacting, are sometimes called the innovation ecosystem. So we have this concept that there's some sort of ecosystem out there that's supporting and facilitating the exchange of ideas so that they come together, they meet and they go on to produce useful innovations.

I've got into this problem by looking at patents, and so in fact the map we've got here is a few years old now, but what we did is we looked at a large patent database, we looked at all the individuals named as inventors in that database and then we looked at where individuals co-invented particular inventions – because we looked for where they were named on the same patent. And from that we could work out in some ways the social network of innovators in New Zealand and of course we could also look at how they were linked to people overseas. And in some sense we're looking at a representation, a slice in some way, through the innovation ecosystem. We're looking at how people have worked together and presumably exchanged ideas to come up with new inventions.

And you start to be able to say some things about different places, some characteristics and of course these are based on patents. And patents are a very useful dataset because they're open and they're transparent, but they don't tell us everything, necessarily, about innovation, but there are some very interesting things that tend to come out. And we see these things not only in New Zealand but people see the same effects happening overseas.

... larger cities produce more patents per capita.

One of the stylised facts that people see with patents is that larger cities produce more patents per capita. So if we go from Wellington to Auckland – we’re going from, from a smaller to a larger city – and Aucklanders are producing more patents per person. If we go offshore to Sydney, Sydney’s a larger city than Auckland. Sydney is producing more patents per capita. And if we go from Sydney to Tokyo, Tokyo is producing more patents per capita. This is a consistent trend that we see across the developed world. So that’s an interesting stylised fact.

...the larger the city, the denser the network of innovators in that city.

The other thing is we can zoom in and we can actually look at these networks. It’s not just about counting patents. We can actually look at the characteristics of networks in different cities. And again another stylised fact is that the larger the city, the denser the network of innovators in that city. So in some ways this is a little bit counter-intuitive because we often think in a bigger city you’re less likely to bump into someone you know. If you come from a small home town, you go back to that town, you’re going to bump into your relatives but in a bigger city you don’t expect to know as many people. But of course the bigger cities are supporting richer, denser social networks of innovators. And again this is something we see in New Zealand and people see overseas.

...larger cities are producing more diverse portfolios of technologies.

The other interesting thing is that larger cities are producing more diverse portfolios of technologies. So when you look at the range of patents being produced, again the larger the city, the more diverse the range of technologies that are being patented in that city.

...the cities with more diverse technology portfolios, which tend to be the larger cities, also have more novelty in those portfolios.

And then finally the cities with more diverse technology portfolios, which tend to be the larger cities, also have more novelty in those portfolios. This last fact, there’s still a lot to be thought about here because there’s still a lot of disagreement about how you measure novelty, but in this case what I’m talking about is the fact that cities with more diverse portfolios are doing more things that other places aren’t. So that’s my use of the word “novelty” here: they’re doing things that other cities aren’t.

This is, of course, a challenge for New Zealand because we don’t have large global scale cities. We don’t have the cities that support the same density of innovators and we don’t have the cities that support the same range of diversity as some of the places that are innovating strongly overseas. And so when we want to think about policy solutions for New Zealand, we have to take these factors into account and think about how this might affect and limit our ability to do things.

I’m just going to talk about two different types of networks. You can look at networks in a number of different ways from these datasets. This is what you might call a traditional inventor network. It’s based around a company, so we can look at a particular company – in this case Nokia – and we can look at the inventors that came together to produce a piece of



technology like this, the Nokia cell phone that probably 10 years ago we would have all had in our pocket. And so each dot here is an individual. This is an engineer at Nokia, and the lines connecting them are where we see a relationship because they've co-patented together. So this is in some sense why companies exist. They exist to bring people together with a range of skills so they can produce novel products. This is what I would call a traditional network, based on the unit of a firm. And it's important to recognise that these still play a very key role in invention and innovation.

But actually the network I wanted to spend a bit more time on is to do with open innovation. So this is based on a PhD project with one of my students, Katrina Sissons, and she's looking at where companies work together. So we can look at where individual inventors have co-invented; we can also look at where companies have come together and have joint ownership of a particular patent, and so this is what she's looking at in her PhD.

And actually if we go back in time into our dataset, we can see that back in the 1970s this

is a relatively uncommon thing. Companies didn't tend to jointly own patents. But we first see it starting to emerge in Japan and so actually Hitachi in the 1970s seemed to have started this practice of co-owning patents and so the big dot in the centre – the dots are scaled by the number of patents that each company is producing – the big dot in the centre is Hitachi and the big dot next to it is actually the Japanese National Rail Corporation. So in Japan there are a number of different companies that came together in the 1970s and were presumably jointly developing technologies and jointly developing R&D. In today's terminology, we'd call this a form of open innovation. It doesn't describe all open innovation, but certainly you'd describe it as a form of open innovation where presumably firms are sharing knowledge in order to develop new products.

We can track this network through the next few decades. If we go into the mid-1980s you'll see that the practice has spread in Japan, but now you see firms in the US, Germany and France starting to share and co-own intellectual property. We can get into the 1990s and you'll

see that it's actually become as strong in the United States as it is in Japan. We can move through and start to see it become very strong practice, particularly in Germany now as well and to a certain extent in France, but it certainly has kept on going in Japan and the US. The early 2000s we start to see Korean firms entering this network and adopting this practice. Then our most recent dataset, a few years ago we start to see Chinese firms adopting this.

 **Donal Curtin** @donal_curtin:
Absolutely fascinating spatial analysis of networks of patents at #InnovateNZ from AKL Uni's Shaun Hendy...

...firms that are sharing patents are producing about two-thirds of the world's patents.

The total number of patents that are being shared by firms is a little under 10% of all patents, but the firms that are sharing patents are producing about two-thirds of the world's patents. So in some sense it's become quite an important business practice that's adopted by many of the firms that are technologically innovating.

...how much is the technological overlap between what they share and what they don't share?

It's interesting to look at – and this is my last slide – at what their strategy is, why are they exchanging and sharing patents? Well we can analyse that by looking at two things about

the things that they share and the things that they don't share. We can look at the patents that they've shared with other firms and those that they've developed themselves and don't share with other firms and we can look at this on two axes. One is the technological proximity between the things that they share and the things that they don't share. So by looking at the classifications of patents we can get an estimate of how far away in technology space, if you like, are the things that they're pulling together and sharing – the things that they're not sharing and they are sharing? And how much is the technological overlap between what they share and what they don't share?

Now if you're a perfect open innovator – if you actually don't really care whether you're sharing something or not, then you'll sit on this dotted line. You'll have no particular preference whether you do it in-house or whether you do it with some other firm.

If you're a slightly more selfish entity or a more closed innovator, you're going to sit down here. You're going to have a core of technologies that you keep to yourself and you'll be sharing things that are on the periphery of those core technologies.

If you're up here, you're some sort of outsourcer. You're looking outwards more than you are internally. So we can analyse every firm and we can see where they sit on this map, and we see, to a large extent, they're sitting down here. And this is based on the ideas associated with open innovation – this is probably what we'd assume is most common. Firms are keeping a core of technologies to themselves. That's their core expertise in some sense and they're sharing things at the periphery. So they're sharing things at the periphery with other firms' core knowledge. That seems to be the business practice.

And just to put a few companies up here, here's Unilever and Philips. I think Unilever actually advertises itself as a great open innovator. You can see it's nice to see that theoretically they're sitting close to the open innovator line. Then the companies that are up here, the unusual ones, they just tend to be pharmaceutical

companies. So they don't seem to be developing core IP [intellectual property] to themselves anymore. They seem to be much more engaged in looking outwards and outsourcing.

...these firms are looking for ways to recombine their core technologies with the core technologies of other firms to produce novel innovations.

Really I've just presented two types of networks that we see in our database. One that's very traditional – one that exists to bring people together, to work together within a firm and of course that firm owns the intellectual property. And these are important because they do bring together the skills and capabilities that a firm might need to support a complex innovation. But increasingly we're seeing this other type of model, other type of network emerge, where companies are working with each other. We think – and that previous slide supports this – that these firms are looking for ways to recombine their core technologies with the core technologies of other firms to produce novel innovations. Thank you.

Discussion



Patrick Nolan: Well, thank you to all our speakers who so perfectly stuck to time. We've got about 25 minutes or so for questions. Sarah kicked this off, talking about Callaghan's mission to increase the level of business expenditure on R&D and the billion dollar question, so it's quite nice to have a quantifiable number there. Also she gave the example of the firm drikolor and categorised New Zealand firms as having short arms and deep pockets, and so that's certainly something that we can maybe pick up on in the questions.

Kaj talked about one of the challenges of being a small, open economy is that we tend to focus on what other people think about us, but also that we need to think beyond just an expenditure on business, expenditure on R&D and think about market innovation. He also discussed what market innovation is and what it isn't and discussed the importance of market shaping strategies and creating a new market. And he distinguished exchange value from use value as well.

...should we be just be thinking domestically or should we be thinking internationally? In a sense is this sharing and this coordination, how much of this has to cross borders and how much of this has to involve global value chains?

Then Shaun, as you just saw, not only did he remind us of the underarm bowling incident, but he talked about the importance of the innovation ecosystem and also drew out some of the challenges for New Zealand, particularly issues around scale and density and why companies share and don't share.

This is very much a working event, so I'm hoping that you all have heaps of questions. I'll just pick up on one and it goes back to this point around companies sharing and also companies working together and it's for all three panellists. One of the issues is our small companies and whether or not we could get them to coordinate more, and this is something that Kaj mentioned, but when we're thinking about this should we be just be thinking domestically or should we be thinking internationally? In a sense is this sharing and this coordination, how much of this has to cross borders and how much of this has to involve global value chains?

I might start with Sarah and then we'll walk down the panel that way.



...you can't underestimate... the value of face-to-face contact, to build up those relationships and build trust and once you do that you start to get more creative ways of working together, sharing IP and formation in the value chain as well.

Sarah Holden: Actually it's a great question. One of the things we've been piloting is getting groups of companies together who might have a shared interest: they might be working in the same sector or they might be interested in the same technology for different applications. Then we're taking them to international events, where you've got up to 3,000 companies working in that same area. What we're finding is that actually the act of taking them overseas and in a plane forces them to create quite strong connections together and they work out new ways in which they can collaborate and do business and also they start to form new types of relationships internationally. And I think our experience is that you can't underestimate, or it's really important not to underestimate, the value of face-to-face contact, to build up those relationships and build trust and once you do that you start to get more creative ways of working together, sharing IP and formation in the value chain as well.



Patrick Nolan: Thank you. Kaj.



...collaboration internationally probably is even more important and... that would then lead to national collaboration also...

Kaj Storbacka: Yeah well, that's a big question. [Laughs] Just a short answer, I think that there's nothing that would say that you would do this only domestically. In fact if you do it domestically, there might be anti-trust questions that need to be addressed and so on. When I talk about collaboration I think it's important also that I don't talk about collaboration within one industry. I also talk about collaboration between industries. In fact, most industries are defined around product, so I would somehow, sometimes also challenge [laughs] the whole industry definition in terms of if you want to shape a market. Also I think if you're interested in getting into the use value, or getting a share of the use value, the only way to get a share of the use value, or a central way of getting a share of that use value is to do that internationally – because the use value in many product categories, if I use product categories now, is actually created somewhere else than in New Zealand. Hence I think that the collaboration internationally probably is even more important and I think that would then lead to national collaboration also if you do that internationally. So I would be interested in looking at the international aspect of this.



Patrick Nolan: Right, thanks. Shaun.



We still think of cities and regions as being very important units for innovation because information decays with distance.

Shaun Hendy: Yeah, so as a small country we certainly have to look to collaborate internationally, but we do have to recognise the challenges. Underlying some of the stylised facts I gave you was the fact that face-to-face interaction is really important, and so there's an agglomeration effect. We still think of cities and regions as being very important units for innovation because information decays with distance. It's harder to exchange complex information across distance. So yes, how we perform is always going to be dependent on our international links, but those links will be costly. It's interesting, putting people on planes in order to get them to [laughs] talk to each other. So yeah, I think that's a really good way of doing it in some sense. Not only are you building international collaborations but you're also engineering domestic collaborations that hopefully survive the international trip.



Patrick Nolan: Wendy McGuinness and then Eric Bartelsman and then Mark. Wendy, I know who you are but if you could just say who you are and where you're from and we'll capture that in the transcript.



Wendy McGuinness: Okay, Wendy McGuinness, McGuinness Institute which is a little thinktank in Wellington. I'm really interested in exploring the difference between use and exchange value and your comment that focusing on exports actually provides us perhaps not the right direction going forward. My understanding is that you're really talking about a cultural change there and I'm really interested to understand how that could play out, how you could make that happen. And I see the very strong relationship between the other two speakers, in response to that, because you're talking about the same thing. It's just that's another door into this discussion and I'm really interested in it. Thank you.



Kaj Storbacka: Yeah, so if I start. Just to get it really clear: I'm not against exports. [Laughs] Obviously exports are really, really important. But if I continue the example that Shaun mentioned here, again being a Finn, so obviously it's nice to talk about Nokia, or maybe sad to talk about Nokia, I'm not really 100% sure. [Laughter]

But anyway, so if you take Nokia as an example there was lots of research done about Nokia in their heyday, on where is value created? And the question was, does it make any sense for Finland that we have Nokia and they manufacture phones in China and sell them in Asia somewhere. Does that create any value to Finland? And the interesting thing was that there were lots of studies made about that and they actually could easily show that the majority of the value was actually captured in Finland, although there were no exports. Nokia had the patents and they had the technology and they were running this thing and so on.

So from that perspective, I think one of the issues would be that how could we be economically active somewhere else than in New Zealand? And again, that might require collaboration because it's obviously a question of capital and how can we create that amount of capital so that we can build or establish some sort of activity abroad?

KONE [is] the second largest elevator company in the world... nowadays, they define themselves not as an elevator and escalator company but they actually claim that what they're delivering is people flow.

If you think about use values, in terms of cultural change, it might also start from simple things like companies re-defining their own way of thinking about themselves. So if I can continue with a Finnish example, there's a very excellent Finnish company called KONE, which actually means machine in Finnish which is a weird thing, but it's an elevator company. It's the second largest elevator company in the world. Actually, nowadays, they define themselves not as an elevator and escalator company but they actually claim that what they're delivering is people flow. And when you hear that the first time you think that hey these guys are crazy, but they have some really good arguments around it.

...the CEO of that company... once said that maybe a really good matrix of success would be decreased market share, and people were looking at him that the guy's crazy.



Kaj Storbacka: Their argument is that people buy these escalators and elevators to create some sort of people flow within building or in metro stations or whatever and that's what creates value. And if you can optimise that then obviously your business is much bigger. So even the CEO of that company in one big conference once said that maybe a really good matrix of success would be decreased market share, and people were looking at him that the guy's crazy. But he meant that why don't you take a bigger denominator, put yourself in a bigger market where there's more things happening. And now suddenly IBM is looking into intelligent buildings and Google's looking into internal navigation in buildings and suddenly they now are part of a much, much bigger ecosystem, if I use Shaun's language here, that creates a lot of interesting opportunities for them.



Patrick Nolan: Shaun and Sarah do you want to come in on that as well?



Shaun Hendy: I'm happy with that guy's answer. [Laughter].



... if you don't get exchange value at the same time, then what are the incentives for a business to create use value on its own?

Sarah Holden: I think one of the interesting issues for us – definitely if you stand from an economy perspective – use value seems to be where we're getting a lot more of the growth happening. But if you don't get exchange value at the same time, then what are the incentives for a business to create use value on its own?



Patrick Nolan: Great. Eric Bartelsman, we're just waiting for the microphone.



Eric Bartelsman: I'll keep it short because I have the opportunity to speak this afternoon, but I enjoyed all the presentations and I'm actually sitting there in my head trying to lump them together. They're all from three different perspectives and types of language and communication and so I'm trying to find words to fit in the way I would speak about this. So I think there's more commonality than we might know.

Do you have any evidence that the cost of distance in collaborative R&D has gone down?

In particular though I'm interested in one thing that has to do with the distance and you said there's cost of distance – this is particularly to Professor Shaun Hendy – there's cost of the distance in terms of collaborating on R&D, but it can be testable whether that cost of distance changed before 1995 and after 1995 because of the internet. Do you have any evidence that the cost of distance in collaborative R&D has gone down? And then maybe it's not 1995 with the beginning of the internet – maybe it's 2008, Nokia and Smartphones. But are there discrete jumps in those costs?



Shaun Hendy: Yeah, so I'm not as up to speed on the literature as I should be on that. What I think is that the advantage of agglomeration and knowledge creation seems to be getting stronger. So in our data we're seeing that advantage grow over time, so that doesn't seem to be affected by these technologies that we have for collaborating and trading information. And I think it comes down to the value of the information that you're able to trade, the tacit versus the codifiable information. So yes the costs for transmitting codifiable information – the things you can send in an email or exchange through a written document – that's come down, but also I think the value of some of those things that we can share that easily has come down, and so the value is now in these very difficult things that you'd require face-to-face. Those are the things that have the uniqueness now, that are difficult for other places to compete with you on. If you can pull together those face-to-face interactions that will allow you to exchange and build on very complex information, tacit information, then a lot of the value I think is now associated with that.

I'll do anything to avoid having a video conference.

So yeah, video conference and those of us that use video conferencing technology, I really don't like it [laughs]. I'll do anything to avoid having a video conference. It does save me times on planes, but trying to talk through complex ideas or where you're dealing with a complex social interaction where you might be talking with another organisation or there are funds involved, that's always easier to do face-to-face.



Patrick Nolan: Sarah and Kaj, do you want to pick that up? How dead is distance, I guess is the question?



After a very successful video conference in the early 2000s I bought shares in Polycom and... they've completely flatlined.

Sarah Holden: Well, it's a quip really. After a very successful video conference in the early 2000s I bought shares in Polycom and I don't know if any of you have watched the shares in Polycom, but they've completely flatlined. No, I think the face-to-face contact's really important.

One thing is interesting. We have a facility called Global Expert which is a search engine to help companies find the world-leading expert in a particular field and we've found a 10-fold increase in that search facility over the last two years. So I think for certain things – that's only one data point, but it does seem people are using the internet where it makes sense for a fairly easy transaction. And certainly again, visiting Fisher & Paykel last week, they said look, we can get the world's leading expert three clicks away at the bottom of a train line in Cardiff. So companies are obviously using it. But is it really important in driving their strategies for growth? I don't know.



Patrick Nolan: Mark, and we've got two more which I'll take as clusters, so go for it Mark.



Mark Cox: Mark Cox, BERL Economics. Question for Sarah. Sarah, you alluded to the difficulty in engaging smaller firms in R&D and I understand that Callaghan Innovation have got some programmes where, rather than waiting for small companies to come to you, you can put postgrads and PhD students into firms to work on fellowships. I wonder if you could tell us more about those programmes and how they're going.

...in those small niche start-up companies, we're doing really well. The challenge is, can those companies grow?

Sarah Holden: I'm looking desperately to see if there's someone from Callaghan who can speak more knowledgeably. I think, there was certainly an earlier evaluation that showed that our student internships where we placed students in a company for a few months, did actually have a positive impact on the company. The start-up community is really vibrant in New Zealand, and in fact if you go to any of the incubators around the country, it's quite impressive the number of companies that are coming out of there. So I think in those small niche start-up companies, we're doing really well. The challenge is, can those companies grow? And so what I'm seeing is we've got a number of companies on our portfolio, really exciting products, but they're still there 10 years later and they're still the same size.

Patrick Nolan: Okay, so we're going to take a cluster of questions. We'll start there and then Arthur Grimes and then Beth. And we've got one over there, but we'll see how we go for time.

A lot of low tech manufacturing is actually hugely innovative but they're not necessarily getting patents for it. It's just constant innovation and that's not necessarily captured.

Catherine Beard: Catherine Beard, Business New Zealand. My question's for Shaun, I think. Are patents the best proxy for innovation? There was a good article in The Economist recently that said actually the IP system that we know and love's getting a bit 20th century and it's actually blocking innovation. A lot of low tech manufacturing is actually hugely innovative but they're not necessarily getting patents for it. It's just constant innovation and that's not necessarily captured. Could you comment?

Patrick Nolan: And Arthur, if you ask; we'll take them as a cluster.



We seem to downplay this extraordinarily high-tech sector [agriculture] and yet Kaj's work would suggest that market shaping for this sector might be far more important than much of the other so-called innovative activity that we're doing.

Arthur Grimes: Thanks. Arthur Grimes, Motu. I just wanted to contrast Sarah and Shaun's talk with Kaj's. Both Sarah and Shaun seem to be downplaying one of our really high-tech industries, which is agriculture. It's very high tech. I don't know if you've been to a farm recently but it's an incredibly high-tech industry, and for a start they convert vegetable matter into animal matter which is unbelievable. But more than that it's very fast productivity growth and over the last 20 years it's probably been the fastest of all our sectors. We seem to downplay this extraordinarily high-tech sector and yet Kaj's work would suggest that market shaping for this sector might be far more important than much of the other so-called innovative activity that we're doing.



Helen Anderson @HelenAnderson43: Great question from Arthur Grimes #innovatenz – why are the primary industries not considered high tech? Been on a farm recently?



Patrick Nolan: Okay, great and Beth. And if we could get the microphone over there as well. We'll take them all at once.



Beth Webster: Thank you. Beth Webster of Swinburne University. A question just for Shaun. One of the problems we have in this area of economics is we slide between the "what is" and "what ought to be" pretty fast without realising it. So your pattern data really tells us what is happening. Now to go from that to, is the collaboration a really good strategy, one that we would recommend others follow, you actually need to link that up with firm performance, firm survival and all that sort of stuff. Are you planning on doing that?



Patrick Nolan: Okay, and then the final question over there.



| ...what can governments do to promote innovation[?]

Carlos Abeledo: Yes Carlos Abeledo from Buenos Aires, Argentina. I came all the way to this seminar. One question for Sarah. Sarah, in the presentation was a question that was left open. She was asking what can governments do to promote innovation and I would like to see if you could offer some tentative answers to that.



Patrick Nolan: Thank you Carlos. So we have four very good questions. Catherine started off by asking whether or not patents are a good proxy for innovation. Arthur pointed out the slightly different perspectives on the role of agriculture. Beth asked Shaun if you're going to link your work on collaboration back to firm performance. And then Carlos asked Sarah what could governments do? So a lot of very big questions and you've got about four minutes to answer them, [laughter] so what I'll do is start with Sarah and you can pick and choose, and we'll then go back this way. Thank you.



Sarah Holden: I'll do the easy one which is the primary sector and high tech. Sorry, I was using the OECD definitions of high, medium and low technology sectors, so I didn't mean to be pejorative in any way about the primary sector.




Kaj Storbacka: Can I just make a comment about this particular question because I think it is interesting. I used to, in the 80s, work a lot with what then was called service companies and there was lots of debate about manufacturing versus service companies and so on and nobody talks about that any more. Now we talk about manufacturing economy versus service economy. Everything is service now, and I would argue that's the same with high tech. It's not a firm or an industry. It's a fact that the society has changed, so we are all high tech. To describe some industries as high tech I think it is 90s. [Laughter].



We don't get spill-overs necessarily from other industries back into agriculture.

Shaun Hendy: Okay, I've got three minutes, a minute per question. So Arthur, I think my worry about the ag sector is around the distribution of spill-overs and I guess my concern is if we're very focused on that one industry sector, we don't take advantage of the spill-overs we could be getting from it, for example, in other industries and vice versa. We don't get spill-overs necessarily from other industries back into agriculture. This is where my interest in diversity of technologies comes from and we are very low diversity for an advanced economy. So that was my answer to that one.

 **Helen Anderson** @HelenAnderson43: #innovatenz @hendysh NZ's problem is low diversity in our economy so primary sector doesn't get spill in from tech sector. Not sure ...

...patents aren't the perfect indicator of innovation...
[but] I think they're still an important thing to look at.

Catherine, I think you asked about whether patents are a good indicator of innovation. I think there were actually two bits. My answer to that question is usually two parts. One is there's a difference between whether the patent system is effective and whether patents are an indicator of innovation. The analogy I use: if you're driving your car, wind resistance is slowing you down but actually it's still a good measure of speed. [Laughs]. So that's one answer. But of course patents aren't the perfect indicator of innovation. There is a lot that you don't capture by looking at patents. You really are looking under the lamplight for your keys, and I guess you've always got to be cautious about things that you might generalise from studying patents to other areas. But still, because we've got that great visibility on that dataset, I think they're still an important thing to look at.

And then Beth – yes – [laughs] – that was an easy one. Yes, something that we're working towards now is trying to not only look at types of patents, counts of patents, sharing of patents, but then at how firms perform and relating that to where they sit in that ecosystem. So yes, that's something we're working on at the moment.



Patrick Nolan: Great. Well thank you to all our panellists. What a fantastic start to the day. If you could just join me in thanking the panellists in the usual way. Thank you. [Applause].

We now have morning tea and then we'll be back here at 11 to hear two keynote addresses from the New Zealand Treasury and from HM Treasury.

Also, I've been monitoring Twitter as I've been going, so Arthur you'll be pleased to know Helen Anderson tweeted, "Great question from Arthur Grimes [laughter] why our primary industry's not considered high tech." Bill McDonald, I saw you over there, you've tweeted a few times, so thank you for that, Bill. Talked about Callaghan's work on global experts, access to global experts at the click of a button. Donal again tweeting like a legend and discussed Shaun's work and absolutely fascinating spatial analysis. Please do keep the tweets coming in and as we go through the day I'll report back to you. Enjoy your morning tea.

Session 2

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Patrick Nolan: Okay, well thank you all. I hope you all enjoyed your morning tea and got plenty of caffeine. From the buzz in the room, obviously the Wellington coffee was as good as ever. So welcome to the second session of the day. This is very much a Treasury-themed session.

We're going to hear from Gabriel Makhoulf. He's the Secretary and Chief Executive of the Treasury. Gabriel was previously in the UK civil service where his responsibilities ranged from policy development on domestic and international tax and welfare policy through to large-scale customer-focused operational delivery.

We will then hear from Sir David Ramsden who's the Chief Economic Advisor from HM Treasury. Dave was appointed to the Treasury Board in June 2007 and in 2008 was appointed Chief Economic Advisor. He's also the Head of the UK Government Economics Service and very kindly spoke for us yesterday at the Government Economics Network event, so I'm very much looking forward to hearing him again. He's also a Trustee of Pro Bono Economics and is also President of the Society of Business Economists, on the Council of the Royal Economic Society and a Governor of the National Institute of Economic and Social Research.

I'm very much looking forward to hearing these presentations where the speakers will link back some of the earlier discussions and the theme of innovation back to some of the issues around the broader economic narrative. That's enough from me. I'll pass over to Gabriel. Thank you.



Keynote address:

Gabriel Makhoulf, New Zealand Treasury

Gabriel Makhoulf: Thank you Patrick, and good morning everyone. I'm very pleased to be here and even more pleased to be delivering the first of today's keynote addresses alongside my friend and colleague Dave Ramsden.

When I spoke to the inaugural Productivity Hub Symposium [in 2013] I noted how a cross-agency body like the Hub models the right approach to understanding productivity and its challenges. I'm confident that gatherings such as this, bringing many perspectives, experiences and values together, generate ideas that should be good enough to survive formidable intellectual examination and debate. And since that symposium two years ago, the Hub's done a lot of work to unpick the so-called paradox at the heart of New Zealand's productivity.

Why do our very good policy settings, combined with our immense natural capital, our skilled and energetic workforce and our reputation for innovation and agility in business, leave us with persistently low productivity growth compared with other countries?



As Paul Krugman said...
“Productivity isn’t everything, but in the long run it is almost everything. A country’s ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker.”

Now productivity – that’s going to be the structure of my talk and I’ll come back to that – now productivity does, of course, matter. As Paul Krugman said over 20 years ago now, “Productivity isn’t everything, but in the long run it is almost everything. A country’s ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker.” I agree with Paul Krugman.

I pointed out to somebody, more than one person actually over the past few years and quite recently, that the answer to improved productivity is not a lower exchange rate. And you will be surprised, the number of people who actually think a lower exchange rate is the road to greater productivity. And actually that’s a concern. I told this individual that if that was the way that he thought, he was on the road to doom, and he was both shocked and unhappy at that. But if only the newspapers actually spent some time talking about productivity rather than talking about the exchange rate, we might get a better and more informed discussion out there.

...the answer to improved productivity is not a lower exchange rate.

But moving on, it’s important that we’re clear on some other things that also matter and I hope it won’t surprise anyone in this room if I say that it remains a fundamental truth that

successful economies need, among other things, a stable and sustainable macroeconomic framework, sound monetary policy that delivers stable and predictable prices, a prudent fiscal policy and debt that's under control. And it remains true that a well-regulated financial system matters, that properly functioning markets matter, that price signals matter and that incentives matter.

...we have a productivity challenge and all sectors of the economy need to respond to it. The public sector... has a big role to play in contributing to improve its own effectiveness,... and business needs to play its part too. In fact, how business responds is at the heart of the productivity challenge.

But first let's turn to some facts. In terms of official productivity statistics, average annual labour productivity growth has been 1% over the period 2008 to 2014. Multi-factor productivity growth has averaged 0.1% over the same period, so that capital deepening contributed the remaining 0.9%. There's been a slowing in average labour productivity growth over recent growth cycles to around 1.3% per annum, and amid the global improvements in trend productivity associated with the benefits of ICT, New Zealand's per capita income gap with the OECD average did not materially reduce during this period – this despite the fact that our average real GDP growth was 2.6% over the 1995 to 2013 period. So we have a productivity challenge and all sectors of the economy need to respond to it. The public sector is a big part of the economy and has

a big role to play in contributing to improve its own effectiveness. That's a road we've been travelling on and will continue to travel, and business needs to play its part too. In fact, how business responds is at the heart of the productivity challenge.

 **Helen Anderson**

@HelenAnderson43: Gabs

Makhlouf says 97% of NZ firms have <50 employees. We have a productivity challenge in all sectors #innovatenz @treasurynz

Statistics New Zealand has just released their business demography stats showing that as at February 2015, New Zealand had 502,170 businesses, up 1.9% from February 2014. These businesses had just over two million paid employees – that's over 2.3% up from the previous year. Of the 502,000, 353,000 have zero employees and of the remaining 149,000, 90% have fewer than 20 and 97% have fewer than 50. We know that rich data about these businesses helps us understand current productivity levels and identify where improvements can be made. And the firm-level work the Hub has been doing and the new insights this is generating on New Zealand productivity is making a significant contribution in this area. And I commend the Hub and the Commission for the work that they've been doing in productivity, generally.

...firm-level data is giving us unprecedented insight into the specific local forces at work on productivity across the country.

As recent work has indicated, firm-level data is giving us unprecedented insight into the specific local forces at work on productivity across the country. It can, for instance, reveal significant variability and performance between individual firms, even within the same industry. And like in so many other areas of the economy, data helps us to understand elements of productivity that may otherwise remain obscure. Taken together, the firms for which we have this kind of data make up the majority of New Zealand employment and with careful application this material becomes a solid foundation from which we, all of us, can address future challenges.

Productivity and production tends to be what we focus on, but there is a far bigger game involving how and what we consume, whether it's provided by the public or private sectors, from technology-enabled services in transport and infrastructure, to broader forms of infrastructure, planning such as telecommunications, and to services more generally.

At the same time it's important that we ensure we can indeed capture all productivity data. Productivity and production tends to be what we focus on, but there is a far bigger game involving how and what we consume, whether it's provided by the public or private sectors, from technology-enabled services in transport and infrastructure, to broader forms of infrastructure, planning such as telecommunications, and to services more generally.

As Robert Solow said back in 1987, "You can see the computer age everywhere, but in the productivity statistics." And there remains a strong suspicion, certainly in my mind, that our current data sets are not capturing the immense impact that ICT and digitisation, in particular, has had on our lives. Nor that we're capturing all services productivity data. And this measurement challenge is faced by Statistics New Zealand and all its peers around the world.

So that brings me to an important theme that I want to talk about: innovation and the pace at which it spreads or diffuses throughout the economy. It is the key to lifting aggregate productivity. The Productivity Commission has been working on a narrative which is important for continuing to build our collective understanding about the possible drivers of New Zealand's productivity performance and where policy responses may lie. And I want to draw on a number of conclusions of that work here.



Helen Anderson

@HelenAnderson43: Productivity improvements from technology don't diffuse well in NZ – Gabs Makhlouf @treasurynz #innovatenz
But is there evidence for this?

The broader policy challenge is to cement in the dynamic policy gains that lift productivity growth with rapid technological change. Continuing future gains in GDP per capital will become more dependent on skills and investment in innovation and other forms of knowledge-based capital.

There are a number of reasons why technological diffusion may not work particularly well in New Zealand. First, weak international connections may limit the extent to which new technology diffuses from the globally most productive firms to the most advanced New Zealand firms. And second, small and insular domestic markets may reduce diffusion to firms within New Zealand further away from the frontier – so-called “laggard firms”. So fixing the diffusion machine is a key policy challenge. The broader policy challenge is to cement in the dynamic policy gains that lift productivity growth with rapid technological change. Continuing future gains in GDP per capital will become more dependent on skills and investment in innovation and other forms of knowledge-based capital.

...while technological advances proceed apace at the global productivity frontier, the diffusion machine appears to be broken, especially across firms in the services sector...
weak investment in knowledge-based capital is a potential explanation, among others.

Ongoing technological change also implies a focus on diffusion as a key source of productivity growth and policy focus. The diffusion of new productivity-enhancing technology from high to low productivity firms is a key driver of productivity growth. As the world’s most innovative firms innovate and push out the global technology frontier, they create space for the most advanced firms nationally to adapt and adopt frontier technologies to local conditions and, in turn, this allows laggard firms

to use the technology in their own production processes. But it’s not a smooth process and much can go wrong along the way.

During the 2000s, productivity growth for the world’s most productive firms was much stronger than for the laggards and substantial productivity gaps have opened up, particularly in services. So while technological advances proceed apace at the global productivity frontier, the diffusion machine appears to be broken, especially across firms in the services sector. And there are a number of possible reasons why such diffusion has slowed, but weak investment in knowledge-based capital is a potential explanation, among others.

...limited international connection prevents leading domestic firms from growing and adopting frontier technologies...
knowledge-based capital is also critical in facilitating technological diffusion.
If lagging firms under-invest in these assets, they will struggle to adopt new technologies and lift their productivity growth.

In particular, international connection via trade, capital, people and idea flows is a key channel for the diffusion of new technology. In small economies, access to international markets in all its forms and whether through trade, foreign direct investment, outward direct investment, employment of skilled migrant labour, etc., also allows productive firms to grow and benefit

from scale and specialisation, while at the same time maintaining or even increasing competitive pressures. It follows that limited international connection prevents leading domestic firms from growing and adopting frontier technologies.

Knowledge-based capital, which includes assets such as product design, inter-firm networks, R&D and organisational know-how, is more conducive to productivity growth than other capital assets. And as well as being important in pushing out the frontier, knowledge-based capital is also critical in facilitating technological diffusion. If lagging firms under-invest in these assets, they will struggle to adopt new technologies and lift their productivity growth.

To improve productivity, we also need to recycle and up-cycle, adapt the old, reconfigure the old, re-examine and find new uses for the old in the face of change.

But productivity is not only about enhancing the new – as if new challenges demand the exclusive use of new tools. To improve productivity, we also need to recycle and up-cycle, adapt the old, reconfigure the old, re-examine and find new uses for the old in the face of change. Change is the only constant. Being smart about the use value of new tools and how they will interact with older mechanisms and levers will be a great advantage.

It's important that our frameworks for understanding contestability are dynamic enough to enable new ways of doing things and new markets, rather than holding us to old and established understandings of productivity. And part of this is about understanding markets from the perspective of the end user, the consumer, rather than simply looking at how concentrated the existing competitive playground looks. And debates about market power in New Zealand tend to be polarised,

with some suggesting that we are so small and isolated on the global stage, that we should emphasise economies of scale as much as possible, and others pointing out our smallness as a reason for using policy to promote competition more actively, i.e. to drive efficiencies.

...properly functioning markets matter and there is a continuing need to detect and prevent anti-competitive conduct, even when the market is seemingly competitive.

As I said earlier, properly functioning markets matter and there is a continuing need to detect and prevent anti-competitive conduct, even when the market is seemingly competitive. It does appear from the Commerce Commission's work in the construction sector, for instance, that the meaning or impact of damaging collusive behaviour is not well understood. And two weeks ago the Government released an issues paper calling for submissions on potential reforms to section 36 of the Commerce Act, including reforms to the market power prohibition and the potential introduction of market power studies for the Commission. And I urge anyone interested or concerned with these issues to read the paper and make a submission.

...do our skills and labour markets operate efficiently? Do our professional and vocational qualifications operate to promote the competition and innovation that could make a difference to productivity? We should keep an open mind and avoid the risk of becoming complacent about the quality of our policy settings.

The question of properly functioning markets isn't simply about whether big or small firms can compete. It's about all markets and whether they are functioning well. For example, do our skills and labour markets operate efficiently? Do our professional and vocational qualifications operate to promote the competition and innovation that could make a difference to productivity? It is accepted wisdom that our policy settings are right and are working well, but perhaps some of them may no longer be fit for purpose. We should keep an open mind and avoid the risk of becoming complacent about the quality of our policy settings. That might be part of the explanation of the so-called paradox when we look at our productivity performance. We may need to challenge accepted paradigms if we want to ensure that our markets are functioning well and encouraging the competition, entrepreneurship and innovation that make a difference to productivity and ultimately our living standards.

...given the centrality of cooperatives in the New Zealand economy, ...do cooperative structures support innovation and promote increased productivity?

As I noted earlier, most of our firms are very small and one response to some of the disadvantage of size has been the development of cooperatives. Although they are most prominent in the primary sector, the cooperative form is widespread throughout New Zealand business, including in retail, insurance and finance. Cooperatives meet some obvious interests and provide some real advantages in the New Zealand context. They provide a strong sense of control for members, an effective mechanism for spreading risk and better ability to weather cyclical downswings in revenues. However, there are certain disadvantages. They're typically less transparent in performance reporting. Owners are more motivated by growing the value of their own business than providing for the growth of the cooperative and usual market disciplines faced by conventional, structured entities tend to be less visible. So given the centrality of cooperatives in the New Zealand economy, are the advantages of this corporate form sufficient to outweigh any disadvantages? Or to put it another way, do cooperative structures support innovation and promote increased productivity?

Diverse thinkers illuminate blind alleys and uncover new pathways.

Technology has certainly aided businesses in communication and data collecting, but at the core of business lies the human element.

How can we marshal our common understanding and sense of purpose? While technology may help greatly in improving elements of manufacturing, distribution and design, its use value for people in workplace of all kinds remains its greatest attribute. Whether it's fostering new relationships and new markets or improving efficiency in existing processes or attracting fresh thought and talent to business, people hold the key to improving productivity. So productivity's not only, as we're sometimes told, about scale. To me it's also about being smart and embracing the human element in all its diversity. Diversity of thinking drives innovation. It helps identify opportunities quickly and inventively. Diverse thinkers illuminate blind alleys and uncover new pathways.

The question we should be looking to answer is, how do we deepen our integration into the Asia-Pacific region?

Let me get back to the issue of distance. New Zealand remains challenged, in being a small market far away from large trading partners, and technology has not yet eliminated distance completely, but it has brought us closer than ever before to the rest of the world. And I remain positive about the potential of technology to bring us even closer. But the reality is that in terms of productivity, the challenges of distance still loom large. We haven't been able to benefit from agglomeration of economic activity in our particular location to the same extent as, say, countries of similar size that are in or close to the EU. But while we are far from European markets, we are part of the fastest-growing region in the world. The question we should be looking to answer is, how do we deepen our integration into the Asia-Pacific region? How do we take advantage of our increasing closeness to the global centre of economic activity? How do we take advantage of that closeness to improve our productivity?

We need to share experiences, build agile and resourceful innovation, promote its diffusion, deepen our international connections and make sure we use all of New Zealand's diversity of talent and ideas.

You'll be glad to know that I'm about to wrap up. The Government's efforts to support improvements to New Zealand productivity are concentrated around the Business Growth Agenda, and depend, of course, by sound management of the nation's finances and a state sector that is focused on delivering outcomes and improving its own productivity. But meeting the challenge of improved productivity is a task that we all have to face up to, public or private sector, big or small firm. If we had all the answers I wouldn't be here speaking to you today. We need to share experiences, build agile and resourceful innovation, promote its diffusion, deepen our international connections and make sure we use all of New Zealand's diversity of talent and ideas.

Thank you to the Hub for inviting me here today. [Applause]

Patrick Nolan: Now I will ask David to take the stage. Thank you.



Keynote address:

Sir David Ramsden, HM Treasury

David Ramsden: Well, thank you very much to the Hub for inviting me to speak today. This is my second consecutive day in this room. Luckily, for me, compared to yesterday, based on London time it's only 25 past 10 in the evening for me today, so bear with me.

There should be a body called "Macroeconomists Anonymous" that one can confess to.

Confession, first of all. I'm a macroeconomist. There should be a body called "Macroeconomists Anonymous" that one can confess to. I'm going to give you a macro perspective on productivity. But I am also a data hound, so I hope I can rise to Gary Dunnet's challenge. I'm Chief Economic Advisor at the Treasury so I'm going to be giving my perspectives on productivity as what we call in the Government Economic Service back in the UK, a professional practitioner – so if you like, both the analysis that I corralled for our ministers in the UK and then how that led to the policies which were announced in the Productivity Plan that was published in July in the UK.

I am guilty of what Kaj called "small country syndrome".

Quite a lot of my themes will be common to what Gabs [Gabriel Makhoul] had to say. I am guilty of what Kaj called "small country syndrome". I'm going to assume that you might be strangely interested in the UK and want to know a bit about it, but I am going to try and put it in more of a global context and also nod to New Zealand. And my first slide, hopefully, does that.

The main message of this is that any of us dealing, certainly with a puzzle or the bit of the paradox for New Zealand that follows from the crisis, we're really not alone. If you look, this chart shows growth rates in the decade up to the GFC in 2007 and then productivity growth rates since then, taken from the OECD database – and you might be able to pick out the G7. I didn't ring it, but it's marked.

You can see it there in the middle. Growth slowed from 1.9% in the pre-crisis decade to 0.9% so the difference, which is shown by the little diamond, is 1%. New Zealand is somewhere in between the G7 and the UK, marked in red, with a shortfall of about 1.2 or 1.3%. The UK, productivity growth of close to 2% in the pre-crisis period. It's only just regained its pre-crisis level, as you can see, and so the shortfall is more like 2%. And this in the UK, when you add it up over the seven years, that comes to something like 13 or 14% in terms of the productivity shortfall, compared with the pre-crisis period, and we've been calling it the productivity puzzle for a few years.

 Productivity growth stats pre / post GFC by @DaveRamsden1 a little alarming #innovatenz

I do want to get onto the policy so I'm not going to dwell on all the explanations. Lots of people for the UK and other countries have tried to quantify the different contributors to this puzzling gap of 13 or 14%. And the relative size of the hexagon shows my preference ordering and I'm just going to focus on three today.

First, and I'd argue the most important, is impaired reallocation of resources – particularly, evidence for the UK suggests – from low productivity companies to high productivity companies. And I think given the nature of the financial crisis and the way it impacted on the credit allocation mechanism, this intuitively seems very appealing. I know Eric Bartelsman, who's speaking later, has done analysis on the Euro areas that suggests that actually the cleansing affect in the Euro area was rather stronger than the analysis that various people had done for the UK, suggests it was in the UK. So it's quite interesting how the Euro area crisis played out and did actually enable some cleansing, if I understood Eric's analysis.

The OECD have done a lot of work on the slowing down TFP [total factor productivity]. For the UK specifically, there's been some really interesting analysis that shows increased dispersion in rates of return on capital in sectors, and actually at the GEN [Government Economics Network] Conference yesterday we heard that similar results applied for New Zealand. And then you get within the labour market, lots of evidence of less churn, a big slow-down in job-to-job moves. So these are all suggestive, if you like, intuitive factors, but it's also suggestive, it's why I've stayed away from trying to put a hard quantification, but you've got the size of my hexagon.

The second issue I want to flag is data measurement issues that we've already heard about today, and actually over this year I've increased the size of this hexagon because I've got more and more convinced that it's an issue and I'm going to come back to it at the end.

Then thirdly, and again others have talked about this already this morning, the sectoral story, obviously relevant in New Zealand in terms of the primary sector and also, I think,

in Australia. If you were looking on the right-hand side you'll see that Australia is actually one of the countries that's not seen a productivity shortfall. And I don't know if this is consistent with Eric's cleansing theory. I reckon it probably is, because look at Spain's performance – it is almost off the scale.

...financial services before and after the financial crisis... were measured as being very strong contributors to productivity [before] and have shown weak, measured productivity since, but are in a more sustainable place as a sector.

The sectoral story for the UK is really more around financial services before and after the financial crisis, where they were measured as being very strong contributors to productivity and have shown weak, measured productivity since, but are in a more sustainable place as a sector.

...what's striking is that the UK and the US are often thought of as having similar labour markets – very flexible, encouraging lots of participation, but actually the trend of US participation ... has really been markedly downwards since the crisis.

I want to move on. There's lots of commonality to these factors and they will apply to different degrees to different countries, but it is also worth remembering wider context and here's a chart that I particularly liked to show when I was in the US recently for a productivity conference at the Peterson Institute two weeks ago. These are participation rates, so some measure of labour supply – and the left-hand side is the G7 and various other countries, or some of the G7 and then New Zealand and Australia. Then the right hand is just blowing out UK and the US.

And what's striking, along with New Zealand, what's striking is that the UK and the US are often thought of as having similar labour markets – very flexible, encouraging lots of participation, but actually the trend of US participation, showing in grey, has really been markedly downwards since the crisis. And as we heard from the minister at yesterday's GEN Conference, New Zealand has had a really impressive participation performance, as has the UK.

A really, really big question is, what's going to happen next to productivity growth? ... such a prolonged stretch of poor productivity growth hasn't been seen in the UK... since the 19th century outside of wartime.

A really, really big question is, what's going to happen next to productivity growth? In the UK this is a series going back to 1860, so that gives you a very long perspective and it does show that such a prolonged stretch of poor productivity growth hasn't been seen in the UK, really, since the 19th century outside of wartime. We are finally seeing at the end – you can just see the little tick up at the end, the pickup in productivity growth – but this does lead to a big question.



Most people think of financial crises as impacting in some permanent sense or semi-permanent sense on the level of productivity, but the growth rates will eventually recover to their pre-crisis rate or thereabout. In the UK's case that would imply productivity growth getting back to about 2%. That is indeed what the OBR [Office for Budget Responsibility] and OECD forecast. Remember, that doesn't mean we get back what we lost in the puzzle. That would be the permanent bit, but we would at least stop that puzzle increasing. But that is a judgement and the fact that the data is finally picking up is a help.

French workers are much more productive than UK workers but there are huge constraints on how many hours, for example, they're allowed to do...

But just thinking about the consequences of this, our independent fiscal council, the OBR, estimated that in a high productivity scenario, public sector net debt would fall from – it's forecast to be about 70% of GDP. That's 70, just because I know it's much lower in New Zealand. It would be 15% lower in a high productivity scenario, but it would be over 15% higher in a low productivity scenario and rising. So we've got a puzzle in the UK and that's added to our long-standing gap – what Gabs was calling the paradox for New Zealand – and this gives you where the gap is now on the latest data. It shows Germany as the leader amongst the G7, relative to the UK, with productivity about 33% higher than the UK. In France and the US – productivity is about 32% higher. Remember that context point though. French workers are much more productive than UK workers but there are huge constraints on how many hours, for example, they're allowed to do – that labour supply point I was making earlier.

When I was preparing for this slide I got my team to put in where New Zealand would be, and New Zealand would actually be below the bottom of this scale. They would be more than 20% lower than the UK. So I thought, oh God I'm going to get really hammered if I put such an obviously incorrect number into the chart. [Laughter] And so they did loads of QA and then emailed me that I picked up somewhere in Singapore to say, actually the numbers are right. But it just shows you where New Zealand is and what a challenge New Zealand faces.

...US productivity growth is really beginning to flat-line. So conferences and hubs like this are really becoming very important in the US.

I just want to mention something. I'm going to come back to data, but just in terms of growth rates, you can see why productivity's really rising up the agenda in the US. The UK's known it's had a worry, really since early on in the recovery phase and that is shown by the dotted blue line, showing growth really not picking up very much. Whereas the US, in the early stages of the recovery, are doing pretty well. That's the red dotted line. But then more recently, and particularly on the latest data, US productivity growth is really beginning to flat-line. So conferences and hubs like this are really becoming very important in the US.

...every member of the OECD where average wages are above UK levels, productivity is also higher.

Gabs has already emphasised and quoted from Krugman about productivity being the single most important determinant of average living standards. You can see from this really tight correlation between living standards, average wages and productivity, every member of the OECD where average wages are above UK levels, productivity is also higher. So all of this background and analysis has framed our advice to the Government on how it should pitch its thinking about productivity and the policies it should follow.

And we've gone for this two-pillar approach. Think of the left-hand side of the classic capitals that Gabs was talking about – physical, human, infrastructure. Think of those as the ingredients and then on the right hand side in a dynamic, flexible economy, how they're mixed together. And if you like, the Government's agenda is about very much encouraging the left-hand side long-term investments and then promoting a dynamic economy on the right-hand side.

...large companies do nearly all the business investment in the economy... large companies do the vast proportion of R&D... and then we also know that large cities contribute most to growth and also to innovation.

Kaj was talking earlier about markets as complex, adaptive systems and in the kind of analytical work we've been doing in the Treasury, we increasingly think of productivity, and particularly given that a lot of the analysis is firm level, as an emergent property of a similar set of complex adaptive systems. But that's not to say that there aren't some constants that easily get forgotten about and we've heard about some of them earlier today.

It is worth remembering – I haven't got the exact stylised facts in my notes – but large companies do nearly all the business investment in the economy, certainly in the UK and I think this true of the wider EU, and as we heard from Sarah, large companies do the vast proportion of R&D. And then we also know that large cities contribute most to growth and also to innovation.

...we're really trying something transformational in the UK in terms of funding three million new, quality apprenticeships through a levy on large employees.

So in terms of some policies – I haven't got time to go through all of these – they were first set out in July and then with an update last week with the Government's latest policy announcements, including some serious funding commitments. But I do want to mention a few, and this comes to the point about learning from each other through events such as this, through peer to peer learning, learning through events convened by the OECD and the like. So under skills and human capital we're really trying something transformational in the UK in terms of funding three million new, quality apprenticeships through a levy on large employees.

Secondly, infrastructure, which I know is key also here, the UK Treasury is getting over its traditional resistance to hypothecation, creating a roads fund from the car tax. And we've done some serious learning. I think New Zealand has an independent body that we've drawn on to establish recently the National Infrastructure Commission under the interim chairmanship of Andrew Adonis. Flexible and fair markets, a reformed planning system to ensure more land is made available – I know what a huge issue that is in Auckland. It's a huge issue in London.

The competition plan that was published at the end of last week to further bear down on prices and costs and it's very striking. This is my first visit to New Zealand and to Wellington and in the prices of some goods you can see quite a tangible difference with back home, which again is another way of reflecting the size of the gaps.

Resurgent cities – this is very important in the UK, as I'll come back to in a second.

...20% of the UK economy is the public sector and we ... have done what we think is a really innovative analysis on how you can improve efficiency and productivity while maintaining and enhancing outcomes in the public sector...

What I haven't put on the slide – and given that this is a conference about innovation I feel I've let down my colleagues in the Government Economic Service – 20% of the UK economy is the public sector and we in the Government Economic Service have done what we think is a really innovative analysis on how you can improve efficiency and productivity while maintaining and enhancing outcomes in the public sector – work that's not just informing the recent announcements about spending, but also the wider public sector reform agenda.

This is a conference about innovation, so these are the announcements that were made last week when the Government set out its detailed spending plans for the next five years and spending on science – constant in real terms, so that's quite a significant boost. And then \$6.9 billion going into research infrastructure and a whole set of other policies highlighted there, which obviously work alongside the UK's R&D tax credits that it has for big and small firms.

London accounts for 28% of UK GDP, while New York accounts for just 8% of US GDP.

I want to finish with a couple of issues, one around this issue of agglomeration that Gabs was just focusing on. So this is some analysis that we've done of EU countries. These are by NUTS regions [nomenclature of territorial units for statistics]. A NUTS region is a population of 800,000 to three million and we've looked at the range as a percentage of EU GDP and you can see that the UK is really an outlier in terms of, particularly, the productivity of inner London. London accounts for 28% of UK GDP, while New York accounts for just 8% of US GDP. And my team have put in a really interesting comparison on GDP per capita by region for New Zealand and not being that familiar with all the regions, I'll look forward to reactions to that.



Helen Anderson

@HelenAnderson43: #innovatenz
Sir David Ramsden UK chief
economist shows Wellington
GDP per capita 2nd to Taranaki.
Wellington's not dying.
@Wellington_NZ

Many of the UK's comparative strengths are in sectors that tend to have less need to invest in machines and equipment. So-called intangibles, knowledge assets, many of these are not captured in national accounts and they're critical for these firms.

A final point on measurement before I wrap up. Many of the UK's comparative strengths are in sectors that tend to have less need to invest in machines and equipment. So-called intangibles, knowledge assets, many of these are not captured in national accounts and they're critical for these firms. And what we did in the Treasury was update some work by Carol Corrado and Jonathan Haskel and their collaborators on adding these investments into fixed investments, more traditional investments. And you can see that the UK invests 44% more in intangibles than in traditional assets, and more than any advanced countries as a share of GDP. And when you look at all the investments together, the investment gap with the UK with others, narrows a lot with total investment actually higher in the UK than in France, Germany and the US.

On average, countries with larger service sectors build more knowledge assets... [this] highlights the measurement issues for the modern economy, particularly for modern economies with large service sectors.

And again, my team's just put a negative correlation line through investment in tangible goods and the size of the manufacturing sector. On average, countries with larger service sectors build more knowledge assets. And this is another stylised fact but it really just highlights the measurement issues for the modern economy, particularly for modern economies with large service sectors. The UK are 80% of GDP; New Zealand I think approaching 70% of GDP. And we've actually commissioned Charlie Bean, former Deputy Governor of the Bank of England, to do a review of just how good the UK is at measuring the modern economy and his interim report is going to be published on Wednesday, UK time [see Bean, 2015].

Some final conclusions from me. There is a lot of complexity in analysing productivity and we have to admit the uncertainties. That's why we use language like "puzzles" and "paradoxes". But we shouldn't become prisoners of that, and it is really important to keep developing our analytical techniques. This is why the firm-level analysis that we've been talking about today and yesterday, I think is so important and is so much easier now with big data sets and with data linking. And I think the work on data linking that we heard about at the GEN Conference yesterday, just to join Gabs also in congratulating the Hub for pushing this kind of agenda and using its convening power to do that.

...if it works,
build on it, if it doesn't,
try something else.

Measurement really does matter. Based on this analytical approach and recognising all the uncertainties, for me it does imply taking a pretty broad approach to looking at what the evidence implies for what works, experimenting; if it works, build on it, if it doesn't, try something else. But the scale of the challenge and the shortfall in living standards makes this an absolute priority in the UK in terms of policy. Institutions, I think, are really important for this. Again, it was a theme I was saying yesterday, but I've really been impressed by the work I've seen at the Productivity Commission here in New Zealand. As I said, we are looking in the infrastructure space to really push the agenda forward. The Infrastructure Commission in the UK is going to be looking at three priorities for the UK for producing a framing analysis for next spring, on energy, on transport in London and then on northern connectivity.

And then finally, learning. As I've said, I think networks, the OECD has just set up a network. New Zealand – you have this Hub. Peer learning. I think all these things are incredibly important to help us try and solve what I think is the challenge of our times.

Thank you very much indeed. [Applause]

Discussion



Patrick Nolan: Well, thank you Gabriel and David. Two fantastic presentations. I always like the comparisons between New Zealand and UK because we tend to call quite different things the same thing. So we both have productivity puzzles or productivity paradoxes, but we're dealing with quite different economies. But both presentations drew out some key themes, particularly around what the OECD refer to as the broken diffusion machine, the importance of knowledge-based capital – how that also relates to some of these issues around measurement, particularly the measurement of intangibles.

As Gabriel also discussed, the discussion paper that's gone out on section 36 is important, as we know that competition's an important driver of productivity. So an awful lot for us to pick up on there.

You'll know the routine by now, so please put up your hands if you've got any questions. We'll start over there and then Adam.



When we look at the transformation that's gone on in the primary sectors over the last 20 years... I would have thought people are better off. Why aren't we seeing aggregate productivity going up

Brian Bell: I have a question for Gabriel. My name's Brian Bell from Nimmo-Bell. We're agribusiness consultants. Well, firstly I share your scepticism that we're measuring the right stuff. When we look at the transformation that's gone on in the primary sectors over the last 20 years, the massive shift out of sheep and into dairy, profitability increased massively, return on capital increases, revitalisation of those regions that have moved into dairy – I would have thought people are better off. Why aren't we seeing aggregate productivity going up?



Patrick Nolan: Yeah, great. We'll take them as a cluster – and then Adam.



Adam Jaffe: I would just be interested in both of you, given what's going on as we sit here, in Paris. Neither of you mention climate change. Obviously improved technology is part of the story as to how we deal with climate change, but does it change in any more direct way how we think about the problem of productivity growth to acknowledge that we have this other big problem out there.



Patrick Nolan: Okay, great. Two very big questions. So Brian asked if we're mis-measuring productivity in agriculture. And David, I know one of the challenges measuring productivity in the UK is a lot of the decline's been in sectors where it's relatively hard to measure, such as financial services. So there's a measurement issue there, and also climate change. So I'll start with Gabriel.



Gabriel Makhlouf: If I could answer your question about what's happened to agriculture productivity, I suspect we'd probably have a big answer to New Zealand's productivity question. I don't know, is the honest answer.

...just go to Fieldays and you'd be amazed at how high tech it is.

What I do know, one of the things when I was in Fieldays – I was saying to someone earlier – when I went to Fieldays back in June, one of the things that struck me was what an amazing adopter of technology the agricultural sector was. Some of you may be surprised to hear that. But I tell you, just go to Fieldays and you'd be amazed at how high tech it is. And so it just feeds my suspicion that we're somehow not capturing... I don't want to sound as if I'm beating up on Statistics New Zealand, [laughs] because I'm not, because I think it's a global challenge. But yeah, I don't know, is the answer to the question. And I suspect productivity's probably better.

The climate change question. It's obviously relevant. From New Zealand's perspective, we are pretty persuaded that technology will help us to manage the methane part of our emissions and you'd have thought that will have an impact on productivity, so there'll be a win/win situation – improvements in productivity and tackling methane emissions. But I'm not sure I can answer it more than that, to be honest.



I think productivity is probably the challenge of my time, but I would see climate change as probably the challenge of all times...

David Ramsden: On that second question, look at the macro level. I think productivity is probably the challenge of my time, but I would see climate change as probably the challenge of all times, as it were. Nick Stern, who was my predecessor as Head of the Government Economic Service, has been forceful in this. And picking up on Gabs' point about win/win, you can see how both of those challenges can be advanced through the right technologies. I was very conscious of time or I would have at the bottom of my slide on UK policy measures to support science and innovation, I had the additional investment going into what is a really ambitious nuclear programme in the UK, and then right at the bottom additional money on the manufacture of ultra-low emission vehicles. A lot of the time in treasuries you've got trade-offs and it would be really exciting if this was a win/win. The challenge is that quite a lot of the technologies are unproven and so it's having the confidence and deciding on which ones. Either you support the private sector in doing all that or you have to step in on, but I think it's a really great point to emphasise, this week of all weeks.



Patrick Nolan: Okay, thanks. Beth and Bronwyn.



Do you think there's a role for getting the accounting standards to come up to speed with the 21st century [for measuring intangibles]?

Beth Webster: Beth Webster, Swinburne University. Dave, just a comment about your comment about measuring intangibles. One of the reasons measures of tangible – that's assets, that's plant and equipment – is so good is it's embedded in the accounting system and every corporation measures it in pretty much the same way and it's in all their annual reports, etc. That is not true for intangibles and that's why people like John Haskel etc., have to reverse-engineer those data and the data are a little bit fuzzy and not necessarily comparable across countries. Do you think there's a role for getting the accounting standards to come up to speed with the 21st century on this matter? And I don't mean capitalising them – I just mean measuring them.



McGuinness Institute @McGInstitute: Discussing why we need to standardize ways we measure intangibles in annual reports – fully support! #innovatenz



David Ramsden: I do, and great strides have been made by the various statistical authorities, getting for example, R&D, in getting software in. But as you move down the spectrum the softer intangibles, management, the work of John Van Reenen, I suggest, is incredibly important. How do you measure that?

Measuring disruptive technologies is a huge agenda in the US...

No, so I think in terms of measurement, I'm really hoping that the interim report of the Bean Review is going to really give a push on this kind of thing. But then obviously on more some of the issues that would be one type of innovation, but more some of the issues that this conference is talking about. Measuring disruptive technologies is a huge agenda in the US as they try and make sense of things. I think one of the reasons they're so focused on their productivity growth slow-down is the evidence does suggest that they have these global frontier companies and at the same time this slowing in productivity. And it's trying to make sense of that really stark contrast. I was in a conference in London. Olivier Blanchard just put the question out there, "how do you measure the value added or the productivity of Google?" And that's somewhat short of some of the really disruptive, the sharing economy, that kind of thing.



Beth Webster: Could I just, add one thing? London is home to the International Standards Accounting Body, so you're really in the box seat for influencing the debate. [Laughter]



David Ramsden: Yeah, I'll take that one away [Laughter].



Patrick Nolan: Bronwyn.



Bronwyn Hall: I just wanted to suggest one possible, not total explanation, but suggestion for the technological adoption in the agricultural sector coupled with relatively low productivity growth in the agricultural sector – those two look to me like they might be linked – which is they may be coming from things like food safety regulation, which has been changing quite a bit, especially when you get into exporting, when you're heavily into exporting, because the people to whom you export, set requirements. And I just wonder if that's a contributory factor. In other words, there's unmeasured quality change we could say that people aren't willing to pay for, but is being forced on them, and we may be in favour of that but they're not willing to pay for it.



David Ramsden: Could I just pick up on that in the context of the comments I made about financial services. There were a lot of financial services, many of them originated in the UK, collateralised debt obligations, tricky things to measure, but I think we now know the limited value of some of them. And there's been a lot of regulation in the financial services sector. So I think some of your quality points will really apply.



Bronwyn Hall: Well I think particularly in agriculture.



David Ramsden: Yeah okay. No, I think in financial services it's more auditors, but compliance people, but even so it will be impacting on the data. But I think there's a parallel in terms of what you were saying about regulation which wasn't on any of my hexagons.



...what role does public sector productivity play in all this?

Patrick Nolan: Great. Actually we're pretty much at time, but I'm going to exploit my position as Chair and ask one last question. Dave and then Gabriel. Dave, you mentioned the role of the public sector in the UK was at 20% of the economy. We've talked a lot about the firm-level measures and thinking about diffusion among firms – just quickly, what role does public sector productivity play in all this?

... I think we need to do more to measure particular departments and do it in a full way, not in a kind of crude classic outputs and inputs, but getting onto outcomes.

David Ramsden: Well, I think it plays a very big role. For example the ONS [Office for National Statistics], our statistical authority, has been at the forefront of trying to introduce quality improvements into measurement of education, health services. And looking at those, the quality adjusted data, productivity has indeed been rising, but the National Accounts System that we're all constrained to use doesn't allow you to take those quality adjustments into account. So that's one aspect of it where I think we need to do more to measure particular departments and do it in a full way, not in a kind of crude classic outputs and inputs, but getting onto outcomes. That's the real challenge, because that's what citizens want.

But then I think this links to something we were talking yesterday – the work that the Productivity Commission has done on investments – the social, the interventions and all of that. And I think that's the really challenging but exciting bit where you start joining up across different services, making sense of the various inputs from various departments or agencies and the outcomes, and the potential for win/win/wins. Yesterday we were hearing stories, in fact, one of the stories from the UK, of someone who'd had an extraordinary set of interventions to improve their living environment on the first floor and they couldn't climb the stairs in their house. It's the analogue, as you were implying, to the firm-level stuff, getting under the bonnet of that kind of thing. And I think the data is beginning to be there. Getting linked data is also tricky within government, and I think using each other's data sets and having the capacity among civil servants to be able to do that kind of data linking, data science analysis.



Patrick Nolan: Great, thank you. Gabriel.



Gabriel Makhoul: Just to follow on from Dave and not to repeat him too much, when you're 25% plus of the economy, you're a big player, and you've got a big role to play, as I said earlier. But just to dig underneath that a bit, Dave just mentioned the social investment which I described. Those of you who were here yesterday will have heard Steven Joyce talk about it. For me it's about modernising policy making. That's what I keep going on about, and it's about using our new ability to combine these new analytical tools with data and this almost exponential availability of information to really understand what's driving the demand for government services. And to target it so you can see if we can get this right, our productivity is going to improve, so there's a big play.

...we are the people who advise the Government on regulation and regulatory settings and that can have a completely overwhelming dominant impact on productivity.

But the two things I want to just talk about in particular. One is to pick up from Bronwyn's point. I didn't mention it when I spoke, but we are the people who advise the Government on regulation and regulatory settings and that can have a completely overwhelming dominant impact on productivity. So making sure that we're making good regulation. I can't overemphasize how important it is, which is one reason why the Treasury has invested as much as it has done in our regulatory work.

...I think we've got a big part to play. But I am also quite hesitant about saying that because sometimes it sounds as if we are the people who've got the answer to productivity – and it's definitely not just a government issue.

The other thing I want to mention in terms of the role of government: it's our position really to support the community more generally in improving connectivity and the use of digital. So the Government's got these two results which go by the name of Result 9 and Result 10, two of its 10 Better Public Service Results, which are all about improving the digital connectivity between business and government and between individuals and government. Actually, that's entirely in the hands of the public sector to actually introduce that in a way that will make a big difference to businesses, to individuals and to the economy. So in all sorts of ways, I think we've got a big part to play. But I am also quite hesitant about saying that because sometimes it sounds as if we are the people who've got the answer to productivity – and it's definitely not just a government issue.



Patrick Nolan: Great, thank you. That's a good note to finish on, so if you could just join me in thanking the speakers. [Applause]

Right, we will be back here at quarter to one, when we will hear from Beth Webster and Adam Jaffe.

“Back from Innovate New Zealand team break.
No sausage rolls. None at GEN 2015 either. Is the Kiwi
conference tradition dying? Is this the end of days?”

You'll be pleased to know there's been a little bit of debate on Twitter, but I have to say it's not quite the debate I anticipated. I'm not going to name names, but one person tweeted “Back from Innovate New Zealand team break. No sausage rolls. None at GEN 2015 either. Is the Kiwi conference tradition dying? Is this the end of days?” [Laughter] And then someone else has tweeted, “Pleased to see I'm not the only sausage roll aficionado in attendance.” So I guess we've achieved our outcome. We've hit our target of creating a debate, but it's not quite the one we wanted. But please do keep tweeting and I'll see you here at quarter to one.

Session 3

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Patrick Nolan: Well, welcome back from what was a relatively short lunch break. There's a lot of energy in the room, so let's keep that going. We are now into an afternoon session, which I'm very much looking forward to.

We've got Professor Beth Webster and Professor Adam Jaffe who will be talking about particularly the evaluation of some of the government assistance. This should be particularly topical, and it follows on very nicely from the discussion that we just had from the Treasuries.

Professor Beth Webster is the Director of the Centre for Transformative Innovation, Swinburne University of Technology. She's also an Honorary Professorial Fellow of the Melbourne Institute of Applied Economic and Social Research at the University of Melbourne and has authored over 100 articles on the economics of innovation and firm performance – and I should note that the Centre is also one of the sponsors of today. So thank you Beth for helping us with today.

And then we've got Professor Adam Jaffe, who's the Director of Motu Economic and Public Policy Research. He's been in that role since May 2013 where he came from Brandeis University in the US where he was a Professor in Economics and Chair of Economics and Dean of the Faculty of Arts and Sciences. Also, he and his colleagues at Motu have been doing a fantastic job in working with Hub agencies on making more use of the LBD. So thank you Adam, and thank you to your colleagues from Motu for that.

I think that's enough from me. We all know how things are going to work by now, so I'll pass over to Beth. So Beth, thank you.



Keynote address:

Professor Beth Webster, Swinburne University of Technology

Beth Webster: Thank you very much to Paul Conway for inviting me; Patrick Nolan for doing a lot of the organising to get me over here.

What I want to do today is talk about when governments should give support for business R&D, what drives a firm to make a decision to invest in R&D, and that's with a view to then talking about what sort of support mechanisms governments can offer to encourage firms to do more R&D.

...why should public monies be spent on business R&D? ... the additional R&D that's stimulated by the government programme has got to deliver benefits to third parties...

So just starting off, why should public monies be spent on business R&D? Probably the easiest way to think about it is to assume if all of the

benefits from doing R&D or knowledge creation or innovation return to the firm, should public monies be spent supporting that R&D activity? And if you put it in those stark terms it's very easy to see that no, effectively there needs to be benefits to third parties for any case to be made for supporting R&D in business. And it's not just benefits to third parties. There have got to be what we call infra-marginal benefits. They've got to be benefits at the margin. So the additional R&D that's stimulated by the government programme has got to deliver benefits to third parties – not the whole R&D itself. That's essentially the case.


 **Donal Curtin** @donal_curtin:
Beth Webster at #innovatenz back to 1st principles, why you would want to support/subsidise R&D

...is it possible for a firm really to capture all the benefits from creating knowledge or doing R&D, and I would suggest no.

The question then naturally follows – is it possible for a firm really to capture all the benefits from creating knowledge or doing R&D, and I would suggest no. And the reason for that is that benefits from knowledge creation are perpetual. They go on forever and they're non-rivalrous. A very easy example of an idea with perpetual benefits is the wheel. It was a great idea, occurred maybe 10,000 years ago, but it's still delivering benefits to us today and it's non-rivalrous. You can use the wheel, I can use the wheel, it doesn't detract from anyone else's ability to use the wheel.


...why then should a government support R&D spending?

So in the long run probably the business captures none of the benefits from the R&D. The consumer captures it all. So why then should a government support R&D spending? If the New Zealand Government supports R&D, it creates knowledge, it creates a great idea – it might be bungee jumping, it might be The Lord of the Rings, and the benefits flow ultimately to the seven billion people of the world. So what's in it for New Zealand? Well, you have to make an additional case that in the short run, neighbouring firms – they're the third parties – neighbouring firms benefit from the R&D that one business undertakes. So there's some short run capture either by local firms or by local consumers. The short run can be very long, it can be decades, but in the short run they get extra profits or extra benefits.

 **Donal Curtin** @donal_curtin:
Webster's conclusion – yes, the social return to R&D tends to be > than the social discount rate so subsidies etc worthwhile #InnovateNZ

So that's essentially the case you have to think through when you say, we want to put public monies into R&D. In the long run, this whole process is just competition. In the long run, competition drives profits down to normal; and the firm gets no extra return on their investment. They've got to get it all in the short run. And if your country is accruing these short run benefits, which could be very short or they could be, as I said, decades, if you're continually getting these short run above normal profits, then you're getting permanently higher incomes. And that's where countries want to be and that's where I'd argue some of those countries in that Northern

European belt, in the US and Japan, this is why their incomes are so high there – higher than other countries.

 **Shaun Hendy** @hendysh:
Prof Beth Webster from @Swinburne says the world still underinvests in R&D; still a strong case for government support

...what part of the R&D involvement do we want to subsidise?

So the next question you have to confront is, well, what part of the R&D involvement do we want to subsidise? And when most people think about subsidising R&D they think of the boffin in the laboratory with the test tubes doing the experiments – we think of this as the unit that actually undertakes the R&D activity. And in fact I think most public sector programmes that I've seen typically tend to subsidise or support the unit that is actually doing the R&D activity and the externality or the spill-over benefit from that activity occurs when the technical people, the scientists or the R&D workers, talk to each other, or there's a bit of labour mobility between sectors and that's the way the knowledge flows – that's how the knowledge gets to the third parties.

Should we also subsidise or support firms that finance R&D activity?

However, there's another alternative. Should we also subsidise or support firms that finance R&D activity? They might not undertake it themselves but they might finance it. And that's a little bit of a harder one to understand, but there is emerging evidence,

good statistical evidence, that businesses that outsource R&D but still own the output – they probably control the patent – create spillover benefits for other businesses in the same home industry. So we might want to think about that and there are some schemes in the world that do allow support for businesses who outsource their R&D to another country, for example.

...should we support businesses that use the R&D?

And the third one is, should we support businesses that use the R&D? They don't do the R&D, they don't finance it, but they actually consume the products of the R&D. So say I'm in a business and I bring in a really sophisticated IT system, I link my accounts up with my customers and my suppliers for example, and I go and I tell Jim down the road or Adam down the road what I've done. And I say, this is great, you've got to go and talk to this guy, these are the problems and these are the benefits, and Adam says, great idea, I'll do it too. So that's the externality, that demonstration effect is the externality. So should we support that? So these are the issues you've got to think through for a good R&D support scheme.

Knowledge diffusion's really important, so why don't we support knowledge diffusion instead?

The obvious question then is – I've slipped between knowledge creation and R&D and innovation deliberately – but a lot of government programmes are really focused on the R&D and I mean accounting R&D, that hard definition. But we know that that's not the source of productivity increase. It's biased towards certain firms, certainly biased towards industries, manufacturing, mining, telcos are the obvious ones that

I know of. They might be slightly different in New Zealand. It's not the source of productivity increase. Knowledge diffusion's really important, so why don't we support knowledge diffusion instead?

You've got to think through those issues and decide where you get the best bang for your buck. I can't give you answers here and I actually don't know many studies that will pin it down, but Bronwyn's talking after me and she might know more about it than me.

So, essentially, what we've talked about is, is the case for supporting R&D or innovation or knowledge diffusion if you want to make it broader, is the externality or the spill-over problem? The usual line people come out with when there is an externality is "oh okay, just internalise it". And in this specific instance it means introducing intellectual property like patents, trademarks, plant variety rights, etc. That doesn't work in many cases when the externality, the knowledge that's just flowing out, is unobservable or very hard to trace.

A really great example here is the research behind sudden infant death syndrome. This is where new-born babies suddenly died in their cots – cot death. People did a lot of research and they found that to stop that was just the way you put the baby in the cot and that's actually cut the deaths down considerably. It is not possible to observe people using that piece of knowledge. All seven billion people in the world can use it and you certainly can't apply IP to it. So there are certain types of knowledge. IP's just not suitable at all, not practical and you wouldn't want to in any case. You wouldn't want to really go round looking in people's bedrooms and charging them a royalty for using the knowledge.

And then there's the other one, which I am sure most of you are familiar with, which is that where you have a non-rivalrous score, the marginal costs of using it is zero and if you internalise it through intellectual property, you're charging a price above the marginal cost of using it. We all know that's dead weight loss and inefficient. So then public support becomes an alternative policy for these sorts of cases.

One thing I didn't mention is at the very first slide but I included that qualification "national" R&D policies. Many governments around the world do support R&D for the general good of the seven billion people. Think of the green revolution; think of medical research for things like Ebola, SARS, Malaria, and what have you. They're up there in the cot death space. But my talk today is about national policies. Policies to build up the capability and the standard of living of one particular country.

There's an additional reason why markets might fail and therefore governments want to step in to this R&D support space.

There's an additional reason why markets might fail and therefore governments want to step in to this R&D support space. I don't know whether you really want to call it an externality or not, but this is when you've got a mismatch between the person who has the great idea and the person who's got the cash. So the great idea needs cash to be developed, commercialised and then marketed. An age-old problem, that has been recognised since the Late Middle Ages when they brought in marine insurance. Over the last few hundred years, we've got this fairly complicated, or sophisticated financial set of institutions to match the person with the great idea with the person who's got the cash.

...one of the things with intangibles is their value depends pretty critically on who is using it.



However, when you're talking about something intangible like R&D, innovation, knowledge or what have you, you've got an additional problem that you don't have when you're just borrowing to buy, build a building and store plant equipment; you're trading in intangibles. And one of the things with intangibles is their value depends pretty critically on who is using it. It depends on the person it's embodied in. So when I invest in an intangible, it's very hard to mortgage. There's a small market here for mortgaging patents and trademarks, but in general their value is uncertain, it's bound up with how that person behaves; I don't know you, I might not trust you or I might. But the problem is it produces really high rates of discount on how I'm going to evaluate the probability of me getting back my money if I lend you money. And what this means is that you've got the great idea, it's going to save the world, it's going to save the New Zealand economy. You go to the bank, they apply this high rate of discount to you and you don't get the money because they figure it doesn't stack up. And so the demand supply curves for loans don't intersect and you might call that a source of market failure.

Related to this is the uncertainty problem. That's a picture of CERN there, that's my version of penicillin. When you're dealing with an idea that is very, very profound but very, very risky but you really think it's certainly worthwhile – it might be laying optical fibre cables all around a country; it's certainly worth the while to roll them out, but there's huge risks. So a huge amount of uncertainty associated with it. So much so that there are so many unknown and unknowable factors about the costs and the potential benefits that you're not going to get a bank to lend. You're certainly not going to get a financial institution to lend, and the only possible way you're going to get to do it, is to actually spread the risk of the whole project across the entire population, which basically means the taxpayer picks up the tab.

When you've got a situation where you've got fundamental uncertainty, you can't pull risk and get rid of it. You can only spread it across the population.

And one of the reasons this is a particular problem is you're dealing with uncertainty, not risk. So you're not dealing with actuarial risk where you have a probability density function, you can work out expected value, you can apply portfolio reasoning to the problem, as you can with an equity trust or a property trust, and you can say to the person investing that the returns are pretty certain. When you're got a situation where you've got fundamental uncertainty, you can't pool risk and get rid of it. You can only spread it across the population. So this would be another instance where governments step in. An example might be the Manhattan Project. Whatever you think about the morality of the Manhattan Project, they said it is highly uncertain. We'll discover

something that Einstein had dreamed up in bed, we'll make it operational, but we're not going to put money into it, the Government has to do it. And they actually cracked it within a few years. Not the same for fusion energy. They've been working on it for decades and it hasn't worked. But these are examples where there is a rationale for government support.

The evidence is even with the amount of support most developed countries give to R&D, there's still a prima facie case that we are under-investing in R&D.

So that's the set of arguments that I'll bring to bear if I said well is there a case for R&D support? We already do a lot. We've heard from Callaghan Innovation. They already do a lot of R&D support, and similarly for most developed economies, they already do a lot to support innovation through tax concessions or direct procurement or grants. So do we still have an externality problem? Is there still an argument for doing more? And I'll just say briefly the evidence is probably yes, but again I think Bronwyn and perhaps Eric will talk you more through this. The evidence is even with the amount of support most developed countries give to R&D, there's still a prima facie case that we are under-investing in R&D. So I'll leave that one there.

...what drives firms to invest in R&D?

The second thing I want to just talk about very briefly because the evidence is really, really weak, is what drives firms to invest in R&D? Lots of studies try to explain R&D or try to explain innovation, and a lot of them find firm-specific factors dominate and it's a little bit of a black box. We don't know what it is.

One systematic factor, and this is coming from many, many studies across countries, is that size is important. Sometimes I find large firms, sometimes it's medium-sized firms that have the most intensive or dense rate of R&D relative to sales. Exports status and foreign ownership consistently come up as being associated with firms that do more R&D or more innovation.

...the evidence is that being innovative makes you an exporter, not the other way around...

Unfortunately there's a couple of studies I've looked at on the direction of causality with exports and I'd say on balance the evidence is that being innovative makes you an exporter, not the other way around, so that's not a factor we can talk about. Industry comes up as well. But what I've said there is they're relatively empty of content both from an understanding perspective and certainly a policy perspective. You can't make a firm change industry or be bigger than it already is. It's already trying to grow as fast as it can. You probably can't change its ownership either. So it's possible these systematic forces are really proxying for other things that we think are important, but the evidence there is quite weak and I'll just leave it there.

Did you move to a cluster because you're innovative or did the cluster make you innovative?
We just don't know...

We also know that there are other things that are complementary to R&D and innovation – the direction of causation again is unclear. Things like ICT, other forms of innovation, being in a cluster. Did you move to a cluster because you're innovative or did the cluster

make you innovative? We just don't know, unfortunately and a de-risk to the environment's another one.

...how can we influence the decision to innovate?

So the economic research in this area's not flash, but there's no point waiting until we've had the answer – we have to act today. So the question is, how can we influence the decision to innovate? And there is three broad ways.

We can change the cost benefit ratio using money, grants, loans, subsidies of some sort, to make the present value of an investment more attractive.

We can de-risk the environment, and a lot of people here have talked about those sorts of things. Investments are all about confidence and if you don't have much information about where the technology's going, where the market's going, who your competitors are, what the Government's going to do, you are not going to have confidence and you won't invest. But if you are embedded in that environment where you're hearing gossip and know-how, you've got a lot of people around you who are giving you information – and the best information's not from the internet, it's obviously going to be informal know-how, it gives you greater confidence to act, because you have a feel for where all the other people are.

And the third basic type of R&D support are schemes that bring relevant parties together. Governments do this in all sorts of different ways. A famous way was done by the US the Defence Department DARPA programme. As well as doing a number of other things, they brought firms together and told them to share information. They brought firms together with academics and told them to share information.

So there are your three basic ways, but what I want to do is talk about something a little bit more prosaic and more grounded and less abstract. I will talk about the sort of R&D schemes that actually exist today and just make

a few comments on them. Back in Australia I've done a bit of surveying of companies to find out what they understand about these schemes and how they operate, and that's going to be the basis of the remaining part of my talk.

Networking's very important and there's a real huge area of growth in research among sociologists, political scientists to look at what networks work best.

There's three essential types of schemes. There's competitive schemes, entitlement schemes and R&D boards. In terms of what they hand out, the largess, grants is the most common and loans is less common. But they're both financial things and basically they're trying to make the market work better, improve the present value of an investment in some sort of innovative R&D type project. The last four: networking, worker exchange, advice mentoring, blue sky procurement, they're more saying, oh forget the market, we'll just go for something else. I think Sarah from Callaghan Innovation mentioned worker exchanges and student exchanges. Knowledge travels via people, so they're obviously very important. Networking is very important and there's a real huge area of growth in research among sociologists, political scientists to look at what networks work best. Advice mentoring is pretty straightforward.

There's no evidence that we saw in our grant programme in Australia that those additional requirements actually work.

So competitive grants, and I think your R&D scheme here falls into this group. Firms compete for a finite pool of money; there's standard requirements. There's a peak body that usually ranks them, but they also tend to be over-engineered and it's very hard to design them to create additionality. We want to make you do something additional and sometimes they become so over-engineered with rules and qualifiers and things that they don't achieve it. There's no evidence that we saw in our grant programme in Australia that those additionality requirements actually work.

Entitlement schemes are basically saying, okay, here are the rules, everyone who passes the bar gets the money. So typically R&D tax concessions or tax credits are entitlement schemes. Once the rules are set, it then falls back to the accountants or the tax office to actually administer in a more nuanced way. I'll comment a bit more on some of the pros and cons of this scheme in a minute, but one of the problems here is that the research just flows to the company that values their research most – themselves, because they're prepared to put their money in. It's like a matched grant scheme.

And finally, industry boards. These are really interesting beasts, so I'll talk a little bit more about them. The other two are pretty straightforward. I think you have R&D boards in your agricultural area, the R&D councils. We have a lot of R&D boards in our agricultural area and in some of the manufacturing areas like dairy manufacturing, etc. They can be instigated by government. Sometimes they're set up under an Act of Parliament. They're usually funded partly by industry, partly by government. They are owned and controlled by industry, so industry has to engage and the buy-in is great. And what they do is they say okay, here's the problem we've got, it has to be general to all the firms in the industry. We're going to contract someone to do the research for that problem. We're then going to bring it in and then we're going to translate it back out to all our members. These boards often have a lot of extension officers. In the case of primary industry, the extension officers actually do go out and knock on the farm gate. So these industry boards, they take very much a problem-solving approach.

They're the three main generic types of R&D support you can give, but they all have costs and benefits, depending on the size of your budget and what you want to achieve. I'll just highlight some of the most notable ones.

Competitive schemes are usually very costly to deliver. This is when you say here's a grant, apply for it and here are the rules. We surveyed about 150 companies in Australia. We found out that they were spending two to three weeks just writing the proposal. Moreover, we found that the knowledge of the schemes across industry was very poor. Even large companies hadn't heard of the schemes, let alone SMEs, and in addition – and this might be a problem with our Government and not yours – we found that the governments continually change the schemes, rename them, change them. Even when firms had worked out or heard of it from Fred and Jim down at the pub about the scheme, it had gone, it had changed, the rules had changed. So I don't know why governments still do them, but they do. Maybe it's cutting the ribbon, kissing the baby, I don't know.

R&D boards, on the other hand, are not sustainable without solid engagement by most of the industry.

There's no industry engagement with these grants. The company that gets the grants is very engaged and they're very happy, but the rest of the industry generally aren't. R&D boards, on the other hand, are not sustainable without solid engagement by most of the industry. They have a lot to offer and the administrators in the R&D boards, it's their job to make sure they're known and they're engaging with industry, otherwise industry will not pay the levy and their job will disappear. Our R&D boards are set up under an Act of Parliament, which means a new minister or a new government really can't change them very quickly, and there's a lot to be said for that. A lot of them have been going since World War II.

One other thing is most of them really can't handle the additionality problem quite well. So the additionality issue is, if I give you support for your R&D, will you just cut back on what you put in yourself and the amount you do will just be the same anyway – it's just that I'm paying, as a government, paying for part of it. So all the schemes try and minimise that deadweight loss and try and maximise additionality. It's very, very hard to do. Even in a lot of labour market programmes, you've just got to wear it; you're just going to have deadweight loss.

...in Australia... for every dollar the Government gives a firm through the tax concession, the firm increases their R&D by 40 cents, so in fact they keep the extra 60 cents to themselves.

The evidence on entitlement schemes that we've got in Australia is that for every dollar the Government gives a firm through the tax concession, the firm increases their R&D by 40 cents, so in fact they keep the extra 60 cents to themselves. So there is some additionality, it's not huge and it's certainly a lot lower than what they're finding in Europe on that score, and we don't know why, but we suspect that our R&D environment's not very good which is why it doesn't have the same effect. So in theory the R&D boards shouldn't come up against the additionality problem, because they're targeting problems that are general to the whole industry. It might be locusts or it might be a technology that has gone wrong and they're fixing up, that affects all the firms equally. It might be something to do with the export market that will affect all of the firms equally, so they won't be targeting something that the firm would want to do themselves.

I think maybe, just one thing about the grant scheme that might be very relevant to

New Zealand – it's certainly relevant to Australia – is that when you've got a competitive grant you really need a selection committee that knows their stuff. They know the technology, they know who else is doing it elsewhere in the world. They know if this is a goer, or this is just a second rate imitation of what someone else is doing in the world. Now in America and in Europe you probably have the depth of specialised skills to get a board to evaluate every programme that comes across your desk. In Australia and in New Zealand you just don't have that. So that is a really big drawback of having an expert committee rank applications.

Just finally, the last slide. The generic problems with a lot of the R&D support schemes that I've seen here and elsewhere is a) the changes to the programmes, b) the over-engineering. Sometimes the criteria for getting a grant or even getting a competitive entitlement ties the firms up in knots, so on the one hand they've got to say no-one will lend to us – on the other hand they'll say it's a great idea, those sorts of problems. I think they're well-known. There is, across the board, an absence of really good evaluations on whether they work or not, but Adam might have more to say about that. And a lot of these programmes are isolated and fragmented and I would have thought to get a lot of bang for your buck in terms of their programmes, you need to embed it in a bigger programme of bringing up capabilities in a particular industry.

So thank you very much. [Applause]

 **Donal Curtin** @donal_curtin:
V good typology of R&D support schemes and pros/cons from Webster #InnovateNZ

Patrick Nolan: Thank you Beth and sticking perfectly to time as well. I'll invite Adam to the stage and I'll just change the slides.



Discussant:

Professor Adam Jaffe, Motu Economic and Public Policy Research

Adam Jaffe: Thank you Patrick and thank you to the Hub for inviting me here, and thanks Beth for your comments. What I'm going to try to do is connect some of Beth's comments specifically to the New Zealand context and in doing that I'll pick up on some of the things Sarah said this morning and comment on those.

Both Patrick and Beth have suggested that I was going to talk about evaluation of R&D programmes. I actually wasn't going to do that, because I thought I was supposed to be commenting on Beth, but I will tell you I do have a paper with Trinh Le here which looks at the R&D subsidy programme in New Zealand in an evaluation mode and you can get that paper on the Motu website.

Beth has talked to us in general terms about why we would want firms to do more R&D and Sarah also used this term BERD which is the OECD term. I think it is Business Enterprise Research & Development, but we all just talk about BERD. She talked about some of the mechanisms that you could use if you wanted to increase BERD, and I'm going to just try to comment a little bit more on the specific issues that are raised in a New Zealand context.

...we want to increase the wellbeing of Kiwis in the long run... so what can we do that will make Kiwis better off in 2030?

So, before I do that, I want to take a step back. Beth kind of did this, but I think it's really important, and remind us why we think about this. So my assumption and Girol [Karacaoglu] will, I think, agree with me, is that what we're trying to think about as a country and as a government is to make Kiwis better off. Very broadly defined, we want to increase the wellbeing of Kiwis in the long run, off in the future at some point. So what can we do that will make Kiwis better off in 2030?

We could just invest in capital of various kinds. We could build more roads, we could make the environment cleaner, natural capital, we could strengthen our society in various ways. There's lots of things we could do. All of those things cost money and they're subject to diminishing returns. The more you spend, you tend to get less return for the marginal dollar, if you build too many roads, for example.

...if we have new ways of doing things, in the future people will be better off.

So an alternative to do is to try to find new ways of doing things that will actually make it less costly in terms of resources in the future to accomplish the things we want to accomplish, whether those things are mitigating our greenhouse gas emissions or increasing our consumption of sausages. Either way, if we have new ways of doing things, in the future people will be better off.

...historically and globally the effort of private firms to come up with new ways of doing things has been the most successful mechanism for this phenomenon of innovation...

And historically and globally the effort of private firms to come up with new ways of doing things has been the most successful mechanism for this phenomenon of innovation, I didn't use that word in this bullet, but that's what that bullet basically is. So that's why we're doing this. We're doing this because we want to increase our opportunities in the future and we think that firms doing cool, new things is going to be an important source of that. I'm going to come back to that in a second.

BERD is low in New Zealand. Many of you know this, relative to GDP, relative to population, depending on exactly how you counted. We're somewhere like 25 or 30th in the OECD. A partial explanation for our low BERD, there's two important – I don't want to say the reasons – but they're things to understand about why our BERD is low.

Our GDP has a very big share of industries which everywhere in the world spend relatively little on BERD, so in some sense it's not surprising if your GDP is half things that people don't normally do research in – the ratio of your research to GDP is going to tend to be low.

Secondly, in all countries R&D is less prevalent in small firms and as we've already seen today, Sarah had some numbers about this. We have a lot of small firms. What I want to do – we know those things – I want to ask what are the implications of that if we then want to think about increasing BERD?

...why do some industries not invest much in R&D?



So, first of all, why do some industries not invest much in R&D? There are a number of things that might be going on. In the jargon of the field we might say the technological opportunity is low. What we mean by that is that science just isn't giving us many things to do in this sector compared to other sectors. That could be one reason. It could be that there are lots of things we can do to innovate, to make ourselves more productive, but they don't involve research. It's other kinds of things that are the highest payoff in terms of getting better ways of doing things. It could be that we're doing things in these industries that really are research but we just don't tend to count it as such. We only count research when there's a research department or a man or a woman whose title is scientist. But people can be doing research without that being true and in that case we're not going to count it.

Why might small firms not invest in R&D?

And then finally it may be that in some of these industries the fragmented industry structure makes the spill-over problem that Beth emphasised, even bigger than in other industries and that's why firms aren't investing. Why might small firms not invest in R&D? Typically R&D itself is subject to economies of scale. It's more effective if you can do it at a higher scale. A small firm isn't going to be able to do it at big scale. Getting the benefits may require capabilities that small firms don't have, so it may be that they could do research but even if it were successful they wouldn't really be able to exploit it because of other gaps they have. They may not be able to get money – Beth talked about this. Again, they may be doing things like research. If you've only got five employees, it's pretty unlikely you're going to designate one of them as head of research, but any of your five employees may, in fact, be spending part of their time on research and it's just not getting counted. And then finally, their small sales base again may make the spill-over problem more acute.

Motu Research

@moturesearch: Why is Business R&D challenging in NZ? Ag, forestry, tourism low everywhere + NZ firms mostly small #InnovateNZ

...the extent to which BERD is low, because there are things getting in the way, as opposed to it's low just because actually there's not much return there, is crucial to deciding what we want to do as a country.

...we only want them to do a billion dollars more R&D if it's actually going to be useful.

Now why have I gone through this? The reason I've gone through this, I would argue, is we need to understand these things because the extent to which BERD is low, because there are things getting in the way, as opposed to it's low just because actually there's not much return there, is crucial to deciding what we want to do as a country. And if you think back on the two lists I had, they were mixtures of both explanations. Sarah referred to the billion dollar problem that we want to get New Zealand firms to do a billion dollars more R&D. Well, I would argue we only want them to do a billion dollars more R&D if it's actually going to be useful. We don't want them to do a billion dollars more R&D just so we can tell the OECD we moved up from number 26 to number 21 in their list. That doesn't actually make Kiwis in the year 2030 better off if the research itself hasn't been productive.

 **Motu Research**

@moturesearch: Adam Jaffe:
goal is NOT moving NZ up in the
OECD BERD report tables, but
rather increasing innovation and
productivity #InnovateNZ

...I'm sceptical that we
could get a lot of spill-over
benefits without generating
any primary benefits to the
firms involved.

There is an issue: you might argue, well, maybe the problem is it's not going to be valuable to them but there are going to be huge spill-overs. So we want them to do it even if it's not productive from their perspective. And that could be true, but in general I'm sceptical of arguments where you tell me the first order effect of what I'm going to do is zero and the second order effect is really big. There are some cases. The sudden infant death syndrome may be one case of that, but as a general proposition I'm sceptical that we could get a lot of spill-over benefits without generating any primary benefits to the firms involved.

...we can work on
coordinating better
between firms and
between non-profit
research organisations
and firms. We can try to
improve the technological
opportunity by funding
basic science...

This is just saying it again. Depending on which of these reasons are the reason why firms are not doing R&D, you get a different story as to what would actually happen if we succeeded in solving the billion dollar problem and getting more BERD. We can reduce the funding barriers to some extent, depending on how we do the financing. If we create new partnerships, for example, we may be simultaneously giving them money and helping solve a coordination problem which is actually a barrier to R&D. So there are things that we can do. Oh, and then there's also things we could do separate from financing which would try to directly attack the barriers, as we see them. So if there are barriers out there, we can work on coordinating better between firms and between non-profit research organisations and firms. We can try to improve the technological opportunity by funding basic science that's going to generate new science, new ideas, new research tools that then the firms could use and possibly, importantly in New Zealand, we could work directly on trying to build management capability, with the notion that if they had that then they would see the benefit of doing research and they would do more R&D.

...we don't want to think
of BERD as an end in itself.

But the danger is we don't want to think of BERD as an end in itself. It is not an end in itself. It's a means to an end. So as we think about increasing it, I worry that when we say things, with all due respect, when we say things like we need a billion dollars more of BERD, there's a danger that we're going to forget why we wanted more BERD and the million dollars more BERD could become the goal and I think that's potentially counterproductive.

Okay, thank you. [Applause]

Discussion



Patrick Nolan: Well, thank you Adam and Beth – both very punctual speakers, so you have made my job very easy, thanks.

Beth went back to first principles and talked about some of the economic arguments for supporting business R&D, things like the externality problem, mismatch between ideas and money, also the uncertainty problem. She then talked about how can we influence the decision to innovate and the different types of schemes and some of the problems with these schemes. Some of these included, of course, the fact that politicians will be politicians, so the uncertainty of policy settings. The additionality problem; you mentioned the Australian evidence of a dollar in assistance – only 40 cents is additional, so I thought that was very interesting. And some of the challenges around over-engineering and isolated, fragmented programmes and I think for a lot of the New Zealand policy makers some of these concerns will sound relatively familiar, so I guess in a way that's reassuring to know that we are all making the same mistakes.

Is the issue that research in New Zealand is of a relatively low value because the domestic market is relatively small, so why would you do it? Or are there particular social, economic, institutional factors that we should be looking to address?

And then Adam also took a step back and argued why we would want to increase BERD, in particular the importance of lifting productivity as a way of increasing incomes and wellbeing into the future. He highlighted the importance of actually understanding what the real problem is. Is the issue that research in New Zealand is of a relatively low value because the domestic market is relatively small, so why would you do it? Or are there particular social, economic, institutional factors that we should be looking to address? And on that he talked about ideas like financing to reduce the financial barriers or maybe even directly attacking the barriers themselves. One of the issues is a particular bugbear of a lot of people here – around management capability.

So fascinating presentations. You will know the process now, so any questions? We've already got a suite, so I'll start with Eric Bartelsman and Bronwyn and then Andrew. The microphone's at Andrew, so away you go Andrew.



Andrew Sweet: Adam, while I'm worried about your worry, it's hard to argue with your point that BERD is not an end in itself, but I wonder whether your worry is a real practical worry or if it's more of a theoretical worry because when firms, be it tax credits or grants, governments only ever subsidise BERD. They never fully pay for it. So firms are always carrying some of the cost and I'm just not aware of any country in the OECD that has high levels of BERD and low levels of innovation or productivity. In other words, I can't think of any country that's fallen into your trap.



...it's not an accident that we start with low levels of BERD.

Adam Jaffe: But I think the point is it's not an accident that we start with low levels of BERD. That's the point. There are reasons why BERD is low here. It's not just that we haven't had the policies that other countries have had. There are real reasons why it's low. And don't get me wrong, I'm not suggesting we should stop trying to raise business investment in research. I think we should be trying to do it, but I think we should do it in a thoughtful way and be sensitive to the possibility that, as Beth said, if you're only getting 40 cents on a dollar of additional research for any dollar you spend, that's something to be thinking about as, as you're doing it. And I do worry that when, particularly when we set an explicit numerical goal for how much we want to increase BERD, the temptation is going to be very large to engage in activities that will raise the reported numbers without much attention to whether they're really dealing with the real market failures.



Beth Webster: Can I just add, following on from what Adam said, there's probably a reason, and Australia's got the same problem of low R&D to GDP ratio. It looked much lower than the OECD. There's probably a reason for that, and I suspect it's because our environment, in many industries, is just too risky. We have a lot of R&D in the mining industry because we have developed a whole culture, institutions, educational institutions, stock market analysts, who support and de-risk that environment and they know it and when the new IPO comes out in the mining area, they can evaluate it and they can work out whether they should invest in it or not. Outside mining we're hopeless, and it's that environment that is probably driving the low R&D in certain sectors and that we need to de-risk it in some way by no doubt engaging with other countries in a more new, instant and face-to-face way, as people have said this morning.



Adam Jaffe: And just to broaden that slightly, particularly when you're trying to bring about a significant increase, to think about policies that are complementary to the funding policies that try to address the barriers more directly, otherwise you're just pushing on the string of trying to get money into the system and it's probably not going to be as productive.



Andrew Sweet: So I wouldn't disagree with any of that. I would simply point out that other countries have managed to push their BERD intensity up.



Beth Webster: Yeah.



Andrew Sweet: ... through sustained careful effort and they've got dividends. So, I'm not saying it's easy...



Adam Jaffe: Mm.



Andrew Sweet: ... but I'm equally saying it's not impossible.



Adam Jaffe: I'll bet they didn't try to do it in three years.



Patrick Nolan: Right, thank you. So Eric Bartelsman and then Bronwyn and then we've got Wendy, so we're getting a stockpile of questions. Put your hand up quickly if you want them.



Eric Bartelsman: I have a question related to the country's size and related to the fact that we all think that spill-overs are a big reason for doing R&D and so if there are a lot of spill-overs we think the benefits of doing the subsidies publically are large. On the other hand, being a small open economy, you can have a "beggar-thy-neighbour" policy – namely, take the spill-overs from other people's BERD. Try to get those technologies. They will improve the lives of Kiwis and you won't have to pay for it. The neighbours might not like it. They might call you names [laughter], but it's much cheaper if you don't worry about that.



Patrick Nolan: Beth, do you want to... and then Adam.



Beth Webster: Well, that gets back to the point that there is a view that you've got locational stickiness in that knowledge. Eventually it does get to all corners of the globe, but you might get a lead time of decades in terms of developing an expertise in certain areas. And I'm sure New Zealand has got it in your lamb industries. In the beef industry there are certain obvious areas. You look at your export industries and it's a prima facie case for you being very efficient at it and you've probably got it in a lot of industries without realising it and they're sticky and probably the other countries in the world that produce similar products aren't as advanced or at the frontier as much as they are here. So that's why you do it. There is that knowledge travels a bit slowly.



Patrick Nolan: Adam.



Adam Jaffe: I could, but let's take some more questions.



Patrick Nolan: Okay, Bronwyn.



...people from New Zealand and Australia and Canada complain about low R&D and introduce very big tax credits, etc. I don't think it's an accident that they all do less R&D than you'd expect... free riding is a really good activity for them because they speak a language in which all the world R&D is done.

Bronwyn Hall: Just on that, on that point I've listened to people from New Zealand and Australia and Canada complain about low R&D and introduce very big tax credits, etc. I don't think it's an accident that they all do less R&D than you'd expect and the reason of course is precisely that free riding is a really good activity for them because they speak a language in which all the world R&D is done. And they're relatively small, and I think it's not an accident that they see themselves as having a problem. That's one of the reasons.

I really liked the presentations, and thank you both. I found them really good. I had a question and a comment for Beth. One question was, at the very beginning you mentioned some research that showed productivity benefits from the outsourcing of R&D and I wondered if that was coming from the pharmaceutical biotech nexus or if that's a general phenomenon? To me it suggested pharmaceutical biotech. The biotechs are doing the R&D; the pharmaceuticals are showing the productivity from that, because they're buying the output of that R&D.

...the Australia experience is very interesting, but I wouldn't generalise from it except for the fact that New Zealand is somewhat similar to Australia.

The comment I had was to go back to this tax credit thing. The Australian experience is really an outlier. The bulk of the evidence says dollar for dollar. In fact, my evidence says even more, but that's an extreme, but around the world pretty much you get what you pay for. The elasticity is one, and the tax price elasticity. And so the Australia experience is very interesting, but I wouldn't generalise from it except for the fact that New Zealand is somewhat similar to Australia.

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Beth Webster: Yeah, so this is a study that's an industry by country times series study. What happens to the home industry when a company outsources R&D to another country? Say you've got Fonterra: what happens when Fonterra outsources its R&D to say, the UK, for example. This is a bad example because they're virtually a monopoly, but let's say there was another milk manufacturing firm in that industry. Do the other firms in that industry also benefit? So what's happening is Fonterra are going, say, to the UK, because there is the fantastic special person in the UK who's top of the field in powdered milk, for example. They do the research, they bring it back into New Zealand but the other firms in that industry also benefit. So that's what the studies are showing. I didn't do the study, but I don't know if it's pharmaceutical, but it's a good idea. I'll chase it up.

Your other question about why is the elasticity so low in Australia? It was a short run elasticity and I think in Europe the median short run elasticity is 60 cents, so it's not hugely lower. But we thought – and this is combined with evidence that our R&D spill-overs are lower than overseas as well – we thought there's probably something that doesn't have the depth in Australia to take advantage of synergies and connections and what have you.



Patrick Nolan: Thank you. Wendy.



...there is an incentive in other countries to collect R&D and put it in the accounting reports, but there is not that incentive in New Zealand.

Wendy McGuinness: Hi. For those of you that weren't here yesterday, we talked a lot about crocodiles and alligators so it's an interesting word now in BERD. And the reason that I raise it like that is I suspect that BERD is not actually a good indicator. So when I went back and actually had a look at the OECD reporting processes, there is a behaviour that there is an incentive in other countries to collect R&D and put it in the accounting reports, but there is not that incentive in New Zealand. And I'm not an expert in this area, but I went back because I was trying to use it. So I tried to understand it, and I actually thought that you couldn't. These are not comparable systems, because there is an incentive in these other countries to collect this data and there is not an incentive in New Zealand.



Patrick Nolan: Do you want to pick up that and Adam as well, just general, some of the challenges and data in this area.



Adam Jaffe: No, I don't know specifically about the incentives, the relative incentives. I think it relates to the point that I made, that a lot of people do stuff that is effectively research. It doesn't get counted.

...we still think that the social return to research is higher than the private return.

The question is so what's the implication of that? Beth is making an argument which, in general, I think is right, that we still think that the social return to research is higher than the private return. So whether we are truly no. 28 in the OECD or no. 12 in the OECD, it may still be the case, and it would still be the case, that if we could increase the real expenditure in productive R&D in New Zealand firms, that would be a good thing for the Kiwi of 2030. So don't interpret me to be arguing with that. I'm just saying the question then is we want to make sure we do it in a way that it is that real increase rather than moving things, or mostly that real increase. I think Beth is right: there's always going to be some slippage.



Beth Webster: Just on the measurement issue, if you've got an R&D tax credit, tax concession there's a real incentive to report it. So it's probably better measured. You don't have it here, so there is probably not the incentive other countries have to report it accurately. I think you're right.



Patrick Nolan: We've got a question there and then Arthur Grimes and Paul Conway and then Carlos. So we'll go to this fellow here.



...we have a massive problem with reporting business R&D expenditure in New Zealand for a variety of reasons and I think... it might be worth doing some research on it.

Male Participant: I just want to go back to the point about the reporting. I don't have the numbers either, but I can assure you that we have a massive problem with reporting business R&D expenditure in New Zealand for a variety of reasons and I think it might be useful, given that it's quite often a big political point in the debate, it might be worth doing some research on it. I spend a lot of my time talking to manufacturers and most of them systematically don't report because there's a disincentive to do so.

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Beth Webster: And you might get to your \$1 billion very quickly if they report it, yeah.
[Laughter]

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Patrick Nolan: Yeah. Arthur, have you got the microphone.

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Arthur Grimes: Thanks. Beth, you talked about three types of R&D policies, competitive, entitlement and industry board, and one that seems to be increasing internationally, but only in specific places, is prizes. One can think about if we had Shaun's baby of a possum-free New Zealand or something like that, rather than funding people to do research, just put a \$200 million prize out there or something for the person who comes up with something that's going to be effective. Have you thought much about that solution?

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Beth Webster: Yeah, the prizes – you still need the expert committee to award the prizes.

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Arthur Grimes: Only after the fact, not before the fact.

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Beth Webster: True, after the fact.

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Arthur Grimes: It's a lot easier after the fact.
You can tell if somebody's gone to the moon or not.

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Beth Webster: People only get the money after the fact too, so it doesn't cover that up-front financing problem. I assume you'd be talking about prizes where they buy up the IP or it's then freely available to all. But no, I have seen prizes, not prizes but competitions work in the research space really well where everyone jumps in and tries to solve a problem. But they usually have up-front funds.



Adam Jaffe: I think it only applies where there is a very clear socially desirable goal. For a lot of what we're talking about, we don't know what it is we were trying to generate. We just are trying to generate innovation. I think for things like malaria vaccine or something like that where there is a very clear... we could all agree that would have a huge social value. I think prizes might well be of...



Bronwyn Hall: Off terrain robots [indistinct]. They've got prizes for that right now in the [indistinct].



Adam Jaffe: I see. Actually we should advertise that in New Zealand. I think Kiwis would probably be good at coming up with that.



Beth Webster: The fastest Indian.



Adam Jaffe: Yeah.



Tane Dunne @TaneDunne: Interesting point around using prizes to incentivise innovation. XPrize, Netflix algorithms, NZ fastest growing sheep...? #innovatenz



Patrick Nolan: Paul Conway.



We've got lots of small firms and Sarah tells us that they don't really engage with the grants process. Does that push us towards more of an R&D board type of set up?

Paul Conway: Thanks – both were really interesting presentations. My question is whether or not the characteristics of the New Zealand economy, whether we can use that as input into designing the optimal Government support programme for R&D. We've got lots of small firms and Sarah tells us that they don't really engage with the grants process. Does that push us towards more of an R&D board type of set up? And also the point that Eric mentioned that as an economy we tend to be in diffusion mode or catch-up mode. So is that the fact that we're not pushing out the global technological frontier, we're more interested in catching up to it, does that have implications for the optimal way in which Government can support innovation?

 **d harg** @dharg2: #innovatenz Paul Conway wonders if govt innovation support should focus more on spreading overseas ideas to NZ.



Adam Jaffe: Just two quick things. I think it's been mentioned several times here, the issue of trying to work on capabilities more generally for New Zealand firms which would have benefits of a variety of kinds, and the other is this issue of just trying to improve coordination and communication. It relates to Shaun's work as well. If we can increase the extent to which firms and non-firm research entities in New Zealand are working together and talking to each other, that both improves the strength of the network within New Zealand, and as Sarah mentioned, can also be related to strengthening the overseas connections.



Beth Webster: I think those are very good points. The R&D boards have two great advantages. One is it's owned by industry. Industry feel in control. They determine the agenda and that gets great engagement, or else they fall apart. The second one is they often have in-built extensional translation services which means it's an easy way to introduce or diffuse the technology wherever it comes from. And some of the boards I know of, like one of our wine boards, just goes over to Sicily and gets new grape varieties. I don't think they do any R&D themselves.



Adam Jaffe: But that's fine. That's still a public good.



Beth Webster: Exactly, exactly, yeah, exactly. So climate change? Mm, just go to Sicily and get grapes that grow in rocks. And that's a very attractive part.



Patrick Nolan: Great. Carlos, there was a question over there, and then Gary.



Carlos Abeledo: Part of my question was answered now, but since we have time, if you could expand the options for the complementary policies. Much of the earlier questions were more focused on the financing and entitlements and so on.



Adam Jaffe: I've given my ideas. I don't know what more...



Is management more important than introducing the latest whizz-bang ICT system into your company? We don't know...

Beth Webster: Yeah, all of the above are probably complementary. The problem is if you want to really get down to being rigorous about it, we really don't know which ones are more important. Is management more important than introducing the latest whizz-bang ICT system into your company? We don't know, so it is an area where we're great at the theory but in practicality I don't think we can offer that much.



Patrick Nolan: Okay, Gary.



...we do measure R&D... BERD increased by \$53 million since 2012 to \$1.2 billion.

Gary Dunnet: Hi. I think we need to recognise that we do measure R&D, and the latest figures and the first headline indicates that "Business Expenditure on R&D – BERD – increased by \$53 million since 2012 to \$1.2 billion."

There's quite a lot of research that's gone on around the R&D innovation at a firm level and how that's being exploited.

Also just recently, as we've moved to our new measure of GDP under the System of National Accounts 2008, one of the new aspects to the SNA08 was the capitalisation of R&D and we have been looking at our R&D survey and aligning that with what's going through into the GDP measures. Finally, we do have a lot of this inside the Integrated Data Infrastructure [IDI] environment, and there's quite a lot of IDI research that's gone on around R&D innovation at a firm level and how that's being exploited. So if there is more information / data that can be added to the debate I'd be keen to know, but there is a lot in place now. As these statistics follow an internationally approved standard, I think the challenge is to move the discussion to increasing R&D rather than debating the numbers. Thanks.



Patrick Nolan: Okay, thanks. Geoff?



Geoff Lewis: Geoff, Productivity Commission. A question about additionality that Beth mentioned. It seems to me that we worry a lot about additionality, in terms of R&D grants. First of all there's the question of language and it's mentioned as a deadweight loss, but in a technical, economic sense it's simply a transfer. So we're talking about giving a grant to a firm that would have done the R&D anyway and what we want to get is additional R&D. But that's simply a transfer and we don't worry about that, for example, with other policies like tax cuts. So you think of a cut in the corporate tax rate – that's going to induce some extra investment at the margin, but it's also giving away revenue for the intramarginal investment that's already occurred. So, you did say we have to accept some deadweight loss. Well first of all, I wouldn't call it deadweight loss except some giving away of money, but I don't think it's any more serious than the revenue that's given away without a corresponding efficiency gain in many tax cuts, for example.



Beth Webster: No, I think you're absolutely correct. Most of the reason why I talked about additionality is it's an obsession usually with people designing the schemes and I think it does lead to the over-engineering that I spoke about, and it does annoy firms, because they've got to make up this fictional story about how no-one would lend to them. It's a great idea, it's certain to succeed but no-one would lend to them. So if you just give me the money, it'll be additional.



Usually the Government is not using taxpayer dollars to pay for an activity [...] that firms routinely pay for themselves.

Adam Jaffe: Not to disagree fundamentally but to quibble slightly, the deadweight loss is associated with the fact that what you're doing is you're taking revenue that was raised by taxes – so presumably that generated a deadweight loss – and you're substituting it directly for private expenditure. And it's true there are other cases where we do that, but not very many. Usually the Government is not using taxpayer dollars to pay for an activity which is itself an activity that firms routinely pay for themselves. There are other examples – I'm not saying there are no other examples. But that's, I think, the reason why the additionality becomes a concern, is that you're taking money that was raised with taxes, which therefore does generate a deadweight loss, and you're substituting it for money that otherwise is routinely spent by firms out of their own money. So 20% of it might be a deadweight loss – not all of it.



Patrick Nolan: We've got Norman and then Simon.



...it seems there's a massive number of possible places we can invest a taxpayer dollar and we think we're going to get big returns.

Norman Gemmell: I'd just like to almost reiterate Adam's reply there which was the point I would have made if he hadn't made it. And in particular, whatever estimate we have of the deadweight cost of taxation, whether we call it 20 cents in the dollar or whatever, that's quite a substantial cost that has to be recouped from the social gains from any investment. The other point I'd make is that, routinely, government departments tell us that when they look at benefit-cost ratios for all the projects that are being proposed or policy changes that are being proposed, that they're cutting off allegedly a benefit-cost ratio of two or sometimes more. So out there it seems there's a massive number of possible places we can invest a taxpayer dollar and we think we're going to get big returns. I never see this kind of investment in innovative R&D and so on being weighed up against that. It may be that the benefit-cost ratio for that is actually lower than some of the other things that we put our tax dollars into.



Patrick Nolan: Okay. And Simon.



Simon Wakeman: Thank you. Simon Wakeman from the Productivity Commission. So I'm going to take us a little bit wider. This may not be what you were prepared to talk about but hopefully you'll still have an answer.

We've talked a lot about encouraging business R&D, but we know that R&D is only one of the inputs into innovation and there are a lot of other things that can benefit, types of innovation that can benefit the economy, including organisational innovation, management capability. Do you have ideas of what government policy can do to stimulate these types of innovation?



We've talked a lot about encouraging business R&D, but we know that R&D is only one of the inputs into innovation and there are a lot of other things that can benefit, types of innovation that can benefit the economy, including organisational innovation, management capability. Do you have ideas of what government policy can do to stimulate these types of innovation?



Beth Webster: I think you would work through some of the other types of programmes, which I listed but didn't really discuss, whereby you're talking about worker secondments, blue sky procurement, networking things. They tend to come with a lot of those sorts of services attached, looking not just at the R&D but at other broad things. I know we do have programmes to improve the management capability of firms in Australia. I don't know if it's been successful, but they give you a certain number of hours free and then you have to pay if you want to go on and do more extensive work. So you could have programmes like that.

I think the reason, and I'm guessing, I'm not a government person, but the reason they attach the subsidy or maybe the grant or the loan or tax concession to R&D, is it's been externally verified by an accountant, by another party. You're not just asking the firm to report something that hasn't gone through the accounting system and all their rules and regulations, their standards. So there is a bit of probity around it when you give out money – that's my guess. But you're right, you're absolutely right. These other things are probably more important or as important.



...I think there's reasons why we think that innovation that's based on new knowledge generates spill-overs.

Adam Jaffe: Though we should remember, again, the reason we're subsidising the activity is because of the spill-overs and some of these other forms of innovation, like organisational innovation and so forth, may not really generate spill-overs. They may be new ways of doing things that are good for the firm – in some cases they may be, but I think there's reasons why we think that innovation that's based on new knowledge generates spill-overs. Other kinds of innovation may as well, but might not.



Is the problem here that research is of low value in New Zealand or are there particular barriers?

Patrick Nolan: Okay, great. Thank you. Well we're almost at time. I'll just take us back to the question that Adam asked. I'm not sure if we've quite answered it. Is the problem here that research is of low value in New Zealand or are there particular barriers?



...it's worth trying to find opportunities to increase research where it is valuable. It's also worthwhile to try, if we can, to work directly on the barriers...

Adam Jaffe: Well I think it's both. It goes to the very first question. I think it's both and therefore it's worth trying to find opportunities to increase research where it is valuable. It's also worthwhile to try, if we can, to work directly on the barriers, but I just wanted to do so with this caution that if you give no thought to it there is some danger you're going to end up spending money that gets counted as your goal but actually isn't productive.



Patrick Nolan: Yeah. Beth.



...other indices you can look at is how extensively do foreign multinationals outsource their R&D to New Zealand?

Beth Webster: I wouldn't be able to say. I don't know enough about the data, but one way you could test that would be to – and I know the rankings of New Zealand's scientific higher education research sector, they come up quite highly, so that doesn't seem to be an issue. But other indices you can look at is how extensively do foreign multinationals outsource their R&D to New Zealand? So that would be a test for the quality of the research being undertaken here. I don't know what the answer is. And there's various data sources you can use to look at it. But there are talent spotters in New Zealand whose job is to pick out the person who's on the frontier of their particular area and hire them back for some multinational overseas, because they're the best in their field. So barriers, I wouldn't be able to comment on.



Patrick Nolan: Okay, great. Thank you for all of your questions and thank you to Adam and Beth for what was a fascinating session and for your presentations. So if you could join me in thanking Adam and Beth. [Applause]. And so we'll see you back here in 30 minutes, where we've got, first of all, Bronwyn Hall and then Simon Wakeman.

Someone called D Harg tweeted Paul Conway's question about government and wonders, "if government innovation and support should focus more on spreading overseas ideas to New Zealand"

In case you're interested in the activities of Twitter, people are still tweeting so I appreciate that. Someone called D Harg tweeted Paul Conway's question about government and wonders, "if government innovation and support should focus more on spreading overseas ideas to New Zealand", so highlighting the importance of diffusion, which came up in some of the earlier sessions. Also quite a lot of tweets about some of the measurement issues. So there we go, Gary – I'm pleased that you got to put the case for Statistics New Zealand. So thank you and I'll see you again in half an hour.

Session 4

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Patrick Nolan: Welcome back from afternoon tea. You've got an exciting afternoon of presentations lined up.

I'm thrilled to have Professor Bronwyn Hall and Dr Simon Wakeman presenting the next session, where they will get into a little bit more detail around the relationship between innovation and productivity and particularly draw on some of the firm-level data. So it should be a very good session. A few times I've mentioned the potential of linked micro-data, so this is where we actually start to see some of the fruits of that agenda.

Professor Bronwyn Hall's an Emeritus Professor at the University of California, Berkeley. She is also a Research Associate of the National Bureau of Economic Research and the Institute for Fiscal Studies in London and a Fellow of NIESR which is the National Institute of Economic and Social Research, also in London. She currently serves as an Associate Editor of the Economics of Innovation and New Technology and of Industrial and Corporate Change and she's also a member of several advisory boards.

Simon is a Principal Advisor at the Productivity Commission where he leads the Commission's research on the relationship between innovation and the productivity of New Zealand firms. Prior to joining the Commission he was an Associate Professor at the European School of Management and Technology where he taught courses in Business Strategy and Capturing Value from Innovation. So I'm very much looking forward to the presentations.

I'll pass over to Bronwyn. Bronwyn, thank you.



Keynote address:

Professor Bronwyn Hall, University of California at Berkeley

Bronwyn Hall: I want to thank all the organisers, especially Patrick, for not only inviting me to this wonderful country – I'm really happy to be here – but also making the trip so smooth and so forth. It really has been a good experience.

Simon and I have cleverly divided the topic. I'm not talking about New Zealand and he's talking about New Zealand, but I think that will work out since he knows more about it than I do.

This presentation is an overview of what we've learned about R&D innovation and productivity at the firm level. It's going to focus on what people have learned from the Community Innovation Survey which was pioneered in Europe but which is done in many countries, including this one. They don't call it the community innovation survey, but they do a survey which has questions which are similar to the ones on the Community Innovation Survey. And the US is a laggard country, but they've finally begun to do an innovation survey as part of their R&D survey a couple of years ago. Well, at this point, probably five or six years ago.

I want to talk a little about a framework for interpreting some of the results that come from the measurement of the relationship between research and development,

innovation and productivity, and mention some of the problems. As usual when you do empirical research you discover some problems and so I'm going to mention how we might improve things in the future a little bit. I want to emphasise that this analysis that I'm reviewing here, and it's partly for time reasons, is really only the micro firm-level analysis rather than the economy-wide results of R&D and innovation. The fact that we believe that there are spill-overs already tells you that economy-wide results might be different from just adding up the firms'. And that's an interesting topic. It's just I couldn't do everything. I had some slides at one point, but I've just had to shorten things.

So what are the mechanisms that we think connect innovation and productivity?

So what are the mechanisms that we think connect innovation and productivity?

The one that we focus on most of the time is improvements within existing firms, namely, creation of new goods and services and process and organisational innovation which lead to efficiency gains. Now at the economy-wide level you want to keep in mind that big mechanisms, which, among other people, Eric Bartelsman has studied, are the entry of more efficient firms and the exit of less efficient firms. That has good economy-wide effects. The entry of firms with new technologies are on the frontier, leaving aside the question of efficiency. And I'm not focused on those set of topics.

So to summarise my view of what we know in this area – by the way I know it's fun to photograph slides and I think you should, but I guarantee you these will go on somebody's website, on mine if nobody else's, so you won't have to photograph every slide. I just saw somebody photographing, so I figured maybe I should save them the trouble – we know a great deal about the contribution of R&D and innovation to firm-level productivity as conventionally measured. There's been a lot of research using data from a lot of countries



and that's a subject which has been studied for – I always have to do arithmetic here – probably the mid-50s – I mean econometrically been studied from the mid-50s to today. That makes 60 years.

We know something about the contribution of entry and exit to aggregate productivity growth from work. Again, I mentioned Eric and all the work with US data also. We know something about the contribution of R&D to quality improvement and therefore to productivity growth that comes from lower prices. The simplest example, of course, is lower prices for the computers that are sitting on everybody's table. When I started computing I worked on a room-sized computer that was nowhere near as powerful as the little laptop I have sitting there. I started computing in 1963 and in those days, you know, they filled up rooms.

We know much less about some topics we'd like to know something about, which is the contribution of R&D and innovation to welfare and poorly measured but important outputs, namely, health, environmental quality and things of that kind that are basically not priced...

We know much less about some topics we'd like to know something about, which is the contribution of R&D and innovation to welfare and poorly measured but important outputs, namely, health, environmental quality and things of that kind that are basically not priced, either because they're totally public goods or because we subsidise them at the government level and price signals are not very good, as in the case of health. And I think this got mentioned earlier by Adam, among

other people. It's one of the reasons why even if you accept the BERD goal, you still have this problem, is it producing the GDP or the welfare change that you really wanted? And without measuring these other outputs it's hard to say that the quality of life has improved.

...even if you accept the BERD goal, you still have this problem, is it producing the GDP or the welfare change that you really wanted? And without measuring these other outputs it's hard to say that the quality of life has improved.

 **Donal Curtin** @donal_curtin: Bronwyn Hall from Berkeley is giving #innovatenz a v good summary of what we do & don't know about effects of R&D/innovation on productivity

...labour market regulation is very important in influencing how effective innovation can be in a given country.

We don't have full aggregate growth models that incorporate behaviour of individual firms that let us look at things in detail, such as regulatory impacts which is really quite important. When you look across countries, regulation has a big influence, not

just regulation of goods, but labour market regulation is very important in influencing how effective innovation can be in a given country.

I want to talk about something that was mentioned earlier which is the distinction between research and development and innovation, because it's important. That's why the Survey got started and why these surveys of innovation got started in the first place – was a perception that R&D wasn't the whole story. It's especially not the whole story if you're in a service economy. The really important innovations in the service economy are frequently not – they come from other people's R&D, but they don't come from your own R&D.

... R&D doers are more likely to be innovators, but there are plenty of innovators that don't do R&D...

The first thing is – I'd show you Italian firms, just because that was the data I had – and the first thing to say is, yes, R&D doers are more likely to be innovators, but there are plenty of innovators that don't do R&D, based on these surveys. It's especially true in the service sector, partly because they rely on purchased technology to a great extent – customer management software, this sort of thing. So that means that just focusing on R&D might not be the same thing as looking at innovation.

...what do firms spend on innovation?

The second thing is that when you go and ask, "what do firms spend on innovation?" – I'm now giving you the UK numbers on these figures and I believe Simon has some numbers for New Zealand – this is the average breakdown across firms, not the totals, on the spending on innovative activities.

The first thing to note is the category Acquisition of machinery and computer hardware/software associated with innovation. Okay, I didn't put that on the slide, but this is not just I went out and bought new machinery. This is, whatever I bought was associated with the introduction of new processes in my firm – is the largest category. Even in manufacturing. R&D is smaller, so the real spending is this equipment spending. It's even more important in services and "Other" – I forget what's in "Other" – not much, it's mostly services, maybe transportation or something. I mean this is economy-wide, but there are certain sectors, primary sectors are excluded here. I'm not including those.

...internal R&D, even in manufacturing, averages a quarter of total innovation spending.

The other thing to note is you have these other things which become much harder to measure as you go down. Marketing expenses associated with the introduction of new products, processes, training expenses associated with the introduction of new product and processes or processes design expense again. Buying external knowledge or spending money. Buying external knowledge is distinct from spending money on R&D externally. It's more like I took a patent licence. That's why it's a different category. Those are all much smaller, but the main message here is that internal R&D, even in manufacturing, averages a quarter of total innovation spending.

So now you go back and say, "well how have people measured innovation in the past?" You all probably, or many people in this room, know that mostly, most of the work has been done using R&D flows or historical stocks, meaning depreciated accumulated – past R&D depreciated – as proxies for innovation input. In manufacturing that's not a terrible idea. We have a survey on that – what the results are.

There's a smaller literature that uses patents as a proxy for intermediate innovation output. There are weaknesses, having to do with, they don't cover all innovation, especially patents, in earlier periods.

...[do] the direct measures of innovation improve our measurement of the returns to innovation via higher productivity.

So the reason for going to the Community Innovation Survey is to see whether the direct measures of innovation improve our measurement of the returns to innovation via higher productivity. It's a question of how does that fit in the productivity relationship. We know that R&D fits reasonably well for the firms that do R&D. That's not all the firms, and we'd like to see if we could expand our coverage. So just to review what's in the surveys on innovation.

The first thing and the most important question, and the question that is used most often for analysis, is they ask the firm, "did you introduce a new product during the last three years that was new to the firm or new to the market?" In New Zealand's case, I believe they also ask whether it was new to New Zealand or new to the global market. In Canada, also, they ask that question I think, but most countries don't make that distinction.

Sometimes they ask about organisational innovation separately from process innovation. And another question which turns out to be a useful question is they ask firms, "what's the share of sales during the past three years that came from products that were new to the firm?" And that question turns out, based on firm interviews, to be one they know how to answer, in general. Even my tiny firm knows the answer to that question. I mean I don't have it any more, but I had it for 30 years. Because they track sales that way, so it's, it's actually a question that they know they can ... because they track sales by product and so they know when they introduce a new product they have a new item in the register.

The second thing that you get in these surveys is data on productivity employment and what you don't get generally is capital expenditures, which means they're good at measuring some form of broad labour productivity, but they're not going to be terribly good in many cases at measuring TFP – which is okay. In most developed countries that's not a serious problem.

There's a survey by Mairesse and Mohnen in the Handbook of the Economics of Innovation that goes into a lot of detail about these measures and what countries have them and how they vary and all sorts of things like that.

When I get to the framework here, what I want to try to explain is this issue that has to do with price and quantity, because it affects how you interpret the results and I think it's actually potentially quite interesting. At the firm level, when we take productivity, labour productivity, which is usually measured as sales per employee or TFP based on employees and capital – by sales, I mean net revenue or net sales – the typical pattern is that you're not deflating the revenue by a price index that really captures the quality of the product that the firm is selling. You're deflating, generally, by an industry-wide price index and if this firm is producing much higher quality products than another firm in the industry, what you're doing is you're not accounting for quality change by this firm. That's not a bad thing. I just want to be clear that what we're measuring with revenue is price times quantity.

...[these surveys are] good at measuring some form of broad labour productivity, but they're not going to be terribly good... at measuring TFP...

...my interpretation of what the innovation is, is affected by whether it's price or quantity. It might make me more efficient... [or] people are much more willing to buy my product because it's much more higher quality... increasing price or increasing quantity, both will increase my revenue.

Why do I care? I care, because my interpretation of what the innovation is, is affected by whether it's price or quantity. It might make me more efficient, innovation, which means that I can produce more output per unit of input. Another possibility, and in fact the one that is dominant, is that what it causes is demand curves to shift out, which is to say people are much more willing to buy my product because it's much more higher quality, therefore I can charge a higher price. I might be producing the same quantity but I can charge a higher price. That will increase my revenue also. Increasing price or increasing quantity, both will increase my revenue. But as an econometrician, my interpretation of what happened will be affected by how I had deflated to begin with. I'm not doing this with equations, because I think that makes sense, but it makes the explanation much more wordy.

So if you assume that innovation can affect both price and quantity and you've got the product of the two and if you assume some fairly innocuous assumptions – which is, the first one, in perfect competition, which basically characterises almost all sectors, and then you assume that the goal of process innovation is to reduce cost, to make the firm more efficient and the goal of product innovation is typically to shift the demand curve out, which is to say

consumers have higher willingness to pay for the same good, the higher willingness to pay for the computer or whatever because it's much better. They like to pay a lot for the iPhone 6 because it's a whole lot better than the iPhone 4s that they have, or it's a higher quality good for the same price which typically characterises, in fact ICT. I've bought laptops every two or three years for the last 15 years and for a long time I was just paying the same price every time, but the computer I was getting was a whole lot better every time. So if you assume that the product is really pushing demand and process is really pushing efficiency, and you can actually derive what the implications are going to be.

...they actually built a supply and demand model and they were able to show that ... process innovation spending did look like it was going towards efficiency and product innovation spending did look like it was pushing demand out.

I just want to take a little detour and tell you that there's work in progress. I just talked to Emile Petrone in Minnesota and they're still working on this, but unfortunately the paper that's out is dated 2011 and they're expanding to other data. But this is the only case that I have seen where they actually had R&D spending at the product and process level, so the firm could tell them I spent this much on product and this much on process innovation – because most firms can't tell you that. Of course that's with error, right. Obviously not every firm's going to be able to make that split, but still what they did was they actually built a supply and demand model and they were able to show that indeed, as we would expect, process innovation spending did look like it was going towards efficiency and

product innovation spending did look like it was pushing demand out. In other words, there was quality improvement and so forth.

So they were able to identify this contribution separately. So I throw that out as support for the notion that the two can be considered somewhat distinct, but not completely because they tend to go together. The reason why this matters – why does it matter? It matters because product innovation, you can easily show is unambiguously going to increase revenue productivity and labour demand. Both labour demand and the firm will want more workers and it will increase its revenue productivity.

And in many economies there's concern that innovative activity may be so good that what it does is reduce labour demand... That's of concern to policy makers because their biggest concern is making sure there are enough jobs.

Process innovation increases revenue productivity and labour demand only if the demand is elastic, and even in this case it gets dampened. And I throw this out because the data show that this is the case. It hints at this being the case. And in many economies there's concern that innovative activity may be so good that what it does is reduce labour demand, okay. That's of concern to policy makers because their biggest concern is making sure there are enough jobs. There's a larger debate going on right now about digital technologies and labour but I won't get into that.

The allocation of where you think the innovation is going between price and quantity depends on the type of price deflator you're going to use – whether you deflate by the quality adjusted price or whether you deflate by just the GDP deflator or something like that. But that's just an allocation. From the firm perspective, the firm just cares about the revenue, okay, not about the quantity or the price. We might be interested in the quantity and the price, but they're concerned about the revenue.

So to back up here a little, what do the data say? The survey that I have here – which I'm not going to go into in detail because you don't really want to look at all of these numbers; I'll summarise what it says – comes from a large collection of papers that have used a standard model, which is a cross-sectional model, which means that it has the limitations of a cross-sectional model, namely if there's anything left out that's correlated with what's going on inside the model you may have some upward or downward biases to some of the coefficients. Unfortunately, doing more than this is very difficult using innovation surveys because innovation surveys in most countries are based on a sample of firms and the sample is redrawn every time the survey is done in order to reduce respondent burden. The consequence of that is it's very hard to look anything long-term at an individual firm level, which is what you'd really like to do, and you can't really do it because of the way the surveys are designed.

It's a simple model where you essentially say, is the firm going to do R&D and how much is it going to do, and you have equations to describe that behaviour. And that R&D is going to produce some innovations, could produce process and product or it could produce increased sales of new products – whatever innovation measure you choose, you choose. And then you say well the production function will include these innovation outcomes in the production function but we will instrument them – we will predict them. We'll say this is what the firm is expected to get as an innovation, given how much R&D it's doing, or not doing.

One feature of this model – Adam mentioned the fact that firms, especially smaller firms,

are often doing R&D and not measuring it – and one of the features of this model is that you predict R&D for those smaller firms from the first equation. So you predict if this firm did not report how much R&D it was doing but we’re going to assume that it did the amount you would predict given its size, its industry, all of its characteristics – exports, foreign ownership, the things that Beth mentioned. And then we’ll use that as their R&D. You don’t want to know about the econometrics.

...it could also be that process does indeed contribute to productivity, just not as much as product innovation.

It’s been estimated for 20+ countries. It does confirm high rates of return to R&D that have been found in a lot of the earlier studies. Innovation output statistics are a lot noisier than R&D and the reality is that innovation doesn’t add much to the model if you have R&D. You basically don’t need it. The trick is that there are a lot of firms you don’t have R&D for, so you still might want to do things this way. What I did a couple of years ago was summarise the results, and the main thing that I want to point to in this slide is that if you include both product and process innovation in the regression, which is the top half of the slide, the top section of the slide down to that line, basically you get nothing for process, or negative, which is really what you had predicted from thinking about it. The bottom three are where they are included separately. When you include process separately and you don’t include product you get something from process innovation. It does increase productivity. One of the reasons for that, of course, is that process and product are often done together, but it could also be that process does indeed contribute to productivity, just not as much as product innovation.

So the TFP on innovation sales, the elasticities range from meaning, – Point 4 is basically Point 2 – if my innovative sales share doubles, that’s 20% on productivity and productivity goes up 20%, so that’s pretty high. What you also find is that the R&D-intensive and the high technology firms have higher elasticities. That is entirely predicted if you think rates of return to R&D are equalised across sectors, and this is a point I cannot emphasise enough because I’ve had people come and tell me over and over, “oh it’s a high rate of return – we should invest more”.

No. If you have an industry where there are high shares of R&D you will have high rates of return and industries with high share of R&Ds will have higher elasticities. Industries with low shares of R&D will have lower elasticities. That will translate into roughly equal rates of return for the additional R&D dollar, and I won’t do the algebra. So, let’s skip that. I’m just conscious, if I have 15 minutes, is that right? No, I don’t, because I’m supposed to finish in half an hour. I just want to make sure I get through this. I’d hate to rush.

We have done some research where we tried to look at the employment impacts of innovation. The idea is we want to decompose employment change and given data limitations this is the decomposition we can do. We can say there’s an industry productivity trend in old products. There’s growth due to process innovation in old products. There’s growth due to output growth of old products. There’s growth due to product innovation. This is now across Europe, for which I have data, and that shows that the average industry-specific employment growth, without innovation, is negative in all countries. It shows up here right away. The process innovation in old products is pretty positive in these European countries for employment growth and product innovation is, on average, equally positive but it has a much lower impact for Italy. It has a higher impact in France and Germany, lower in Spain.

I want to emphasise – by the way, this is 1998-2000. This is the period we can compare. This is a terrible period to compare, okay. Does everybody know what happened in 1999 to 2000?

Male Participant: Y2K.

Bronwyn Hall: No, not Y2K, much worse, much worse. The Euro was introduced. It's very clear from the Italian accounts that they didn't adjust quickly. There are a lot of bad numbers in the Italian data, because you had to adjust your entire system of accounts to go from Lira to Euros, so that was a problem. But I have this as the only period for which I have comparable data. The other interesting thing to note here is non-innovators don't have any employment growth, period. They're barely on the graph. And that's not relative to anything – that's just they don't have any. So that's a summary, but let's skip that.

...does innovation spending tell us something different than R&D spending[?]

Let's just go straight on to innovation spending. The idea here was, does innovation spending tell us something different than R&D spending, because for the UK I actually had innovation spending. And this graph shows you for the larger European countries, of the 28 European countries, with the key exception of two countries who apparently don't like to share the data with the rest of the EU – namely Germany and the UK. How about that. But they have everybody else here and it goes from Poland all the way down to Cyprus, which is a bit of an exception, and what it shows you is that the blue is intramural R&D. The red is extramural R&D. The green is machinery equipment software and the purple, which is small, is the other external knowledge acquisition. They don't all measure all of the things that I showed you before.

But the interesting thing here is the variation. Across countries there's real variation in shares here. Poland is all about new machinery equipment and software coming in from the Germans so they can run their plants in Poland. Basically, it's what that's about. And you see

it in the Czech Republic, another one. The next one is the Czech Republic with the big green, and the next one after that is Hungary. So we know what happened there. This is 2010 – there was a lot of stuff coming in.

Compared to R&D, innovation spending is more strongly associated with information from suppliers and innovation to meet environmental or health and safety standards, which basically is an equipment story.

The UK evidence, I used total innovation spending. Twice as many, or nearly twice as many, firms have innovation spending as have R&D spending. The median innovation spending is five times the median R&D, as opposed to that four that you saw before. Compared to R&D, innovation spending is more strongly associated with information from suppliers and innovation to meet environmental or health and safety standards, which basically is an equipment story. I should have mentioned that what I did with the innovation spending, was substitute it for R&D in the first part of that model and run the whole model again. It's less strongly associated with exporting and collaboration with other firms and information for consumers. That is, it is more process than product. That makes sense, right. It's a better predictor of innovation probability. However, doubling innovation spending has the same impact on TFP as doubling R&D and I haven't fully figured out why that should be the case. It's interesting.

...innovation dummies are a serious measurement problem.

So my conclusion, and I didn't emphasise this – I'm anxious to make sure that we have time for discussion – one thing I didn't emphasise so I should say more about it: innovation dummies are a serious measurement problem. If you think about asking a firm like IBM, did you introduce a new product in the last three years – that is a stupid question. And so you get people writing papers saying, "large firms innovate more". Well, they don't innovate more – it's just if you ask them the dummy question, of course they introduced a new product. If they didn't they hopefully exited the market. Whereas a small firm may not introduce new products very often but it may be perfectly viable, and if you look at the data, you'll see that. The shares of firms that innovate go climbing up as you increase firm size, but that isn't really informative to you, because that's something you knew a priori and it doesn't really capture how innovative the firm is. The share of sales due to new products does capture it. It actually turns out to be a much better measure. So that's the first thing.

The problem with the share of sales due to new products is that we don't have a corresponding measure for process innovation...

And the only country that has ever dared to do this is Germany, and they did once ask how much cost reduction they got from their process innovation and they got answers, and it's in Bettina Peters' thesis, but that's the only time it's been done. My understanding is that people understand this is an issue. That's a much

harder question to answer. That's the reason why they don't ask it now.

Share of sales to new products is something firms track. Cost reduction from process innovation may or may not be tracked by firms and so there's ongoing work. The OECD is basically exploring how they can improve this level of this question.

But the reason I bring this up is because when you stick process and product innovation in the same productivity regression, because they're both measured with incredible error – they're both very noisy indicators – you essentially will get typically equal – you'll get positive on the one and negative on the other and it doesn't really mean that that's what the story is. It doesn't mean that one type is good for productivity and the other type is bad for productivity. What it means is that they're measuring the same underlying thing, which is innovation, because they are correlated, although not perfectly, and that they're both very poor measures and one of them is a little poorer than the other one, and that's the one with the negative coefficient. So I just bring this up because I've seen it so often in many results and it sometimes gets misinterpreted.

So I'll stop there and go on to Simon.
[Applause]



Discussant:

Dr Simon Wakeman, New Zealand Productivity Commission

Simon Wakeman: Thank you. Bronwyn has outlined to you some of the challenges of doing research in this area on innovation and productivity and so it's my job now to translate this for the New Zealand evidence and understand what we can learn from the research we've been doing through the Productivity Hub on these issues.

...while New Zealand's close to the top of the OECD in terms of scientific research, we're much less effective in getting commercial value out of that research.

So to start off, the international evidence suggests that while New Zealand's close to the top of the OECD in terms of scientific research, we're much less effective in getting commercial value out of that research.

This chart shows you the average ranking out of 40 OECD member and affiliated countries in a range of categories, ordered from the upstream science end to the commercialisation end. And it shows that as we move further down the chain, the worse New Zealand looks.

One thing that the international evidence highlights is that New Zealand businesses invest relatively little in R&D. This is a fact that has drawn a lot of attention in recent years and has already been covered earlier today, particularly by Adam in his talk.

But one thing that he highlighted is that the research shows us some things that are correlated with this, or potential explanations for this, but doesn't give us a smoking gun, doesn't tell us why New Zealand firms invest relatively little in R&D or, by extension, innovation. Possibly the most obvious potential explanation is that New Zealand firms may earn relatively little from investing in innovation, but apart from some anecdotal evidence, it's not something we have a very good handle on.

Through the Productivity Hub and our collaboration with Motu we've been trying to generate some quantitative evidence on the returns to innovation for New Zealand firms that hopefully will help us to shed light on what drives this relatively low investment in innovation by New Zealand firms. For this we use Statistics New Zealand's longitudinal business database which integrates data from a number of different sources, including financial data from tax records and financial surveys, firm responses to the innovation module of the Business Operations Survey, as well as patent and trademark filings. However I'm also required in using this data to tell you two things: first, that this information has been confidentialised or anonymised and access controlled to protect the identity of the firms and their data, and second, that the results do not represent official statistics.

 **Donal Curtin** @donal_curtin:
And now @NZprocom's Simon Wakeman is giving us the empirical innovation/R&D story on NZ data #InnovateNZ

...we can count 40% of New Zealand firms in any year that are innovating.

The LBD contains a range of measures of innovation, including both inputs and outputs of the innovation process, and in this data we have a whole range of results about how many New Zealand firms engage in innovation. On the narrowest measure, only a fifth of a percent, are actually filing patents. However, when we think very broadly, introducing any innovation of any type new to the firm, we can count 40% of New Zealand firms in any year that are innovating. And the LBD data also contains some measures of innovation intensity within the firm, including the one that Bronwyn just mentioned, the share of returns that come from new products.

Only a quarter to a third of firms that engaged in innovative activity are also engaged in R&D...

It's only when we [look at]...innovation that's new to the world, either filing patents or introducing products and services new to the world, that we actually find that more than half the firms that innovate are engaged in R&D.

One thing that this data highlights is that R&D is only one of the inputs into innovation. Only a quarter to a third of firms that engaged in innovative activity are also engaged in R&D. And this is true even when we talk about specific types of innovation – product innovation or process innovation. It's only when we get into the very narrow definitions of innovation, the innovation that's new to the world, either filing patents or introducing products and services new to the world, that we actually find that more than half the firms that innovate are engaged in R&D.

There's also data within the Business Operations Survey on the makeup of the innovation spending or product development spending, and we see that R&D expenditure is a big contributor in some industries, but not in all. So looking across the sectors we see that in primary and manufacturing sectors R&D expenditure makes up about 80% of the innovation or product development spending, although when we break this down into specific types of industries, we see that this is driven primarily by Machinery & Equipment and Food & Beverage with other manufacturing industries being much lower R&D intensity, while R&D expenditure only makes up a smaller fraction of innovation spending in the services – one-third



in the total services sector and less than 10% in some services sectors such as wholesale trade, retail trade and in the hospitality industries. In those industries, marketing or market research drives the bulk of our spending.

This highlights one of the weaknesses of using R&D as a measure of innovation and pushes us to look more at some of these output measures of innovation. In the results that follow I'm going to concentrate on three of these output measures. They are measures of product innovation, process innovation and organisational innovation, partly because I think these are the broadest definitions of innovation. Also, they're the ones that seem to show the strongest results.

Bronwyn recommended the use of the sales from new products innovation, but I've also looked at this as a measure, but find that although we get similar results to what we get on product innovation, the results are very noisy. It's perhaps because the way it's measured in New Zealand is quite crude. The spending on the sales from new goods and services is grouped into some broad categories and we get a lot of variance around our results.

This chart shows you the results from a series of regressions where I've regressed the output measure, one of the various measures of firm output or firm performance, on the individual innovation indicators and doing them separately, one by one in separate regressions. The error bars on these charts show the 95% confidence intervals and the size of the bar is the difference between innovating and non-innovating firms. So we have employment gross output or revenue, which you know what those mean. The productivity estimates used here, particularly the multi-factor productivity estimates here, what Bronwyn referred to as TFP – or we usually refer to as MFP – are derived by the approach developed and tested for New Zealand by Richard Fabling and Dave Maré, and if you want to know more about this it's described in a recent working paper that Motu produced for the Productivity Hub.

...firms engaging in any type of innovation are around 75% larger, both in terms of employment and annual gross output. However, firms that innovate do not appear to be any more productive than firms that do not innovate.

We see in these baseline results that firms engaging in any type of innovation are around 75% larger, both in terms of employment and annual gross output. However, firms that innovate do not appear to be any more productive than firms that do not innovate. There's some evidence that organisational innovators have around 20% higher productivity, and you see that the error bar here is not overlapping with the zero axis, so that this is statistically significant. However, when we look at multi-factor productivity, which captures more the knowledge-based capital, it's not significantly different. And for product innovations the differences aren't statistically different and for process innovation we see no differences at all.

However, as Bronwyn has just outlined, measuring these relationships is not easy and there are a number of issues we need to consider. For a start, using revenue or gross output instead of physical output to measure productivity distorts the relationship between innovation and productivity, especially with respect to process innovation, and so we have to be careful in our interpretation. Also, because multi-factor productivity is the residual from a production function, it depends on the accurate measurement of a number of different inputs and it's likely to be quite noisy. So the way the literature that Bronwyn described deals with this is to use a multi-stage model that instruments for innovation with factors

that predict whether a firm innovates, such as R&D. However, most of the prior literature is in this cross-sectional context and one of the problems with this is that you cannot identify whether the relationships you observe are driven by innovation itself or other factors that you would expect to be correlated with innovation but you can't control for.

So in this research I take a different approach, which is to look at change in firm outputs or productivity over subsequent years. This controls for the unobserved firm characteristics that we think might be correlated with innovation that also drive productivity. I also control for those firm characteristics that we do observe, such as age, size, industry, whether the firm is exporting, etc.

Finally, to deal with the measurement error in MFP, productivity here is calculated as a two-year moving average. So, using the year before and the actual year in which it's calculated.

...firms that are introducing innovation grow faster than firms which are not, and after three years the innovating firms are on average between 5 and 10% larger in terms of output.

These are results in terms of revenue or gross output – we see that firms that are introducing innovation grow faster than firms which are not, and after three years the innovating firms are on average between 5 and 10% larger in terms of output. Product innovation and organisational innovation show stronger results than process innovation, although there's still a statistically significant difference in the first year in terms of process innovation.

...only firms introducing product innovations and organisational innovations are clearly doing better, with around 3% higher growth after 3 years.

However, to emphasise, this is only growth in terms of total output. When we look at productivity, so output for inputs, we see that only firms introducing product innovations and organisational innovations are clearly doing better, with around 3% higher growth after 3 years. There does not appear to be any difference between firms that introduce process innovations and firms that do not, although as Bronwyn has pointed out, process innovation could show up in terms of lower prices rather than higher demand, and so may not be reflected in the relationships that we observe.

...it's firms in the 5 to 10 year age group that see the most improvement after innovation... somewhere between 6% and 10% improvement over 3 years, relative to firms that do not innovate.

Now I look at how these results vary by firm characteristics. For this analysis I've interacted the innovation variable, it's a separate variable in each regression, with the firm characteristics. And I'm also focusing here on the three-year change, as that appears to be the period over which we saw the returns being clearest. And from these results we see that it's firms in the 5 to 10 year age group that see the most improvement after innovation. Innovating firms in this age group see somewhere between 6%

and 10% improvement over 3 years, relative to firms that do not innovate.

We also know from other research that this is the age where there's a lot of firms that either make or break, survive and grow or drop out. It also seems to be a stage at which whether the firm is innovating or not seems to make the most difference.

...whether a firm is engaged in R&D does not appear to make a difference to whether the firm benefits from organisational innovation.

Our data also allows us to separate firms by where the innovation comes from. We see that firms that are engaged in R&D are much more likely to show improvement following product innovation than those that are not. However, we know that only about a third of product innovators are engaged in R&D, but it seems to be this subset of firms that benefit most from doing product innovation. However, whether a firm is engaged in R&D does not appear to make a difference to whether the firm benefits from organisational innovation. So R&D is very relevant when we're talking about product innovation. It does not seem to be very relevant when we're talking about other types, particularly about organisational innovation.

Looking at other places in which the innovator might get its ideas from, we see that those that get their ideas from more formal sources such as universities, Crown Research Institutes and conferences do better following product innovation. However, those that get their ideas from their business environment, especially their staff, their customers and other businesses, show more improvement following organisational innovation.

...[innovating firms] that get their ideas from more formal sources such as universities, Crown Research Institutes and conferences do better following product innovation. However, those that get their ideas from their business environment, especially their staff, their customers and other businesses, show more improvement following organisational innovation.

Finally, we see that those firms with larger potential markets are likely to do better if they are innovating. This chart shows the three-year change in productivity for innovating firms by the extent to which the product that they produce is tradeable across the country, across regions within New Zealand. So firms with the least tradeable products, such as your local coffee shop, do not appear to improve much depending on whether they innovate or not. By comparison, those in industries where the products are traded across multiple regions or across the whole country do much better if they are innovating.

...firms with international connections, exporting, foreign-owned or with overseas investments themselves, do better if they're innovating than firms that are just focused domestically.

Looking more broadly, we see that those firms with international connections – exporting, foreign-owned or with overseas investments themselves – do better if they're innovating than firms that are just focused domestically. This is consistent with other research that shows that market size limits innovation. However, it highlights that for those firms that have the ability to expand their markets beyond their local community or even beyond New Zealand, innovation does appear to make a difference.

...it's not clear... whether innovation actually leads to productivity benefits for New Zealand firms, given what they invest in it.

At the start of this presentation I asked whether one of the main reasons that New Zealand do not invest very much in research and development or innovation is because the benefits from innovation are low. We don't have a full answer to this question yet, but the results are suggestive. We see that product innovations and organisational innovations show a higher productivity growth. The difference is only 3 to 5% percent over 3 years, although when you think of the average productivity growth of New Zealand firms being only 0.1%, this could be significant. However, this does not take into account the costs of innovation and the risk it creates for firm survival. And it's not clear, therefore, whether innovation actually leads to productivity benefits for New Zealand firms, given what they invest in it.

However, there are specific categories in which innovating firms do much better than those that are not. Among young firms, especially that 5 to 10 year age group, those that innovate are clearly doing better than non-innovating firms. At the same time we see that firms that are engaged in R&D or get their ideas from universities or more traditional sources, do better out of product innovation. However, firms that get their ideas from the sources in their business environment show improvement following organisational innovation.

...it shows the benefits of encouraging firms to engage in R&D and connecting with universities and so on if we want to create more product innovation. However, making sure they're connected with their business environment also matters, particularly given that organisational innovation appears to be one of the equal drivers of productivity growth.

From a policy perspective, it shows the benefits of encouraging firms to engage in R&D and connecting with universities and so on if we want to create more product innovation. However, making sure they're connected with their business environment also matters, particularly given that organisational innovation appears to be one of the equal drivers of productivity growth.

The other thing that appears to make a difference is the size of the market, both domestically and internationally. In some cases the size of the markets is exogenously determined by the characteristics of the product, something the firm can't do much about, but in other cases it is. The firms can reach out, they can become more connected both domestically and internationally.

...hopefully a better understanding of the relationship between innovation and productivity and particularly where innovating firms are more likely to experience productivity improvements, will help us shape our innovation policies to focus on where we can make a difference, and that's the next challenge.

Before I finish, I should emphasise that these results we see are merely correlations; that we don't have a lever we can pull and test whether that innovating makes a difference to productivity. And so we can't say explicitly whether there's a causal link between innovation and productivity. Nevertheless, hopefully a better understanding of the relationship between innovation and productivity, and particularly where innovating firms are more likely to experience productivity improvements, will help us shape our innovation policies to focus on where we can make a difference, and that's the next challenge. [Applause]

Discussion



Patrick Nolan: Great. Well, thank you, Simon and Bronwyn. Again two very good presentations. Bronwyn pointed out how we have to always be incredibly cautious about the data, particularly the data coming from some of the business surveys, which was interesting because I think it's also a challenge, I guess, for the work that you've been doing with the LBD, Simon, and I think other work you've prepared has shown actually how hard it is to measure innovation and exactly what is meant by innovation. I thought it was also fascinating, the importance of the product innovation relative to organisational and process innovations, which I thought was really interesting context for some of the earlier discussions that we had today – we were really driving towards management matters and some of these sorts of other factors. I guess that's a counter to that as well. So any questions?



Beth Webster: Thank you both for the presentation. There's some great graphs in there which I will borrow one day.

Just this issue of how to measure innovation as an investment. Bronwyn, you talked about it, and so did you Simon. It's a really vexed one, because until we know who's got the best rate of return, we really need a better measure. And we're not there yet, as you clearly illustrate. The R&D's flawed. It's a great money measure, but it's too narrow. The dummy measures are just dummies, but the share of sales due to new products is a mixture between outcomes and activity. So I don't know if that really gets it for me either. We really need a "how much did you spend on innovation", which is R&D, plus more.



if you introduce a new product in the last three years, that doesn't necessarily mean success, but at least it means you innovated. It could be that that product fails.

Bronwyn Hall: Well, I would distinguish those two things. In fact, when I estimated the model with innovation spending, I replaced R&D with innovation spending, not the innovation output. So I view the share of innovative sales as really an output measure, a success measure. And I view the innovation dummy as a measure of output of innovation. It is true that if you introduce a new product in the last three years, that doesn't necessarily mean success, but at least it means you innovated. It could be that that product fails.

Measuring something other than R&D is a good thing.

Whereas R&D is clearly an input and measuring the inputs is not a bad thing, because the input is the thing that the firm decides on and that's the thing you can tweak with your incentives. So you actually want both measures. So I distinguish among them, but I do think that, especially in service economies which is what most of the people above 20 on this chart are also service economies. The majority of the sectors, the service sectors are much bigger than anything else they have. Measuring something other than R&D is a good thing. I actually had a question for Simon, which is just a clarifying question which is, where was capital equipment spending in the innovation spending you had? Was it left out or was it, was it in "Other"? Because that's an interesting question, given how big it is in the UK.

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Simon Wakeman: Well, thanks for both questions. To Beth's question, I haven't looked at the results with innovation spending. It was actually only Bronwyn suggesting that as a potential alternative to R&D that I discovered that we actually have this data on innovation spending in New Zealand. It doesn't seem to be the same definition as the UK. As far as I know, "Other" doesn't capture the capital equipment spending. That's more prototyping commercialisation costs and so on, so maybe that would be left out as a type of innovation spending. But at least it captures the marketing thing. So I'd like to redo the analysis with innovation spending.

Measuring innovation is an endless challenge. I think we don't have any perfect measure. We have patents, we have R&D spending, we have some of these innovation output measures. The best we can do perhaps is to look at our results across these multiple measures and see if we're getting consistent results, and if we're not getting consistent results, then asking why. But if we are getting consistent results, then we have a consistent story we can tell.

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Patrick Nolan: Okay, Donal and then Eric Bartelsman.

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Donal Curtin: A couple of questions for Simon. First of all, the low results are even on some of the measures in terms of the impact on MFP. Were you surprised by that? Do you think it's very robust? And if you do think it's really what's going on, it's a bit of an issue for us all, because we're at a Productivity Symposium and all this innovation and R&D doesn't seem to be contributing any.



Simon Wakeman: I don't think we actually had any significant negative results. Correct me if I'm wrong, but we did have some very low results on some of the indicators. With the process innovation, as Bronwyn pointed out, you have to be quite careful in interpreting those because process innovation may not necessarily show up in terms of higher revenue productivity for firms. But it suggests that either firms are being rational and not investing in innovation because it doesn't pay off, or there are other forms of things that they're engaging in that are not innovation that are helping to grow the firm. And so even without innovating, these firms are already growing. I can't dissect what is actually going on there, but there are potential explanations for it.



Maybe what we need is actually an Oxford comma between innovative and productive Kiwi firms, because if actually what we're showing is the link between innovation and productivity is a bit more complicated than we may have assumed.

Patrick Nolan: Eric. While the microphone's going there, I can't help myself but just pick up on Donal's question. Maybe what we need is actually an Oxford comma between innovative and productive Kiwi firms, because if actually what we're showing is the link between innovation and productivity is a bit more complicated than we may have assumed. Maybe they're completely separate things, or relatively separate or there's actually more we need to unpack. Eric.



Eric Bartelsman: I'll actually talk about that in the next session. I really liked listening to these conversations and presentations, and we've got all this data so we can take a step back, we can be the scientist looking at everything that's happening at a macro level. And we have in our mind a model where there are firms making decisions. I'd like to hear more about the firms making decisions, and I know Bronwyn's actually spent a lot of her life talking to R&D managers and innovative managers of firms. If the calculations are hard for us to make with all the data on what the rate of return is, how is a manager making this decision ex-ante going to take a stab at what the rate of return might be and how do they make those decisions?



Bronwyn Hall: Maybe there's a manager in the room who will actually answer this seriously, because I really haven't talked enough to be an expert on the topic.

The first rule of thumb is to look over at the guy next to you in your industry and ask what his R&D intensity is, and then that's how you choose yours.

The first rule of thumb is to look over at the guy next to you in your industry and ask what his R&D intensity is, and then that's how you choose yours. [Laughter] And that's about as good as any indicator, because in fact he faces all the same uncertainties that you face. So it's a question of pooling information across members of the industry, all of whom are more or less seeing the same things that you're seeing, but maybe processing them differently. Quite seriously, they do actually do that – they benchmark to a great extent.

I do think, however, that individually their attempts to calculate rates of return ex post which might give you some info, and these guys, the MBAs, when they go to HBS [Harvard Business School] or wherever, I've seen the textbooks; the textbooks spend an awful lot of time teaching them how to compute internal rates of return. I presume that some of them actually try to do it, but it's clearly expected and what you realise is going to be quite different from expected.

However, I want to underline that's one of the reasons why I like R&D spending as a variable and innovation spending as a variable, is because it contains within it something about what the firm thought. It's the choice variable, and innovation outcomes are so uncertain in some ways that the firm clearly has influence on them, but doesn't really control them. And so they don't tell you as much about what the firm thought, because they're full of other pieces of information. They're both good, but they're very different animals. But maybe somebody here knows more about this topic.



Patrick Nolan: I don't know if you want to come in quickly, Simon, and then we've got David and then Richard. It's not compulsory.



Simon Wakeman: Okay, just continue with the questions.



Patrick Nolan: Okay, yeah over there.



David Hargreaves: Hi there, David Hargreaves from the Reserve Bank, so of course my question's about finance. I am interested in whether you've looked at all, Simon, at whether the sources of finance available to firms affect their decisions about whether to innovate or not? And I know from Bronwyn Hall's work, that's something that Bronwyn's worked on, so she might want to comment as well.



Simon Wakeman: The answer to mine. I haven't looked specifically in this research about decisions about whether to innovate or not. This is really looking more at the relationship between innovation and productivity. In previous work I've done I've looked at what are the challenges that New Zealand firms face in commercialising innovation. And I'd say that's not whether to innovate but whether to take your product to a larger market.

Finance does play a role, particularly at the level of going international, which for New Zealand firms can often be quite early, but also very expensive... being able to get the right personnel that are able to take your product overseas in terms of management capability, in terms of marketing ability and so on, can be as much of a challenge as getting the finance.

Finance does play a role, particularly at the level of going international, which for New Zealand firms can often be quite early, but also very expensive. It's having the funding to be able to take your product internationally. But there are other things that can be just as challenging. Being able to get the right personnel that are able to take your product overseas in terms of management capability, in terms of marketing ability and so on, can be as much of a challenge as getting the finance.



Patrick Nolan: Bronwyn, did you want to come in on that as well? Access to capital.



Bronwyn Hall: Oh, I'm sorry. I thought the question was directed at Simon, because the question was about the New Zealand firms, and I really can't comment on whether they have difficulties attracting finance. I guess I don't even know whether that question about access to finance is even asked on the survey. That's a question which is commonly asked on the Community Innovation Survey.



Simon Wakeman: We do have information on our survey about some of the barriers to innovating, but I haven't looked at those as part of this.



Bronwyn Hall: Okay. In the future one must look at them.



Patrick Nolan: Richard.



Richard Fabling: Hi, Richard Fabling from Richard Fabling. [Laughter] An observation and a question. The observation is, when we first put in place the Business Operation Survey and we looked at the Community Innovation Surveys, a lot of the reasons why we don't have some of the questions that are in the Community Innovation Survey is because we did a lot of cognitive testing here in New Zealand and we decided that some of the questions were either unanswerable by the firms that we were asking the questions of, or it imposed a massive respondent load on them. So we made a decision to not force them through that load and get potentially low quality responses.

My question is, and in the morning sessions we talked a lot about intangible assets and stocks of intangible capital and things like that, and the analysis that I'm seeing in this session I think, partly because it's been driven by cross-sectional studies, looks at annual investment in R&D. And is that really what we want to look at the returns to? I think of R&D as an investment in a stock, and a stock has a return over a number of years. Is that the right way to think about this and does it make sense to put R&D expenditure in one year and into a regression with productivity on the left-hand side or is that R&D expenditure in that one year acting as a proxy.



Bronwyn Hall: You're right. Of course, we don't have the data.



Richard Fabling: But we do have the data.



Bronwyn Hall: Yeah, we don't have it typically – we typically don't have the data. However, that's okay, because if you work in logs and you're working with established firms which most people are, because they're basically restricting the sample to something that is reasonably well-measured, it doesn't make any difference basically. Because in logs – I've done it with different depreciation rates – the depreciation rate doesn't enter in logs, because fundamentally R&D for most firms doesn't change a lot from year to year.

So when you take the log, you can write down the capital formulation for the R&D and if it's R over depreciation plus growth rate, if that's stable, that goes into the constant, and so the coefficient you get on R&D is the same, whether you use the stock or whether you use the flow. In a world in which R&D is fluctuating a lot and there are a lot of new entrants that's not going to be as true. But given cross-section results, you're looking across big size ranges – it doesn't really matter what you do. R&D, the flow, is going to be just as good a proxy as R&D, the stock. And the problem – the depreciation rate becomes a bit of an issue. So that doesn't worry me so much.

I'm interested in your comments about the Innovation Survey because he showed all the questions that we've been using, but I agree that there are many questions on the survey that I wouldn't want to go near, because I can tell that they're unanswerable. I'm curious what you dropped.



Richard Fabling: We don't collect a lot of dollar information, like the dollars spent on innovation.



Bronwyn Hall: Where does he get his innovation spending numbers from?



Richard Fabling: Spend, it's 5 to 10% of sales.



Simon Wakeman: Yeah, so we collect the variable but it's zero to 10, 10-20, 20-30 and the rest.



Bronwyn Hall: Oh yes, but, but most of the innovation surveys, the share of sales, they actually collect ranges. You're not the only ones. They collect 0-5, 5-10, this sort of thing. I was going to explain to you later, you actually have to transform the variable and you probably didn't. There's a problem with the distribution of the variable because it has a distribution like that. If you just stick it in, you won't get anything. So I was going to go through that later.



Patrick Nolan: Well, thank you. We're, we're right out of time. Thank you Bronwyn and Simon for your discussion. I think, if anything, you've highlighted the importance of being aware of the measurement issues and really being explicit. But this is an exciting area to be working in and I think in New Zealand we're quite excited about what we're able to do now with the micro-data, so I hope that we can continue these conversations. So if you could just join me in thanking Simon and Bronwyn. [Applause]

Session 5

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Patrick Nolan: And I'll invite Eric Bartelsman and Peter Crabtree to the stage. I'll just quickly see what's been happening on Twitter. Lots of good positive feedback on both Simon and Bronwyn's presentation. I have to say the tweeting activity's dropped off a bit now. People seem to have been happy about the lunch, there's no more complaints about the food, that's quite good, so thank you.

Eric, I'll just quickly introduce you. I'm very pleased now to be able to introduce Professor Eric Bartelsman and Dr Peter Crabtree for our final session. Professor Eric Bartelsman is Professor of Economics at Vrije Universiteit Amsterdam. He has a BSc in Economics from MIT and received his PhD from Columbia University. He served as an economist at the Federal Reserve Board in Washington DC, as an advisor to the CPB Netherlands [Bureau for Economic Policy Analysis], and as Head of the Economic Research Department at the Ministry of Economic Affairs in the Netherlands.

And Peter Crabtree is the General Manager at Science, Innovation and International at the Ministry of Business, Innovation & Employment and he currently has responsibility for enterprise policy, science and innovation policy, international science partnerships, trade and regulatory cooperation and international strategy. So Eric, thank you.



Keynote address:

Professor Eric Bartelsman, Vrije Universiteit Amsterdam

Eric Bartelsman: Well, thank you very much for inviting me, Paul Conway and the Productivity Hub, etc. It's a pleasure to be here. There's pros and cons of being the last session of the day. The benefit, of course, is that much about what this whole day is about, productivity, has already been said. We've had this morning stories on BERD, we've had stories on innovation, how to measure things, how to find the effects on why we're doing this – Adam Jaffe's talk. So that's the benefit to me, I don't need to explain all of that. The danger is that there's very little else, I'm afraid to say, so I hope there's some new things I can bring to the table. There may be; there may not be.

I'm not going to go into the technical details of my own research. After my policy period, the last 15 years I've been doing academic research and teaching, as a macroeconomist, oddly enough, but working with firm-level data, trying to understand how the dynamics of firms' entry and exit, doing innovation, how that adds up to productivity, with as a final goal to try to find out how can a society improve their wellbeing through productivity growth. And so given that that's what I'm doing, I'm not going to talk too much today about my actual research. I'm going to give a few highlights about the talk, but mostly I'm going to look

forward. I'm going to try to look 30 years ahead, see what's going to happen to us in society and maybe think about what can New Zealand do to be part of that.

The preliminaries that I took away from reading the materials for this conference are indeed that the GDP per capita here is similar to Spain, Italy, slightly behind South Korea, Japan and the UK. The framework conditions, the thing that our first speaker from the Treasury, Gabs, was talking about are really excellent in New Zealand. All the policies seem in place for doing the things that economists think should be good for productivity growth and for investing in R&D, innovation, adoption of ICTs and new technologies and going out and trying to collect the rents or the use value of all these new things that you can bring to the market.

However, that's not been happening here. R&D investment seems to be lagging. ICT spending, I don't think I have good data on. I haven't seen much yet, but the innovation certainly isn't as strong as you'd hope it would be, and productivity has not been catching up, possibly even diverging.

... how can you harness the potential of... ICT-led innovation; because I think right now and probably for the last 20 years, but for the next 20 to 30 to come, a lot of the innovation is coming through digitisation.

So the question is, how can you harness the potential of what I call ICT-led innovation; because I think right now and probably for the last 20 years, but for the next 20 to 30 to come, a lot of the innovation is coming through digitisation.

I'm pretty optimistic about that. I'm going to go over the technological prospects and try to understand what's happening. Then I'm going to talk a little bit about economic models. How to think about growth with knowledge-based capital, and I'm going to use



interchangeably the word “knowledge-based capital” or intangible capital. I think they’re two words for the same thing. I’m going to look at some evidence from the EU from research I’ve been working on in rather large teams of collaborators. And then I’m going to have two or three speculative slides, how to connect this with New Zealand policy.

On the prospects, two, three years ago Robert Gordon had a pretty provocative article saying that productivity growth was just going to slow down to a half percent a year. And that means doubling of welfare, of the wellbeing of people. It’s going to take another 100 years to double that, and he sets up a thought experiment and looks at three industrial revolutions, steam, railroad, internal combustion electricity and now the ICT and he says “well this latter revolution really wasn’t that impressive anyway and what impression there was from it, we’ve already seen it, so there’s not much more to come”.

...this technology says look, this really is out there and it’s very possible to have a doubling in wellbeing in 30 years.

Contrasting this is the work by Brynjolfsson and McAfee, the Race Against the Machine in the new industrial age, and related work of various academics looking at technologies. I’ve done some of this myself, some back-of-the-envelopes, where it’s pretty easy using technologies that already exist or are very close to being market-ready, and by very close, I mean somewhere in the next 5 to 10 years. It’s very easy to see a 2.5% per year productivity growth, or a doubling in wellbeing in 30 years. The next generation – we hear lots of negative stuff in the paper about our kids are having trouble and they’re not having the expectations of the future that we had when we were growing up; this technology says look, this really is out there and it’s very possible to have a doubling in wellbeing in 30 years.

...Osborne and Frey from Oxford did some back-of-the-envelopes based upon 800 occupations in standard classifications of occupations... and they tried to understand how many hours worked in each of these occupations can be substituted away by these four technologies in the next 30 years. And it seems that you can cut half of your workforce and then I can see the policymakers – “oh no, cut half of the workforce”.

And just taking four technologies: autonomous transport or the Google Car, universal programmable robots, data-driven expert systems and call it Internet of Things – just these four technologies can easily get to a doubling. So you could do a back-of-the-envelope, and Osborne and Frey from Oxford did some back-of-the-envelopes based upon 800 occupations in standard classifications of occupations that statisticians use, and they went through and they tried to understand how many hours worked in each of these occupations can be substituted away by these four technologies in the next 30 years. And it seems that you can cut half of your workforce and then I can see the policymakers – “oh no, cut half of the workforce”.

I actually discussed this with a journalist and the headlines in the big Dutch newspaper said “Economists predict half the jobs gone in 30 years”.

I actually discussed this with a journalist and the headlines in the big Dutch newspaper said “Economists predict half the jobs gone in 30 years”. My phone didn’t stop ringing for quite a while. And then you have to explain well, but new things will happen, and then they’re like well how do they happen, and I’m well, that’s economics. We do things, we do things for each other. I scratch my back, you scratch yours, and vice versa – it depends where you’re from. We do things for each other and we keep that circle flowing and it really doesn’t matter – what we do changes.

...given these technologies are on the way, how do you get your society ready for this?

In the meantime, what we spend on food and clothing and warmth is really a reduced fraction of our GDP right now, and likely it’s going to get even smaller. But this is still going to have major implications for the labour market and a lot of questions like, how do we get there? Sure, there’s technologies there but we need to use it. We need to experiment with it. We need to adopt it. We need to have it come in society. The returns for this, who’s going to get the benefits of these technologies? They may be widespread. There may be some places where they’re going to have a quadrupling of income, and other places are going to get nothing. So how do you make use, given these technologies are on the way, how do you get your society ready for this?

So here’s some pictures, the Google Car. I think they’re eating McDonald’s in the car. This was a fun one, a company called Kuka set up an internet thing that kind of went viral with Timo Boll from Germany, a world-ranked table tennis player, played against the machine. Oddly enough, the machine lost but the first three points went to the machine and then the caption at the end said, “we might not be the best table tennis player but we’re the best robots.”

Brain science. And here the Internet of Things. I actually got this from a New Zealand magazine and it’s an irrigation system connected to the web, can be driven from a distance. It has devices that can go into the ground and measure the moisture and measure the air temperature and download weather data, etc. These things, a new crop of applications, lots of potential things can happen with these technologies.

If you start thinking about just these four technologies and go through a list of stuff that we make and do for each other, you’re going to start thinking, how could we use this, how could we do this for sustainable land use, new materials, people doing stuff in healthcare. I liked Beth’s – her first slide had a chemist with a mask on and an Erlenmeyer beaker and a test tube. When you talk to chemists nowadays, most of the stuff is done on computers and are simulated. A lot of the new materials and the new things they’re discovering are done in simulation – and this is true in many, many areas of innovation. In our own work we model and we simulate. So you look at these lists and you’re like, well I can see potential ways that in 30 years, if we use these technologies well, we can do a lot for each other and make wellbeing high. So where’s the catch?

How do you free up the resources to start applying and using and playing around with these technologies to actually adopt them in a way that's going to deliver the goods? How are you going to mitigate some of the problems related to income distributions, labour markets, participation, etc.

Well, the catch is that it's not going to come automatically. We need to set up our economies, free up resources today, even though budgets are tight and everyone's worried about the next quarter's numbers. How do you free up the resources to start applying and using and playing around with these technologies to actually adopt them in a way that's going to deliver the goods? How are you going to mitigate some of the problems related to income distributions, labour markets, participation, etc.

So the key of these technologies are that they're intangible. You've heard many different ways of thinking about intangibles. The Productivity Commission has a really cogent piece on various characteristics and which types of intangibles have which characteristics, for example, are they saleable on the market, can you appropriate the benefits. I'm just going to take one key characteristic which is that it's non-rival in production. If I have a hammer that's rival in production. If I'm using it, he can't use the hammer. Intangible assets means we can both use it at the same time. How that's dealt with in terms of spill-overs and appropriability and is it in the head of the worker or is it in some object that both of us can use, that's all separate issues.

But the important part for thinking about the economics going forward – all these other things are important too – but for now, this intangibility says there's a benefit to scale. Because once I have this idea or once I have this new intangible hammer, the return to that hammer to the investments needed to make that hammer go up by the number of people that are actually using it. So scale is incredibly important. Firms invest in these intangibles and they get uncertain outcomes. We've heard that before, too. You just don't know what's going to happen when you start playing around with these new technologies. It may backfire. It may actually work, but the market won't like it. No-one's going to want to buy this stuff because it's just not exactly the way they were thinking that this should work.

So these uncertain outcomes mean that you're very uncertain about the return to your investment and because the things that you're making are non-rival and there are benefits to scale, you often get "winner takes all". One of the versions that got developed gets sold or bought by everybody and so some firms are going to make a lot of profits and other firms are going to find that they failed in capturing the market share, either because the technology draw they got wasn't good or because it might have been good, but the customers didn't like the stuff. It was just not exactly what they were looking for.

Traditional capital and labour are actually going to have a lower share of the total income and some of this income is going to come in the form of rents.

The next thing of this type of model, we were very used to in the last 50 or 100 years. For those of you who were economists, there were the counter facts about distributions of incomes going to capital and labour and Bob Solow who started using the production function that was

called the Cobb-Douglas where these shares depended on the technology and it wasn't because of fighting between labour unions and firms. It was just a matter of the technology. Well that technology is changing. Traditional capital and labour are actually going to have a lower share of the total income and some of this income is going to come in the form of rents.

...the optimal size of a firm is going to depend on its outcome from its investment in the intangible, which may be good and may be bad.

What this also means is the optimal size of a firm is going to depend on its outcome from its investment in the intangible, which may be good and may be bad. If you get a really good one, you can grow your firm much larger than if you get a bad one. If you look in the mobile phone market, market shares are skewed and profits are even more skewed. Someone who got the intangible just right can sell a lot more and make a lot more profit. The share for the traditional workers, well, those are commodities. If you don't have the knowledge associated with your labour or the knowledge associated with your capital goods, you're going to just get a market return. And in a global world that's a race to the bottom. You might be able to eat, but it's not going to be exactly what you want.

...if resources in the economy move to firms with the good productivity draws, aggregate productivity will be higher than if it happens the other way around.

The next thing that happens with an economy driven by this type of technology is that aggregate productivity, which is the thing that the Minister of Finance and the Minister of Business, Innovation & Employment will think about, aggregate productivity depends on the distribution of those productivity draws across firms, but also on the distribution of global market shares by those firms, by the scale of each firm. And that means that if the firms that get the good draws also get the high market share, your productivity is going to be higher than if market shares are even or if all the draws are even. So this is where the story of reallocation comes in. If you can move resources – I shouldn't say you can move – if resources in the economy move to firms with the good productivity draws, aggregate productivity will be higher than if it happens the other way around.

...even if innovation investments by firms on average have a zero mean outcome, the economy can still have a positive outcome

The next paradox here is that even if, on average, these productivity draws have an effect of zero, so even if innovation investments by firms on average have a zero mean outcome, the economy can still have a positive outcome, namely, if those that get a good draw get more resources and those that get a bad draw can shrink. So if your firm-level regression shows that your innovation isn't doing anything, on average, once you start weighting them up you may actually get a positive impact. And that comes through this, this reallocation process in the economy.

Investment in regular capital may appear sluggish. Your normal investment in housing, in buildings, in automobiles, in machines, in refineries may be sluggish for some time to come. Why? Because a lot of these intangibles we often think of them as labour saving, but a lot can be capital saving.

So what is this type of model that you have, this fixed investment, these decreasing returns to traditional capital and labour, these uncertain outcomes and this scale effect? Well, the income going to traditional factors is going to decrease. We're going to see labour share of income actually dropping. Investment in regular capital may appear sluggish. Your normal investment in housing, in buildings, in automobiles, in machines, in refineries may be sluggish for some time to come. Why? Because a lot of these intangibles we often think of them as labour saving, but a lot can be capital saving.

Once we get a self-driving car that you can control through your cellphone, we can probably get the utilisation rate of cars to 60%, which means that the installed base of capital in automobiles can drop a lot.

Our utilisation rate right now of automobiles is 5%, a back-of-the-envelope of how many miles are driven per year – you can get that from the statistical agency; how many cars there are and what the average speed is of a car. You can calculate that as somewhere between 4% and 8% utilisation of automobiles. Once we get a self-driving car that you can control through your cellphone, we can probably get the utilisation rate of cars to 60%, which means that the installed base of capital in automobiles can drop a lot. And that means for the next 30 years while this is happening that the investments in traditional capital is going to be sluggish. Office spaces, as you get mobile office workers who are paperless and can move because the computer follows them around the office, you need less square metres of office space per person. With Airbnb and sharing economy, resources get used at higher utilisation rates. This is going to look terrible to a policy maker, because it's going to look like GDP's not growing because the investment is sluggish. But it's part of the transition.

The next one is that the returns are just becoming increasingly skewed. You just hope that you have your fair share of the ones with this high return near you to all benefit from it. But if they're somewhere else in the world and you're not getting it, your return to traditional capital labour is going to be dropping and if you don't get any of those rents from having the successful innovators, it's going to be not as nice.

How about start-ups? How about this entry and exit process. Bronwyn mentioned before, I've, I've worked on and other people have worked on what does this entry and exit process contribute to productivity? And it turns out, a lot. You hope that not very productive firms fail. New firms, when they come in, you hope that within a short period they're going to be in there and better than, than the incumbents.

And we hope that this new technology's actually going to decrease the cost of start-ups. I can use my cellphone and travel to Middle Earth and make great scenery and videos of the mountains. I can actually do that at very low cost nowadays. On the other hand, the probability of me being successful in selling millions of tickets for people to view my film is pretty low. So this technology is going to go both ways. It's going to reduce the cost of trying something new like this, but it's going to also reduce the probability of it being exactly the right way to do it.

...we hope that this new technology's actually going to decrease the cost of start-ups. I can use my cellphone and travel to Middle Earth and make great scenery and videos of the mountains... at very low cost nowadays. On the other hand, the probability of me being successful in selling millions of tickets for people to view my film is pretty low.



Donal Curtin @donal_curtin:

Fascinating implications at #InnovateNZ from Bartelsman's model of economy where knowledge based capital becomes more important...

So what does this mean, this new model of the world with knowledge-based capital growth, mean in an island? Well let's say Case One, where knowledge growth is random and it's actually in proportion to the population and in proportion to existing knowledge. And let's say existing knowledge is only around locally, well, then what you're going to get is that large areas grow faster and Kramer has a piece predicting how large economies and what population is in economies in different parts of the world. However, remote islands will suffer because of this logic, and even more so if the new ideas that you get dropped as manna from Heaven don't just depend on population, but also on population density. And we've seen that by Shaun's work. It probably does. The more dense your area the more ideas per capita drop on top of you. So that's not very good.

But that's the good news. Bad news is Case Two, where this knowledge doesn't just drop at random as manna from Heaven, but you have to invest in getting it. And so now the knowledge you get, the new ideas that come per unit of time and per unit of person or depending on population density also depend on the investments you're making to make this happen and on the existing knowledge that's out there for you to build upon. In this case, the incentive for firms to do this investment depends on the chance of the technological outcome. What's the chance that I get a good draw and, two, the scalability, because to get the return you need both.

... since the ICT revolution, since the internet, the speed at which new knowledge gets used by new users has actually gone up. The visibility of the existing stock of knowledge has gotten larger for people because of ICT...

With transport costs of trade, output is just less scaleable. It's going to be more costly for a New Zealand firm to get the scale from their new idea globally than for an area that's more closely linked to large masses in high densities of consumers. So this is going to harm the incentive to invest in this stuff.

And with distance and low population density, the visibility of existing ideas may be low, and that was my question before. To Shaun, my question was, did ICT actually make these interactions with people at distance easier, and he said no. Well my last point says I think it probably does, but it might not be traceable yet. So hopefully the cost of distances for the visibility of ideas has increased.

There's a dissertation by Salomé Baslandze from the University of Pennsylvania that has some evidence that since the ICT revolution, since the internet, the speed at which new knowledge gets used by new users has actually gone up. The visibility of the existing stock of knowledge has gotten larger for people because of ICT, and I hope that's the case.

The other one is the cost of distance. At least for things that are digitisable or codifiable or can be sold at distance electronically, the costs of the distance has gone down. As phones get smaller, as the weight – Greenspan used to talk about the specific gravity of GDP – as the specific gravity of GDP declines, transport costs loom less large. So hopefully this is going to help make the story less negative. Yet the case against being remote and not densely populated is worrisome.

So let's get a few minutes of evidence. I've been working on various linked cross-country firm-level data projects. I've done this for the OECD 15 years ago. The last two years I've been doing this with the ECB [European Central Bank] where we have 20 countries looking at firm dynamics, productivity, credit constraints and trade. This is from a project that I did with Eurostat and we had 14 statistic agencies involved. In each country we linked the business registers like the LBD, production surveys, the Community Innovation Survey, which you've heard about, but also something called the ICT Usage Survey. So we know for

these firms what types of ICTs they're using: do they have broadband, do the workers have mobile. Do they use customer relation management software, enterprise resource planning software, etc. We use this data to do similar or identical analysis in multiple countries but we also did this – all these data sets are confidential, as the people here know. You have to be authorised to use it. You get a secure terminal to get access. The data are anonymised. Pretty much these rules are like this in all the EU countries. Some are looser. The Nordic countries are often a little bit looser. The Germanic countries, it's like you can't use it at all.

So what we've done is we've sent code, the same software, to 14 countries to run on these data sets and then we aggregate up. It's not aggregate tables, but it's intermediate results. It's means and variances and higher moments and joint moments of data in these data sets, which you then can analyse in a cross-country setting. And so the idea is when we know across countries what does firm entry and exit look like, what does the productivity distribution look like, what are the tables of people who do innovation and R&D and are productive by size class, we've got them all merged together in a data set that you can use if you want to travel to Luxembourg to use it. There's no cost other than going to Luxembourg involved, and that's just a short plane ride away.

...there's a very surprisingly large role for country effects... In some countries the adoption rates of these ICTs, they're just running four or five years behind other countries.

So what do we find? Penetration of the new technologies is continuing. Firms all over Europe are continuing to grow their adoption

of stuff. Some do it faster, some do it slower. Some do it at a higher level. R&D, ICT use, innovative output, human capital intensity – we also have data on schooling and grades and skills – and productivity are actually correlated across firms. So good firms do all these good things, also exporting, etc., and then there are firms that don't do any of these, but the correlation across these different measures in my database of firms is very strong. Even so, there's a very surprisingly large role for country effects. In some countries the proportion of firms doing these good things is just lower than in other countries. In some countries the adoption rates of these ICTs, they're just running four or five years behind other countries. You'd think that use of ICT or use of innovation, we've heard it today, could depend on your sectors. This is a low R&D sector and I've got more of this, so I'm not going to do as much R&D. Well it turns out there really is a strong role for a country effect and I've sliced and diced this in many ways. So that's a question – is that policy stance or is that distance or something else? There's some country fixed effect in all of this.

The other thing we find is that the aggregate industry impact of intangibles is positive, but often, and in many countries, the average firm-level impact is insignificant, and then the next thing we find is that the variance of outcomes across firms, either in sales growth, output growth or productivity, the variance of these outcomes increases with the use of intangibles. So the more intangible investment-intensive a firm is, the higher its variance in these outcomes.

However, the good news is that the ICT-using firms or the intangible-intensive firms, they grow more over time, both in output, employment and productivity and we see a rising wage premium for ICT. Here's the intangibles from the US and they're going up over time. Here's different countries' adoption of broadband, ICT by firms. Here you see that there's country fixed effects even though across we have three industries – they're weirdly labelled – and then the countries are from up to down. You see that the countries that are good in one industry are

also good in the other and then there's some countries at the bottom which are a lower use of these things.

...having high broadband intensity, having lots of ICT human capital, but also being in a market where the reallocation process, the shifting of resources from poor firms to good firms, where that's positive, all those things contribute to the adoption at the firm level for ICT.

We've run regressions similar to the firm-level innovation stuff we saw Bronwyn and Simon do, and here we did our own version of the CDM model. We have a two-stage version of it, where one is you look at the incentive for firms to do innovative activity and it turns out that having high broadband intensity, having lots of ICT human capital, but also being in a market where the reallocation process, the shifting of resources from poor firms to good firms, where that's positive, all those things contribute to the adoption at the firm level for ICT. And this makes sense, because your incentive as a firm to do this ICT means that if do get a good draw, I want to grow. If I'm in a market where there's product market regulation that doesn't allow me to win market share or where labour regulation is very tight so I can't get the workers I need because they're tied up in other firms with fixed jobs and they don't want to leave because there's a benefit to it... Or where financial markets don't allow the reallocation of capital across firms. In those countries adoption of this innovation is going to be lower.

So if someone tries to evaluate Callaghan and finds that on average their money didn't do anything, really all they need to do is find one good example of one firm that added 50,000 jobs and \$3 billion a year in revenue... Even if all the other 99% of the projects got zero, all you need is that one to make it worthwhile. And so that, that does change the way you have to think about evaluating.

...the point is, be careful with the evaluation and if someone says on average your result is zero, don't despair.

You take the predicted innovation from that equation and you feed it into a productivity equation and here we find that on average the predicted innovation is insignificant, but for aggregates of the industry. So we actually look at the average productivity of each firm and take that as a number by country, industry and year. The aggregate, we take the weighted average, or for capital employment we take the weighted average, and in this case the predicted innovation has a positive macro effect, even though at the firm level it's not very good. So if someone tries to evaluate Callaghan and finds that on average their money didn't do

anything, really all they need to do is find one good example of one firm that added 50,000 jobs and \$3 billion a year in revenue. All they need is one, to justify all the others. Even if all the other 99% of the projects got zero, all you need is that one to make it worthwhile. And so that, that does change the way you have to think about evaluating. Now evaluation actually is much harder, because the question is, would that one firm have made it without your help? If the, if the answer is yes, they would have made it without your help, then you're still not needed. [Laughter]. But the point is, be careful with the evaluation and if someone says on average your result is zero, don't despair. If you have good examples of why it was positive, I would almost say I'd be willing to just take good anecdotes of why those firms really benefitted. That would convince me more than an average firm-level regression.

...in industries where penetration of, for example, broadband is higher, the variance of productivity goes up.

Here's some data showing that in industries where penetration of, for example, broadband is higher, the variance of productivity goes up. And that's both in levels and first differences and I've hit up this in a thousand different ways.

...ICT-intensive firms have higher variances or higher dispersion in output growth and in productivity growth.

Another way to slice it with the data we have is I can track firms, I can take what's called a long panel. I can look at firms that are available between 1995 and 2010 in each industry in each

country and I can split them into two groups: those that are intensive in innovation or ICT and those that are not. And what we find is that the ICT-intensive firms have higher variances or higher dispersion in output growth and in productivity growth.

...the relative wages of ICT-intensive firms in the EU have been growing at 1.4% more per year.

...if I compare employment growth of firms that are intensive in ICT to firms that are not intensive in ICT, their employment growth across countries and industries is, in general, higher... their productivity growth is high, but they get it through an output growth that's even higher than the employment growth.

The next thing we can do with these firms, within each country industry in year, I can aggregate up all the firms that are ICT-intensive and all the firms that are not ICT-intensive and I can look at their relative wages over time. And as it turns out, the relative wages of ICT-intensive firms in the EU have been growing at 1.4% more per year. Over 10 years or 12 years I've got, what is it, 14 percentage points or 15 percentage points higher wages in the firms that are ICT-intensive. I can do the same and look over a long range at output growth, productivity growth and employment growth, and this goes to the policy makers worry that this new technology's going to cost jobs. Well, maybe so, but if you're not

going to use this technology, it might cost even more jobs. And indeed we find that if I compare employment growth of firms that are intensive in ICT to firms that are not intensive in ICT, their employment growth across countries and industries is, in general, higher.

Their productivity growth is higher and their output growth is higher and the trick is that their productivity growth is high, but they get it through an output growth that's even higher than the employment growth. It's not the case for all industries and countries, but predominantly I'm in the top quarter where both employment growth and output growth are higher for the ICT-intensive firms than not.

So how do you connect this – what does all this mean for policy? And, I must say, I haven't done research on this but I've been involved in the debates on R&D and on policy and national innovation systems for 20, 25 years. I think I've been changing my point of view on these issues, just by looking at the case of what's happening here.

...don't try to bet on everything, but in the small subset where your chances are good that if you make an improvement you're actually going to be able to be visible to the rest of the world and be able to ship your products to the rest of the world, go for those. Start from the current strengths, the primary sector, maybe instrumentation. Digital effects, yacht building, racing yachts.

There's this paradox that the framework conditions for high intangible investments seem okay. In my previous work, I said, look you need the scalability so you need your flexible markets and once you got that, firms are going to want to invest in these intangibles and you're off. Well that's okay, but there might be another bottleneck. Even if your internal markets, capital and labour markets and product markets work okay, maybe it's difficult to geographically ship your products, either within your own country or between countries. So this potential market size could remain small because of distance, and the visibility of this existing knowledge may be low as well. And one possibility is, as the world moves more and more to a production function of a knowledge-based capital growth model as opposed to a Solow growth model, it could be that New Zealand's going to fall further and further behind. Or you could try to connect yourself, but not broadly in the economy but actually narrowly focused: try to maintain connections in those areas where you're already linked-in in the global sales and global knowledge space. So for a smaller subset, don't try to bet on everything, but in the small subset where your chances are good that if you make an improvement you're actually going to be able to be visible to the rest of the world and be able to ship your products to the rest of the world, go for those. Start from the current strengths, the primary sector, maybe instrumentation. Digital effects, yacht building, racing yachts. I don't know what exactly you're good in, but I'd try to identify those and say, we need to focus our efforts exactly there if we're going to be trying to maintain this connection.



McGuinness Institute

@McGInstitute: Eric Bartelsman discusses importance of having a narrow focus on connecting with rest of world, be clever #innovatenz

...paradoxically, it calls for government involvement that goes beyond... the Anglo-Saxon innovation policy which says we need generic instruments, we're not going to pick winners...

So I would say, paradoxically, it calls for government involvement that goes beyond or is orthogonal to the Anglo-Saxon innovation policy which says we need generic instruments, we're not going to pick winners and those are all the things that actually up until a few weeks ago I would have called for. Looking here and contrasting this new area of innovation with knowledge-based growth, it seems to be heading in this direction in my idea.

If you can take away some of that future market uncertainty by giving a prize, you'd be amazed how much investment money appears out of nowhere to go for that prize.

I put down innovation prizes, even though today we heard well, it's a very limited area. But exactly when you're trying to pick areas where you have an idea of where it might be going, having thematic platforms and having directed technical change in areas that you want to have anyway; the worst thing that can happen is that you don't sell it internationally but it's going to really improve your life here. So invest in those things. And one way to do that is with innovation prizes. Entrepreneurs and innovators have hubris. They think they're going to win whatever happens. Their uncertainty

isn't the technological uncertainty. Their uncertainty is, can I actually get this to market later? If you can take away some of that future market uncertainty by giving a prize, you'd be amazed how much investment money appears out of nowhere to go for that prize. The prizes that we've seen so far in space vehicles or in these self-driving Land Rover automobiles, often a \$10 million prize will elicit \$80 million in R&D investment, just because the type of people that go for this think and know they're going to win. So choose these prizes carefully though. Choose thematic areas with a medium to longer-term horizon. Define the prize for achieving well-defined functional targets, so the board at the end, that decides, it's actually really easy to see ex post whether or not you've met the criteria. And this is going to provide the certainty on a future market that will help elicit the intangible investments today. And it doesn't cost the Treasury much today. I don't know whether you can actually make this promise without putting in on your books. I'll have to ask a national accountant that. Can the Treasury promise a future prize and not put it on the books today as an expense? They shouldn't be able to, but they'll probably find a way.

...the 20 to 25% of the economy where the Government's involved, these are really good areas to start thinking about innovation as well... Having these things being expensive and taking scarce resources is going to hurt your competitiveness, so try to do innovation in areas where the benefits could be exported.

So the next one, and again this morning we heard the 20 to 25% of the economy where the Government's involved, these are really good areas to start thinking about innovation as well. In a small, sparsely populated country, the relative costs of public service must be comparatively high. You've got to make it accessible in different areas. Having these things being expensive and taking scarce resources is going to hurt your competitiveness, so try to do innovation in areas where the benefits could be exported. Health care – not just the technological side of health care, but the organisational side. How do you organise it? I know lots of governments are interested in how the educational system here is being financed. That's an innovation. I don't know how you can sell that innovation – maybe through consulting services. But also, you could attract other students who might get a good deal coming here. You can think as we're getting richer through all this new technology, and so that's the positive message. In 30 years we're going to be twice as rich. We're going to be spending a lot more on health care and arts and leisure and back scratching than on automobiles and things that go whizz in the night. So these areas that right now are under budgetary pressure, we can open up for innovation by being clever about how to finance it and being clever about finding ways to innovate in these areas. And I think that's another good way forward.

That ends my talk. [Applause]



Discussant:

Dr Peter Crabtree, Ministry of Business, Innovation & Employment

Peter Crabtree: Thank you. I'm just going to change gear for a minute and I'm going to talk very much as a policy practitioner.

And where I start is probably where Eric has ended really, in terms of some of the conundrum that we face as policymakers in New Zealand around the evidence base on innovation and the fact that what we see is we have a lot of the framework conditions that you would expect to see underpinning really high performance in an innovative economy, but we don't necessarily see the performance from that, the outcomes from that, that we would hope for.

I'm going to talk a little bit about performance on innovation. Then I'll move to the Government's Strategy for Innovation, how that fits within a broader economic strategy and then drop down into just three main areas of priorities that we're focused on at the moment, and I'll pose some questions that we're facing as policy makers.

So just starting off: every time we look at a global index on innovation, New Zealand actually generally looks reasonably good, apart from a few areas, which we'll dig into in a moment. We've been spending a lot of time over the last few years, stopping comparing

ourselves so much from a policy context from the US and UK and large economies and focusing in on small, advanced economies where we think there are particular challenges for policy makers that we share. For example, how do you run a small science system, an open science system and how do you make choices around prioritisation, because you can't place thousands of bets in the same way a large country can.

...it's in the area of knowledge-based capital where we really fall down in terms of the levels of investment...

But anyway, when we compare ourselves, against some countries which you think are pretty high performers generally, we do pretty well. However, we think dropping down, it's in the area of knowledge-based capital where we really fall down in terms of the levels of investment and then that leads us to some of the areas of priority that we have, whether it's the public investment in R&D, for example, or private investment in R&D in particular.

The way that we work on it is we've got an integrated agenda across a set of themes which we see generally as enablers for business activity in the economy. We have a particular innovation theme, but I'd just like to point out that others of these themes obviously provide enablers for innovation. So if you're thinking about infrastructure, well we've had a huge focus on ultra-fast broadband roll out for New Zealand, which we see as a huge enabler of innovation in the investment context. Very significant reform of the financial markets; we think a lot at the moment around the shape of the early stage capital markets, venture investments, seed capital investment and so on. And there's quite a lot of innovation going on in those types of markets as well at the moment with things like crowdfunding and so on.

The key priorities at the moment are making the most of the digital economy, knowledge production, diffusion.

actively around the regulatory frameworks and how they adapt and examples would be areas like in telecommunications, what you're seeing around convergence of different technologies and making sure that you've got a regulatory framework that is really enabling and fit for purpose for the future and for innovation in those contexts.

If I think about the building innovation theme. What we have is a cross-government process, an action plan on innovation and it has a set of priorities which, I was looking at the most recent OECD strategy the other day and they line up pretty closely, as you'd expect with those. So a lot of the difference really is when you start to drop down into New Zealand's country-specific characteristics. The key priorities at the moment are making the most of the digital economy, knowledge production, diffusion. I'll talk really about the science system in particular, because that's where we've been placing a lot of effort in recent times. And lifting business expenditure on R&D which has been a key topic for discussion today. But I'll just also point out that we are thinking

...to what extent do you focus on STEM skills versus other skills. How important are they for innovation? I'd have to say that that one certainly isn't settled in the New Zealand context.



The whole question of skills for innovation, there's a hot debate between to what extent do you focus on STEM [science, technology, engineering and mathematics] skills versus other skills. How important are they for innovation? I'd have to say that that one certainly isn't settled in the New Zealand context. I think we were generally concluding that we could probably make a whole lot more investment in STEM, we probably lag quite a lot anyway.

...you're facing disruptive technologies and so on and New Zealand needs to be able to adapt and be resilient...

Just dropping into the ICT area. We think that the rationale for making sure that New Zealand could make much greater use of ICT certainly in the business context; well certainly as consumers, as government and as business – really strong arguments in terms of the gains for the economy and for consumer welfare and so on. But also in terms of things like, which Eric touched on, which is you're facing disruptive technologies and so on and New Zealand needs to be able to adapt and be resilient in that type of context.

If you were changing the way that your tax system operates in terms of the interface, your company's registrations and a whole bunch of other government services, taking those online and streamlining them, there are productivity gains for government.

Working on something like the digital economy means working on a lot of different things at the same time, and some of those things are more amenable to government activity than others. So if we were thinking around digital government, putting government services online, we think that could be quite a significant catalyst for, for example, business use of ICT. If you were changing the way that your tax system operates in terms of the interface, your company's registrations and a whole bunch of other government services, taking those online and streamlining them, there are productivity gains for government. There are certainly significant gains for business at the same time, and especially if you're seeing lags in terms of business uptake. We think that could be one of the ways in which you could catalyse that.

What we're seeing with the digital sector at the moment, the ICT sector in New Zealand is that it is growing extremely fast. It appears that we have an area of not only comparative advantage, but some emerging competitive advantage as well in that it certainly plays to the whole notion of a weightless economy – and I'll get to that later on. But that's where we are seeing a lot of the growth and investment in business R&D at the same time. There's a huge amount of that growth as well.

But again, underpinning all of that, you've got to work on skills, you've got to work on the infrastructural questions, particularly geographically, and that's expensive. We think we're quite far along in that process and there are really significant challenges around security and privacy at the moment and in the regulatory frameworks.

...New Zealand business use of ICT, we think it's been improving but it certainly hasn't been improving at the rate at which we would aspire to...

In terms of New Zealand business use of ICT, we think it's been improving but it certainly hasn't been improving at the rate at which we would aspire to, and here we've set ourselves a target of getting into the top 10 in the world in terms of business usage of ICT and we're currently at 19th.

So how do you work on this? Because when you start to really hone in on the business side of the equation – and this is an open question at this moment because we don't think it's settled at all – is that it's quite a black box. It appears that when you're dealing with how businesses are making choices around the use of ICT, they're obviously responding to a lot of external incentives to competition and so on, but there's a whole bunch of stuff going on inside the firms in terms of their capability to make these choices and adapt and so on. And they're the same types of issues around questions like management capability that we're seeing in other areas such as firms' ability to trade and so on and so forth.

While we see the Government has relatively few levers in these areas, we want to think quite creatively about how we can create the conditions for firms to adapt, and there's certainly going to be significant creative destruction in this area over time as well.

So just thinking about knowledge production diffusion, I'll talk about the science system really. We've just released a national statement of science investment which is a 10-year strategy, a government policy statement for the science system. It sets out a clear statement about where we want to go with New Zealand's science system. Generally, a science system we would observe as a very efficient science system. The quality of the outputs from the science system are good. There are a few areas of excellence, but there are far fewer areas of excellence than we would expect to have, compared to some of the countries that we compare ourselves to.

...thinking about the science system, there's actually some significant cross-overs in the economy with the business investment in R&D as well, because in the New Zealand context we've often seen the public science system doing a lot of work that you may well see in other economies being done by the private sector as well.

And the Government has made a very clear statement that it will invest over the next 10 years significantly in the public science system, but at the same time there are two major themes that we're thinking about in doing that. One is the focus on excellence across the whole system and the two on impacts. And thinking about impact in as a sophisticated way as possible – because impact obviously means something quite different from when you're doing it really far away from market research – and it may mean something quite different when you're thinking about health research or environmental research than it does in the economic context, and often these things are also joined up. So we've set out some goals for the science system but I just thought that, in thinking about the science system, there's actually some significant cross-overs in the economy with the business investment in R&D as well, because in the New Zealand context we've often seen the public science system doing a lot of work that you may well see in other economies being done by the private sector as well.

This diagram's quite revealing, because we're starting to, as we think our way through this, start to drop more and more into thinking in the sectoral sort of a basis. Because you're seeing quite different dynamics playing out in different sectors, whether they're economic or non-economic. And here you see a pattern and in many respects this chart tells a story around the New Zealand economy and path dependence in the New Zealand economy, so you're seeing a significant investment in primary industries' research. You're probably going to see a whole lot of associated investment in the environment part of the pie which are around essentially externalities from the primary sector and you'll see a bunch of manufacturing which is also in related processing as well.

But what you see in each of these different areas is a very different composition of who invests what in what kinds of research. And so generally in the primary industries you see the Government and the government labs. We have Crown Research Institutes that do a lot of the quite applied research that you may well expect others to do. But at the same time, what you're doing there is that you do some research that makes grass grow faster that applies across thousands of farms that has a more general effect, whereas if you were across in the manufacturing sector, you're dealing often with very particular technologies that relate to, in a small economy, something like, it could be one firm. So you have quite different questions about who should do what kinds of research over time.

...we, in our contestable funds, spend about 3% of our portfolio in ICT. That doesn't seem right given the scale of the ICT sector at the moment... how do you adapt your institutions and your funding mechanisms to keep up with these types of challenges?

One thing to point out: information and communication services is quite interesting at the moment. What we're thinking about at the moment is okay, this is a representation of where the economy's been and as investors in the science system, how do you make choices about where you're going? And in areas like ICT, you'll see that the Government has made very little investment further from the market research in ICT. Partly that just makes a lot of sense, because the market's moving so quickly and firms are best placed to move, but at the same time we can see that we, in our contestable funds, spend about 3% of our portfolio in ICT. That doesn't seem right given the scale of the ICT sector at the moment and where it's going and there are definitely areas such as cyber security or dealing with big data where there are really strong arguments for going further from the market research. And so we're thinking about okay, how do you adapt your institutions and your funding mechanisms to keep up with these types of challenges?

Another way of looking at it, and I'd just say here that we don't think of the system as a linear model of the science/designs and innovation but what this represents is the pattern of an investment portfolio. And how we're thinking at the moment is that we will make a whole bunch of complementary investments, because there's a lot of interdependencies across this.

There's a lot of acronyms up here, but generally they'll be further from the market. You've got funding mechanisms for more basic research, higher education research. You've got contestable funds in the middle which are largely around mission-oriented research, and you have the CRI core funding which is largely for our Crown Research Institutes which are very much facing the primary sector or environmental sectors as well.

...big questions around connectivity across this whole system and how you use these types of funding mechanisms to incentivise much higher levels of interconnection.

And on the right-hand side you have the Callaghan Innovation and really the demand side mechanisms that we've been using from a financial perspective to incentivise. So the big question at the moment is, how much do you work on the demand side, and big questions around connectivity across this whole system and how you use these types of funding mechanisms to incentivise much higher levels of interconnection.

...we need to have a basic capability to be able to adopt and diffuse knowledge in certain ways and we have to think very carefully about where we want to be fitting more closely to the frontier really.

And the other aspect here is, we do not see this as a closed system. We are very focused on the idea that New Zealand imports the vast majority of all of the knowledge that is used here; we need to have a basic capability to be able to adopt and diffuse knowledge in certain ways and we have to think very carefully about where we want to be fitting more closely to the frontier really. And as Eric said before, we have to make some quite hard choices about some of those areas, because we can't place lots and lots of bets. We simply cannot afford it.

 **Donal Curtin** @donal_curtin:
Listening to @MBIEgovtnz's Peter Crabtree at #InnovateNZ, struck by how many different buckets the national R&D \$ go into...

Just hitting on business expenditure on R&D. You've been talking all day about this, so I won't repeat it. It is a top priority. I understand there was some discussion earlier in the day about the target. It's an aspirational target, but we're pretty focused on it. New Zealand's level of business R&D is low. You can explain it away: firm size, sectoral composition of the economy and so on, but that's quite different from, I suppose, thinking about where we would like to be over time and where we would like to be over time is going to result in some sort of structural shift in the economy. The question is, how do you have that structural shift in the economy? To what extent does it evolve out of what you've already done? To what extent does it evolve out of things that you are going to be surprised about and so on, and to what extent are you deliberate about that, or do you essentially just create the enabling conditions for that to happen?

So things that we've been actually doing in recent times: Sarah talked earlier in the day about Callaghan Innovation. We created essentially a new institution that was going to drive a focus on business investment on R&D and the commercialisation of innovation.

Yes, a focus on using financial instruments to lift business investment but really packing around that a whole bunch of other things which is really stimulating businesses' connection to each other: networking, technology networks, connections to global technologies, thinking ahead in terms of foresighting and a whole bunch of other sort of services, and the idea was to bring those all together. And certainly we work really closely with Callaghan Innovation to push that along.

... we've moved much more to a grants mechanism which is non-discretionary, which is much more predictable for the firms, but the trade-off has been... a much lower rate of subsidy, but the firms can certainly plan around it much more...

We've also thought quite a lot about the redesign of the business R&D grant schemes. We did previously have quite a focus on what we call discretionary approaches, discretionary grants where we had investment managers making choices about projects that they thought were the best projects and so on. We've moved quite significantly. There was also quite a high level of subsidy rate at that – something like a 50/50 type subsidy on average. What we've done is we've moved much more to a grants mechanism which is non-discretionary, which is much more predictable for the firms, but the trade-off has been – and we've been thinking very much from a fiscal perspective – a much lower rate of subsidy, but the firms can certainly plan around it much more so. And that's very much, at this point in time, in the midst of implementation and we're really keen to see that succeed.

As I pointed out before, we're starting to think that we're probably getting into diminishing returns in terms of thinking about some of those financial instruments, so we need to think more cleverly about a whole bunch of other things that are going on. And that would range from regulation to government procurement and so on. But in different sectors as well. What are the dynamics that are going on and what types of institutional support is appropriate there, and so on.

We're very focused on a set of priority sectors, priority technologies where we think that New Zealand already has significant capability, where it has a presence of domestic firms that are really active, and essentially what we're looking to do is to create stronger little innovation systems and so on, including multinationals in the equation.

So we have moved quickly onto focusing on attracting multi-national investment in R&D and we see that as multinationals being involved in the New Zealand innovation system, whether that's in partnership with our science institutions or whether that's here as economic investors in R&D in and of themselves. We've got some countries here that obviously do a lot more than us at it, and we're certainly not proposing to get into a game of offering financial incentives to induce this to happen, other than the types of incentives we would offer to any firm. But where we're at, at the moment is we have a task force underway. We're very focused on a set of priority sectors, priority technologies

where we think that New Zealand already has significant capability, where it has a presence of domestic firms that are really active, and essentially what we're looking to do is to create stronger little innovation systems and so on, including multinationals in the equation. And you can take areas like agritech – where you would think that it was a no brainer that we should be having more global agritech firms in a New Zealand context because we have very strong agricultural science and it's essential to our economy. And the whole approach here is to join up a whole bunch of government actors and mechanisms to work on different barriers to that happening, whether that's making complementary investments in your science system, making sure that there's access to the right kinds of labour force, your regulatory environment, your infrastructure and so on. So that's a current work in progress.

So that was just a brief skitter across a bunch of priorities that we have at the moment. Obviously we come to these types of fora, we listen really hard, we try to synthesise the findings as much as possible. So this could look a little bit different next year, as I would expect, and have a rolling set of priorities over time. Thank you. [Applause]

 **Donal Curtin** @donal_curtin:
Quite liked idea from Peter Crabtree at #InnovateNZ that we may be looking at attracting MNCs to NZ cos the big ones are big R&D spenders...

Patrick Nolan: Thank you Peter and Eric.

What a fantastic final session to finish. I would just note that yesterday we had a conference in this room looking forward five years but I think you've sufficiently lifted our horizon to 30 years, so thank you very much for that.

It was a strong case for the technological optimists, which I think in the Productivity Commission that's where we like to position

ourselves and it raised a lot of really important considerations, as if the process of productivity growth and economic growth is going to be significantly different going forward. We really need to think quite differently about our policy settings and those sorts of things, and Peter followed on from that by discussing the Business Growth Agenda and some of the work that's being done to reconfigure that. There's some real challenges in there around the science system, not just pursuing excellence. Some of the work that Simon Wakeman has done has shown actually we do have relatively good outputs from the science system, but the challenge is commercialising it, so going that next level. And some of the stuff around ICT adoption as well – work that the Productivity Commission has done for our services inquiry has shown that one of the challenges is getting the organisational process to wrap around the ICT, not just the physical investment in the ICT, but going beyond that.

Discussion



Patrick Nolan: We've got 15 minutes for questions. Yes, Arthur Grimes.



Arthur Grimes: Eric, can I ask you a question? One of your important results was there were still country differences when you had your 14 country panel and you're trying to think why might that be the case. I'm wondering if you've got countries within them that have different cultures in there, and the reason I ask this is a) because I've been working on it myself. But Alesina and others are talking a lot now about the importance of culture on economic outcomes. In Switzerland I saw a very interesting study where dividing the French and the German, or French, Italian and the Germans versus the German systems where entirely different savings propensities, for instance – not surprisingly, the Germans save and the French don't. They didn't say anything about making love as the first one. And then you've got Belgium as well where you've got very different cultures and things like that, whether you've thought about whether there might be cultural differences within countries as well as country-specific effects.



I think I once even said thinking about cultural differences is like the last refuge of the scoundrel economist... But lately I'm changing my mind on this.

Eric Bartelsman: Again, I think my ideas on this are shifting. I think I once even said thinking about cultural differences is like the last refuge of the scoundrel economist or something like that. [Laughter] But lately I'm changing my mind on this.

I was at a conference that Ned Phelps at Columbia organised about four weeks ago and he's working whole hog on this issue of culture and productivity. There's this thing called the World Values Survey and we're actually incorporating, as we speak, there's an RA [research analyst] working on the World Values Survey merged with these data I have on innovation. I only have the country level. Ned Phelps and his collaborators are now also looking at these NUTS regions, these lower-level regions, where they can take the World Values Surveys, look at the values within each sub-region.



It might be that as your economy develops from an agricultural society with a high risk of droughts making you go hungry, towards an economy where the worst thing that can happen is that you'll have to cancel your third vacation when a recession hits, your values might change.

Eric Bartelsman: They've got something that they can split within a country to regions. Maybe I got that wrong. Anyway, they're starting to find some smoking guns, but it really is just preliminary and one of the problems with the culture, of course, is that like with a lot of our work, what's exogenous? If you've been in a certain circumstance for 20, 30 years with a certain way of thinking and a certain economic outcome, you might have very different cultures. It might be that as your economy develops from an agricultural society with a high risk of droughts making you go hungry, towards an economy where the worst thing that can happen is that you'll have to cancel your third vacation when a recession hits, your values might change.



Arthur Grimes: They do tend to be very long-lasting, according to the literature.



Eric Bartelsman: Right.



Arthur Grimes: But then there's a very multi-generational [indistinct].



Eric Bartelsman: Okay, but still actually the World Values Survey has on their website a thing where they're showing, they actually show transitions. As an economy moves, in 30-year periods, there can be quite significant changes.



Patrick Nolan: Peter, I think effectively the discussion today has just made your job harder, because if there were simple levers that we could pull, we would have identified them. Now we're talking about culture. You could also drill down into other things like regional disparities and differences between sectors. What sort of implications do you see that has, particularly for things like the Business Growth Agenda?



Peter Crabtree: Well, I think it is that you move down to more disaggregated levels of analysis in how you act at a particular point – regional development's hot at the moment. Obviously you see things playing out in quite different ways in different regional contexts.



Patrick Nolan: Okay. Bronwyn and then Beth and then at the back.



...labour market regulation... just has a huge impact on your willingness to start a firm, or your willingness to grow a firm or to try something risky – because if you can't lay workers off it's just too risky. And that varies, partly for cultural reasons, across countries substantially, just within Europe.

In the US you fail in starting a business, you don't even have to stay where you are. You can move to some other place and there's no memory of it, and it's just a lot more difficult in Europe.



Bronwyn Hall: On a previous discussion, even if you don't get as deep as culture, one of the interesting things about some of the work there is they try to instrument for this endogeneity with stuff which is 3,000 years ago and so forth. But more importantly, once you get into this business, there are some things that actually matter immediately. One of them is what I alluded to before, which is labour market regulation. That just has a huge impact on your willingness to start a firm, or your willingness to grow a firm or to try something risky – because if you can't lay workers off it's just too risky. And that varies, partly for cultural reasons, across countries substantially, just within Europe.

And the other one is attitudes towards failure. That's been pointed to over and over and over again as a big difference between the US and Europe. In the US you fail in starting a business, you don't even have to stay where you are. You can move to some other place and there's no memory of it, and it's just a lot more difficult in Europe.

And one of the things the World Values Survey revealed, I think, is that indeed this thing we thought was true is true, and that affects innovation rates. I would have thought that New Zealand would actually be on the US side of this. It's composed of people who took the risk – the descendants of people who took the risk of coming a very long way to improve their lot and that is actually part of the story in California also.



Patrick Nolan: Thank you, Beth. Although Peter, that does makes me think of bankruptcy provisions and those sorts of things. I should know the Business Growth Agenda better than I do, so is that an area of activity?



Peter Crabtree: Not that I know of at the moment.



Patrick Nolan: Right, okay.



Eric Bartelsman: But those are actually rules, so even if the bankruptcy is part cultural, in the US in many states, if you go bankrupt, you get to keep your house, your primary residence. So you take a mortgage on your house, you start up a business, you fail and you keep your house. So these rules that you can change. Whether you want to is another...



Patrick Nolan: Beth. We've got lots of hands in the air. There's one at the back and then I saw...



Beth Webster: One little point to follow on from that is that Australia last week has just announced they're going to change their bankruptcy rules to make it less punitive when you do fail business. They're going to do it in a way that doesn't allow those unconscionable developers [laughs] to get off the hook though.

...whenever I see those studies that show that the rate of return to innovation at the firm level... is positive or when innovation has a positive effect on productivity or profits, you immediately think, well why doesn't everyone innovate, if it was that easy.

My question was, whenever I see those studies that show that the rate of return to innovation at the firm level – and this is where culture's probably uniform across the whole sample – is positive or when innovation has a positive effect on productivity or profits, you immediately think, well why doesn't everyone innovate, if it was that easy. So there's obviously some additional factor in there that's explaining why some people are successful and some people aren't. Why some people, therefore, make the decision. Do you know what it is? [Laughter].



Bronwyn Hall: That's why we invited you. [Laughter]



Eric Bartelsman: Well, one is I don't think on average, there are excess returns. I think it's this makeshift that it turns out that someone's successful. On the other hand I think the type of people that become entrepreneurs are people with the hubris. So Giovanni Dosi, he has a 1998 piece where he does a lab experiment with students going into the electronic lab and the game is set up that you get money and you put up to enter in a firm. And it turns out that business students do much more so, even though it turns out that the average return is negative, even stronger, once people know that they can enter in a field that they're good in. If they select the people, for example, on football statistics and are like, "I know that", they even put in more money forgetting that everyone else selected is also self-selected on being good at soccer statistics. So there is something about the entrepreneur's hubris. At Ned Phelps' conference two weeks ago, Peter Thiel was there and he actually said he selects his ventures, where he invests in, on people who don't see the risk. He says once they see this as a lottery they become intellectually lazy and stop preventing failure. He wants people who don't even see it, but are continuously fighting to ward off the risks as they come along. So he's like, oh I asked them what percentage of your money fails. I think he was kind of cagey. I think he said 87%, but I think that means he put in 100 and got 87 back, so I'm not...

• • •

Female Participant: [indistinct] in their own abilities.

• • •

Eric Bartelsman: Right.

• • •

Patrick Nolan: We've got a question there and then Andrew.

• • •

Male Participant: Apologies if it's already been asked before. I missed some of today. Question about ways to improve connectivity and commercialisations of already existing innovations, innovative output. Unlike encouraging takeovers by foreign firms or bringing foreign firms here as a way to transfer knowledge and connecting to the rest of the world, were there any studies or discussions about basically buying in world top CEOs, managers, like I don't know, Google's ex-CEO, as a way to really push... someone who had been there and done that. Is it something that's been discussed, studied?

• • •

Patrick Nolan: Peter, do you want to start and then Eric.

• • •

Peter Crabtree: Well, not the Government doing it. Firms do it all the time. It's the labour market. [Laughter]

• • •

Patrick Nolan: Peter, do you want to start and then Eric.

• • •

Eric Bartelsman: Motu does it now. [Laughter].

• • •

Patrick Nolan: Okay, and Andrew.

Other places throw a heck of a lot more money on infrastructure, say, than Anglo-Saxon countries do and certainly they throw a lot more money and attention on innovation.

Andrew Sweet: Thank you very much. I didn't introduce myself last time. Andrew Sweet, now working for the Secretariat of the Small Advanced Economies Initiative. I'm too tired to try and frame this as a question, so I'll just make it an observation, which is that I think policy systems have cultures as well, so I'm picking up the cultural point. In the Small Advanced Economies Initiative we spend a lot of time talking to the countries which are now increasingly turning up on our comparative graphs. And I was really glad to see mention of the Anglo-Saxon innovation policy paradigm. You didn't use the word paradigm, but what I found really interesting, when you go to those other countries, is that they do just think quite differently about these things and you notice how policy develops really incrementally in innovation, but also other places. Other places throw a heck of a lot more money on infrastructure, say, than Anglo-Saxon countries do and certainly they throw a lot more money and attention on innovation. So I think there's a huge opportunity but also a huge challenge for us to really take the time and effort to understand how they think and compare it to how we just naturally have been taught to think.

Patrick Nolan: Okay. So I'll get Peter and then Eric to respond to that statement rather than question. Eric, you were talking about, I guess, the attitude of the entrepreneur, always believing that they'd succeed. You often will find that with civil servants too [laughter] and so I'm just wondering how do we, in a sense, choose the right areas. If there's going to be a need for a new model, how do we choose the right areas to be thinking more creatively? How do we choose the right battles and targets?

Peter Crabtree: I think innovation policy, by its very definition, is going to be experimental at times because you are very much about creating the future, so you will rely as much as possible on the body of evidence that you have at your disposal. But we always have, I suppose, as part of our portfolio some things which are more risky. They're punts. You're thinking often quite creatively about what you think is going to work in your particular context and some of that particular context is going to involve questions of culture and political economy and so on and so forth. So, yeah, definitely the whole notion of the policy entrepreneur is, they exist, but it's all about teams and you've got balances of people who are highly analytical and are probably asking harder questions at times.



Patrick Nolan: Yeah, great, thanks. Eric.



Eric Bartelsman: Well I think looking at Peter's slide where they have the balls and the two axes of the different instruments and it just made me, in a way, humble as an academic saying well we don't have an answer to your problem. You've got a certain amount of money that you think should be spent on innovation and there's all these different instruments. There's the fundamental from Marsden in the top left to Callaghan in the bottom, and then a bunch of nameless acronyms in the middle. [laughter]. Well you've just got to get nice names for them as well – there must be some. [Laughter] It's hard to think about how to structure the decision process of what to put where. So in a way, I'd like to challenge the community here to think about ways in which to build criteria for what goes where. So one is the thematic – which are the areas, and I think that might be the easy one. The difficult one then is, at which stage in this process do you put how much? Do you first put it in education and wait 10 years till they're ready or do you go both directions at once? Within each of these balls too, there's a whole set of work on institutional setup. How do you do your R&D subsidies? Beth went through the list of all the pros and cons for various ones. Each of these balls will have similar issues of incentives and spill-overs and drawbacks.



Peter Crabtree: Oh very much so. We just redesigned our approach to contestable funding of science – where we've moved from ex-ante specification of research questions, very specific, to one which is very much about setting out some high level outcomes, turning it over to the research community to compete. So we're looking for a far greater level of competition. We'll test the level of excellence, but we'll test the potential impact much harder than we have in the past – but those types of things, where we're just trying to tip the balance to get more, in a sense, more disruption, more creativity.



Patrick Nolan: Well, we're a little bit over time but I think that the themes of disruption and creativity are a good note to finish the discussions on. So if you could please join me in thanking Eric and Peter. [Applause]



Shaun Hendy @hendysh: Great day at #innovatenz – pairing international experts with locals seemed to work well

Closing remarks

Patrick Nolan: So I'll invite Murray Sherwin up, who will give the closing address. But just as Murray's making his way I also want to quickly note the fantastic job done by the runners, both today and yesterday. So Sharnae Taylor, James Miller-Coot, George Ritchie and Andrew Palmer. Thank you all for giving up your time, both today and yesterday. So maybe we could thank the runners as well. [Applause]

And I should also mention as you leave if you could return your name badges to the desk at the end, just outside. So I'll pass over to Murray Sherwin, who's the Chair of the Productivity Commission. Murray's an economist with over 35 years' experience across a wide range of public policy roles.

Murray Sherwin: Thanks for all that.

Patrick Nolan: There we go, so thank you Murray.



Closing remarks:

Murray Sherwin, New Zealand Productivity Commission

Murray Sherwin: Thank you Patrick. I promise not to keep you all from your drinks for very long at all.

I'm delighted with both the quality of the presentations, the quality of the engagement, the numbers we have here and also the diversity of organisations represented.

This is our second Hub Symposium. I found it a really interesting day. I'm delighted with both the quality of the presentations, the quality of the engagement, the numbers we have here and also the diversity of the organisations represented. So well done to our organisers. We look forward to another one, but not for a little while, Patrick. Not for a little while.

At the macro level, New Zealand's productivity challenges are pretty well tramped over. We see the scale of the challenge in our per capita income levels relative to whichever comparators we choose to use. We've seen reference to the underarm bowlers across the Tasman as one comparator or the OECD averages as a more

conventional measure. David Ramsden, with some delicacy, chose not to show us at all as we were off the bottom of his chart. But that's okay. [Laughter].

That macro story's important, but it struggles to explain why New Zealand is 30% or so behind where others are and where we'd like to be, despite the quality of our institutions... we need to be looking for a more finely-granulated examination of our performance and what shapes it, in order to develop the effective policy responses required.

That macro story's important, but it struggles to explain why New Zealand is 30% or so behind where others are and where we'd like to be, despite the quality of our institutions. What it tells us is that we need to be looking for a more finely-granulated examination of our performance and what shapes it, in order to develop the effective policy responses required. In that context, the innovation of the Productivity Hub has been a major advance for us. By joining the key agencies – Treasury, MBIE, Stats New Zealand in partnership with our friends at Motu we've formed a very strong collaborative network. It has a very well-focused work programme, including building capability, which helps us to explore firm-level behaviour and performance via the LBD. The programme is really bearing fruit and we've seen evidence of that in the material presented today. I have no doubt we'll see a lot more of it down the track.

Today was a chance to share some of this emerging work and explore a bit further what

the experts in this field are thinking about. A few themes that I have picked up on through the course of the day include the challenge of encouraging R&D, designing and implementing cost-effective, innovation-effective and productivity-effective programmes. They're not all the same. We know that what drives R&D doesn't necessarily drive commercialisation of product. But a number of our speakers have touched on that today. Firm size emerges regularly as an influence, and a number of speakers picked that up as well. Bigger firms seem to be significant in the innovation process and in applying innovation effectively.

In the New Zealand context, Gabs, this morning, drew attention to the nature of our larger firms. He drew attention particularly to co-ops – mixed blessings which can be summarised as being well-grounded with their shareholders and suppliers in New Zealand and offering effective risk diversification across the wider supplier/shareholder base. But co-ops bring with them capital constraints and governance constraints. It's very hard to grow vigorously across borders if you can't get your shareholders to invest and if your governance is inherently conservative about growing the business beyond the farm-gate.

As the owner, the Government is generally not strongly motivated to grow SOEs, either domestically or abroad, and not much interested in innovation and its associated risks. So if big firms and their behaviour matters, then the ownership structure of New Zealand's large firms means we start somewhere behind the play here.

We could add into that category, as we look at New Zealand and the characteristics of our large firms, by which I mean the ones with the billion dollar + turnover, the SOE [state-owned enterprise] sector, for the same sorts of reasons. As the owner, the Government is generally not strongly motivated to grow SOEs, either domestically or abroad, and not much interested in innovation and its associated risks. So if big firms and their behaviour matter, then the ownership structure of New Zealand's large firms we start somewhere behind the play here.

We've heard a good deal today about the importance of international linkages of all sorts, including networks for information flows, participation in large-scale value chains, feeding those connections into the intellectual capital of the local knowledge base. That's an important theme that we're going to be coming back to again and again. Indeed, it is already showing up in some of the work coming out of the LBD.

...how do we encourage the diffusion of knowledge and technology from the leading edge back to the laggards.

There was a lot of discussion, also, of the diffusion machine and how it is that we have firms that happily survive in New Zealand well behind the innovation and technical frontiers. Moreover, they survive for a long time. One presumes they have rational owners responding to the incentives around them. So what is it that's driving that characteristic about New Zealand firms and how do we encourage the diffusion of knowledge and technology from the leading edge back to the laggards. You can expect to see quite a lot more on this theme from Paul Conway and his team and the Hub as they progress with their work programme.

We now derive over 70% of GDP from services and that share is growing... what happens in services matters a good deal for what happens to the more traditional and better understood parts of the economy.

Measurement issues are a huge challenge in this field, of course, it is not surprising that we heard plenty on that theme. Issues of quality adjustments and other measurement challenges, particularly in services, are enormous. For more on that, I refer you to the Productivity Commission's Services Inquiry from 2014. We now derive over 70% of GDP from services and that share is growing. It's a sector which is highly diverse in all sorts of ways. While there are some very high productivity sectors within it, other areas are very strong on employment growth, but very weak on per capita output. Not only are the component industries in the services sector very diverse in almost every dimension, but also as we discovered in that services inquiry, they are very highly integrated with the goods economy. So what happens in services matters a good deal for what happens to the more traditional and better understood parts of the economy. I recall one chart from that inquiry which featured those logs that everyone sees down on the wharf as unprocessed, bulk commodity exports. In fact, around 60% of the value of that log sitting on the wharf is derived from services, some very sophisticated and most added in the last week or two before export. So highly integrated.

And of course within the services sector is the public sector at 20% plus of GDP and not that well understood in terms of its productivity performance. I'm delighted that we have work underway within the Commission –



Grant Scobie leading that, on secondment from the Treasury – and really aiming to get under the hood of the definitional and measurement issues in public sector productivity and to extend our understanding of the productivity performance in the non-measured sector.

So it has been a great day's discussion. The Hub's doing a great job of bringing researchers and policymakers together, sharing insights and sparking conversations that will help shape where we go into the future, help shape our future research agenda and an agenda that's highly policy relevant.

It is a tribute to the Hub that it's been so effective in pooling our resources to get access to this top international talent to increase our international linkages, which is important.

Let me wrap up by acknowledging a few people and some efforts here. First, the work and effort that's gone into the symposium; our international guests, thank you very much. You've made the long trip to bring your expertise and perspectives to bear on innovation in New Zealand and globally. We appreciate that. It is a tribute to the Hub that it's been so effective in pooling our resources to get access to this top international talent to increase our international linkages, which is important.

Eric and Bronwyn are both going to be in Wellington for a few more days so we've got plenty of meetings scheduled. We're going to work them hard, so my thanks to them for making themselves available. I hope many of you will have the opportunity to engage more intimately with them in those discussions.

Our local presenters also – demonstrating that we have depth in our economics and public policy talent in this country and we can put it to good use in improving policy and lifting economic performance. Thank you for your contributions.

Thanks also to the agencies that have contributed to making the symposium work.

Thanks also to the agencies that have contributed to making the symposium work. The Treasury, MBIE, Statistics New Zealand, Callaghan Innovation, the Swinburne Centre for Transformative Innovation, Te Pūnaha Matatini and of course the Productivity Commission, all of whom have written out cheques for this one. Thank you.

Paul Conway, Robyn Sadlier, Catherine Jeffcoat, Virginia Wright and the rest of the team have done a great job in holding all of this together, but particularly Patrick, our Master of Ceremonies today. He's been a busy boy. He's had a big hand in organising this and chairing the day. Thank you very much, Patrick. He was also very heavily involved in the GEN Conference yesterday, so he's seen plenty of this room over the last couple of days. Patrick also does a fantastic job running the Hub Secretariat, so the buzz and the vibe you see around it has got a lot to do with the way he drives that. He's having a big impact since arriving back in the country 18 months ago, so again thank you Patrick. What I would advise Patrick is that you go home tonight, take your dear wife, give her a kiss on the cheek and say relax, my dear, you can now take your own time, you are now free to go into labour any moment you like. [Laughter]

So that's it, folks. There's some drinks outside. Great day and congratulations to all. [Applause]

 **Bill McDonald** @connect_nz:
#innovatenz well done Patrick and the @nzprocom team. Looking forward to catching up on the speakers I missed.

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Session 1
 Panel discussion 1:
 Sarah Holden
 Callaghan Innovation

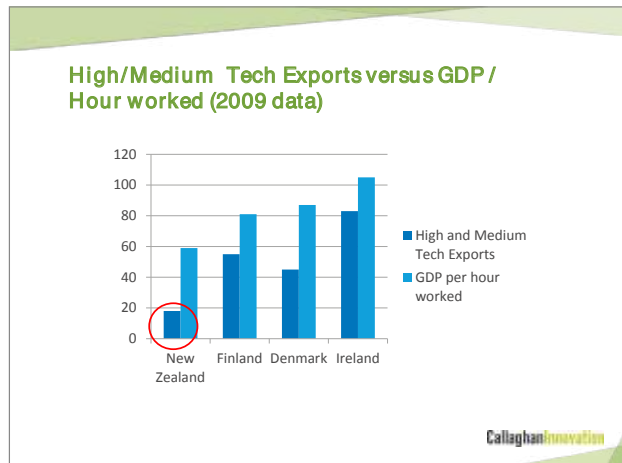
CallaghanInnovation
 BUSINESS TECHNOLOGY SUCCESS

Increasing BERD

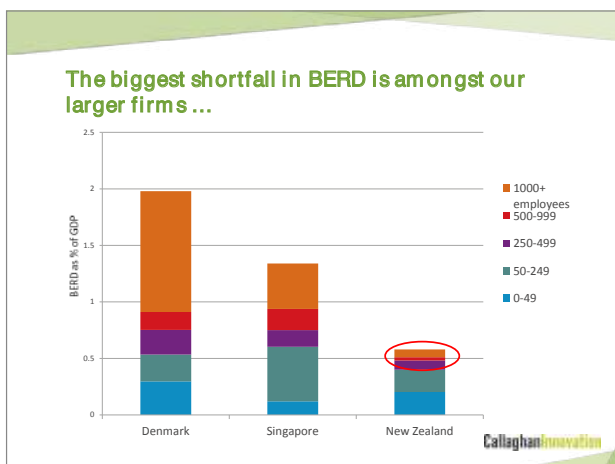
Experiences from the front line

Sarah Holden
 General Manager, External Relations
 1st December 2015, Productivity Hub Symposium

1



2



3



Session 1
 Panel discussion 2:
 Professor Kaj Storbacka
 University of Auckland




Market Innovation

Associate Professor **Suvi Nenonen**
 Professor **Kaj Storbacka**

THE UNIVERSITY OF AUCKLAND
 ADVANCEMENT THROUGH KNOWLEDGE
 NEW ZEALAND

1



Markets are ...

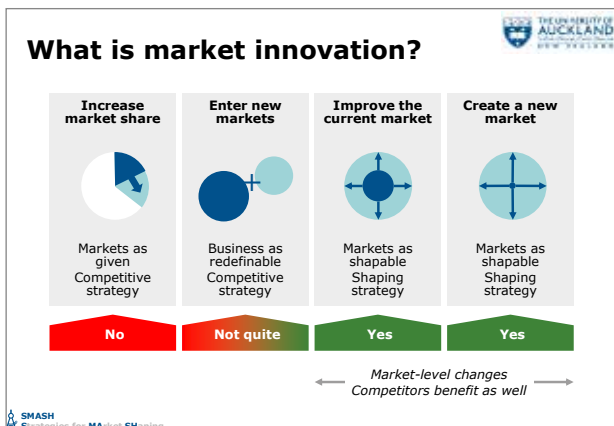
... (also) socially constructed
... complex adaptive systems

→ markets are malleable





SMASH
 Strategies for Market SHaping

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2



What is market innovation?

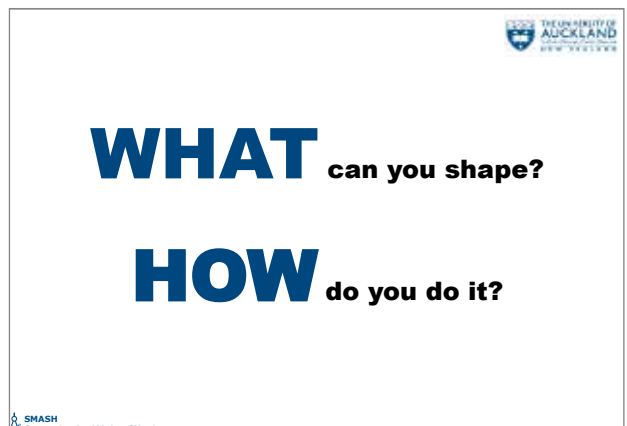
<p>Increase market share</p>  <p>Markets as given Competitive strategy</p> <p>No</p>	<p>Enter new markets</p>  <p>Business as redefinable Competitive strategy</p> <p>Not quite</p>	<p>Improve the current market</p>  <p>Markets as shapable Shaping strategy</p> <p>Yes</p>	<p>Create a new market</p>  <p>Markets as shapable Shaping strategy</p> <p>Yes</p>
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← Market-level changes Competitors benefit as well →

SMASH
 Strategies for Market SHaping

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3



WHAT can you shape?

HOW do you do it?

SMASH
 Strategies for Market SHaping

4



5



Is New Zealand betting on the wrong horse in the international innovation race?
The importance of market innovations for small open economies

Suvi Nenonen & Kaj Storbacka
 s.nenonen@auckland.ac.nz • k.storbacka@auckland.ac.nz

6

Session 1
 Panel discussion 3:
 Professor Shaun Hendy
 University of Auckland

THE ROLE OF NETWORKS IN INNOVATION



Te Pūnaha Matatini
 Data • Knowledge • Insight

Shaun Hendy
 @hendysh

Te Pūnaha Matatini 'the meeting place of many faces'



1



2

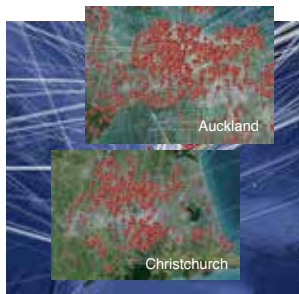
RECOMBINANT INNOVATION



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3

THE INNOVATION ECOSYSTEM



Stylised facts (patents):

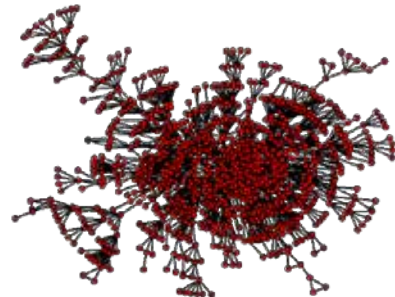
- Larger cities produce more patents per capita
- Larger cities have denser networks on innovators
- Larger cities have more diverse portfolios of technological capabilities
- Cities with more diverse technological portfolios have more novel portfolios



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4

INVENTION AND INNOVATION



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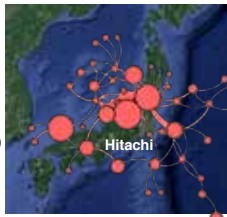
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OPEN INNOVATION

"Because not all the smart people work for us."
Bill Joy, Sun Microsystems co-founder



Catriona Sissons (PhD)



1975-77

Japanese companies



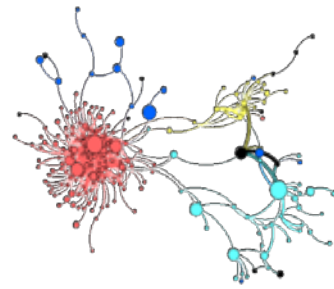
Te Pūnaha Matatini
Data • Knowledge • Insight

EPO (1975-2010)

6

1984-86

- Japan
- France
- USA
- Germany



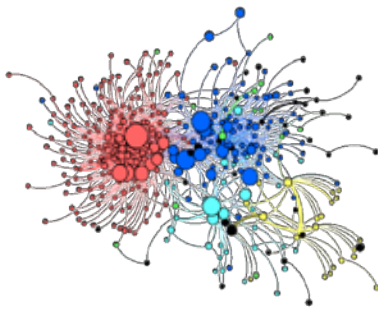
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EPO (1975-2012)

7

1990-92

- Japan
- France
- USA
- Germany



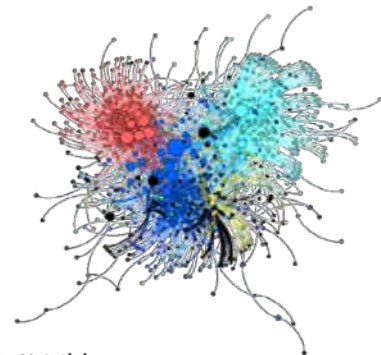
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EPO (1975-2012)

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1996-98

- Japan
- France
- USA
- Germany



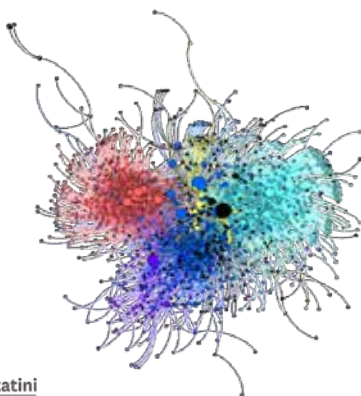
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EPO (1975-2012)

9

2002-04

- Japan
- France
- USA
- Germany
- Korea



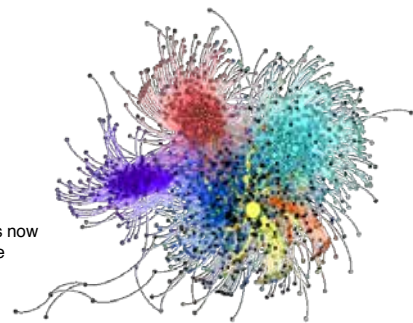
Te Pūnaha Matatini
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EPO (1975-2012)

10

2008-10

- Japan
- France
- USA
- Germany
- Korea
- China

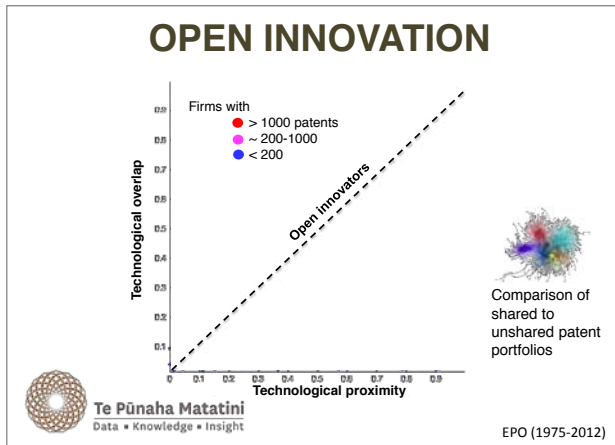


Te Pūnaha Matatini
Data • Knowledge • Insight

EPO (1975-2012)

11

These companies now
produce 2/3 of the
world's patents



12

SUMMARY

- Networks bring together the skills and capabilities to support complex innovations
- Networks also support the process by which technologies are recombined in novel ways

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Session 2

Keynote address:
Gabriel Makhoulouf
New Zealand Treasury

Productivity: innovation, diffusion and markets

Gabriel Makhoulouf
Secretary to the Treasury



1

- What we know, and what we might not know
- Innovation and diffusion
- Markets
- The structure of firms
- People
- International connections



2

“Productivity isn’t everything, but in the long run it is almost everything. A country’s ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker.”

- P. Krugman



3

Economies need:

- stable and sustainable macroeconomic frameworks
- sound monetary policy
- prudent fiscal policy and debt that is under control
- a well-regulated financial system
- properly functioning markets
- price signals
- incentives



4

- **What we know, and what we might not know**
- Innovation and diffusion
- Markets
- The structure of firms
- People
- International connections



5

- **What we know, and what we might not know**
- Innovation and diffusion
- Markets
- The structure of firms
- People
- International connections



6

Conclusion



7

Session 2
Keynote address:
Sir David Ramsden
HM Treasury



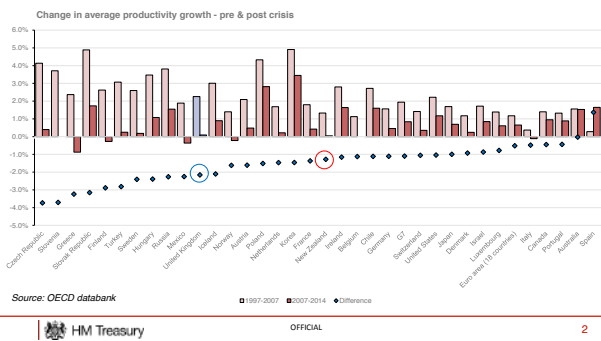
UK perspectives on productivity

Dave Ramsden
 Chief Economic Adviser to the Treasury and
 Head of the Government Economic Service
 @DaveRamsden1

1 December 2015

1

Weak productivity: a global issue



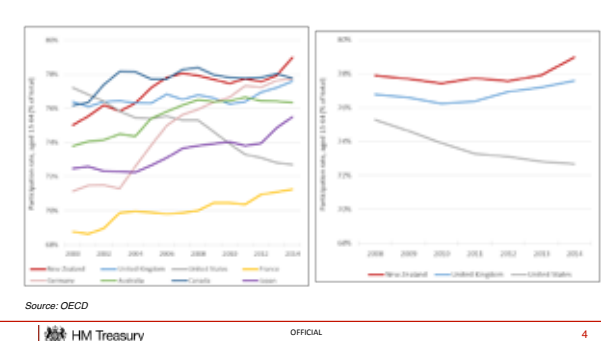
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Leading explanations of the UK productivity slowdown



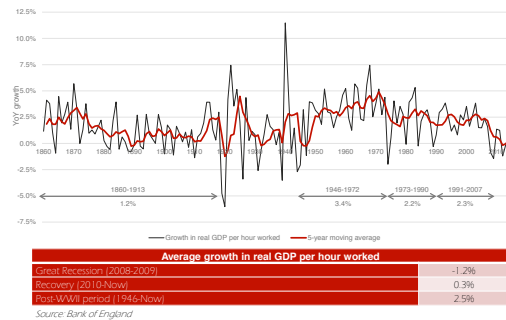
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National context matters: trends in labour market participation



4

Hit to productivity level or growth rate?



5

The historic gap between the UK and most of the G7 has continued to widen



Source: OECD

6

Productivity growth has picked up

Current and previous estimates of US and UK productivity growth



Source: BEA, BLS, ONS

Source: Economic and Fiscal Outlook, OBR, Autumn Statement 2015

7

Tight relationship between productivity and living standards



Source: OECD Dataset

8

A framework for raising productivity



9

UK policy measures spurred by the Productivity Plan

- Business investing for the long term**
 - Cutting the UK's Corporation Tax to 18%, the lowest in the G20
- Skills and human capital**
 - From 2017 introduce a levy to fund the step change needed to achieve 3 million apprenticeship starts and boost their quality
- Economic infrastructure**
 - Creating a Roads Fund and reforming Network Rail to deliver faster, more reliable and more efficient railways
 - Establishing an independent National Infrastructure Commission
- Ideas and knowledge**
 - Putting higher education funding on a more sustainable footing
- Flexible, fair markets**
 - Bring in a new Living Wage
 - Introduce a reformed planning system to ensure more land is made available for house building
- Productive finance**
 - A joint New Bank Unit to promote competition in banking
- Openness and competition**
 - Remodel the Government's delivery of support to trade and investment
 - Competition plan to cut red tape and open up markets, bringing down costs for families and firms
- Resurgent cities**
 - Building a Northern Powerhouse and ensuring the productive potential of all parts of the UK is realised

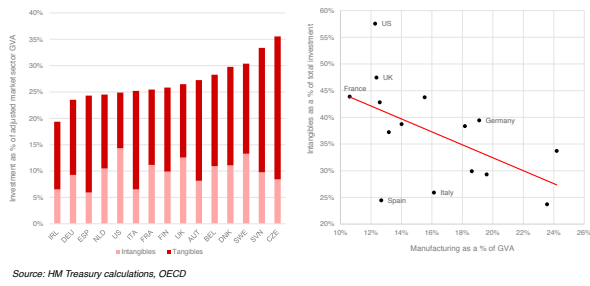
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UK policy measures to support science and innovation

- Protected Science spending and investment**
 - £4.7bn in spending for the next five years, together with £6.9bn of investment into the UK's research infrastructure up to 2021.
- Protecting expenditure on Catapult centres, the Aerospace Technology Institute (ATI) and the Advanced Propulsion Centre (APC).**
- Additional financial support for mature and part time students wishing to attend University.**
- From 2017-18, the UK government will make tuition fee loans available to those students wishing to do a second degree in a STEM subject.**
- An additional £250m of investment over 5 years in an ambitious nuclear research programme.**
- £600 million of investment to support uptake and manufacturing of ultra-low emission vehicles (ULEVs) in the UK.**

11

Measuring the modern economy



Source: HM Treasury calculations, OECD

12

Conclusions

- Complexity and uncertainty
- Firm level analysis
- Measurement
- Approach to policy
- Institutions
- Learning: networks, hubs, peers

13

Session 3

Keynote address:
Professor Beth Webster
Swinburne University of Technology



1

Why should public monies support R&D in local businesses?

- What if all benefits captured by the business?
- R&D must have benefits to 3rd parties (that would otherwise not come forward)
- Is it possible for a business to capture all benefits?

2

No - benefits are perpetual & non-rivalrous

- LR all benefits accrue to consumers
- Neighbour firms get for lead time advantage in using R&D
- Local firms earn SR above normal profits
- Local consumers gain SR benefit



3

- LR all benefits accrue to consumers as competition drives profits to normal
- SR above normal profits earned by those more able to exploit the knowledge
- Continual lead time – means permanently higher incomes

4

- **R&D activity** ? – neighbour firms transfer knowledge between technical workers (even if not used)
- **R&D ownership** ? – statistical evidence that industries that own but do not produce R&D have higher productivity *ceteris paribus*
- **R&D use**? – extension/translation activity. Externalities associated with this activity? Demonstration effects. Improvement via use.

5

Why R&D? Not the only form of knowledge creation. Not the only form of knowledge diffusion

Why not support knowledge diffusion...?



6

Externality problem

Internalisation (eg IP)

- Impractical if R&D has unobservable & far-reaching benefits (can't exclude).
- Charging a price for a "good" where $MC = 0$ creates static deadweight loss. Negative effect on sequential technological progress.
- Public support an alternative



7

Mismatch between ideas and money

- Inventor not the one with the cash
- Stock market, banks, private equity etc.
- Trading an intangible
 - Perceived risk
 - Unknown/unknowable factors
 - What is mortgaged?
 - Bundled with borrower
 - Large risk discount



8

The uncertainty problem

- If MC of bearing risk increases with the amount of risk held
- Then total cost of given uncertainty can be reduced by spreading it (Arrow & Lind 1970)
- Government funding = spreading the uncertainty of R&D across the entire tax base



9

We already do a lot – still an externality problem?

- Social rate of return to R&D > social discount rate
(Jones and Williams, 1998; Frantzen, 2000; Lederman and Maloney, 2003; Hall et al., 2009, 2010).
- Prima facie: investment in R&D < social optimal

10

What drives firms to invest in R&D?

- Firm-specific factors dominate – but what are they?
- Systematic: size; exports; foreign ownership; industry – relatively empty of content

11

What may these systematic factors represent?

- Better managed?
- More networked?
- Better B2B services (more overheads)?
- More accumulated capabilities?
- Better profit margins - employ better workers...?



12

- Complementary factors – ICT; desire to go international; other forms of innovation
- Context in which firms operate; clusters; de-risked environment.

13

How can we influence decision to innovate?

- Change C/B ratio using \$\$
- De-risk environment
- Bring relevant parties together



14

3 types of schemes

- Competitive schemes
- Entitlement schemes
- R&D boards

Largesse

- Grants
- Loans
- Networking
- Worker exchange
- Advice/mentoring
- Blue-sky procurement

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Competitive

- Firms “compete” for a finite pool of funding
- Stated merit criteria – can add in qualitative requirements
- Easy to over-engineer
- Hard to design additionality
- Ranked by peak bodies

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Entitlement

- All entitled receive
- Decided by accountants, tax officers
- Eg. R&D tax credit
 - Usually applies neutrally across all technology types and industrial sectors
 - Automatically flows to research most valued by firm NOT 3rd parties

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Industry R&D boards

- Industry levies, member fees & govt funds
- Industry controlled
- Suits: price-taking industries that don't directly compete
 - Export
 - Not complete on technology

18

- Problem solving approach
 - Challenges facing whole industry
 - Procures R&D
 - Often built-in extension/translation services



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Attributes of schemes

	Competitive	Entitlement	R&D Board
Total funding	Capped	Uncapped	Uncapped
Engagement	Costly; hard to discover; commercial sensitivities	Good except for SMEs (ignorant)	Not sustainable without solid engagement
Project selection	Depends on skills of committee; little evidence it targets spillovers	Aligned with private benefits; bureaucratic rules	Targets intra-industry spillovers but not inter-industry
Additionality	Hard to prescribe	Gross R&D ↑ less than govt transfer	Targets ex-firm activities
Payment	Often matching \$	Least generous	Can be in-kind or \$ matching
Admin costs	Expensive, 2-3 weeks work in application	Low; random audits	Fixed admin team

20

Generic problems

- Changes to programs – problem of knowing about the program/ planning for the program
- Over-engineered requirements
- Absence of generalisable evaluations
- Isolated, fragmented programs/policies

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Thank-you for listening

emwebster@swin.edu.au

INNOVATION =  IDEAS + CHANGE 

22

Session 3

Discussant:

Professor Adam Jaffe,
Motu Economic and
Public Policy Research

Motu

What is Emperor BERD Wearing?

Adam B. Jaffe
Motu Economic and Public Policy Research

Productivity Hub Innovation Symposium
1 December 2015

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1

- Beth has explained why business R&D (“BERD”) is valuable for the country
- Described some of the mechanisms that can be used to encourage BERD
- What are the specific challenges of the NZ context?

2

- We want to improve Kiwis’ long-run well-being
- We can invest in human, physical, natural, social capital (good idea but diminishing returns)
- Find new ways of doing things that reduce the cost of achieving any given level of well-being
- Historically, globally, firms’ efforts have been the most successful mechanism for “innovation”

3

- BERD is “low” in NZ
 - Relative to GDP
 - Relative to population
- **Partial** explanations for low BERD
 - Agriculture, forestry, tourism are low R&D industries everywhere
 - In all countries, R&D is less prevalent in small firms, and we have almost entirely small firms

4

- Why do some industries not invest much in R&D?
 - “Technological opportunity” is low
 - Largest opportunities for improvement not research-related
 - Research-like activities occur but are not recorded as such
 - Fragmented industry structure makes “spillover” problem particularly acute

5

- Why might small firms not invest in R&D?
 - R&D often more effective if carried out at relatively large scale
 - Securing the benefits of R&D requires management or other capabilities they don't have
 - Difficulties in financing
 - Research-like activities occur but are not recorded as such
 - Small sales base makes "spillover" problem particularly acute

6

- Key question for policy:

To what extent is NZ BERD low because research is just not that valuable in NZ, and to what extent is BERD low because of social/economic/institutional or other barriers to firms' undertaking valuable BERD?

7

- If technological opportunity is low, more R&D will not produce useful results.
- If non-technological factors are most important for success, or if management capability limits implementation, R&D results may generate little benefit.
- If research is occurring but not being reported, new policy may increase reporting without changing real activity.

8

- R&D financing can reduce financial barriers.
- Certain funding mechanisms (e.g. partnerships) can improve coordination for otherwise fragmented industries.

9

- Policy can also attack barriers directly
 - Foster creation of coordinating organizations or mechanisms (e.g. industry research organizations)
 - Improve technological opportunity by fostering flow of scientific/technical knowledge from non-profit research sector to firms
 - Try to build management capability

10

- **Danger:** goal is NOT moving NZ up in the OECD BERD report tables, but rather increasing innovation and productivity
 - Can produce increase in reported BERD with no change in real activity
 - Can produce real increase in R&D that generates little economic/social benefit

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Session 4

Keynote address:
Professor Bronwyn Hall
University of California at Berkeley

R&D, innovation, and productivity

Bronwyn H. Hall
University of California at Berkeley
NBER, IFS London, NIESR London, and Max Planck Institute Munich

1

R&D, innovation and productivity

- Many researchers have looked at the links among these 3 using data from the Community Innovation Survey and other similar surveys
- This presentation
 - Reviews what we know
 - Provides a framework for interpreting results
 - Draws some conclusions about how we might improve the data/analysis
 - Analysis reviews micro (individual firm-level, partial equilibrium) results only

2

2

Innovation and productivity

- What are the mechanisms connecting innovation and productivity?
 - Improvements *within* existing firms
 - Creation of new goods & services, leading to increased demand for firm's products
 - Process and organizational innovation leading to efficiency gains in production
 - Entry of more efficient firms
 - Entry of firms on technology frontier
 - Exit of less efficient firms

3

3

What do we know?

- A great deal about
 - the contribution of R&D and innovation to firm-level productivity as conventionally measured
- Something about
 - The contribution of entry of more efficient and exit of less efficient firms to aggregate productivity growth
 - The contribution of R&D to quality improvement and therefore productivity growth (via lower prices)
- Much less about
 - Contribution of R&D and innovation to welfare and to poorly measured but important outputs (health, environmental quality, etc)
 - Aggregate growth implications in detail

4

4

R&D vs innovation

- Not all innovative firms do formal R&D
- R&D-doing firms do not innovate every year (or even every 3 years)

Italian firms 1995-2006		
	Non-innovator	Innovator
Does not do R&D	30.9%	34.8%
Does R&D	6.2%	34.3%

- Especially true in the service sector:
 - Many innovations are not technological, such as new ways of organizing information flow, new designs, etc.
 - Many innovations rely on purchased technology, such as adoption of computer-aided processes, CRM software, etc.

5

5

R&D vs innovation spending

- UK firms on the CIS 1998-2006 – average breakdown of spending on innovative activities.
- Service sector firms spend more on new equipment and marketing and less on R&D.

	Manufacturing	Services & other
Acquisition of machinery & computer hardware/software	43.2%	47.0%
Internal R&D spending	25.1%	12.0%
Marketing expense	10.6%	16.5%
Training expense	5.4%	13.4%
Design expense	8.8%	4.2%
External R&D spending	4.2%	3.2%
Acquisition of external knowledge	2.6%	3.7%
Share with nonzero spending	71.1%	54.7%

The shares shown are for firms that have some form of innovation spending reported.

6

Measuring innovation

- Large literature using R&D flows or stocks as proxies for innovation input
 - Hall, Mairesse, Mohnen 2010 survey, *inter alia*
- Smaller literature using patents as a proxy for intermediate innovation output
- Both measures have well-known weaknesses, especially outside the manufacturing sector.
 - Most surveys of the service sector find many innovating firms, fewer R&D-doers
- Now we have more direct measures – do they help?

7

Innovation surveys contain.....

- Data on innovation:
 - Product or process new to firm/market (yes/no)
 - Share of sales during past 3 years from new products
 - More recent surveys have expenditures on various kinds of innovation investments
- Data on productivity and employment:
 - Usually sales per worker (labor productivity)
 - Sometimes TFP (adjusted for changes in capital)
 - Issues arising from deflation and level of aggregation
 - of goods, and of enterprises

More information in Mairesse and Mohnen (2010)

8

Interpretive framework

- Innovation-productivity regressions use revenue productivity data
 - Include coarse sectoral dummies
 - Relative within-sector price changes not accounted for
 - Quality change not generally accounted for
- In the case of innovative activity, omitting price change at the firm level can be helpful, as it allows estimation of the contribution of innovation to demand as well as efficiency
- Analysis of the implications of distinguishing productivity from revenue productivity
 - Based loosely on Griliches and Mairesse 1984

9

Productivity-innovation model

- Innovation will affect both the price the firm can charge and the quantity it produces from a given set of inputs
- Output measure -- revenue (sales) -- incorporates the joint response of price*quantity to product and process innovation
- Assume the following:
 - Imperfect competition (nonzero markup; downward sloping demand with constant elasticity)
 - Process innovation reduces cost (same inputs produce more)
 - Product innovation shifts demand curve out (higher willingness to pay for the same good, or higher quality good for the same price)

Algebra for this analysis given in backup slides

10

Product vs process

- Can one distinguish between innovative activity directed toward
 - new/improved products (increased demand) vs.
 - new/improved processes (increased efficiency)?
- Work by [Petrin and Warzynski \(2011\)](#) provides some evidence that the product/process distinction is meaningful
 - Danish micro data on wood products and iron & steel
 - R&D at the product/process level within firm.
 - Allows estimation of the contribution of R&D to demand (quality improvement) and technical efficiency separately
 - Finds product R&D more related to quality improvement and process R&D more related to technical efficiency
- Work in progress

11

Conclusions

- Product innovation unambiguously increases *revenue productivity* and *labor demand*
- Process innovation will increase *revenue productivity* and *labor demand* only if demand is elastic; even in this case impact is dampened unless there is perfect competition (price taking)
- Allocation of the impact of innovation between price and quantity will depend on the type of price deflator used
 - the closer the deflator is to a true quality-adjusted price, the higher the *measured* innovation contribution to quantity rather than price (with a corresponding *negative* effect on price).
 - However, estimates of the innovation impact on firm *revenue* are not affected

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What do the data say about this relationship?

Results from a large collection of papers that used the CDM model for estimation (Crepon Duguet Mairesse 1998):

- Innovation survey data reveals that some *non-R&D firms innovate* and some *R&D firms do not innovate* during the relevant period
- Data is usually cross-sectional, so possible simultaneity between R&D, innovation, and productivity (productivity sometimes measured a year later)
- Sequential model:
R&D → innovation → productivity

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The CDM model

1. The determinants of R&D choice: whether to do it and how much to do (*generalized Tobit*)
2. Innovation production function with innovation variables as functions of predicted R&D intensity (*regression or probits*)
3. Production function including the predicted innovation outcomes to measure their contribution to the firm's productivity.

Effectively a triangular simultaneous equations model, but nonlinear. (bootstrap s.e.s if sequentially estimated)

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CDM model applied to CIS data

- Estimated for 20+ countries
- Confirms high rates of return to R&D found in earlier studies
- Like patents, innovation output statistics are much more variable ("noisier") than R&D,
 - R&D tends to predict productivity better, when available
- Next few slides - results summary
 - regressions of individual firm TFP on innovation
- Sources: Hall (2011), *Nordic Economic Policy Review* and Hall and Mohnen (2013), *Eurasian Business Review*

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Productivity-innovation relationship in TFP levels

Sample	Time period	Elasticity with respect to innov sales share	Process innovation dummy
Chilean mfg sector	1995-1998	0.18 (0.11)*	
Chinese R&D-doing mfg sector	1995-1999	0.035 (0.002)***	
Dutch mfg sector	1994-1996	0.13 (0.03)***	-1.3 (0.5)***
Finnish mfg sector	1994-1996	0.09 (0.06)	-0.03 (0.06)
French mfg sector	1986-1990	0.07 (0.02)***	
German K-intensive mfg sector	1998-2000	0.27 (0.10)***	-0.14 (0.07)**
Norwegian mfg sector	1995-1997	0.26 (0.06)***	0.01 (0.04)
Swedish K-intensive mfg sector	1998-2000	0.29 (0.08)***	-0.03 (0.12)
Swedish mfg sector	1994-1996	0.15 (0.04)***	-0.15 (0.04)***
Swedish mfg sector	1996-1998	0.12 (0.04)***	-0.07 (0.03)***
Swedish service sector	1996-1998	0.09 (0.05)*	-0.07 (0.05)
Innovative sales share and process innovation included separately in the production function:			
French Hi-tech mfg	1998-2000	0.23 (0.15)*	0.06 (0.02)***
French Low-tech mfg	1998-2000	0.05 (0.02)***	0.10 (0.04)***
Irish firms	2004-2008	0.11 (0.02)***	0.33 (0.08)***

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TFP levels on innov sales share

- Robustly positive, supports the view that product innovation shifts the firm's demand curve out and increases revenue
 - Elasticities range from 0.04 to 0.29 with a typical standard error of 0.03
 - R&D-intensive and hi-tech firms have higher elasticities (consistent with equalized rates of return across sectors)
- Coefficient of process innovation dummy usually insignificant or negative, suggesting either inelastic demand and/or substantial measurement error in the innovation variables

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Productivity-innovation using dummies

Sample	Time period	Product innovation dummy	Process innovation dummy
Argentinian mfg sector	1998-2000	-0.22 (0.15)	
Brazilian mfg sector	1998-2000	0.22 (0.04)**	
Estonian mfg sector	1998-2000	0.17 (0.08)**	-0.03 (0.09)
Estonian mfg sector	2002-2004	0.03 (0.04)	0.18 (0.05)***
French mfg sector	1998-2000	0.08 (0.03)**	
French mfg sector	1998-2000	0.06 (0.02)***	0.07 (0.03)**
French mfg sector	1998-2000	0.05 (0.09)	0.41 (0.12)***
French mfg sector	2002-2004	-0.08 (0.13)	0.45 (0.16)***
French service sector	2002-2004	0.27 (0.52)	0.27 (0.45)
German mfg sector	1998-2000	-0.05 (0.03)	0.02 (0.05)
Italian mfg sector	1995-2003	0.69 (0.15)***	-0.43 (0.13)***
Italian mfg sector SMEs	1995-2003	0.60 (0.09)***	0.19 (0.27)
Mexican mfg sector	1998-2000	0.31 (0.09)**	
Spanish mfg sector	2002-2004	0.16 (0.05)***	
Spanish mfg sector	1998-2000	0.18 (0.03)***	-0.04 (0.04)
Swiss mfg sector	1998-2000	0.06 (0.02)***	
UK mfg sector	1998-2000	0.06 (0.02)***	0.03 (0.04)
Innovative sales share and process innovation included separately in the production function:			
Irish firms	2004-2008	0.45 (0.08)***	0.33 (0.08)***

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Productivity-innovation using dummies

Sample	Time period	Product innovation dummy	Process innovation dummy
German mfg sector	2006-2008	0.04 (0.02)*	
German mfg sector	2006-2008		0.09 (0.05)**
German service sector	2006-2008	0.21 (0.07)***	0.16 (0.06)***
Irish mfg sector	2006-2008	0.18 (0.22)	
Irish mfg sector	2006-2008		0.24 (0.24)
Irish service sector	2006-2008	0.51 (0.30)*	
Irish service sector	2006-2008		0.19 (0.28)
UK mfg sector	2006-2008	0.05 (0.02)***	
UK mfg sector	2006-2008		0.07 (0.02)***
UK service sector	2006-2008	0.07 (0.03)**	
UK service sector	2006-2008		0.04 (0.02)*

Source: Peters et al. 2014

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TFP level results with dummies

- Product dummy supports innovation sales share result, although much noisier.
- There is substantial correlation between product and process innovation, especially when they are instrumented by R&D and other firm characteristics.
 - Without instruments, innovation dummies frequently do not enter productivity equation at all.

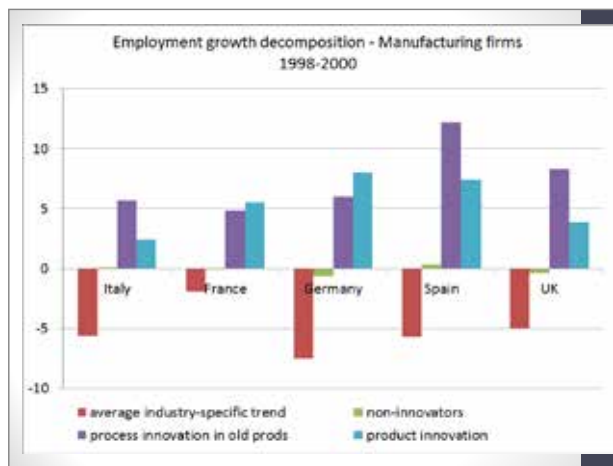
NB: Correlated measurement error can lead to bias in both coefficients (upward for the better measured one and downward for the other) – see Hall (2004) http://bronwynhall.com/papers/BHH04_measerr.pdf

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Employment impacts

- Harrison et al (IJIO 2014) and Hall, Lotti, Mairesse (ICC 2008) - decompose employment change as a function of process and product innovation, using coefficients from a regression of employment growth on innovative sales growth and process innovation:
 - Growth = industry productivity trend in old products
 - + growth due to process innovation in old products
 - + growth due to output growth of old products
 - + growth due to product innovation (net of substitution away from old products)
- A reinterpretation of the labor productivity equation to focus on employment

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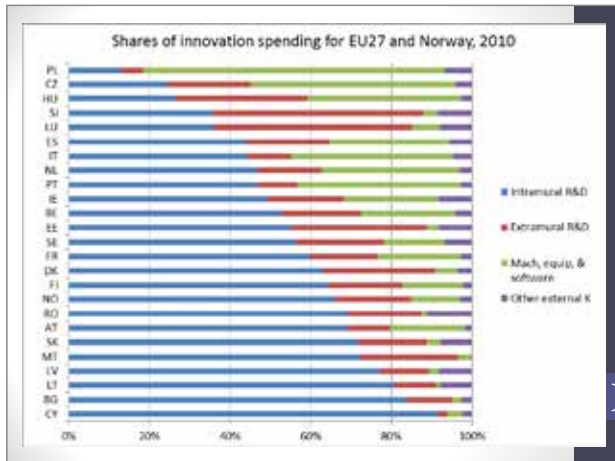


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Summary

- Elasticity wrt innovative sales centers on (0.09, 0.13)
 - higher for high tech and knowledge-intensive firms
 - Lower on average for low tech and developing countries, but also more variable
- With product innovation included, process innovation often negative or zero
- Without product innovation, process innovation positive for productivity
- When not instrumented, little impact of innovation variables in production function (unlike R&D)
 - See Mairesse & Mohnen (2005), Hall et al. (2012)
- Both process and product innovation are positive on average for firm employment growth in manufacturing,
 - at least during the late 1990s in Europe
- What if we had spending on innovation (rather than just R&D, a component of innovation spending)?

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UK evidence

- Definition of IS: internal & external R&D; new equip & software; design expense; training; acq of patents & knowhow; marketing – all associated with intro of new products or processes
- Out of 10,500 firm obs 2001-2006
 - 6500 have some form of innovation spending (IS)
 - 3400 have internal R&D
 - R&D firms: median IS is 5 times median R&D
- Compared to R&D:
 - IS more strongly associated with info from suppliers and innovation to meet environmental or H&S stds; less strongly with exports, collaboration, and info from customers (that is, more process than product)
 - IS is a better predictor of innovation probability
 - Doubling IS has the same impact on TFP as doubling R&D – increase of 0.05

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Discussion

- R&D spending remains a better predictor of productivity improvement at the firm level
- Innovation dummies may be too noisy a measure to be very useful.
 - Share of sales due to new products is more informative.
 - What measure would be useful (and reportable) for process innovation?
- Further exploration with innovation investment (instead of R&D) is warranted

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Thank you for listening

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Backup Slides

Technical detail for production function with innovation

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Conventional productivity equation

$$r_{it} = a_{it} + \alpha c_{it} + \beta l_{it} \quad i = \text{entity}, t = \text{time}$$

r = log value added (sometimes just output)

c = log tangible capital

l = log labor input

a_{it} = TFP (total factor productivity)

Coefficients α , β measured as shares (growth accounting) or by regression (econometric)

R&D or innovation often added to this equation to measure productivity impacts

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Revenue productivity

- Firm (enterprise) level: measure sales, value added, or revenue, the product of (relative) price and quantity, not quantity alone
- Equation in logarithms, so left hand side is sum of price and quantity

$$r_{it} \equiv \log R_{it} = \log P_{it} + \log Q_{it}$$
- Coefficients measure the sum of price and quantity impact from changes in capital, labor, and R&D or innovation

30

30

Revenue productivity

If firms have market power and idiosyncratic prices, we observe real revenue r , not output q :

$$r = p + q \quad (\text{all in logs})$$

Add a CES demand equation: $q_{it} \sim \eta p_{it}^{-\eta}$, $\eta < 0$

Then the revenue productivity relationship is

$$r_{it} = \text{const} + \left(\frac{\eta+1}{\eta} \right) (a_{it} + \alpha c_{it} + \beta l_{it}) \sim \left(\frac{\eta+1}{\eta} \right) q_{it}$$

If imperfect competition ($\eta > -\infty$), revenue impact is dampened relative to output; if demand is inelastic ($0 > \eta > -1$), revenue falls with increased output

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Adding innovation

Add two terms involving knowledge stock:
 process: γk_{it} in the production function, $\gamma > 0$
 product: φk_{it} in the demand function, $\varphi > 0$

This yields the following revenue function:

$$r_{it} = C + \left(\frac{\eta+1}{\eta} \right) (a_{it} + \alpha c_{it} + \beta l_{it}) + \left(\frac{\gamma(\eta+1) - \varphi}{\eta} \right) k_{it}$$

Product improvement from k ($-\varphi/\eta$) is always positive for revenue

Process improvement from k ($\gamma(\eta+1)/\eta$) could be small or even negative

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Implication for prices

Recall that $q_{it} = \eta p_{it} + \varphi k_{it}$

Then

$$p_{it} = \left(\frac{1}{\eta} \right) (a_{it} + \alpha c_{it} + \beta l_{it}) + \left(\frac{\gamma - \varphi}{\eta} \right) k_{it}$$

If demand elasticity is constant, price falls with innovation if $\gamma - \varphi > 0$ (recall $\eta < 0$)

That is, if efficiency enhancement effect outweighs product improvement effect

Impact of innovation on price greater the more inelastic is demand, $c.p.$

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Implication for employment

- Similar to that for output
- Short run profit maximization given ordinary and innovation capital yields labor demand as a function of capitals:

$$l_{it} \sim \left(\frac{\eta+1}{\eta(1-\beta)-\beta} \right) (a_{it} + \alpha c_{it}) + \left(\frac{\gamma(\eta+1) - \varphi}{\eta(1-\beta)-\beta} \right) k_{it}$$

- Denominator is always negative =>
 - Process effect of k is negative for labor demand if demand is inelastic
 - Product effect of k always positive for labor demand

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Econometrics (1)

Only some firms report R&D; use standard selection model:

$$\text{Selection eq} \quad RDI_i = \begin{cases} 1 & \text{if } RDI_i = w_i \alpha + \varepsilon_i > \bar{c} \\ 0 & \text{if } RDI_i = w_i \alpha + \varepsilon_i \leq \bar{c} \end{cases}$$

Conditional on doing R&D, we observe the level:

$$RI_i = \begin{cases} RD_i^* = z_i \beta + e_i & \text{if } RDI_i = 1 \\ 0 & \text{if } RDI_i = 0 \end{cases}$$

Assume joint normality => generalized tobit or Heckman selection model for estimation.

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Econometrics (2)

Output of the KPF are various binary innovation indicators or the share of innovative sales. For example,

$$DI_i \sim \phi(RD_i^* \gamma + X_i \delta + u_i)$$

DI = Dummy for innovation (process, product, organizational)

$\phi(\cdot)$ = normal density

Why include the latent R&D variable RD^* ?

1. Account for informal R&D effort that is often not reported
2. Instrument for errors in variables and simultaneity

Estimation is via multivariate probit

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Econometrics (3)

Production function:

$$y_i = \pi_1 k_i + \sum_j \pi_{2j} DI_{ij} + Z_i \phi + v_i$$

y = log sales per employee

k = log capital stock per employee

DI are predicted probabilities of innovation from second step or predicted share of innovative sales (with logit transform)

Z includes size, age, industry, region, year, wave

Estimated by OLS

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Aggregation

- How does individual firm relationship aggregate up to macro-economy?
 - productivity gains in existing firms
 - exit and entry
- Aghion et al (2009); Gorodnichenko et al (2010)
 - Competition and entry encourages innovation unless the sector is very far behind
- Djankov (2010) survey – cross country
 - stronger entry regulation and/or higher entry costs associated with fewer new firms, greater existing firm size and growth, lower TFP, lower investment, and higher profits

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Entry and exit

- Olley & Pakes, Haltiwanger & co-authors have developed decompositions that are useful
- Foster, Haltiwanger, and Syverson (2008) – US data
 - Distinguish between revenue and quantity, and include exit & entry
 - Revenue productivity understates contribution of entrants to real productivity growth because entrants generally have lower prices
 - Demand variation is a more important determinant of firm survival than efficiency in production (consistent with productivity impacts)

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Future work?

- Full set of links between innovation, competition, exit/entry, and productivity growth not yet explored
- Bartelsman et al. (2010): Size-productivity more highly correlated within industry if regulation is “efficient”
 - Evidence on Eastern European convergence
 - Useful approach to the evaluation of regulatory effects without strong assumptions
- Similar analysis could assess the economy-wide innovation impacts

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Session 4

Discussant: Dr Simon Wakeman New Zealand Productivity Commission



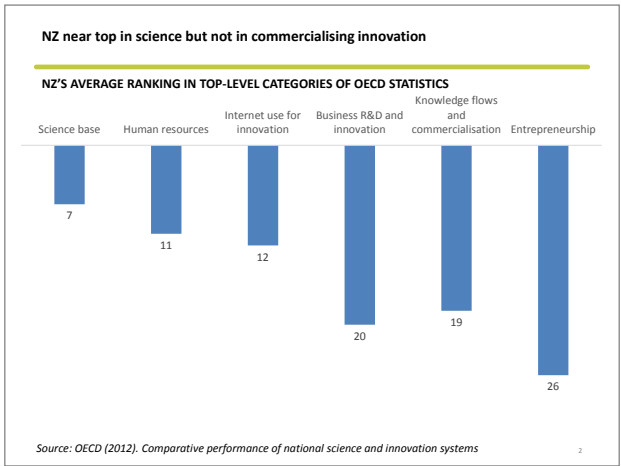
Innovation & Productivity of New Zealand Firms

Simon Wakeman
Innovation & Productivity Symposium
1 December 2015

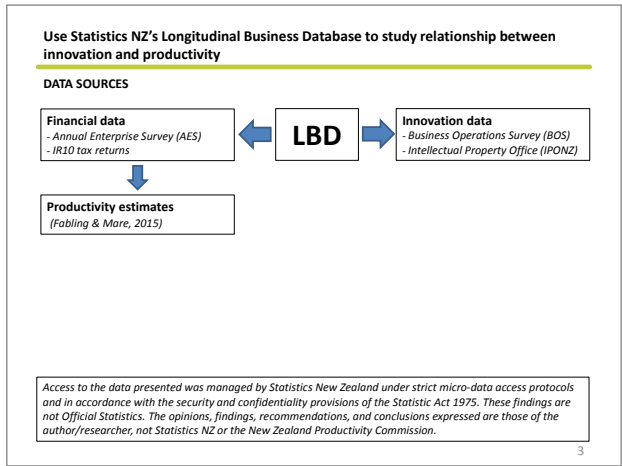


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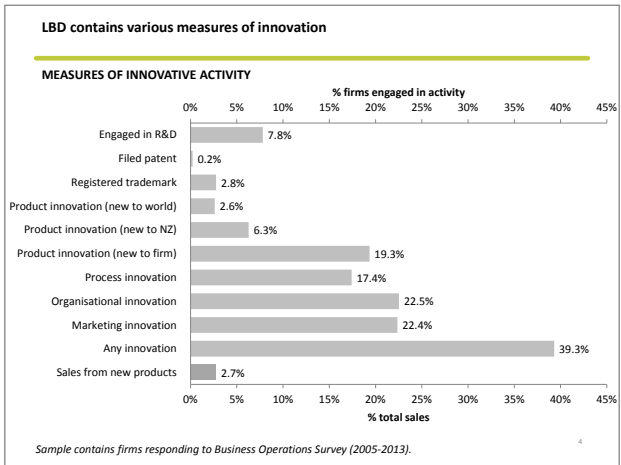
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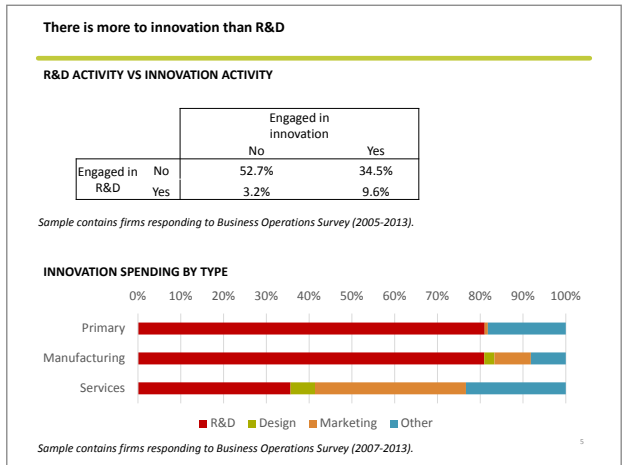
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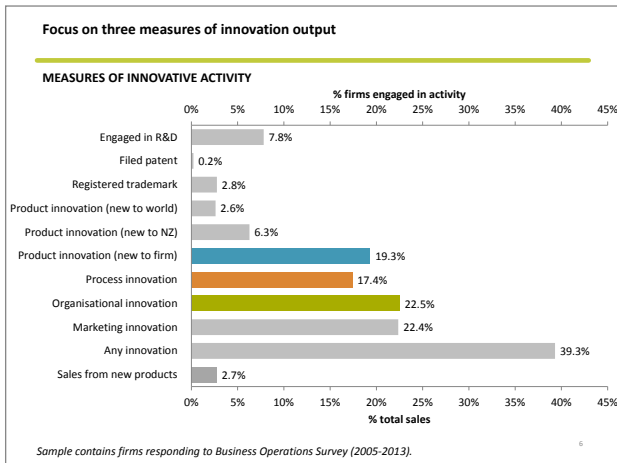
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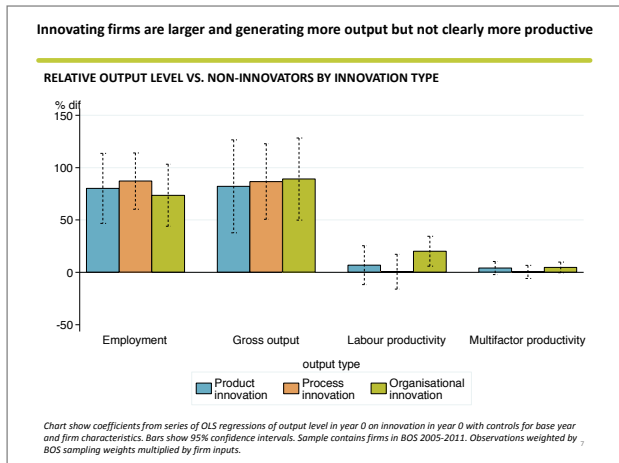
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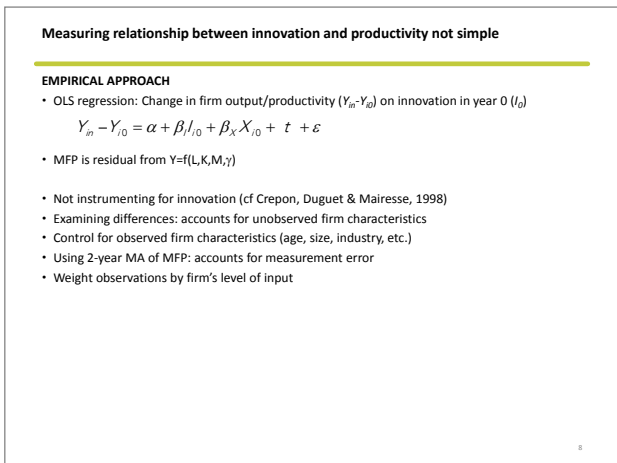
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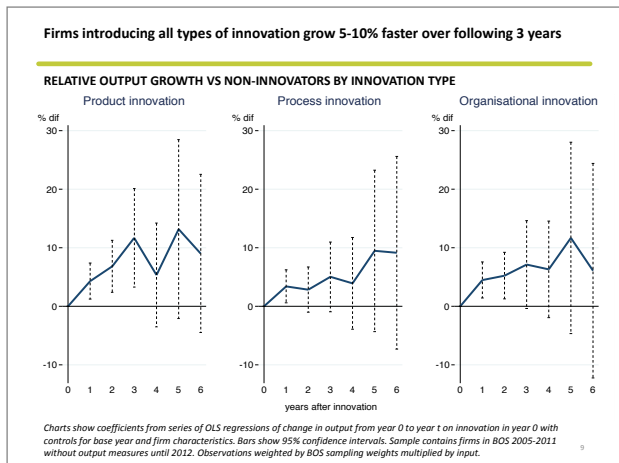
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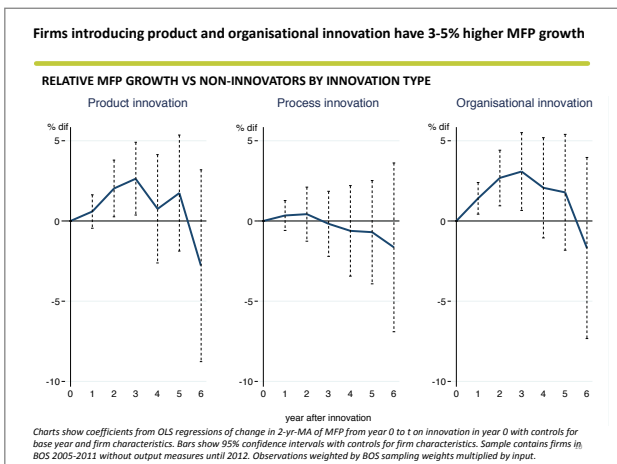
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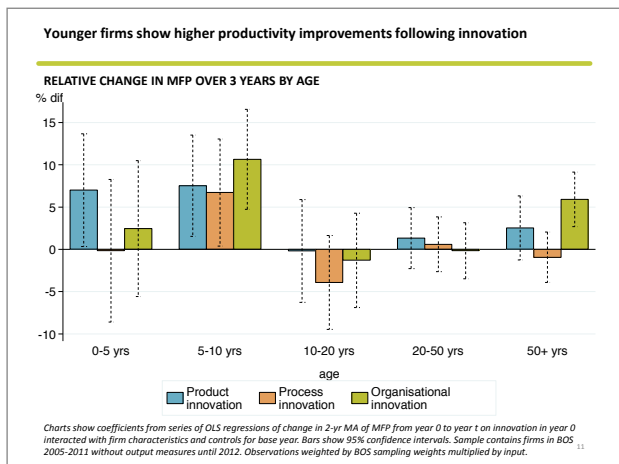
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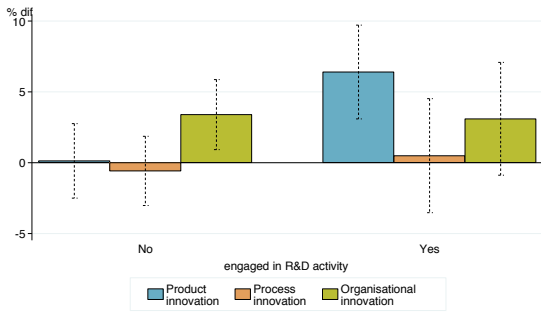
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Firms engaged in R&D activity show higher MFP growth after product innovation

RELATIVE CHANGE IN MFP OVER 3 YEARS BY WHETHER ENGAGED IN R&D

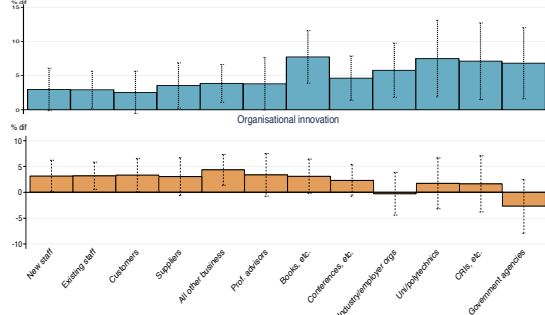


Charts show coefficients from series of OLS regressions of change in 2-yr MA of MFP from year 0 to year t on innovation in year 0 interacted with firm characteristics and controls for base year. Bars show 95% confidence intervals. Sample contains firms in BOS 2005-2011 without output measures until 2012. Observations weighted by BOS sampling weights multiplied by input. 12

12

**More formal sources of ideas associated with MFP growth after product innovation
Ideas from business environment with higher growth after organisational innovation**

RELATIVE CHANGE IN MFP OVER 3 YEARS BY SOURCE OF INFORMATION/IDEAS

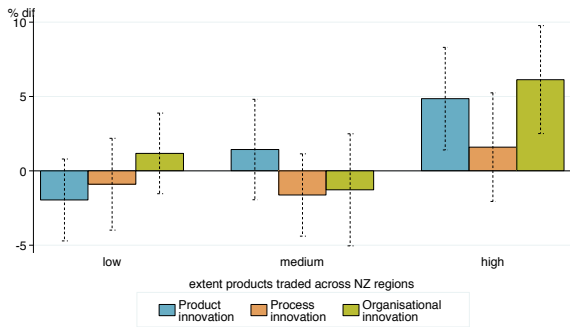


Charts show coefficients from series of OLS regressions of change in 2-yr MA of MFP from year 0 to year t on innovation in year 0 interacted with firm characteristics and controls for base year. Bars show 95% confidence intervals. Sample contains firms in BOS 2005-2011 without output measures until 2012. Observations weighted by BOS sampling weights multiplied by input. 13

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Firms selling more tradable products show higher MFP growth after product and organisational innovation

RELATIVE CHANGE IN MFP OVER 3 YEARS BY PRODUCT TRADABILITY

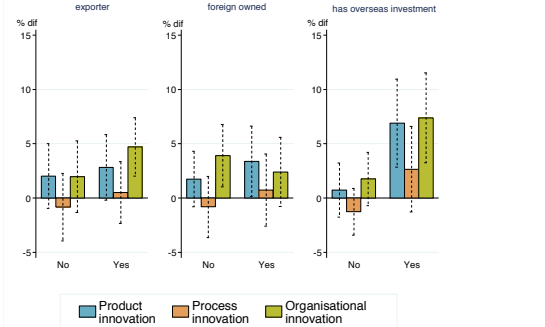


Charts show coefficients from series of OLS regressions of change in 2-yr MA of MFP from year 0 to year t on innovation in year 0 interacted with firm characteristics and controls for base year. Bars show 95% confidence intervals. Sample contains firms in BOS 2005-2011 without output measures until 2012. Observations weighted by BOS sampling weights multiplied by input. 14

14

Internationally connected firms more likely to show MFP growth after product or organisational innovation

RELATIVE CHANGE IN MFP OVER 3 YEARS BY INTERNATIONAL CONNECTIVITY



Charts show coefficients from series of OLS regressions of change in 2-yr MA of MFP from year 0 to year t on innovation in year 0 interacted with firm characteristics and controls for base year. Bars show 95% confidence intervals. Sample contains firms in BOS 2005-2011 without output measures until 2012. Observations weighted by BOS sampling weights multiplied by input. 15

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Innovation matters for productivity, but more for some firms than others

CONCLUSION

- Product innovators and organisational innovators do better but improvements small
- Matters most for young firms
- R&D are other formal sources matter for product innovation; business environment matters for organisational innovation
- Firms with larger markets improve more after innovation

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Session 5

Keynote address:
Professor Eric Bartelsman
Vrije Universiteit Amsterdam

ICT, Innovation, and Productivity Growth Connect or Disconnect

Eric Bartelsman*

*Vrije Universiteit Amsterdam, Tinbergen Institute, IZA

Productivity Symposium — Wellington
December 1, 2015

Bartelsman (VU, TI) Connect ⇌ Disconnect 04/22/15 1 / 30

1

Preliminaries

- NZ GDP/capita similar to Spain, Italy, and slightly behind South Korea, Japan, UK.
- Framework conditions are fine
- But investments in R&D and ICT are lagging
- Productivity has been diverging
- How can NZ harness the potential of ICT-led innovation?

Bartelsman (VU, TI) Connect ⇌ Disconnect 04/22/15 1 / 30

2

Overview

- Technological Prospects
- Modelling Growth with Knowledge Based Capital
- Some evidence from EU
- Connecting with NZ Policy

Bartelsman (VU, TI) Connect ⇌ Disconnect 04/22/15 2 / 30

3


Two Futures

- Bob Gordon (2012)
 - Slowing of growth to 1/2 percent per year; doubling in 100 years.
 - Of the three industrial revolutions (Steam/Railroad, Internal combustion/electricity, ICT) the latter is least impressive and already has made its mark
- Brynjolfsson and McAfee
 - Growth of 2.5% per year; doubling in 30 years.
 - New Technologies: Autonomous transport (Google car), Universal programmable robot, Data-driven expert systems, Internet of Things.
 - Major implications for labor market
 - Many questions how economics of innovation will be different

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4

A Driving Vision



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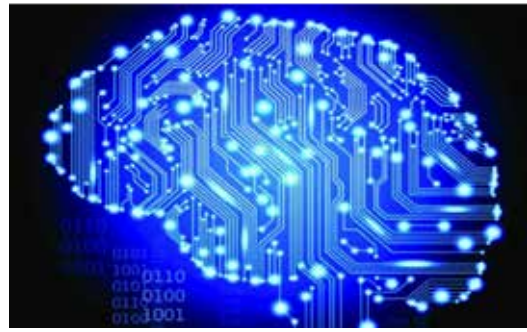
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Keeping your Eye on the Ball



6

Historical Prescience



7

A New Crop of Applications



8

Promising Areas for Technological Advances

- Clean Energy
- Sustainable land use
- New Materials
- Health (Biotech)
- Elderly Care
- Livable Cities, livable countryside
- Education, Knowledge Dissemination
- Managing Production, Supply Chains, Labor Markets

9

Overview

- Technological Prospects
- **Modelling Growth with Knowledge Based Capital (KBC)**
- Some evidence
- Connecting with NZ Policy

10

Dynamic Firm Models with Intangibles

- Intangibles are non-rival production inputs: benefits to scale
- Firms invest in intangibles and get uncertain productivity outcome
- Profit across firms becomes very skewed. Optimal size dependant on productivity outcome. Income share for labor and 'traditional capital' low.
- Aggregate productivity of the economy is determined by distribution of productivity draws and by market shares

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Model Implications

- What happens when importance of KBC in economy increases:
 - The share of income going to traditional factors decreases; labor share is falling
 - Investment in regular capital may appear sluggish: ICT and intangibles likely are capital saving (utilization rates of traditional capital may become higher).
 - Returns to intangible investment become increasingly skewed: While cost of startups may be decreasing, probability of success decreases as well.

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An Island in a World of KBC Growth

- Case 1: knowledge growth is random, and in proportion to population and existing knowledge. Large areas grow faster (Kremer, 1993). Remote islands suffer (and more so if new ideas depend on population density).
- Case 2: knowledge growth is dependent on investment and existing knowledge:
 - Investment depends on chance of technological outcome and on scalability.
 - With transport costs of trade: output is less scalable, thus returns to success are lower
 - With distance and low population density: visibility of existing ideas may be low
- Luckily, with ICT: costs of distance are reduced and visibility of ideas increased.

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Overview

- Technological Prospects
- Modelling Growth with Knowledge Based Capital
- **Some evidence**
- Connecting with NZ Policy

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ICT, Innovation, and Growth in the EU

- Data from Linked Surveys, 14 countries, 2000-2010
 - Business register and production surveys
 - ICT Usage Survey
 - Community Innovation Survey
- Micro analysis in each country
- Public Use Dataset (MMD): Combined cross-country information aggregated from firm-level data to country/industry/time panel

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Findings on Intangible Investments from MMD

- Penetration of new technology continues
- R&D, ICT use, innovative output, human capital intensity and productivity are in general correlated across firms
- There is a surprisingly large role for 'country' effects in intangible investment
- The aggregate industry impact of intangibles is positive, while the average firm-level impact is insignificant: (re)allocation matters
- Variance of firm-level outcomes (productivity, sales, employment) increases with intangibles
- ICT-using firms grow more (output, employment, and productivity)
- Wage premium for ICT is rising

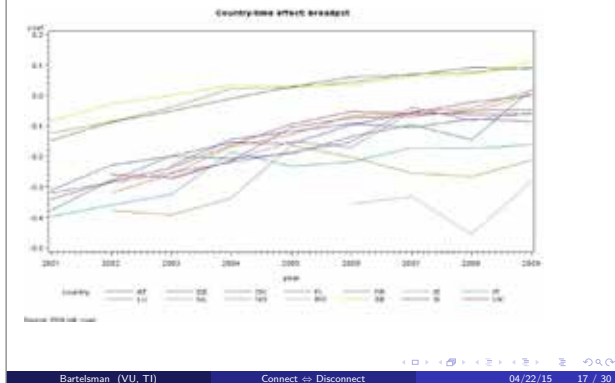
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Increasing Intangibles



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ICT usage is still increasing



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Variation in ICT usage Across countries

country	ICT	Mfg-x	Svc-x
FI	1	4	1
SE	2	1	2
DK	4	3	3
NO	3	2	4
NL	5	5	5
UK	6	6	6
LU	8	7	7
DE	10	8	9
SI	11	11	8
AT	7	10	10
FR	9	9	11
PL	12	13	12
IT	13	12	13
IE	14	14	15
RO	15	15	14

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ICT, Innovation, and Productivity

- With MMD, cross-country industry panel data, we can estimate
 - determinants of innovative activity (intangible investment)
 - impact of innovative activity on productivity
 - impact for firms on average, and for aggregate economy

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Determinants of Product Innovation

Table : Probit Regression, marginal effects

Variable	Average	Aggregate
Broadband Intensity	2.29*	2.02*
Electronic Buying	0.14	-0.42
Electronic Selling	1.05*	0.78*
ICT Human Capital	8.15*	4.42*
Reallocation	0.34*	0.10
Fixed Effects	c,i,t	c,i,t
Obs	732	732
Likelihood	-184.4	-226.8

Fixed Effects for country, industry, size included.
* denotes significance at 5%.

Source: Bartelsman, van Leeuwen, Polder (2015)

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Determinants of Productivity

Table : (log)Labor Productivity regressed on predicted product innovation

Variable	Average	Aggregate
Cap/Emp	0.02	0.09*
Human Cap	0.69*	1.07*
Reallocation	0.32*	0.60*
Predicted(Innov)	0.03	0.12*
Fixed Effects	c,i,t	c,i,t
R ²	0.53	0.60
Numobs	732	732

Fixed Effects for country, industry, size included.
* denotes significance at 5%.

Source: Bartelsman, van Leeuwen, Polder (2015)

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ICT use and dispersion: Industry-level evidence

Table : Std. Dev. of firm-level productivity distribution regressed on Broadband intensity

	Levels	First-differences
γ	0.47 (5.02)	0.28 (2.59)
R ²	0.52	0.03
D.F.	1180	1021
Fixed effects	ctry, ind, time	ctry, ind, time

$$\sigma_{c,i,t} = \alpha + \gamma \text{BBI}_{c,i,t} + FE + \varepsilon_{c,i,t}$$

FE: country, industry, time fixed effects

Source: ESSNet, Micro-moments database, v4.0

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ICT Use and Dispersion: Firm-level evidence

Table : Output Growth Dispersion by ICT intensity

Country	Time Series		Cross Section	
	ICT=0	ICT=1	ALL	ICT=1
DK	.24	.26	.29	.32
FI	.21	.31	.30	.33
FR	.22	.18	.21	.19
NL	.11	.13	.20	.21
NO	.21	.29	.33	.35
SE	.32	.38	.49	.52

Source: ESSnet, Micro-moments database v3.4

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ICT Use and Dispersion: Firm-level evidence

Table : Productivity Growth Dispersion by ICT intensity

Country	Time Series		Cross Section	
	ICT=0	ICT=1	ALL	ICT=1
DK	.19	.21	.23	.24
FI	.19	.28	.25	.27
FR	.20	.18	.21	.18
NL	.13	.14	.22	.24
NO	.18	.26	.32	.35
SE	.20	.26	.33	.37

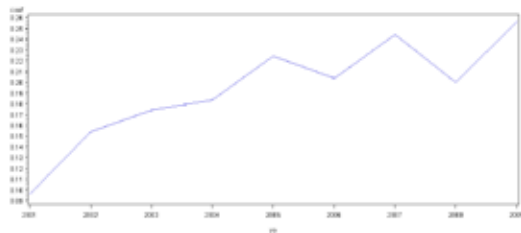
Source: ESSnet, Micro-moments database v3.4

25

Wage polarization: ICT intensive vs non-intensive firms

- $\log(w^{ICT=1}/w^{ICT=0})_{c,i,t} = \alpha + \gamma \text{ time-trend} + FE + \varepsilon_{c,i,t}$
- $\gamma = 1.4(3.95)$: each year 1.4% larger wage difference
- Instead of time-trend, time dummies: coefs shown below

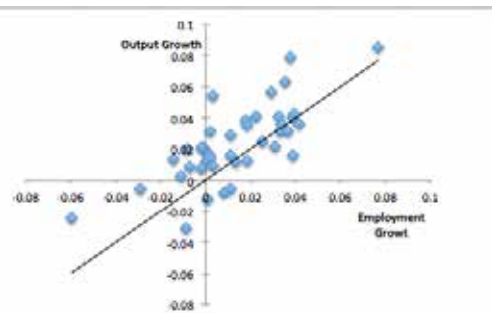
Figure : Differential Wage Development



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ICT intensive vs non-intensive firms

Figure : Output Growth and Employment Growth Differentials



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Overview

- Technological Prospects
- Modelling Growth with Knowledge Based Capital
- Some evidence
- **Connecting with NZ Policy**

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Connecting with NZ Policy

- Paradox: framework conditions for high intangible investment seem ok, but uptake of ICT and innovation is low
- Potential market size remains small owing to distance
 - 'visibility' of existing knowledge may be low as well
- As KBC and global productivity increase NZ could disconnect and fall behind further
- or
- Connection increased for small subset of product space
- Starting from current strengths: primary sector, instruments, digital effects, yachts,

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Knowledge Based Government

- Situation paradoxically calls for government involvement that might go beyond Anglo-Saxon innovation policy
 - Thematic platforms
 - Directed technical change
- Innovation prizes:
 - Choose desirable thematic areas with medium- to long-term horizon
 - Define prize for achieving well defined functional targets
 - Provides some certainty about future revenue (conditional on technological success)

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Innovation in Public Goods and Services

- Costs of gov't services relatively high in small, low density area: improvement through innovation is crucial for competitiveness of private sector exports
- Innovation in the following sectors can be 'exported':
 - Health care
 - Education
 - Transport
 - Arts and Leisure
 - Housing

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Session 5
 Discussant:
 Dr Peter Crabtree
 Ministry of Business,
 Innovation & Employment

Priorities for Innovation Policy

Peter Crabtree,
 Ministry of Business Innovation and Employment

1

Overview

- Mixed performance on Innovation
- Innovation in the Business Growth Agenda
- Innovation priorities and questions for policy development

2

New Zealand's Innovation Performance

The **Global Innovation Index** scores countries on their innovation performance. It is published by Cornell University, INSEAD, and the World Intellectual Property Organization.

The index consists of a ranking of world economies' innovation capabilities and results

The index scores countries on the inputs that enable innovative activity, including institutions, human capital, research infrastructure, market and business sophistication.

The index also compiles a score for countries' innovation outputs, including knowledge and technology outputs and creative outputs.

3

However

- NZ has a persistent income gap compared to other advanced economies
- Despite progress in reducing the gap in recent years, NZ GDP remains 6.9 percent below the OECD average
- OECD suggests that about a third of that gap could be explained by a lack of investment in knowledge based capital
- In some areas NZ does **well** (software investment and trademarks)
- In other aspects NZ compares **poorly** (our R&D intensity and the share of total R&D performed by business are among the lowest in the OECD)

4

Business Growth Agenda

Creating a more productive New Zealand economy will require a restructuring towards knowledge intensive sectors, such as high technology manufacturing, as well as an increase in productivity across all sectors of the economy

National Statement of Science Investment 2015-2025

5

BGA Building Innovation

Strengthening innovation performance through a comprehensive action plan. Key priorities include:

- Making the most of the digital economy
- Investing in knowledge production and diffusion
- Lifting BERD

The plan also encompasses

- Adopting regulations that support innovative new products and services
- Growing the availability of innovation skills

Strong arguments for raising performance (for the firm and the economy)

- New Zealand firms that make more extensive use of the internet are 6% more productive than average firms in their industry.
- The gains that firms can reap from the Internet depend overwhelmingly on the extent to which firms use the internet to *reorganise the way they do business*.
- Smart use of Ultra Fast Broadband could contribute \$33bn in productivity benefits over 20 years.
- Adoption of ICT may also increase the resilience of firms (and industries) to the impacts of disruptive change

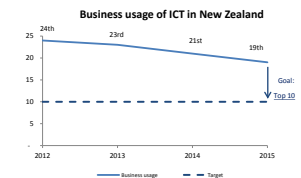
Making the most of the digital economy



Digital Business

Business usage of technology is less in NZ than in similar countries, though this appears to be improving.

Global Information Technology Report



Firms reporting the introduction of new goods and services not possible without ICT	2012 - 21%	2010 - 22%
Firms reporting improved efficiency of workflow processes from ICT use	2012 - 54%	2010 - 54%
Firms with online ordering facilities (e.g. e-commerce)	2012 - 15%	2010 - 14%

Challenges in lifting investment and performance

Broader barriers to improving SME productivity need to be considered if thinking of any interventions. Challenges aren't unique to ICT, eg:

- Time poor, risk averse, cash flow, limited knowledge, vendor information push and lack of impartial information
- Limited competition and management capability lead to low productivity

Some lessons can be learnt from interventions here and internationally

- Government has relatively few levers in this area and it is still unclear what interventions will be worthwhile
- International examples show us that business and sector led initiatives more likely to succeed than "government push", and avoid risk of "crowding out"
- Each sector has different ICT needs and transformation path - different and tailored approaches needed.

Knowledge production and diffusion

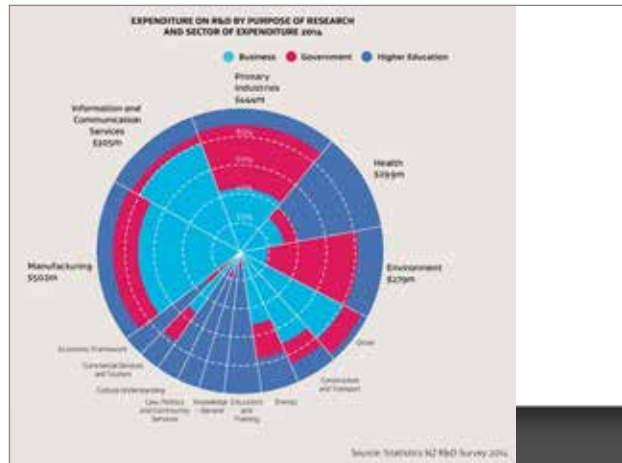
We want to see a society fully engaged with, and benefiting from, a larger, more engaged and more responsive science and innovation system that leverages strong international connections

National Statement of Science Investment 2015-2025

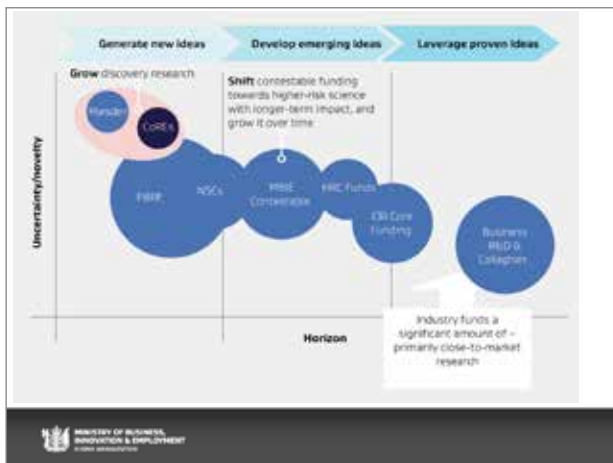
IN 2025, WE WANT TO SEE...

- a better-performing science system that is larger, more agile and more responsive, investing effectively for long-term impact on our health, economy, environment and society.
- Growth in BERD to well above 1 per cent of GDP, driving a thriving independent research sector that is a major pillar of the New Zealand science system
- Reduced complexity and increased transparency in the public science system
- Continuous improvement in New Zealand's international standing as a high-quality R&D destination, resulting in the attraction, development and retention of talented scientists, and direct investment by multinational organisations.
- Comprehensive evaluation and monitoring of performance, underpinned by easily available, reliable data on the science system, to measure our progress towards these goals.

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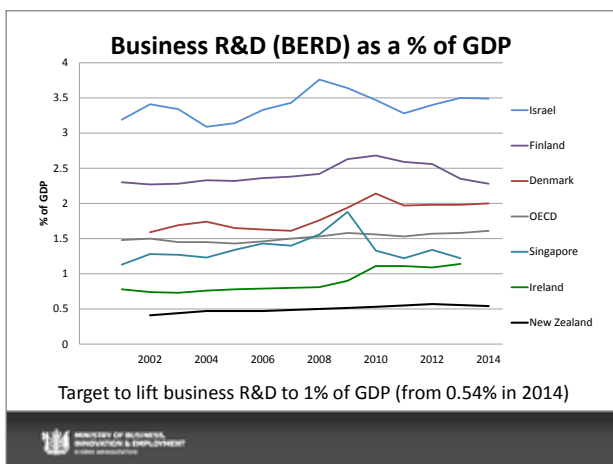


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Business expenditure on R & D

- OECD estimates that NZ's weak R&D investment could account for between 3 and 11 of the 27 percentage points productivity gap between New Zealand and the OECD average
- Low levels of private sector R&D can be largely attributed to its distance from world centres of economic activity, industry structure (in particular, the high employment share of the agriculture sector) and firm size
- This does not indicate that there is no problem – as New Zealand's industry structure and firm size is at least partly a result of past R&D expenditure and an increased rate of growth would almost certainly require structural change.

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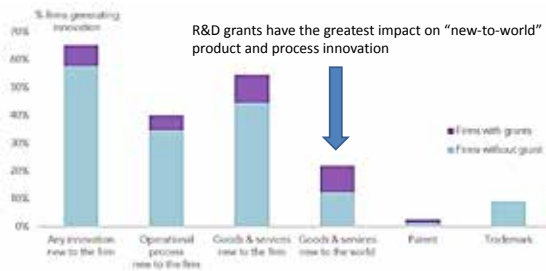
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What are we doing?

- Callaghan Innovation – creation of an organisation to drive business investment in R&D
- Re-design, and further investment in, business R&D grants
- Moving towards sector-specific approaches
- Attracting Multinational R&D

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Impact of R&D grants on innovation



Source: Jaffe & Le (2015). The impact of R&D subsidy on innovation: A study of New Zealand firms
 Note: this research looked at data from 2005 to 2013 so doesn't include the new Growth Grants introduced in 2013

Attracting Multinational R&D

- Multinationals do most of the world's business R&D:
 - top 2,000 do 90% of the world's business R&D
 - top 100 do half of the world's business R&D
- Ireland and Israel attract large amounts of MNC R&D:

	Business R&D as a % of GDP	% of all business R&D performed by foreign-owned subs
Ireland	1.14% of GDP	71% (0.81% of GDP)
Israel	3.49% of GDP	65% (2.27% of GDP)

- Implementing a MNC R&D attraction programme to facilitate specific investment deals

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