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 Makhlouf** 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 Makhlouf 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?

> …market innovation… could unlock greater use value to the benefit of a small open economy such as New Zealand.

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.

> 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.

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.

> One opportunity could be to make more effective use of virtual networks as an alternative to face-to-face contact…

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.

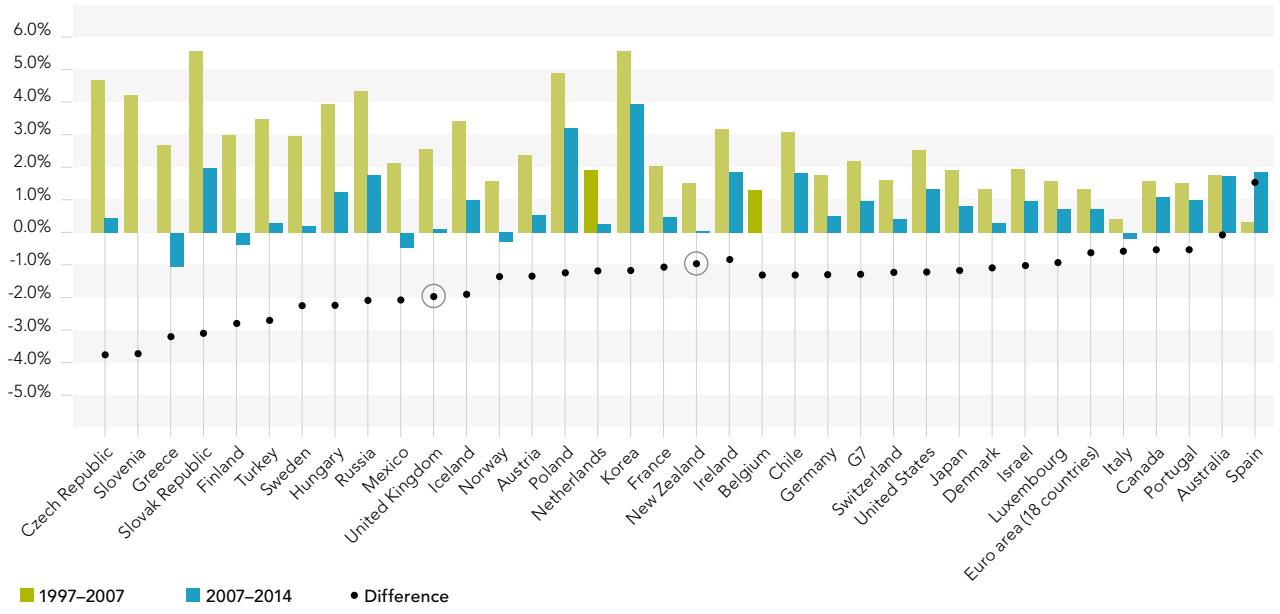
UK perspectives on productivity

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.

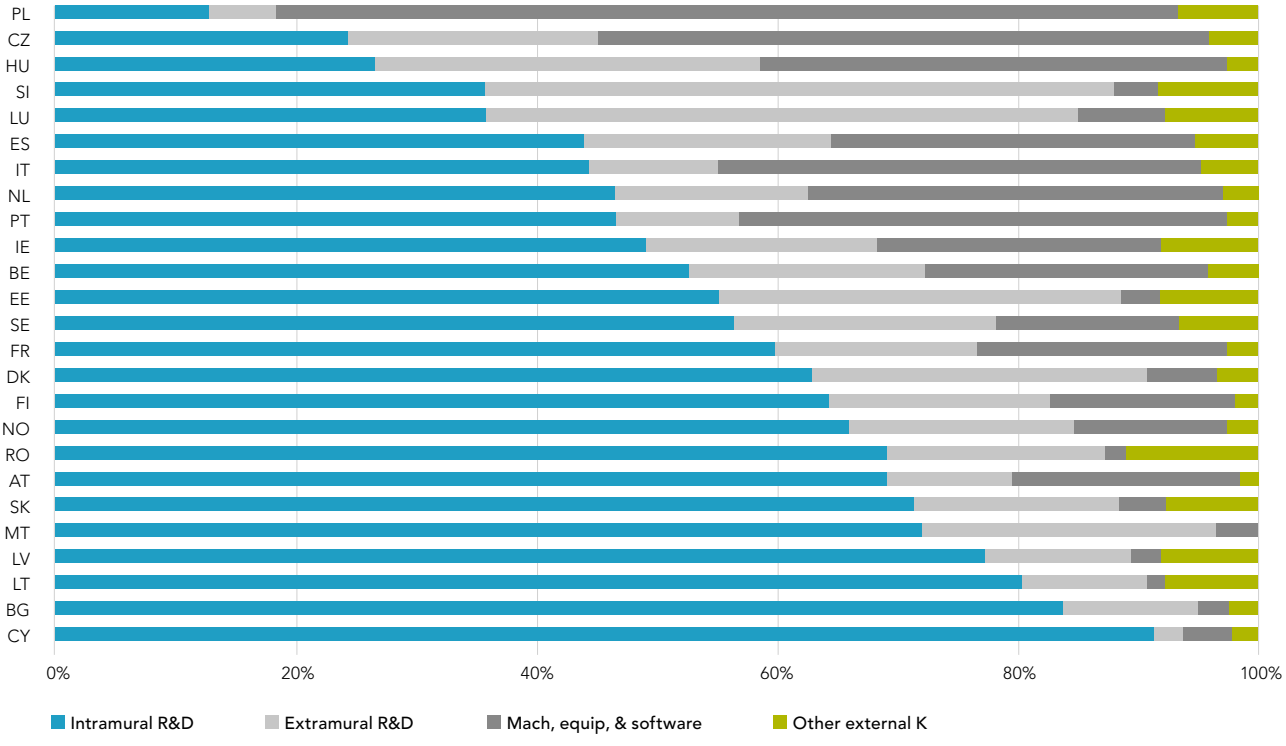
> The impact of innovation on productivity is more difficult to estimate because of imprecise measures of innovation, but product innovation shows a robustly positive impact.

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.

> 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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