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Productivity: What it is and why it matters

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This is a discussion about productivity and the related challenges we face in Australia.[1] What exactly is productivity? Well, it's clearly important because it has driven our growth in living standards since the Industrial Revolution. Conceptually it's not very difficult to define. It's simply output per unit of input. But the practicalities are more elusive because what is output? At the firm level or at the level of an organisation you can pretty much define what your output is. But at a national economy level what does it look like?

There's a lot of controversy in economics about the fact that output is increased when you chop down old-growth forests or commit acts of environmental degradation that, according to current measurement conventions, increase the output of the economy. This leads many people to try to devise alternative measures of what productivity should be. But, for better or worse, this is the one we've got: it's GDP, the numerator, with a denominator that is also quite challenging. Originally it was output per person, but with non-standard hours this was changed by governments through the OECD and various measurement bodies to hours worked.

Even if there are defects in the measure, it also provides a comparative benchmark over time. But then the question arises: where does capital fit in, because both capital and labour contribute to productivity growth? It has led to various broader versions of productivity that are also included in the national accounts: multifactor productivity, total factor productivity.

Productivity and wage stagnation

I won't go into a disquisition about the various interpretations of those forms of productivity. The important thing is that we're looking at a trend growth of a particular measure over time and we're going to focus on Australia for that purpose. The worrying thing that we find in Australia — even though business groups and the financial press and everyone bangs on about it every day — is that our productivity growth has been languishing.[2] For some years now, between 2010 and 2020, we have experienced the lowest productivity growth in 60 years, at 1.1% p.a. We were ranked sixth for productivity growth in the OECD in 1970, but we had fallen to number 16 in 2020.

The Productivity Commissioners (Productivity Commission 2023) calculated that if we'd kept going at 2.2% p.a. productivity growth from 1995 to 2023, then we would have a real average annual incomes boost of $25,000 per person. I don't necessarily agree with all of their prescriptions but they can do some pretty good arithmetic at times. The boost would even be more — maybe $3,000 to $5,000 more — had it not been for

1 This is an edited transcript of a talk given on 7 February 2024. [Ed.]

2 "Australia's real long-term problem is its fading productivity," *AFR*, Jan 21, 2024.

the fact that in recent years workers have had a lower share of the productivity gains than has capital. That's another story in itself, which is generally described as "wage decoupling."

What this has meant is that we are now experiencing something everyone is painfully aware of: a cost of living crisis (Figure 1). It won't be solved by changing tax policy because it's a much deeper problem. It relates to the underlying structure of the economy.

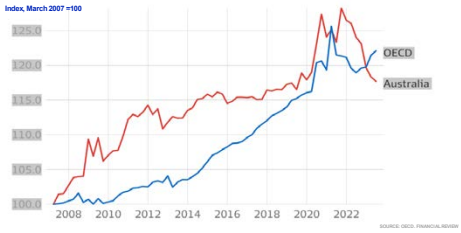

Figure 1: Real gross household income per capita, AU v OECD

What connection can we draw between productivity growth and the growth of national income — in this case, real income growth per head? Figure 2 is a very useful graph. It's a Treasury graph that was provided for the Intergenerational Report; it describes the history of what's been happening over the last 30 years or so.

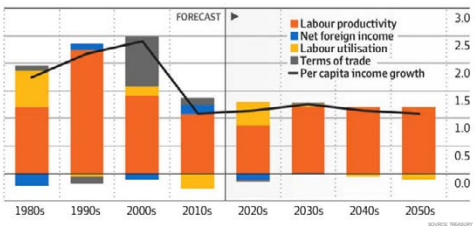

Figure 2: Components of real income growth per capita

On the left-hand side (in the 1990s) is a big red blotch which is the growth of labour productivity. Labour productivity was growing quite fast then: it was the period of the Hawke/Keating government's economic reforms. What people don't recognise about those reforms is that they weren't just about freeing up the capital and labour markets: they were also about the development of a very coherent industrial policy to transition industry from large-scale mass-production industries to smaller-scale, more specialised SMEs that could find a place in global markets and value chains.

A complete restructuring of the Australian economy was going on at that time. People forget that in the late 1990s, the fastest growing area of world trade for us was elaborately transformed manufactures. Even though a lot of our traditional manufacturing industry had been hit by the earlier removal of tariffs, nevertheless new, more specialised, knowledge-based industries were growing at that time, because there was a commitment to R&D and to innovation.

Commodity boom

Things changed in the 2000s. For many people living in this country the change was quite beneficial because we experienced a massive commodity boom, an unprecedented commodity boom, the biggest most likely we'll ever have in our lifetimes, increasing our standard of living by 15% over a six-year period without us having to do a thing. We were getting higher prices for our raw materials, especially iron ore and coal, which we might call the gift from China.

It boosted our terms of trade and hence boosted the dollar, but the impact was to make uncompetitive a lot of those new, growing, interesting, specialised firms in manufacturing. We lost about 100,000 man-

ufacturing jobs over an 18-month period. It was a genuine crisis for manufacturing industry, but no one noticed because everyone was experiencing an increase in their income per head, and life went on without addressing the underlying issues.

Other countries have faced that problem as well, other resources-based economies. The most obvious one in the post-war period was Holland — hence the term the "Dutch disease" — because they discovered North Sea gas and the price of the guilder went up and much of their manufacturing went to the wall. It took them about 10 years to restructure their economy to accommodate to the new situation.[3]

During the 1970s and '80s, the UK also experienced this phenomenon after the discovery of North Sea oil and gas, which drove up the price of sterling. A lot of manufacturing went to the wall; after a period of a consumption boom there was nothing to show for it at the end. It was part of Mrs Thatcher's economic experiment: she wasn't interested in reconstructing the economy, she was simply interested in ensuring that financial interests got a greater foothold over the national operation of the British economy. And that's exactly what happened, with everyone facing crumbling infrastructure — schools, universities, hospitals — at the end of the 1980s. People at the time suggested that this is a price that the British will pay for decades, and of course they are.

Did we learn from this experience in the commodity boom that we enjoyed in the 2000s? Sadly not. Others did, but not us. We had a consumption boom as well and we've ended up with lower living standards now because the terms of trade boost is gone, which at the time masked a structural deterioration in our productivity performance.

Norway is the counter example, again with access to North Sea oil and gas. They took a public stake in their major oil company, Statoil. They introduced a resource rent tax — you might recall Kevin Rudd trying to do the same here — but their resource rent tax wasn't the 20 or 30 or 40% that was being proposed in Australia; instead, theirs was a 76% resource rent tax. They used that to create what has now become the world's largest sovereign wealth fund, which invests around the world and in the future of their economy, for future Norwegian generations, building up their research and education infrastructure for many, many decades to come.[4]

That was clever. We missed the chance to do that and so what we have is a hollowed-out economy, as we'll see below, especially with the decline of our manufacturing sector.

Explanations of stalled productivity growth

The decline of productivity growth isn't just a phenomenon confined to Australia: we see something like it happening across the world. It's just happening more acutely in this country. It is also occurring in the US and Europe, and there are various interpretations that have been applied to why this might be the case. One is that the last couple of decades are in fact not so transformative by comparison with what we saw occurring in the late 19th century and early 20th century, with indoor plumbing, electricity, the tel-

3 The Australian equivalent in the 1970s was the Gregory Thesis. See Gregory 1976. [Ed.]

4 https://www.nbim.no/en/ [Ed.]

ephone, commercial flight and many other developments that we now take for granted but which were genuinely life-changing at the time. These developments provided a huge boost to productivity, and hence living standards, for those populations.

What Gordon (2000) and various economists in the US would now say is, "The internet — what's it ever done for us?" by comparison with all of these major innovations that changed our lives in the past. He's a bit of an outlier but there's a certain amount of common sense in the argument.[5]

Another interpretation is that productivity is just too hard to measure — it's ongoing but we can't measure it because so much of what is now produced is intangible, especially with the growth of digital and AI. How do you measure it, for example, if a lawyer uses AI for a brief? Does that appear in the national productivity statistics? That's going to be a big challenge.

But the most widely accepted interpretation among economists — especially Erik Brynjolfsson and Andrew McAfee at MIT and various scholars in the UK and in the OECD — is that, yes, we do have productivity growth but it's at the technology frontier, in relatively small cohorts of firms in each country. Productivity growth on average is defined by the size and success of that cohort. The problem is that the productivity growth and the technological change that they're experiencing haven't been diffused or deployed through the economy — that is yet to come — so we must wait for the impact. In the meantime it's this cohort of firms — all the big tech firms, the really sharp manufacturers that have captured world markets in the US, China, Europe — these are the firms that are driving productivity.

In this interpretation, the issue of how much productivity growth we get on average is determined by the proportion of these firms in the economy. The proportion of such firms in the Australian economy is very small. We have a much larger group of the firms that the OECD would describe as "laggards," and very little in the way of institutional structures to deploy the productivity growth and the technology expertise at the frontier to the rest of the firm population.

The AlphaBeta consulting firm did some interesting work for the Federal government a couple of years ago, when it analysed the R&D intensity of different sectors. It was less the R&D intensity within the sectors than the composition and presence of those sectors in the economy that made the difference. If you have a larger manufacturing sector, and the manufacturing sector is the biggest driver of productivity in the economy, then you have greater productivity growth in your national statistics. If your manufacturing is hollowed out — well, that's us — then you're highly likely to have a lower rate of productivity growth.

Technological change and innovation

What drives productivity growth in these high-skill, high-value-adding firms? (Figure 3). Essentially, it's technological change and innovation, but it's not always technological innovation: there can be non-R&D forms of innovation as well — new business models, systems integration, new work and management practices — but, generally speaking, technology is what drives it.

5 See https://en.wikipedia.org/wiki/Productivity_paradox [Ed.]

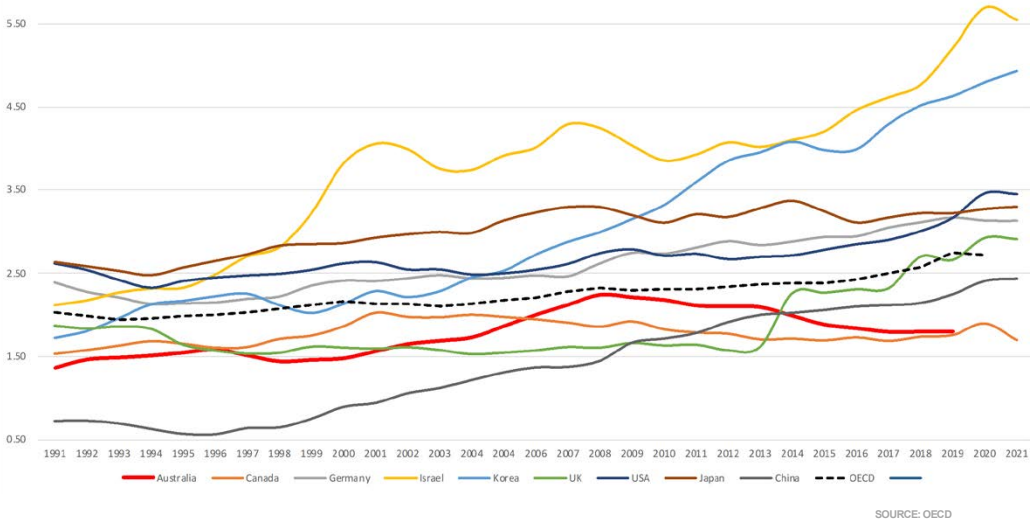

Figure 3: Gross Expenditure on R&D as % of GDP 2003–2020

Technology hasn't been recognised in the traditional neoclassical production function models in the past, but new theories around so-called endogenous growth have made technology the centrepiece of productivity and industrial transformation in modern advanced economies. What we find in Australia is that R&D for this country has been languishing, along with Canada's — Australia's is the red line going down the bottom in Figure 3. Others — Israel, Korea, Japan — have been experiencing massive productivity growth, and that is entirely through their commitment and investment in R&D. In Australia, R&D has been going backwards for some years — we were at about 2.2–2.3% p.a. a few years ago, but we're now scraping along the bottom at 1.68%.

The government has a target to get to 3% of GDP, but at 1.68% the question is what's the road map for getting there? In particular, our business expenditure on R&D has fallen behind almost every other country. For Australia, BERD (business expenditure on R&D) is about 50% of R&D generally. In the US it's 70%. This is partly because we have a very fragmented research and innovation system, if we can call it a system.

My colleagues and I did a study a few years ago for the government showing that we had research and innovation spending spread across 13 different portfolios of government, 150 different budget line items, very few having connected with each other. We have also, by the way, 60 official review reports since the Keating/Hawke period, on how to improve our R&D system, none of which has had any implementation strategy attached to it.

How do we get to this 3% target? In one sense it's quite easy because ATSE has done a calculation, together with Universities Australia, in which they find that $1 of R&D creates or adds $3.50 to the economy overall.[6] So if we spent $4.4 billion per annum up to 2035, we would reach the 3%

6 https://www.csiro.au/en/news/all/articles/2021/november/value-innovation-investment [Ed.]

target, and it would also add $133 billion per year to our economy. Why don't we do that? $4.4 billion a year is not all that much: you might want to compare that with how much we spend, for example, on the diesel fuel tax rebate — $7.9 billion a year for a handful of international mining companies to drive diesel trucks across their mining sites. Wouldn't it be smart to start allocating those resources to R&D instead, and to contribute to the future of this economy?

Narrow trade and industrial structure

But the problem is even deeper, unfortunately, than simply R&D. It goes to our narrow trade and industrial structure. There is a very interesting exercise that some of you may be familiar with — the Harvard Atlas of Economic Complexity.[7] It's an annual report that's done to show the economic complexity or otherwise of 130 or so economies around the world. Economic complexity measures the diversity and research intensity of the export mix. I'll give you a couple of examples.

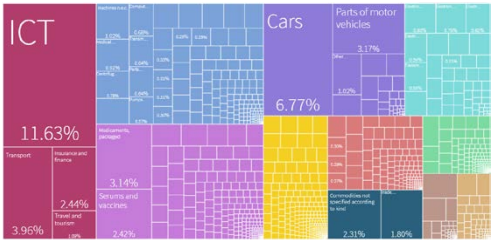

Figure 4: Economic complexity — Germany #4

Germany is number four and the area which predominates in the German export mix is around Machinery, the next area around Medtech and Pharma, and cars and car parts, ICT — this is a highly complex economy and it is very largely driven by advanced manufacturing (Figure 4). Canada (Figure 5) (#41) is a bit more comparable with us — another resources economy — also languishing in this ranking, and there is a predominance of raw-material exports, but also a fair sprinkling of complex activities and value-adding within manufacturing, particularly in the automotive industry.

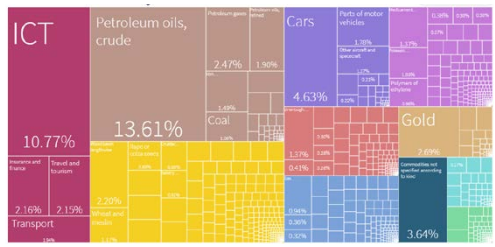

Figure 5: Economic complexity — Canada #41

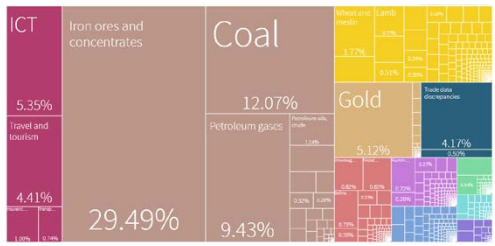

Figure 6: Economic complexity — Australia #93

When we look at ourselves (Figure 6), we're now #93 — in the 1990s we used to be around #50 — and unprocessed raw materials dominates our export mix. The Productivity Commission thinks this is absolutely fine because we have a comparative advantage in unprocessed raw materials. But we only have to imagine what might happen if the raw materials component of exports disappeared overnight — for example, if the Chinese decided not to buy our iron ore — we would have a big gap in our export mix to fill. Coal volumes are

7 https://econlife.com/2020/01/a-simple-look-at-the-worlds-most-complex-economies/

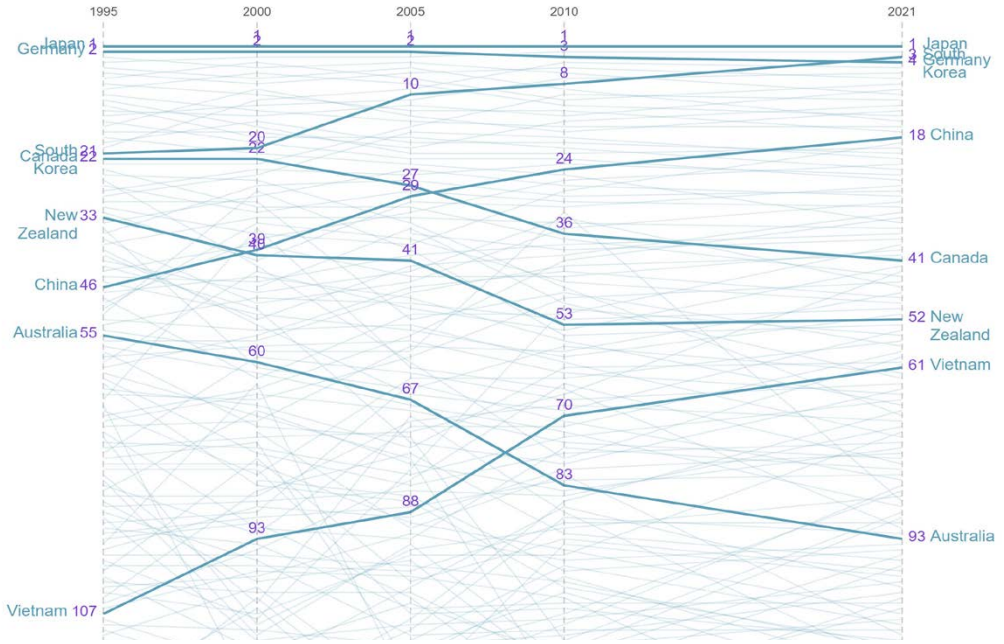

Figure 7: Complexity comparison

already in decline. Those export values are what enables us to import all the complex stuff that we don't manufacture or build here ourselves.

There is an indication of the degree to which we've slid down these rankings — Australia, also Canada to some degree, but what's happening to the rest of the world economy, or at least the examples I've selected? (Figure 7). The East Asian countries have really begun to dominate these rankings and even Vietnam has managed to pull itself up into, if not a first-world country, then well on the way to being a technological powerhouse.

The issue around our narrow trade and industrial structure is exemplified in a vaguely amusing way by this *Economist* (2023) article recently, which asked the question: what if Australia and Canada were one country and we called it Ozanada? It would be an economy almost as big as Germany's but based almost entirely on the export of raw materials. Lagging far behind other comparable countries in terms of its high-tech exports, representing 7% of the combined exports of OECD countries, but only 4% for Canada and less than 2% for Australia. The article concludes that this is "not for want of well-nourished brains" — Ozanada is "home to world-class universities and boasts some of the highest rates of tertiary education". Rather, the problem is an "underfed innovation system."

It's not as though we didn't know this, and we've known it for a very long time. I'm reminded always of the Science and Technology Budget Statement in 1993 issued by Treasury, which said, "Our most urgent task is to build an innovative culture in industry. Above all, we need a cultural change among business leaders, decision makers and the community generally, which recognises the major significance that innovation has for

building national competitiveness. A clear sense of direction, planning, leadership are needed to achieve our goals." Well, we have a long way to go and it isn't just a question of market failure. It's a massive systems failure across our economy and in our institutional structures.

This failure is also reflected in another measure — location quotients — that was devised by an American think-tank, the Information Technology and Innovation Foundation (ITIF), which looked at the presence of advanced industries in each country.[8] If we say the average is 1.0, then in 1995 we were 0.56, so quite well behind the average. In 2018 it fell to 0.41 and now we've dropped almost to the bottom of the 74-country ranking. By "advanced industries" here we mean Medtech, Pharma, Electronics and IT machinery. This has also meant that we've dropped down every other ranking — for example the IMD competitiveness ranking and the Global Innovation Index, which we come to below.

Ranking	Country
1	Switzerland
2	Sweden
3	United States of America
4	United Kingdom
5	Singapore
6	Finland
7	Netherlands
8	Germany
9	Denmark
10	Republic of Korea
24	Australia

SOURCE: GLOBAL INNOVATION INDEX, WIPO,2023

Figure 8: Global Innovation Index Ranking

Innovation inputs and outputs

A recent finding by the Australian government itself was that, of our companies, 98% do not produce new-to-the-world innovation; only 2% do. Let's unpack that by looking at the latest Global Innovation Index rankings[9] (Figure 8). At the top of these rankings are the usual impressive suspects, and we're at number 24, so you might not think that's too bad. But when we drill down, we can see where and what the issues are (Figure 9). We're pretty good at innovation inputs, but it's the innovation outputs that are the major problem. Innovation inputs, tertiary enrolments — we're right up there, also females with degrees, our university rankings, scientific articles which essentially drive the rankings, and our use of ICT.

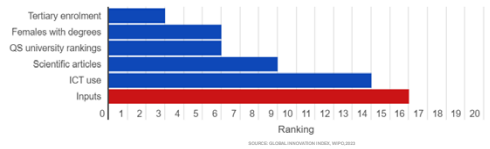

Figure 9: What Australia is good at

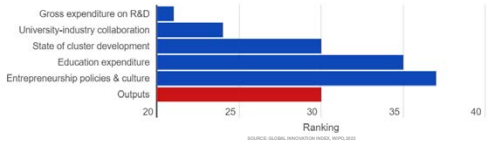

Figure 10: What Australia is not so good at

What we're not so good at (as we see in Figure 10):

- the translation of university R&D into commercial value through university/industry collaboration
- cluster development: the development of areas of specialisation that can achieve

8 https://itif.org/publications/2023/12/13/2023-hamilton-index/ [Ed.]

9 https://www.wipo.int/pressroom/en/articles/2023/article_0011.html [Ed.]

critical mass in global markets and value chains

- our education expenditure: we think we spend quite a lot on our education expenditure, but we don't, compared with other countries — if we took that number and made it public expenditure per pupil, we'd go out to about number 60
- entrepreneurship policies and culture: we're improving but we're still not up there with the entrepreneurial leaders.

Our outputs of innovation — what we do with the inputs — lag far behind all the other OECD countries. Let's return to R&D and disaggregate our expenditure on that (Figure 11). This is a growth index; the orange and yellow bars are the growth of government and business expenditure on R&D in Australia. It's not going anywhere; in fact, it's going down. What's going up is higher-education R&D: it's universities in fact that are doing the heavy lifting now for Australia's R&D effort.

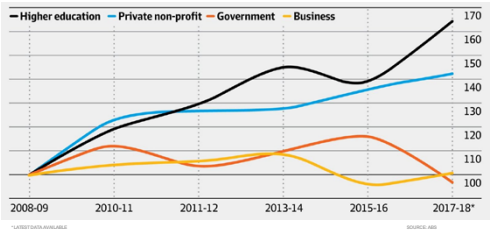

Figure 11: Gross expenditure on R&D, Australia growth index

This is good in a sense but not for the best of reasons. It is only occurring because we're attracting large numbers of international students whose fees are then diverted to filling the gap that would otherwise be filled in other countries by public expenditure on research and innovation. By diverting these student revenues to research, we increase our rankings and attract more international students, and we continue on what one of my colleagues has depicted as a very precarious hamster wheel. It's not necessarily producing the research that we need as a country: a lot of it is medical research, which is fine, but the sort of research that's needed in industry is science and engineering, or business and organisational design, and that's the research that we're not necessarily funding.

More than that, world research is no longer necessarily breakthrough research that can change the game in industry and society. There was a very interesting piece of work published in *Nature* on research productivity recently (Park et al. 2023), which noted that more research is being done than ever before but asked the question, Why are we getting less and less breakthrough research? Is research becoming too incremental? The authors looked at 45 million published articles across the world, using an AI tool with various keywords, to determine which were the breakthrough research pieces, as affirmed by citations, that would transform the way we work and live, and certainly the way future authors would understand an area of interest.

They found that over a long period of time since the Second World War, we've seen a significant decline in breakthrough research as it becomes more incremental. Why is that occurring? Because research itself is becoming narrower and narrower in each of our disciplines and subdisciplines, hence we're missing the sparks of creativity that occur at the intersections of disciplines. It's another angle on productivity — something that's not just peculiar to Australia but is a global phenomenon.

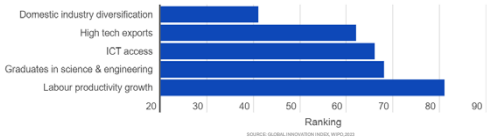

Figure 12: Where Australia lags most

The bad news for Australia becomes even worse (Figure 12). Let's look at our domestic industry diversification. We looked at the export diversification with the Harvard Complexity Index: this is our domestic diversification, lagging at 40 out of the various countries surveyed. High-tech exports which are part of that ICT access, essentially reflecting the botched National Broadband introduction. Graduates in science and engineering lagging — we are short of 50,000 engineers in Australia. Where are they going to come from? We only produce 13,000 a year. All culminating in the poor performance as reflected in our labour productivity growth.

Government priorities

What we can do about productivity and wage stagnation? It's always possible to undertake policies that are transformational in this country, should governments at every level decide to do so. Why is it so hard to make these decisions? The Federal government would argue that it has sorted out its priorities, primarily in the context of the new National Reconstruction Fund. These are: Renewable technologies; Transport; Value adding in agriculture; Value adding in resources; Defence capability and aerospace; and Enabling capabilities around new technologies. All of these are good so far as they go, but the NRF is not an industrial policy, just a financing mechanism.

The key questions must be: what are the problems we are trying to solve; can we build national missions around them; and what does the implementation strategy look like? The new NSW Industry minister has identified some areas where missions can be devised. He advocates that we support firms developing the industries and technologies of the future; he has identified various sectors that we can focus on. We're very good at listing these things, but where is the implementation strategy? The minister hosted an innovation blueprint summit in February 2024, so we might find out more about his thinking and how we would like us to contribute.

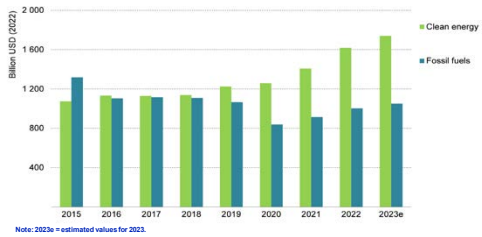

Figure 13: Global energy investment in clean energy and in fossils, 2015–2023e

Finally, let's ask ourselves: since we've missed so many opportunities up till now, where can we play as a country? Ross Garnaut (2019) has made the compelling argument for Australia to be a renewable energy superpower. We're fortunate to have been given another chance as a country, after falling down on the job during the commodity boom. Global energy investment is the fastest-growing sector in the world for productivity growth (Figure 13). It will be a $1 trillion sector by 2050. Already the investments are way out-stripping fossil fuels. It's a tremendous way to increase productivity and restore our manufacturing capability, because we can now use the immense resources of wind and solar to produce the electrons — which we can apply either directly or through hydrogen and its

various forms — to create new industries and transform existing ones, with green iron and green steel, green aluminium and green copper. Europe is about to introduce a border adjustment mechanism[10] which will penalise supply chains that are not low-carbon. We can do low-carbon manufacturing activities here and become a manufacturing exporter at scale, if we get all of these things right, in a framework that does it coherently, which we currently don't have.

Policy architecture

What I think is essentially missing is a coherent, coordinated innovation system, which is in fact what you find in most other countries that do enjoy a high level of productivity growth and related presence of advanced research-intensive industries.

Five components in a policy architecture

Mission-led industrial policy

What are the problems we're trying to solve? How do we turn these into national missions for the country and put our resources behind those missions? It starts with technology foresighting: where are the areas of current and future competitive advantage, as opposed to simply comparative advantage? Comparative advantage is about our natural endowments; competitive advantage is about our knowledge and ingenuity. How do we identify these, rather than just list priorities? What are the issues and problems we need to address, and importantly how do we build a coordinating focus in government to take missions forward? Examples elsewhere include Sweden's Vinnova, InnovateUK, Netherlands Top Sectors etc.

Research and technology development

Let's not miss the opportunity to put additional public resources into research and technology development, including basic research, because basic research has declined as a proportion of our research spending. While some might say we shouldn't do research for its own sake, the fact is that if we don't have basic research, we won't have anything to commercialise. That connects then with the applied research that we do in CRCs, in CSIRO, in universities, which can then be mobilised around the missions.

Place-based innovation ecosystems

These are an increasingly important part of the process of translating ideas into commercial and social value and diffusing them across SME networks. This is an approach that is taking place around the world, not only to promote research and innovation, but also to transform existing industries and create new ones.

The Fraunhofer Institutes are probably the best longstanding example, in Germany.[11] The British picked this up, albeit less well-funded, with their Catapult Centre network, especially the High-Value Manufacturing Catapults.[12] The US is now doubling down on this approach in the Biden CHIPS and Science Act of 2022,[13] with National Science Foundation Regional

10 https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en [Ed.]

11 https://www.fraunhofer.de/en/about-fraunhofer.html [Ed.]

12 https://catapult.org.uk [Ed.]

13 https://new.nsf.gov/chips [Ed.]

Innovation Engines[14] and something called the Microelectronics Commons[15] which are technology hubs around the US. An immense amount of money is being spent on each one — $200 million per ecosystem or hub. They are characterised by their ability to bring together universities, research institutions, industry — especially large anchor companies — and government funding in a collaborative way, to not just do a linear pipeline from an idea to a commercial outcome — which is the traditional way of understanding commercialisation — but through the interaction of multiple disciplines, individuals and institutions to devise programs and industrial applications that no one might have thought of before those interactions took place.

A good example with the Catapults is Formula 1 technology: they thought, "You know, our car industry is gone now so we'll at least work on Formula 1 cars which we're pretty good at". Out of new precision pit-stop engineering, they designed new ways of managing operating theatres in hospitals which then became a new export industry for Britain. These are the sort of things that happen at the intersection of disciplines.

Public sector as innovation driver

The US does this very well with the SBIR (Small Business Innovation Research program),[16] where each government department is compelled — it's not voluntary — to set aside a certain percentage of their funds to enable local SME technology development to solve the problems and meet the needs of those public-sector institutions, especially in the health system. It's the most important innovation program in the US, along with DARPA and a few others, and it has certainly been transformative for SMEs and micro firms, enabling them to scale with leading-edge technologies and business models.

We could do that here: nothing to stop us from making sure that, if we do procurement in certain areas, we don't do this crazy Treasury "value for money" thing, which means that we buy Chinese or Korean trains that don't fit on the tracks or ferries that don't fit under bridges, ultimately costing much more and destroying local capability in the process. Why wouldn't we do procurement in such a way that we build potentially scalable home-grown companies and workforces? This would be value for money!

Skills and capability building

Finally, that brings us to skills development, which is often neglected — especially when contracted out to private operators — but is essential here.

For example, we could go into offshore wind. The Port of Newcastle is supporting the development of an offshore wind facility which will supply 3–4 gigawatts of energy. This will feed onshore hydrogen electrolyser infrastructure for the production of ammonia and possibly green iron and green steel, facilitating the region's energy transition and economic diversification. The company that's currently the front runner for allocation of the tender has set out — it's a Norwegian company, of course — its vision of what this would look like. Part of its

14 https://new.nsf.gov/funding/initiatives/regional-innovation-engines/about-nsf-engines [Ed.]

15 https://microelectronicscommons.org [Ed.]

16 https://www.sbir.gov [Ed.]

vision is they would build the platforms here, onshore, but they've said to us, "By the way, if we're going to do that, we need 4,000 welders on day one." Where are they going to come from?

Conclusion

To finish, these are the challenges that we face; all of them are solvable, I think. But we need a vision of what the system can look like: a system that draws on the best examples from around the world, then designs and implements it in a way that works for this country.

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Questions & Answers

Q: There's a wonderful example of the place-based innovation ecosystems from the '50s which was summarised in a really good book called *The Ideas Factory*, which described the success of Bell Labs, where they invested a huge amount of money and hired scientists and told them just to go for it, not measuring what they did.[17] Not giving any instructions. There was an economic analysis of this and the value added was just fantastic, so it does work but you know there's got to be some innovation and drive to do it.

A: Yes, that's a really interesting area. Those large labs — Bell Labs, IBM — they were the drivers of a lot of innovation, more so at the time than from universities, and the question people ask is why did those labs disappear, why did they decline and

17 Jon Gertner (2013) *The Idea Factory: Bell Labs and the Great Age of American Innovation*, Penguin.

disappear? Because those companies — this is really interesting — began to outsource their R&D in tandem with the weakening of US antitrust legislation. While antitrust provisions were in force, those companies couldn't just buy other companies and take their ideas (which is what's happening now), they had to develop everything within their own organisation, hence building their own labs. Now, if you're a very large company in the US — and the big tech companies are the obvious example of this — if you see an innovation going on in a start-up or even something a bit larger — like Facebook taking over WhatsApp — you just buy it. Obviously, Facebook and Google and so on are doing a lot of R&D themselves as well, but it certainly ensures that they can consolidate their position without doing everything themselves or being in competition with anyone.

Q: Thank you for your wonderful talk. I wonder if I could ask two questions: one, could you comment on the impact on all of this by the corporatisation of universities and, as an aside to that, would you comment on the fact that the next Vice Chancellor of ANU is Genevieve Bell. The second question is: does the different social environment of Scandinavian countries have an impact on all the kind of stuff you've been talking about, having in mind that generally in global economic statistics Scandinavian countries are well in advance of Australia?

A: I'll answer the second one first; it's lot easier than the first. Absolutely, so the Scandinavian countries have not only an innovation system but they also have a social system which supports it. So if you want to take the risk of undertaking start-up activity and you fail, you have a social safety net, and that gives people a great deal of security about pursuing R&D activities or entrepreneurial activities that you might not have in a more deregulated economy.

They also put a huge amount of their own public resources (because they pay more tax) into R&D and so you know if you're paying high rates of tax, you can devote substantial public expenditure to both social and economic ends. Hence those countries have the highest productivity growth, contrary to the impression given by neoliberal think-tanks who don't like to mention the Nordics, as well as having the highest rating on the Global Happiness Index.

As for universities, I'm not quite sure where they fit on the Happiness Index these days, but yes there's a certain amount of corporatisation that's occurred since the Dawkins reforms. I remember in my university at the time we were looking at this in the early 1990s and asking ourselves what did it all mean. What it seemed to mean was that the vice-chancellor was effectively no longer an advocate for us in government, but instead an advocate of the government in our university. Clearly vice-chancellors have pushed back since then, and I'm sure Genevieve will be one of those, but universities have nevertheless become more corporate institutions. There's still a lot of scope for academics to do the things that they're good at, despite having to rely increasingly on the international student revenues I mentioned earlier, but I can't imagine anyone has not noticed the huge rise in bureaucracy and form-filling that makes life more challenging these days. Fortunately, I don't have to do much of that anymore.

Q: Roy, thanks very much for your very interesting talk. One of the underlying themes in your talk was the fact that manufacturing industry is much more innovative

than the services sector, though the way that exports of raw materials has boosted the exchange rate has had a damaging impact on the manufacturing sector. I don't see how we can change that system because at the moment we still think it's very important to export rocks. I think the whole policy we still follow seems to be that we must export more of our minerals and that's going to help our society in the future. How are we going to change that?

A: Well, that's the $64 billion question. The Productivity Commission would say we don't need to change it because we're good at exporting rocks. And what a thrill it was when we found that batteries were made of lithium because it meant that we could continue exporting raw materials, and now lithium will take over from iron ore and be the next big commodity boom. Well, that didn't go so well: lithium is already oversupplied now in the world economy and its price has dropped dramatically. But even if it hadn't, wouldn't it be smart for us to move into the whole value chain of battery production, energy storage, personal mobility, as Canada is in fact trying to do itself?

Right now when it comes to lithium, we produce 50% of the world's lithium and export 90%, most of it to China. We capture 0.53% of its final value, and so when the AUKUS arrangements suggest to us how wonderful it will be to be incorporated into the U.S. Defense Production Act, the question we should be asking is not how much raw lithium can we sell to the U.S., but do we have the opportunity in that arrangement to move up the value chain? At this stage, the jury is out.

Q: You mentioned the importance of generating research that upon implementation maximises the productivity of all other sectors of the economy. Could research productivity be improved through adopting a collaborative approach across all portfolios during the translation of research?

A: Do you mean across government portfolios?

Q: Not just government portfolios but also across various faculties within universities as well?

A: Yes, absolutely. Well, certainly at the government level with limited resources, it doesn't make any sense for us to have a defence research strategy, an energy research strategy, a health research strategy, and something around the departments of industry and education. There should be a single strategy around industrial transformation, and social well-being, and all of these elements can feed in, because there's so many potential crossover points and points of intersection between the disciplines.

But that sort of siloed thinking mirrors exactly how we operate our universities, because, with the focus on top-tier peer-reviewed publications (which are increasingly narrow), everybody's incentive is to publish in those journals, not to work with someone in a different discipline. Except, you know, there's a few odd-balls around who might like to do that, but it won't stand you in good stead if you're a young aspiring researcher in a university. It won't give you the sort of promotion opportunities you would have if you doubled down on the narrowest possible subdiscipline area and published in the top journal in that area, that might not ever have any further application, or even have a very wide readership. I think universities need to push against the ranking exercise that forces them to do this.

How many German universities are there in the rankings? Not all that many:

they've made a conscious decision that it's more important to connect research to the future of their economies and societies rather than simply chase rankings for their own sake, and the same goes, I've noticed, in business schools in Germany, with their complete disregard for MBAs. They have very interdisciplinary Masters of Management programs that bring together engineers, designers, all social scientists, all sorts of interesting people. That plays into the whole Fraunhofer system as well. So there are different ways of doing this — we just don't do it.

Q: Thank you very much, Roy. You're absolutely right about the inputs: the most recent index of creativity showed that Australia is the most creative country in the world, but we rate very poorly on innovation, exactly as you say, and we obviously need a mission-led industrial strategy, so thanks for promoting it. We see all the problems but in terms of an opportunity I'm wondering what you think about opportunities from AUKUS, given that the US and the UK will be sharing IP with us.

A: If the submarines appear by 2050, I'll be very surprised, and money we spend on refurbishing American shipyards is money we won't be spending on our own R&D. So I guess I'm not very favourable to that way of thinking. Maybe there will be some opportunities, but I think they've been overblown because politicians like to give the impression that it's going to be nirvana for Australian industry. But, as I said before, it will be for very specific areas of Australian industry. There might be some small defence companies or space companies that get picked off by American primes — we might lose them; we are losing them as we speak. I would put a lot more emphasis on sovereign capability even though it's the rhetoric of governments now, but we don't actually do it and I'd be very concerned if we lose a lot of the important research collaboration opportunities that we have with other countries because we're putting all our eggs in that basket.

Q: Roy, a lot of this is déjà vu: we've been hearing about the issues in the Australian innovation system for a long time and you've got mission-led industrial policy up the top. The problem is that it changes every three years. So how do we overcome the lack of continuity in our thinking; how do other countries overcome that?

A: Well, you have continuity if you insist on it and other countries do: if the government changes in the Netherlands (which it's currently doing) or in Finland or Ireland or other places like that, the whole corpus of R&D policy is not overthrown. The next government will maybe tweak it or develop it in different ways, but it will continue. The institutions continue, the key personnel in the departments continue, and there is continuity.

In Australia, and to some extent in the UK and even more so now in the US, when government changes everyone has to change their positioning as well. In this country we have missions, in the CSIRO and elsewhere, but we also have multiple priorities. And we have challenges. We have all sorts of schemes that are inconsistent with each other across the institutions of government, universities and the Science and Technology Council. Unless we clean that up and say, "Here are the five things we're going to do and we're going to do them really well and we're going to pull all the resources in to make it happen," we'll be in this very fragmented environment where another government

could be elected next year or in three years' time and it all changes.

One of the examples that always strikes me is with the Hawke/Keating government: a number of excellent programs were developed in the industrial policy space, especially a program people don't even remember now, called the National Industry Extension Service (NIES), which was a cooperative federal-state joint government program. No-one knew where the money came from: it came from all sorts of places that were cooperating to ensure that it happened, and it was all about capability-building in enterprises and the development of their innovation absorptive capacity, because we're not going to do all the R&D here — we do 2% of the world's R&D. Most of it we will bring in from elsewhere and so enterprise absorptive capacity is a really important thing: are your companies able to adapt, adopt and absorb technology and implement it to improve productivity? And that program? 1996 — Howard government elected. Gone!

Q: Roy, that was a tremendous presentation as always. The question on skills and capability — I'm sitting next to the CEO of Advance.org who looks after a million Australians living and working overseas. We export all this talent, and yet when they come home we give them short shrift, ignore them. They come home either to retire or to educate their children. Given everything you've described, they leave again. How do we change that dynamic so that they can come home and be the entrepreneurs and lead the companies and bring the innovative thinking and stay?

A: Well, it's not hard: mainly having the infrastructure and the money is what it's about. The Irish did this extremely well because they decided in the 1980s they were going to be an innovation economy. Everyone knows the story: they had 17% unemployment, inflation, the economy going nowhere, and some civil servants, together with research institutions, decided, "This is the moment when we introduce policies that will transform our economy forever." So they introduced a foreign direct investment attraction agency especially focused on R&D-intensive FDI. How well do we do that? We don't. They introduced Enterprise Island, which builds up the capability of local businesses to become part of the supply chains of these large companies that were attracted, and not just by tax policy. They built a skills agency, and then the big piece of the puzzle was Science Foundation Ireland which devised policies and programs in conjunction with the universities and large companies to attract back the clever Irish people who had left and were in senior positions in American and European universities. And they asked, "How much will it take for you to run our fabulous new research centre in our university?" When I was a dean in one of these universities, I was involved in establishing a number of these research centres, including a regenerative medicine institute and digital enterprise research institute. "How much will it take to get a top Irish émigré academic from Carnegie Mellon," we asked ourselves, "A million Euro? one and a half million Euro?" Whatever it is, we want to bring you back plus bring a few Germans and Californians with you while you're at it." That's what we did and in a ten-year period the economy was transformed: highest GDP per head in Europe, next to Luxembourg, and a massive shift to high-tech exports.

Q: Roy, I don't want to end on a pessimistic note and I would love to see a policy and architecture like that implemented and I think you've mounted such a coherent argument, but I must admit to being profoundly depressed. I think Australian business has a culture of rent-seeking that has been in place ever since the country existed. They have governments of both persuasions totally under their thumb. We see it reflected in competition policy. If you look back in history, what really transforms countries is a catastrophe: the Civil War in Britain, the Civil War in the United States, the Great Leap Forward and the Cultural Revolution in China, the destruction of the two world wars in Japan and Germany. That's what leads to this sort of transformation. I don't know what the catastrophe has to be to shake Australia out of its complacency, but it will happen. I hope it doesn't happen with great effect, but it could well be something like climate change. But unless we come to grips with those issues, then I don't think that we will make progress in these areas because no one really is interested. Maybe that would be a good topic for a Forum.