Australian Government
Department of Industry, Innovation and Science

Australian Academy of Technology and Engineering

Innovation Metrics Review

Workshop Proceedings

13-14 March 2019

Contents

Executive summary

Using current innovation metrics, Australia generally compares well against OECD countries, and there was general consensus from workshop participants that the Australian innovation system is competitive in enabling innovation. The inputs, outputs and outcomes of the system are being measured to varying degrees of accuracy, particularly with regard to outcomes. Workshop participants were strongly of the view that the quality of information available to support decision-making should be improved.

The following paragraphs summarise the outcomes of the workshop.

Measuring what matters

Consistent with the principles articulated in *Improving Innovation Indicators Consultation Paper March 2019*, workshop members agreed that attention should be directed at those areas of innovation measurement which are:

1. of significant policy interest, as determined through consultations and engagement with policy makers
2. aspects of the innovation system that are known to be associated with improvements in productivity (or a broader measure of living standards).

Issues of policy relevance included the need to be inclusive of small and medium enterprises (SMEs), and not to focus solely on the higher end of the innovation spectrum (e.g. new to the world innovation) but also on the significant gains that can be achieved by diffusing new to the firm innovations through the economy. This was expressed as 'the democratisation of innovation'. The examples provided relate to the adoption of digital technologies by SMEs.

It was emphasised that ensuring the operating environment of the Australian innovation ecosystem facilitates innovation as much as possible is critical. For example, the quality of Australia's transport system has a significant bearing on the quality of Australia's innovation system.

Participants also urged the review to be aspirational and to include in the scorecard measures related to social and environmental impacts. For example, Victoria's Lead Scientist, Amanda Caples, advocated for consideration of the UN Sustainable Development Goals as a basis for identifying relevant innovation objectives and outcomes (and associated metrics).

In a global context, it was noted that users of data have become more demanding, with low tolerance of the trade-offs that are almost always present when comparing characteristics of innovation between countries where country-specific needs conflict with international comparability. This can lead to the misuse of metrics at times. The digitalisation of data globally offers unprecedented opportunities for sourcing science, technology and innovation data but such data requires careful curation.

Opportunities for better measurement and to fill gaps

A fundamental innovation measurement challenge was identified as the lack of consensus on the definition of innovation or the Australian innovation system in the minds of data providers, most of whom have no awareness of the Oslo Manual.

Some information collections, such as that of the Australian Bureau of Statistics (ABS), avoid the term 'innovation' altogether for this reason.

Participants proposed that the scorecard output of the Review should serve both to communicate with policy makers the most significant aspects of innovation and to draw boundaries around the innovation system. The scoreboard will need to mirror the ecosystem and have a cross-section of actors represented.

The mining sector case study highlighted significant gaps in innovation measurement, with some large, innovative projects classified as business as usual or capital expenditure by mining businesses internally and hence not reported to the ABS. It was acknowledged that this was in effect a categorisation problem in the corporate accounts for firms. There may be scope to capture such hidden innovation in future in innovation expenditure totals.

The mining sector case study also noted that it is presently paying for goods and services to be provided by firms overseas, because they are not available locally. The net effect of this is to build capacity internationally, rather than in Australia, in operating mining technology remotely. Mining firm representatives noted that Australia presently does not measure imports than cannot be sourced domestically, which means that the case for developing substitutes locally cannot easily be made. Mining firm representatives felt that there was likely to be enough domestic demand for an Australian Government intervention to establish an Australian capability in remote operations to be successful.

Improved measurement of intangible capital was highlighted as a major opportunity for innovation measurement. Current national accounts measures of intangible capital include research and development (R&D), copyright and software and data but omit brand equity, marketing, design, skills and training. Furthermore, what is included is known to be an undercount. It was noted that the ABS possesses the capability to undertake the work, with sufficient progress having been made globally by key researchers on the methodology that improving measurement of intangible capital is implementable.

One area of intangibles that does require additional research effort to bring it into the ‘measurable’ space is ‘learning by doing’, which is estimated to be responsible for a significant portion of innovative activity. This aspect is not currently being captured and is not easy to capture. However, it affects capability building and where comparative advantages develop over time.

Members urged the Review to be cognisant of not only national level data but also state and local data, in particular that offered by Australian governments through programs.

Various speakers alluded to the importance of making more effective use of governmental administrative data, for example data based on procurements and grants across countries. At present, this data is not available for Australia. Australia would need to introduce a reporting requirement to separate procurements and grants for innovation from those for existing goods and services.

Methods of measurement

Workshop participants stressed the need for experimentation and pilot work. The innovation ecosystem in Australia is changing over time and it is important that a flexible approach is taken to measurement.

Different approaches to measurement were outlined during several sessions that included specific mention of entrepreneurship and start-ups; the creative industries; and the higher education sector.

The predictive analytics approach presented in the ‘start-up cartography’ project offers an alternative way to relating innovation characteristics to outcomes using a probabilistic measure and uses a combination of ‘digital signatures’ to track the development of start-ups. The approach is well-equipped to deal with skewed data (e.g. through predictions of rare outcomes) and may be able to offer a more up-to-date measure.

The need to have a complete understanding of the start-up lifecycle was highlighted in a presentation on university start-ups. It was emphasised that measurement needs to advance beyond measuring start-up formation and follow firms throughout their lifespans using variables such as license provision, obtaining follow-on funding, mergers and acquisitions, initial public offerings and firm deaths. Significant opportunities can be realised through linking university administrative data sets with other administrative and transactional data, through the Business Longitudinal Analysis Data Environment (BLADE) and perhaps longer term through the Longitudinally Linked Employer-Employee Database (LLEED).

In the creative industries, due to its intrinsically subjective nature, metrics that are inherently qualitative may be appropriate. Whilst some existing survey data can be re-purposed and combined (e.g. through fusion of innovation survey questions), hybrid strategies and novel data generation is likely to be required.

Survey instruments

The innovation profiles approach presented by Professor Anthony Arundel was thought to be a useful way of visualising sectoral innovation typologies that could then be used for further policy development. The profiles differentiate between: firms for which innovation is a strategic activity; firms that innovate through modifying their products and processes; and those that are technology adopters. The profiles make use of Community Innovation Survey data and could be modelled using the ABS Business Characteristics Survey or a new innovation-specific survey.

Administrative and transactional data

Further linking of administrative and transactional data was identified as a significant opportunity for the improvement of innovation measurement. Key activities identified included further development of the suite of datasets relevant to innovation that can be linked through BLADE and LLEED. Participants identified the addition of trade (customs) data to BLADE as their highest priority, followed by university administrative data.

Alternative data sources

There was general agreement that private data providers should be considered in innovation measurement (including web data scraping) but challenges exist in ensuring uniform coverage across countries and statistically representative data within countries. A number of OECD countries are equipping their national statistical officers with the means to assess when such sources can be reliably used for official statistics.

Mr Fernando Galindo-Rueda from the OECD encouraged Australian authorities to become more proactive in expanding data collection opportunities through surveys, administrative and commercial sources. He suggested Australian authorities consider how they can provide relevant incentives for firms to keep and report on the types of records that they wish to use as a basis for policy development, program evaluation and statistical measurement. He stressed the importance of being fully cognisant of the synergies and trade-offs between different uses of data about innovation.

Workshop participants indicated that a hybrid data strategy is required, supported by a suitable governance system.

Introduction

The purpose of the Innovation Metrics Review, scheduled to report later in 2019, is to improve the measurement of Australia's innovation system, in order to support better decision-making which will drive improved economic outcomes for Australia.

The purpose of the Innovation Metrics Review Workshop held on 13 and 14 March 2019 in Canberra was to inform the Innovation Metrics Review about international developments and share the thinking of international and domestic experts on how innovation measurement may be improved.

The audience for the workshop consisted of selected innovation metrics experts and innovation system stakeholders, and members of the Review's governance and advisory bodies.

Context

The *Innovation and Science Australia 2030 Plan*[1] includes recommendation 30:

'Support the development of a suite of innovation metrics and methodologies to fully capture innovation and link it to economic, social and environmental benefits. In particular:

- request the Australian Bureau of Statistics (ABS) and the Department of Industry, Innovation and Science (DIIS) to review business and research and development data collections to ensure they are fit for purpose and take full advantage of all available data sources
- commission an independent body, such as the Australian Academy of Technology and Engineering, in consultation with the ABS and DIIS, to review existing innovation metrics and report on a set of recommended metrics within 18 months, including new innovation metrics to track other areas of our innovation economy with a view to promoting these for use by the broader international community.'

The Government's response to this recommendation was 'The Government supports this recommendation.

The Government supports ongoing improvements to innovation metrics and methodologies. This creates a robust evidence base that provides us with a clear picture of our performance on innovation and will help pin-point issues in the system that may be limiting our capacity to innovate. This enables the Government to design cost-effective and robust policies to best address such issues.

The Government commits to a review of innovation metrics. The adequacy of the current innovation data collections and methodologies will be reviewed with a view to refining existing methods and developing new ways of measuring innovation performance.

The Department of Industry, Innovation and Science will absorb the cost of the Innovation Metrics Review. The ABS and the Australian Academy of Technology and Engineering (ATSE) will also be involved in the Review. It is envisaged that the Review will produce a co-branded report that will be launched in December 2019.'

Two teams have been working on the Review, one led from within DIIS, that includes departmental and ABS staff (the Taskforce), and one led by the Academy. The intent of involving the Academy was to add an independent voice to ensure the Review considered long term Australian priorities for innovation metrics rather than just government needs. Both teams have worked in close co-operation to avoid duplication or gaps in work.

Workshop participants were introduced to the conceptual framework that had been developed by the Taskforce and the Academy to map the Australian innovation ecosystem. The framework is centered on impact and captures innovation activities, the innovation ecosystem, the innovation environment, the broader operating environment, and policy levers that can influence innovation. Preparing this framework provided a useful reference to ensure that metrics selected by the Review provide suitable coverage of all the aspects of innovation.

Participants were also given an overview of the findings and key points of the literature review, which was prepared by the Academy and aimed to cover current, state-of-the-art and novel approaches to considering and measuring innovation. The literature review highlighted a number of indicator gaps and priorities for policy in Australia, along with several opportunities for measuring different aspects of innovation more comprehensively.

[1] Innovation and Science Australia 2017, Australia 2030: Prosperity through Innovation. Australian Government, Canberra. p. 4.

Prior to attending, workshop participants were provided with:

- a workshop pack containing an agenda, abstracts of speeches and speaker biographies
- the Improving Innovation Indicators: Consultation Paper March 2019 that summarized the consultations with stakeholders
- a draft Compendium of Innovation Metrics that assessed the suitability of existing metrics for the purposes of the Innovation Metrics Review
- a draft literature review prepared by the Academy.

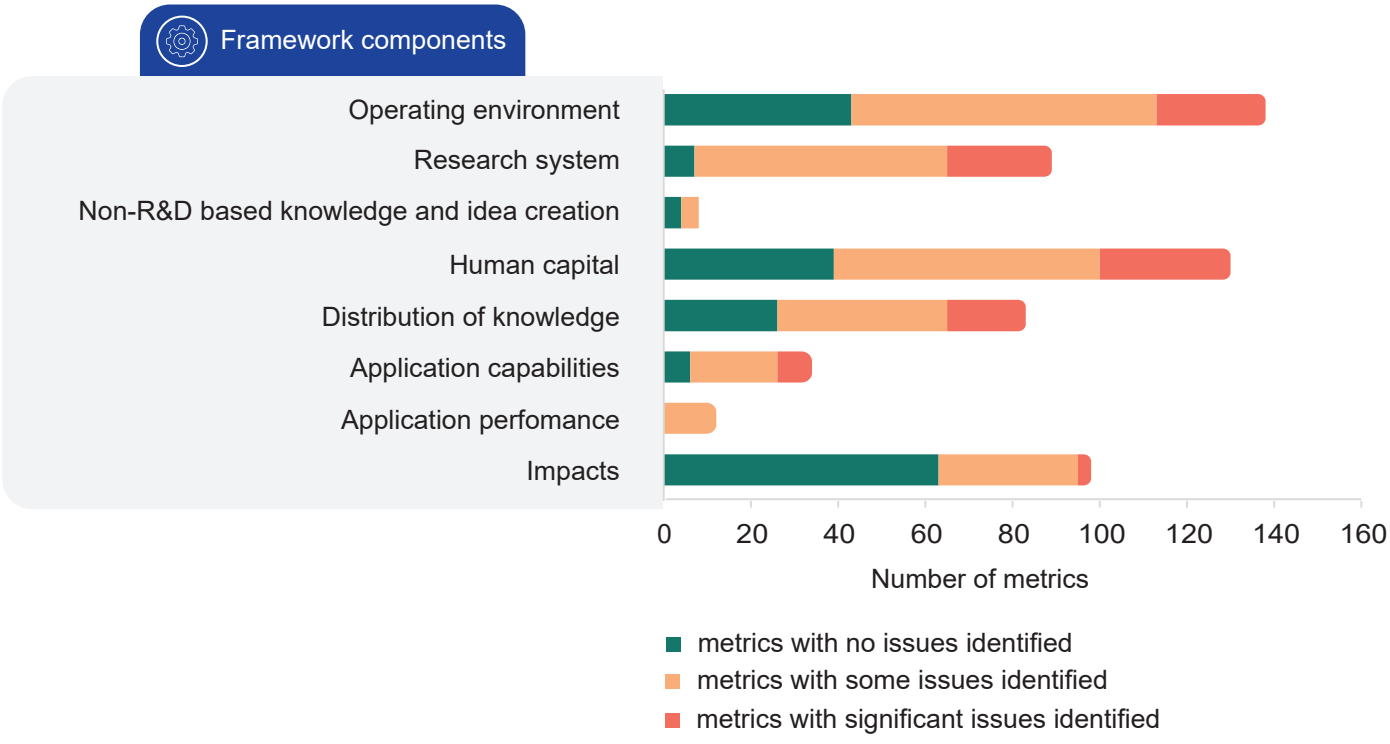
After mapping existing metrics to the innovation framework developed, the metrics were assessed as green (broadly fit for use), orange (still useful, with caveats) or red (significant data quality issues), according to the following criteria:

- relevance
- timeliness
- accessibility and clarity
- accuracy and validity
- reliability and precision
- coherence
- comparability.

Three key gaps were identified by the Taskforce, as shown in Figure 1 below:

- non-R&D based knowledge and idea creation
- application capabilities
- application performance.

Figure 1 – Number of quality-assessed metrics within each Framework component



Workshop participants noted the focus on R&D and advanced manufacturing by much of the rest of the world. This focus was considered inappropriate for many countries, including Australia, given the different structure of the Australian economy and the importance of non-R&D based knowledge and idea creation.

Some preliminary views were shared regarding how to improve the data underpinning innovation metrics, and what this could mean for ABS and other collections.

These included making better use of administrative and transactional data available from Australian government agencies and private sector sources, and also integrating more data, for example through the Business Longitudinal Analysis Data Environment (BLADE) or the Longitudinal Linked Employer Employee Database.

Some preliminary views on analytical gaps were also shared.

Workshop sessions day 1

Session 1: Entrepreneurship

The Start-up Cartography Project: A New Agenda for Measurement, Policy and Action

PRESENTER: PROF SCOTT STERN

Abstract

A central challenge for innovation policy is developing real-time and granular metrics of entrepreneurship. This presentation introduces a novel approach that combines comprehensive business registration records with predictive analytics to develop a new class of statistics characterizing not only the quantity but also the quality (growth potential) of new companies. The Start-up Cartography Project offers insight into the evolution and dynamics of regional entrepreneurial ecosystems (to an arbitrary degree of granularity), allows for the assessment of particular policies and initiatives, and provides insight into the role of institutions such as research universities and venture capital. The general principles can be applied to regions around the world, and provide comparative insight into the similarities and differences in innovation-driven entrepreneurial ecosystems around the globe.

Session summary

A central concern for policymakers is the state of business dynamism – the net birth rate of firms that have the potential to serve as sources of future employment and productivity growth in the economy. However, despite its importance, there is a sharp disconnect between alternative measures of entrepreneurial ecosystems. For example, in the United States, the Longitudinal Business Database (LBD) that tracks the total quantity of newly established enterprises has seen a secular decline in business dynamism over the past twenty-five years, while more selective measures such as the funding by venture capital investors has seen a sharp upswing over the past decade.

Not simply a measurement question, real-time and granular metrics that account for both the quantity and growth potential of entrepreneurship are necessary for policy analysis, including the assessment of policy initiatives aimed at spurring entrepreneurship and the commercialization of new technology. To overcome this impasse, the Startup Cartography Project (SCP), led by researchers at Massachusetts Institute of Technology (MIT), Columbia and Boston University, aims to provide such data by combining comprehensive business registration records with a predictive analytics approach.

The SCP combines three interrelated insights. First, as the challenges to reach a growth outcome as a sole proprietorship are formidable, a practical requirement for any entrepreneur to achieve growth is business registration (as a corporation, partnership, or limited liability company). This practical requirement allows us to form a population sample of entrepreneurs 'at risk' of growth at a similar (and foundational) stage of the entrepreneurial process. Second, we are able to potentially distinguish among business registrants through the measurement of characteristics related to entrepreneurial quality observable at or close to the time of registration. For example, we can measure start-up characteristics (which result from the initial entrepreneurial choices in our model) such as whether the founders name the firm after themselves (eponymy), whether the firm is organized in order to facilitate equity financing (e.g. registering as a corporation or in Delaware), or whether the firm seeks intellectual property protection (e.g. a patent or trademark). Third, we leverage the fact that, though rare, we observe meaningful growth outcomes for some firms (e.g. those that achieve an initial product offering (IPO) or high-value acquisition within six years of founding). Combining these insights, we measure entrepreneurial quality by building a predictive model on the relationship between observed growth outcomes and start-up characteristics using the population of at-risk firms.

This approach is implemented on a large dataset comprising all business registrations for 34 US states, accounting for 83% of the US GDP, from 1988 to 2014. The dataset contains 29,961,838 firms. The predictive analytics results (though not causal) are striking: at the time of founding, a startup registered in Delaware that files for a patent is close to 200 times *more* likely to realize a significant growth outcome than one that is not. Firms named after their founders or entering into local businesses, on the other hand, are anywhere from 29 – 73% *less* likely to achieve a growth outcome. Importantly, however, startup characteristics correlate with growth outcomes, but do not cause them.

The SCP then maps the predictions that result from the model to estimate the level of entrepreneurial quality of each firm. In out-of-sample tests of predictive

power, 69% of realized growth events fall within the top 5% of the models' estimated entrepreneurial quality distribution, and more than 50% of the realized growth outcomes fall in the in the top 1%.

We can use these estimates to assess not simply the quantity but the quality-adjusted quantity of entrepreneurship in a given entrepreneurial ecosystem. Once one accounts for quality, there is a striking divergence relative to the traditional quantity metric: relative to the secular decline in entrepreneurship observed in the LBD, the SCP documents a cyclical pattern, and a strong pattern of recovery commencing after the 2009 financial crisis.

As emphasized in the MIT Regional Entrepreneurship Acceleration Program, this type of measurement tool can catalyze shared understanding and strategic action across the various stakeholders within innovation-driven entrepreneurial ecosystems. The combination of a real-time measurement tool and a user-focused design approach that allows various stakeholders to examine the data at a granular level allows for both assessment of particular policy initiatives as well as insight into challenges facing particular regions.

Finally, the core elements of this type of data, and the general applicability of our approach, have potential not only in the United States but also in Australia. Professor Char-lee Moyle at Queensland University of Technology is already heading up an ambitious effort to do so using Australian data.

From Little Things Big Things Grow: How Digital Connectivity is Helping Australian Small Businesses Thrive

PRESENTER: DR ANDREW CHARLTON

Abstract

The Review should consider the drivers of innovation in Australia. Many Australian businesses are innovating by taking up cloud-based process applications (apps). This is a silent productivity driver in Australia. The report 'From little things big things grow' examines how changes in digital connectivity affect Australian small and medium-sized enterprises (SMEs). The paper examines the effect of faster high-speed broadband on SMEs to understand the impact at the macro level. To understand it at the micro level, the paper analyses the take-up and impact of cloud-based apps on individual businesses.

Session summary

When many small firms implement innovations this adds up to large national productivity changes. We should be measuring this. But how? They may be collecting their own data, using platforms such as Xero. If we look at how businesses are adopting and adapting new ICT-based productivity software, we can also see how this may be impacting upon their productivity.

Cloud computing is saving businesses' money, data and time. It is helping them reduce infrastructure costs, refresh aging infrastructure, support new business opportunities, enhance business continuity, increase collaboration and improve capacity and scalability.

Different types of businesses have different 'pain points' that lead them to use different types of apps.

For example, the hospitality sector has a large casual workforce with variable hours to roster and pay. Rostering must comply with regulations, and there is a high volume of customer transactions to process. By contrast, the trade and construction sector has a mobile workforce that needs remote coordination and supervision. It has a high volume of client jobs to schedule, perform and invoice. It also has quality, safety and compliance assurance needs.

These different types of needs are now being met by different types of apps. Many of these apps are able to be integrated with Xero. Xero is a New Zealand-based public software company that offers a cloud-based accounting software platform for small and medium-sized businesses. The company also has offices in Australia, the United Kingdom, the United States, Canada, Asia and South Africa. Its products are based on the software as a service (SaaS) model and sold by subscription, based on the type and number of company entities managed by the subscriber.

Bigger businesses are more likely to use apps than smaller businesses, and SMEs that have higher revenue growth use more apps. Different industries have different adoption rates for different types of apps. There are apps in areas such as clerical and accounting, business intelligence, job scheduling and invoicing, rostering, and point of sale.

Discussion

A recent paper by Jacquelyn Pless (Oxford, MIT) was highlighted which provides a summary of the issues regarding the complexity of interactions between different forms of government subsidies for R&D. There are ongoing questions about R&D subsidies vs tax credits. Discontinuous changes of eligibility make it possible to study the effectiveness of tax credits. There are many challenges in studying them, but they appear to be one of the few robust measures.

There is a much broader range of literature, including OECD work, which looks at the impact of R&D tax incentives.

The need for reliable measurement of entrepreneurship was noted and the possibility of adopting the approach of Scott Stern for use in Australia. Data coverage is in particular a challenge in the entrepreneurship and start-up space, although it was noted that ultimately a firm that grows will have to register. In spite of this, apparently about a third of firms that are registered with the company Xero are unincorporated.

Key findings for the purposes of the Review

- The predictive analytics approach presented in the 'Start-up Cartography' project offers an alternative way to relating innovation characteristics to outcomes using a probabilistic measure. The approach is well equipped to dealing with skewed data (e.g. in making predictions of rare outcomes) and may be able to offer a more up-to-date measure. This approach may also be useful for application to what the review terms 'alternative data'.
- Innovation measurement and policy needs to ensure that SMEs are not left out. This is both good policy and good politics. Whilst it is tempting to focus on the more radical innovations, significant, economy-wide gains will require the adoption of innovation by the SME population (the 'long tail' of the distribution argument). One area that offers clear benefits is the adoption of digital practices by SMEs. Any measurement of the innovation system should be cognizant of this.

Session 2: Innovation Metrics – state of play: a WIPO GII perspective

Lessons from 10 Years of Innovation and Intellectual Property (IP) Metric Work – Global Innovation Index and WIPO

PRESENTER: DR SACHA WUNSCH-VINCENT

Abstract

The objective of the presentation is two-fold. First, we will report on our experience on what makes for effective and policy-relevant innovation metrics at the national and international level. Some of these insights can possibly inform the aim and the resulting outputs of the Australian Innovation Metrics Review. Second, we will report on the main weaknesses in available innovation metrics, to flag where action is most and least needed, and, finally, what WIPO is doing about IP and intangible asset indicators in particular.

Session summary

A well-designed scorecard, underpinned by an innovation system framework is essential for:

- stimulating dialogue with the public and with policy makers about innovation and advancing policy development
- aiding in the development of new metrics, which should seek to reflect the quality and not exclusively the quantity of innovation.

The Global Innovation Index can offer the Innovation Metrics Review insight into designing, maintaining, and using an innovation system framework and scorecard of metrics to understand the structure and performance of the innovation system. These products of the GII are powerful tools for benchmarking and analysing the performance of countries' innovation systems. They can serve as a focal point for uniting different ministries in a dialogue about the innovation system. They can contribute to incentivising data collection. They can also serve as a foundation for experimentation with new data and metrics.

It is absolutely necessary to have an innovation scorecard or dashboard. A scorecard must mirror the innovation system, and there must be a cross-section of innovation system actors who develop goals and monitor progress. Scorecards can also serve as a foundation for experimentation with new data and metrics.

A key requirement of a scorecard is that it is relevant to advancing innovation policy.

Several areas in which innovation metrics are most urgently needed include metrics that capture:

- innovation that is currently hidden from existing data and associated metrics. Innovation is hidden most notably in the services and resources sectors; when it does not involve technology; and when it occurs informally
- innovation clusters and networks, and innovation collaboration and linkages
- innovation outputs and impacts that go beyond describing innovation outcomes and impacts simply in terms of returns to the firm
- innovation quality, rather than simply quantity. We rely overwhelmingly on measuring the quantity of innovation by looking at the amounts invested in R&D, and numbers of citations, patents and start-ups. We should seek to develop metrics that reflect the quality of these activities.

Given the limitations of many existing metrics, and the need for new ones, it is important to innovate and experiment with innovation concepts and metrics themselves. Developing new metrics takes time, but ultimately it is important to develop new ones that overcome some of the major issues with existing metrics.

Lessons for Australia from 10 Years of Innovation and Intellectual Property Metrics Work

PRESENTER: DR AMANDA CAPLES

The presentation by Dr Caples outlined two problems:

1. there is a lack of understanding of what constitutes an innovation system
2. the government narrative revolves around several factors, which do not resonate with the business sector or the general public, including
    a. inputs and outputs (publications and patents)
    b. government's role
    c. high-tech products (which are the exception rather than the norm).

The Victorian Government's innovation framework is an organising framework that starts from the position of a user (small or medium enterprise, start-up or large corporation) rather than from government's role in supporting the system. It seeks to clarify the three primary drivers of innovation in a business and illustrate how a business draws upon elements of the system for its needs as required. It is intended to be used to:

1. map cross-portfolio initiatives to identify gaps and opportunities to scale-up successful programs
2. align and connect initiatives to enhance their impact
3. provide a common basis for discussion, mitigating the risk of miscommunication and improving relevance to the broader community.

Discussion

This session promoted a discussion about the boundaries of the innovation system, the definition of which will have implications for the metrics which aim to describe it.

A rhetorical question raised through this discussion is as follows: if innovation ultimately drives productivity, how can the Review avoid simply stating that measurement of innovation is the equivalent of measuring productivity? It was noted that the focus - both political and policy – is increasingly on the employment element.

There was a brief discussion about risk-appetite. Risk taking is an important element of innovation. There is variation across firms with respect to risk appetite, as there is for individuals – both of which have implications for innovative entrepreneurship. More work is needed on measuring 'risk appetite'. One key factor noted was access to information as this is a principal factor in de-risking. A low risk but high gain strategy is to facilitate the adoption of existing innovations and technologies by firms.

Key findings for the purposes of the Review

- An innovation scoreboard is required both to communicate those metrics that are of policy importance, and to help to draw boundaries around the innovation system. The scoreboard accordingly needs to mirror the ecosystem and include a cross-section of actors. The scoreboard also needs to allow for international or yearly benchmarking over time.
- Risk appetite is hard to measure but is a key determinant of innovative activity and it is therefore worth investing effort to measure this.
- Absorptive capacity is also a key determinant and needs to be included in any discussion of innovation system and measurement.
- Employment is a key policy focus and needs to be incorporated into the measurement framework.

Closing day 1
Speech by Dr Alan Finkel

Dr Finkel gave an introductory address at the Innovation Metrics Review International Workshop on 13 March 2019 in Canberra.

> *I acknowledge the Ngunnawal people who are the traditional custodians of the land on which we meet and pay my respects to their Elders past and present. I extend this respect to all Aboriginal and Torres Strait Islander peoples in attendance today.*

You all know the old joke about a police officer who sees a drunk searching for something under a streetlight and asks what the man has lost. He says he lost his keys and they both look under the streetlight together. After a few minutes the officer asks the drunk if he is sure he lost them here, and the man replies, no, he lost them in the park. The officer asks why he is searching here, and the man replies, "the light is much better here".

The moral: we look where it's easy, not necessarily where it's useful.

And that's where the story ends.

But I say it's where the real story begins.

Because the police officer could shake her head and walk away in frustration…

…or she could persuade the man to get a torch and go to the park…

… or even better: she could persuade the local council to move the streetlight.

How do we, the police officers, achieve the right result?

To start, we need to focus on the outcome.

In our case, it's simple: what we all want is increased productivity and higher living standards.

Innovation is the key that unlocks them – and metrics are the light with which we find the key.

So that's why Chief Economist, Mark Cully, and I teamed up – as Good Cop, and Bad Cop, I'll let Mark decide which is which – to help this country to move to the park and find the damn keys.

My own journey into the police force began several years ago.

Like most people in my field, I'd always accepted that innovation was hard to define and even harder to measure, but the measures we had were no doubt the best we'd got.

I began to suspect that something wasn't right when I was President of the Australian Academy of Technology and Engineering, and somehow was made to feel guilty for Australia coming up in last place on the measurement of collaboration between universities and innovation intensive companies.

As Chief Scientist, colleagues expected me to travel around the country berating our research institutions about our woeful record.

But it was also my job to travel around the country launching business-university collaborations.

And I discovered at the first university I visited that they had lots of collaborations with industry. So I asked the Vice-Chancellor how he explained the discrepancy – and he told me that the problem must lie in all the other universities.

Funny, at the next university I visited, I made the same observation, asked the same question and got the same answer!

Something wasn't right. I discussed the problem extensively with Mark Cully. Eventually, I called some colleagues at two of our leading universities and each of them had nearly as many collaborations as we reported to the OECD for the whole country. So Australia was coming up as infeasibly low, dead last in the list, at about 3% of innovation-active companies. It didn't seem plausible.

And I must say that at a gut level I am equally surprised that the leading countries on this particular metric, at the other end of the spectrum, have apparently achieved a collaboration rate of nearly 70%.

This dead-last collaboration statistic for Australia was driving a frenzy of negative commentary. All the while, our economy is outperforming most of the OECD…

…we have had 27 years of recession free growth – not achieved by any other country since GDP records began…

…we have a world-class health-care system, and we're a world-class exporter of minerals, agricultural products and educational services…

… and still, we were convinced that we were somehow devoid of innovation.

None of the policy measures we adopted seemed to make a measurable difference.

As Chief Scientist, I felt that the discrepancy between what the data were saying and what the Australian innovation system was actually achieving could no longer be ignored.

We were stubbing our toe on the streetlight that was supposed to be helping us find something useful.

Worse, we were starting to believe that the keys didn't actually exist.

It all came to a head for me in my role as Deputy Chair of Innovation and Science Australia.

We were asked by the Prime Minister for a comprehensive review of the Australian innovation system.

This request was for the obvious reason that in order for governments to implement innovation policy they need to be able to measure innovation, to decide where to intervene, and to determine whether their interventions have been successful.

Inherent in the purpose of the review is that our audience is government rather than business, because published indicators are generally too broad for management purposes.

It is obviously important to have meaningful measures of performance – a scorecard of useful metrics. Not too many and not too few.

Instead, we were constantly frustrated by measures that were incomplete, likely to be affected by erroneous or non-comparative data, or wrongly adapted to our economy.

My pet peeve is the Australian mining industry. Every industry insider, here and globally, will tell you that this country is a world leader in mining innovation, with remotely controlled underground drilling machines, possibly the largest autonomous vehicle fleet in the world, algorithmically determined process quality control and remote control rooms to optimise the overall operations.

And now they are adopting artificial intelligence approaches to make their operations even more efficient.

And yet, in most innovation metrics, the mining industry is basically invisible. Why? Because a lot of their innovation is in-house, and even more comes from the R&D buried in supply contracts.

Even worse, on minor metrics such as the percentage of high tech exports, since the mining industry's actual exported product hasn't changed in ten million years and is regarded by many as 'dirt', our mining exports do not contribute to the top 'high-tech' line in the ratio. However, they do contribute to the bottom 'total exports' line of the ratio, which means that every time our mining industry innovates and captures a greater share of the world market this particular measure of innovation gets worse, not better.

I started to use the phrase 'hidden innovation' to refer to important innovation that is fundamentally invisible to the existing innovation metrics.

I've already mentioned mining, but what about education? International education is reported as bringing in $30 billion of revenue to Australia. The industry was developed by innovative vice-chancellors, but I can't see where its growth shows up in any of the innovation metrics.

The problem is probably because, in part, the existing innovation metrics focus on the linear process of research and development leading to new products. That works well for countries with strong manufacturing and high tech industries, but in Australia only 7% of our workforce is employed in manufacturing.

Another problem we encountered is that the methodology used for business surveys is so different between countries. Some are compulsory, while others are voluntary. The surveys are administered at different intervals and they use different reference periods. These differences contribute to statistical noise that sometimes dwarfs the signal.

So, in one of its recommendations, Innovation and Science Australia called for a review of the existing innovation metrics for accuracy and adequacy.

And I became a cop.

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There are several goals for this Review.

First, in the short term, to improve data sources and metrics that are not quite fit for purpose, or are in some way inaccurate, or do not allow direct country comparisons.

Second, to identify and fill measurement gaps, so that innovation is measured in the hitherto invisible, or perhaps difficult to see, sectors of our economy such as mining, education and hundreds of thousands of small businesses.

Third, to build a short list of metrics – what I call a scorecard – that will be of policy relevance to government.

It is a task for Australia, but at the same time we aim for this to be a project for the world: our measures have

to be comprehensible, credible and comparable to our global partners.

To start, we have to think about what, in a nutshell, is innovation.

You all know the formal definition, but my simplest definition is doing things differently and doing them better. I am attracted to this simple definition for a few reasons.

First, it is not locked into the linear definition of research being the starting place of all innovation. Instead, in addition to evolving from research, innovation arises from an idea in the middle of the night or the creative outputs from a brainstorming meeting.

Second, this definition eliminates consideration of the trivial.

Third, my definition is short enough that it is easy to remember!

This definition of innovation arguably applies to this international workshop and the Innovation Metrics Review. If we are going to be innovative, we need to do innovation measurement differently and we need to do it better.

Dare I say it? – we need to be innovative in our approach to innovation measurement.

A lot of attention internationally is focused on advanced manufacturing and high tech.

And so it should be, because these are important.

But there is so much more to our economy.

If we get it right, we will make visible the innovation in traditional industries such as mining, health, education, banking and agriculture. These sectors have a major impact on people's lives, and they are critical to the economy.

I want to stress that this is not an exercise in making Australia look better than it is.

It is an exercise in giving us useful information.

That includes the problems we're not seeing.

I also want to stress that we are not blind to the limitations of data when it comes to capturing a complex phenomenon like innovation in policy-relevant terms.

That is why, for example, in Australia we have started a process to try to understand the research relationship between universities and end users such as industry and government departments.

A few years ago, work began on a fair and credible metric for university impact – first through a pilot program led by the Australian Academy of Technology and Engineering, called Research Engagement for Australia; and then through our national research funding body, the Australian Research Council.

The new ARC Engagement and Impact metric is now a compulsory data gathering exercise for all Australian universities, collected last year, with results expected soon.

One thing to note is that after a lot of design work the ARC decided that data alone would not be enough and that a series of short impact statements would be required. These will be evaluated by expert panels. This will be difficult and expensive but the conclusion was that impact statements will provide insights that would otherwise not be available.

Perhaps there is a role for impact statements, evaluated by expert panels, in innovation measurement. This would be hard work and fraught with risks, but if that is the only way to measure innovation in some sectors we should be open minded about the possibility.

It could be another important step to moving the streetlight – and finding the keys.

The Innovation Metrics Review Taskforce, my co-chair Mark Cully, the Academy of Technology and Engineering, the Steering Committee and the Expert Reference Panel have done a lot of excellent work to get us to this point.

But we don't have a solution in hand yet.

The purpose of this workshop is to bring into the open innovative thinking about innovation measurement.

We need to come to meaningful conclusions so that we can finish our report by the end of June.

I urge you not to be incremental. Our goal must be to go beyond tweaking.

We must avoid doing things differently for the sake of it, but be prepared to recommend new ways to do it better.

Above all, whatever we recommend must go beyond the academic and be useful for policy formulation.

I thank every one of you for what you have contributed so far and I thank you in advance for what you will contribute to the remainder of this workshop.

And, for the sake of all of us, may the Force be with you.

Thank you.

Workshop sessions day 2

Session 3: Hidden innovation in mining

Hidden Innovation in Mining

PRESENTERS: DR ALAN BYE AND MR MARK THOMAS

Abstract

For the purpose of this review, we have defined innovation as 'the execution of new ideas to create value'. The innovations considered span continuous improvement, step change and transformational innovation. Creation of value in a mining organization manifests in improved performance in safety, productivity, culture and contribution to society.

To address the question 'is there hidden innovation in mining?' a review of activities driving company performance improvements was compared with information reported in the ABS Business Characteristics and Research & Experimental Development (R&D) surveys.

Results indicate that there is hidden innovation in mining. This innovation can be categorised into broad activities including:

- efforts on improving the safety of mining operations
- continuous improvement initiatives including process improvement
- efforts applied to the adaptation, modification and implementation of technology and solutions
- step change efficiency achieved through vendor contracted programs such as automation and large scale operating model innovation
- greenfield capital expansions or developments
- partnerships with broad ecosystem stakeholders focused on driving social and cultural benefits.

Case studies from each of the categories identified were developed to gain insight and provide recommendations on potential metrics to reflect the innovation activity in the mining sector in Australia better.

Session summary

The mining sector has experienced declining multifactor and labour productivity relative to other sectors, as the quality of remaining deposits is declining and they are generally less accessible. However, the mining industry is targeting productivity improvements.

Relative to other sectors, the mining sector has a low R&D intensity – about 0.4% of revenue. The adoption of technology as measured by process improvements can be slow, taking up to 20 years for 50% adoption in the industry. This does not however cover broader measures of innovation where adoption is faster.

In mining centres, the definition of innovation is where new value is added to businesses. Much of the innovation in mining is through adoption and adaptation. Outcomes include improved safety and capability and training improvements. Safety is improved by automation that takes people out of dangerous areas.

Recent examples of innovation in mining at BHP that have not been captured in innovation measurement, due to it not being reported as innovation, include:

- halving of iron ore operating costs over five years due to pressure from the collapse of ore prices
- drilling automation, where one person can now operate five drilling rigs from a safe location
- ship-loader automation
- integrated remote operations
- digital mines in setting up greenfield capital expansion.

A lot of these expenses are measured as business as usual costs or as capital expenditure.

In the future, the focus will shift from operation to services. Currently a large portion of the capability and skills needed have to be sourced from overseas due to domestic shortages.

Australian mining firms are presently paying for automated remote operations technology-related goods and services to be provided by firms overseas, because they are not available locally. It is in effect building capacity internationally rather than in Australia in operating mining technology remotely. Australia presently does not measure imports than cannot be sourced domestically, which means that the case for developing substitutes locally cannot easily be made.

There is a significant opportunity to create new jobs in Australia that will support the expected increase in automation of the mining, petroleum and agricultural industries.

Discussion

The challenges around evaluating the impacts of research were raised. In mining, it can take a long time before R&D results in innovations being implemented and impacting commercial operations. The Co-operative Research Centre (CRC) Mining R&D work funded in the 1990s showed impact in 2005.

One needs to be careful about overly focusing on productivity as safety and environmental outcomes do not contribute to it (or contribute negatively). One of the reasons why productivity is low is certain outcomes, such as improved safety and reduced environmental impact, are not fully captured in productivity measures.

A significant part of the innovation in this sector is through learning by doing. This is not being captured and is not easy to capture. However, it affects capability building and where comparative advantages develop over time.

Key findings for the purposes of the Review

- There is evidence of systematic underreporting of innovative activity – 'hidden innovation' – in the mining sector based on the case studies presented.
- The underreporting is a result of innovation expenditure being categorised as other types of expenditure such as business as usual or as capital expenditure.
- There may be scope to work with key stakeholders in the sector to capture innovation-related expenses better. This would improve at a sectoral level the estimates of innovation activity. It may also offer insights to generalise this approach to cover other sectors.

Session 4: Measurement of R&D and innovation policies

The Measurement of R&D and Innovation Policies

PRESENTERS: DR FERNANDO GALINDO-RUEDA AND PROF THOMAS SPURLING

Abstract

Understanding the effects of innovation policies on the overall innovation system is a major priority for policy makers and one, if not the main, rationale for investing in innovation measurement. However, and somewhat paradoxically, there are not as many reliable indicators about innovation policies and their key attributes as one would wish for to serve basic accountability objectives, allow comparisons of policy use and design, let alone support ex-ante and ex-post policy evaluation.

This presentation will explore the reasons why innovation policies are challenging objects of measurement. The design and delivery of innovation policies and practices can be complex and differ from the explicit intentions of the enabling legislation and budgetary decisions, as different administration layers and jurisdictions interact. Access to administrative data may be jealously guarded for reasons that have to do as much with confidentiality as with concern about how data might be used for decision making, impacting on the careers of their policy managers. Those directly responsible may not see information as a basis for data that can be useful for others nor a need to compile it, while suitable aggregated data can help compare countries or regions over time. Building an understanding of innovation policies across different jurisdictions requires additional efforts to use common language and taxonomies, or at least to be able to transpose local realities onto them.

This presentation will focus on what can be done to address this gap in a national and international context, arguing that coordination between these two levels is essential to make the most of efforts in this area. A number of examples (capturing specific policy instruments, thematic policy interests and modes of data collection and analysis) will be provided to highlight recent and ongoing OECD initiatives that exhibit varying degrees of success and promise, with a view to promoting a dialogue about what types of innovation policy 'metrics' are feasible and desirable in the Australian context.

Session summary

According to OECD data, Australia is an innovative country. Australia is seen as a leader in terms of progressing dialogue surrounding non-R&D innovation and its measurement.

The changing nature of the demand and use of innovation metrics

Sometimes trade-offs are necessary when it comes to the metrics required by individual countries and metrics that allow international comparisons. Data users are

becoming more demanding and have low tolerance for trade-offs. This can lead to irresponsible use of metrics.

As innovation gains a place in management and public debate, more areas of the innovation system will understand the value of reporting on their activities, and will encourage others to do so. Government policy has a role in influencing this behaviour.

Innovation measurement and data in policy

The Government can and should do more to incentivise businesses to build precise and comprehensive records about their innovation activities and report in the appropriate manner. The Government's ability to collect such data depends on whether businesses collect it and value it. Businesses can report with some accuracy on their activities if this information is valuable to them, and this is evident from the fact that they do so for many activities, including for compliance, grant applications, and claiming tax subsidies.

The OECD uses data about policies for analysis of national and global innovation systems. Data about policies are often qualitative and inaccessible. Data about policies can be valuable when aggregated, and can aid in comparing policies across countries and over time. OECD comparative policy analysis is progressively evolving from descriptive to impact-focused. This work is most advanced with R&D tax incentives as a policy instrument, but work is underway to consider procurement policy and other tools that place more emphasis on the demand side of innovation.

The OECD needs countries to provide data to make this analysis possible.

Innovation policy must be data-aware. Policy analysts need to take responsibility in co-developing data collection. Policy makers must be data literate, and understand the data life-cycle.

Data analysis and policy should have a reflexive relationship – understanding which data are of policy relevance is aided by development and analysis of data.

Data collection and use

The OECD Blue Sky Agenda is promoting the empowerment of national statistical offices to access and use data from a broader range of sources.

A hybrid strategy is required to enable comparison of official and private data.

State and local governments also hold relevant datasets. For example, the City of Knox Business Visits program has data relevant to firms' networking behaviour.

Innovation procurements and grants are not separable from other procurements and grants using current data.

There are opportunities for digitisation – and barriers are often more social than technological.

Discussion

Around 95 percent of the budgets of state governments are allocated to service delivery, with the remainder allocated to discretionary items, of which innovation is but one. It is therefore important for the Review to consider metrics for innovation in government service delivery. This fact also means that governments need metrics that inform about whether and how to invest in innovation.

The lack of data available for China was highlighted as a major gap in international comparability for innovation activities and performance. It was noted however that the OECD has a long-standing program of engagement with China on R&D and innovation statistics which has already resolved many gaps, and that more will be addressed when China has finished implementing the latest edition of the 2018 Oslo Manual.

Key findings for the purposes of the Review

- Governments should work on incentives for private sector participants to improve data coverage and quality.
- A hybrid strategy is likely to be required, linking data from public and private providers.
- Users of innovation statistics need to appreciate the trade-offs involved when balancing country needs against international comparability, as well as other trade-offs such as timeliness versus handling data revisions.
- The digitization of data globally offers unprecedented opportunities for data integration, which have not yet been fully realized.
- Data analysis has shifted from being descriptive to impact-focused, but needs the latter as a starting point. The best example demonstrating this is the R&D Tax Incentive. On-going work in procurement illustrates the same point. At present, more information is required on this from OECD member countries.

Recommended background reading

OECD R&D Tax Incentives Database. http://oe.cd/rdtax

OECD/Eurostat (2018), *Measuring external factors influencing innovation in firms*, in Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, OECD Publishing, Paris/ Eurostat, Luxembourg. DOI: https://doi.org/10.1787/9789264304604-10-en.

S. Appelt and F. Galindo-Rueda (2016), *Measuring the link between public procurement and innovation*, OECD Science, Technology and Industry Working Papers, No. 2016/03, OECD Publishing, Paris, https://doi.org/10.1787/5jlvc7sl1w7h-en.

OECD STIP Compass Database. https://stip.oecd.org/.

Session 5: Creative inputs into innovation

The Creative Industries and Innovation: Drivers, Definitions and Data

PRESENTER: MR JUAN MATEOS-GARCIA

Abstract

The creative industries are defined by the UK Department of Culture, Media and Sport as 'those industries which have their origin in individual creativity, skill and talent and which have a potential for wealth and job creation through the generation and exploitation of intellectual property.'

This collection of sectors, which ranges from creative services such as Advertising and Design to digital sectors such as Software or Video Games and cultural activities like Publishing and Music are increasingly recognized as a locus of innovation that does not always take the form of traditional scientific R&D, instead relying on 'soft' (aesthetic) forms of novelty and on innovation in business models, and new combinations of technical and artistic inputs via design. There is also growing evidence that the creative industries can act as a driver of innovation elsewhere in the economy through the supply of relevant inputs for innovation (including talent, services and spaces for innovation) as well as the generation of knowledge spillovers.

The presentation summarises the state of play in the definition and measurement of the sector highlighting the challenges raised by fluidity in sector definitions and structural change, and the importance of freelance talent for the sector. It also identifies opportunities to use novel data sources such as social media and text to capture creative activities, networks and clusters.

Session summary

The presentation highlighted that creativity is across all industries, not only what are generally termed the 'creative industries' associated with the arts.

One differentiating feature of economic value associated with creative industries and inputs is that the notion of value is highly subjective – in the eye of the beholder. The illustrative example presented was the humble coffee cup, where the purely functional ceramic mug without any branding cost a few dollars, compared to the high end, highly branded, digitally enabled coffee mug that sold for about $40.

Components of value are therefore beyond the functional and include aesthetic and cultural elements. Four components of economic value in the creative industries were identified and explored – (1) fusion; (2) non-technological innovation; (3) decentralization; and (4) concentration.

1. Fusion refers to the combination of elements from the arts, technology and business. The example in the presentation was the level of innovation activity in companies with different levels of arts-tech fusion.

2. Three elements of non-technological innovation were presented – diffusion, soft innovation (e.g. innovation in aesthetic terms), and new business models. The key point was that value often does not come from advancing the technological frontier. These aspects can be probed through the use of various technologies. Evidence was presented using data on UK games companies by platform and year based on creative platform data.

3. The decentralized characteristics of creative innovation were illustrated through the distribution of networks and knowledge exchange using the connections between creative communities in different parts of the UK based on social media data.

4. The concentration of the creative industries and the premium that can exist on co-location and spatial proximity was highlighted using the dashboard of located creative activity in the UK.

The high level conclusion was the need for a hybrid strategy in measuring the creative industries that makes use of both existing and novel data. Approaches to capturing this information may include existing innovation surveys, sector specific web data analytics, and interactive formats that enable exploration (open source).

The Dynamic Essence of Innovation – A Challenge for Innovation Metrics

PRESENTER: PROF RON JOHNSTON

Abstract

As innovation can be taken to be essentially the 'doing and producing of new or better things'. It is inherently constantly in flux. What was recognised as an innovation yesterday will not be an innovation tomorrow – it will be an imitation.

Some of the new forms and embodiments of innovation are essentially variations on an established model or practice. Others are systematic and structural transformations, often referred to as disruptions. Furthermore
'just as innovation is increasingly seen as relevant to a wide range of policy objectives, so policy in a wide range of areas is increasingly seen as relevant to innovation' (Australian Academy of Technology and Engineering *Innovation Metrics Literature Review*, 2019).

Traditional metrics highly prize characteristics of stability over time, universality to allow comparability with other performers and quantitative reliability.

The fluid, dynamic characteristics of innovation, together with its intention of difference to achieve competitive advantage, suggest contemporary innovation metrics should emphasize:

- identification of new types of innovation and their characteristics
- recognition that durable time series may be not relevant
- qualitative measures may be more revealing than strictly quantitative ones.

Session summary

The presentation by Juan Mateos-Garcia from NESTA provided a clear exposition of the characteristics of the 'creative industries' viz: fusion between the arts, technology and business; value that mostly does not arise from advancing the technological frontier; a premium on flexibility and open innovation; and, perhaps paradoxically, spatial proximity.

The creative industries are considered to include music and performing arts, film, television and radio, advertising and marketing, software and interactive content, writing, publishing and print media, design and visual arts, and architecture.

Its significance in the Australian economy is officially recognised. The industry value added in Australia was estimated at $33 million in 2011-12 with a labour force of 4.4% of the total.[2] The achievements of this industry are also widely covered in general and specialist media.

As is widely acknowledged, models and metrics of innovation have been largely shaped by the manufacturing sector, with distinct processes of R&D (usually preceded by some form of customer input), manufacture, distribution and maintenance. Innovation was largely confined to R&D activity to generate new products, processes and services.

As exemplified by the characteristics of the creative industries, and many other drivers of change in the nature and impact of innovation, these assumptions no longer mirror experienced reality.

The key differentiator between the creative industries and others is the inherent emphasis of the subjectivity of value; and multidisciplinarity (e.g. STEAMs). This creates economic dynamism in itself.

From a measurement perspective, four elements were identified that could be considered in measuring subjective value:

1. a fusion of existing metrics
2. employing a variety of technologies to explore the 'creative frontier' (e.g. the share of UK games companies by technology platform)
3. taking into account decentralisation and networks, (e.g. connections between creative communities)
4. measuring concentration effects due to spatial proximity and co-location (e.g. clustering of local businesses).

[2] 'Valuing Australia's Creative Industries', Creative Industries Innovation Centre, 2013

[3] https://www.globalinnovationindex.org/gii-2018-report#

Discussion

It was proposed that a strong candidate for inclusion in the final scorecard was a metric that reflects 'creative industry' innovation. Its particular advantages are that it is a form of innovation that is widely recognised and indeed celebrated by the public and hence presumably also policy-makers. Just think of the attention that the 'Oscars' attract; likewise the opening of new films or drama, the launch of new games, the plethora of 'apps' that enter the marketplace every day, the design of public space and new buildings.

The most recent Global Innovation Index[3], based on a range of indicators, shows Australia's creative outputs rank the country as 22nd in the world, well ahead of its knowledge and technology outputs, and in line with the overall score on all factors.

Key findings for the purposes of the Review

- Due to the intrinsically subjective nature of the creative industries, metrics that are inherently qualitative may be appropriate.
- Whilst some existing survey data can be re-purposed and combined (e.g. through the fusion of innovation survey questions), hybrid strategies and novel data generation is likely to be required.

Session 6: Knowledge diffusion and research commercialization

Metrics to capture innovation more fully

PRESENTER: PROF MARYANN FELDMAN

Abstract

This presentation makes four suggestions to support development of a suite of innovative metrics and methodologies to capture innovation, and link science investments back to economic, social, and environmental benefits.

First, it encourages you to track beyond start-up formation, recording firm survival and progress towards commercialization. These data are within reach, as technology licensing offices require reporting for licensing agreements, which typically have provisions for milestone payments that can be used to track progress towards commercialization. These data could be incorporated into the BLADE platform, and be a resource for academics and policymakers. This would permit evaluation that extends beyond the original start-up phase, enabling consideration of: how companies grow and mature, and what conditions promote survival and commercialisation.

Second, using licensing agreements it is possible to collect annual data from a larger set of firms to build a time series of progress towards introducing new products or generating revenue from university inventions. The idea of better harnessing licensing data would allow further consideration of how knowledge diffuses.

Third, strategies are presented to capture important sectors of the Australian economy that do not conduct R&D.

Finally it recommends considering some efforts that are currently underway that have successfully broadened the discussion about impact. These efforts build on the idea that all people, including policymakers and politicians, like stories. Rather than simply telling stories, we now have the ability to weave narratives with numbers, and data with descriptions to add life to the metrics on which we rely.

Session summary

Four suggestions for improving innovation measurement related to research commercialisation and knowledge diffusion were put forward:

1. **Better measurement of University start-ups**
   There needs to be better tracking of the development of new firms. Typically data collection stops at license and launch, however it is possible to follow firms forward, especially if they take a license.
   What is important is not just the number of start-up firms created, but also: are they successful; how long do they last for; what happens with their technology?

   Then it would be useful to track such things as:

   - follow-on funding
   - fommercialization progress
   - exits; mergers & acquisitions; initial product offerings; and deaths
   - what happens to their ideas and people.

2. **Outcomes from university licenses**
   We are interested in general, rather than just specific outcomes. These outcomes might include follow-on research projects and progress towards commercialisation. Outcomes may be reflected in royalty payments from licensing agreements. Making better use of administrative records could assist with tracking such outcomes. The ‘dirty little secret of university technology transfer’ is that it does not usually generate much – if any – revenue for universities when considered in the aggregate.

3. **Innovation activities that are not based upon R&D**
   For example, agricultural innovation is difficult to capture but this is an important economic sector in Australia. There is declining government investment in extension services, education and training and research funding. Consequently it is particularly important to understand how these changes are affecting agricultural innovation. Environmental services are another area where non-R&D innovation needs to be better captured. For example, remediation can lead to cost savings, and there are examples of need based and user innovation that could be explored.

4. **Broadening the discussion – policy makers need stories as well as metrics**
   The AUTM Better World report demonstrates the importance of stories, as does the Association of Public and Land-grant Universities (APLU) and its Commission on Economic and Community Engagement (CECE), which established the Innovation and Economic Prosperity (IEP) Universities Program.

Heading a mission-based approach to measuring research translation

PRESENTER: PROF BETH WEBSTER

Abstract

The desire for effective research translation is desired not for its own sake, but rather as a means for achieving societal goals. Before we decide the how much, where and when of translation, we need to be clear about 'for what'?

Rather than opting for a mashup aggregated measure of 'innovation' or 'research translation', the presentation recommends we consider metrics within the context of missions. It gives examples of two missions – low carbon energy and digital transformation – and discusses the metrics we can use to track (a) the attainment of the goals and (b) the success of strategies in place to achieve these goals.

Session summary

Innovation is not just about material goods and services. Climate change, childhood cancers, chronic disease in the young, mental health conditions, intractable disadvantage and global poverty are also issues where innovation is important.

But material and immaterial well-being are related (they enable each other). Strategies to enable improvements in such areas include direct intervention and market forces. These represent two polar opposite views on how to approach such problems. Measures should apply to both strategies (and everything in-between).

Research translation should not be treated as a goal in itself. Rather, it is undertaken to achieve societal goals. Before we decide how much, where, when, we need to be clear about 'for what'? There is doubt that mashup measures of 'innovation' or 'research translation' are useful. They may be useful for media headlines (e.g. as part of a 'shock and awe' strategy) but are not good guides for public policy.

Governments increasingly use mission-oriented approaches (e.g. National Science & Research Priorities, Growth Centres and Precincts). The presentation is going to give an example of how I believe we should measure innovation using two common missions as examples: (1) low carbon energy and (2) digital technologies/ 'industry 4.0'.

Government sets goals (e.g. for 2030) and metrics should clearly separate annual progress towards the attainment of goals from implementation of strategies (e.g. direct, market or a mix).

1. Low-carbon energy

Goals might be:

- carbon emissions (-28% of 2005 levels by 2030)
- energy storage capacity (x GW by 2030)
- carbon sequestration (x tonnes CO2 per year by 2030)

Strategies might include:

- the Clean Energy Finance Corporation
- the Clean Energy Innovation Fund
- the Emissions Reduction Fund
- the Carbon Tax
- collaboration programs: Cooperative Research Centres; Rural R&D Corporations; Australian Research Council (ARC) and National Health and Medical Research Council (NHMRC) programs.

The appropriate metric for these strategies would be carbon reduction per dollar spent.

2. Digital technologies/ 'industry 4.0'

Goals might be:

- number of firms using robots
- number of firms with integrated information and communication systems
- number of firms with other automated systems
- number of firms entering global value chains.

Strategies might include:

- managerial change (e.g. through the Entrepreneurs' Program),
- development and use of new digital technologies.

Appropriate metrics for these strategies include:

- number of new technologies (with or without patent applications)
- number of new PhD student interns and graduates placed in industry
- activities to engage the finance sector with new technologies
- number of (first and third) party firms commercialising/exporting new technologies.

Other potentially significant gains may be had through the development of LEED and the linking of trade (customs) data to BLADE.

Discussion

Universities' engagement in the form of consultancies was identified as comprising a significant, largely unmeasured, form of interaction with industry. Technology transfer is a much smaller component of

industry-university engagement. The Better World report was highlighted as a source of data on the activity of faculty and consulting. It was also raised that ultimately, the greatest spillover between academia and industry occurs on graduation day.

The power of a narrative and of case studies were discussed, with both pro and contra positions advocated for. It was agreed that both numbers and stories are required to capture the complexity of the interaction. Stories help to communicate the events on the ground and the accompanying quantitative analysis lends it the broader context to show how representative the case studies are.

To properly understand the collaboration phenomenon, more is required than simply expenditures on the input side. Managerial capability is an important aspect but is somewhat of a 'chicken and egg' issue. Until we measure it, we don't know what the important aspects are that need to be measured.

It was noted that the National Survey of Research Commercialisation (NSRC) collects data on contracts, fee for service and collaboration. It may be worth investigating the feasibility of linking university data to BLADE.

Key findings for the purposes of the Review

- When measuring entrepreneurship, the focus needs to expand from counting the number of new firms created to tracking the development of firms, as well as other commercialisation pathways. Useful variables include licensing and consultancies.
- In the university context, this could include variables such as follow-on funding and exits – mergers and acquisitions, initial product offerings and deaths.
- The linking of university administrative data with BLADE would afford a more complete picture of the interaction between universities and industry.
- Other key data sets that could be linked to BLADE include trade (customs) data.
- Accelerating the development of the LLEED would be a significant step in furthering the understanding of human capital in innovation.

Session 7: Intangibles

Intangibles

Presenters: Stian Westlake and Dr Ben Mitra-Kahn

Abstract

Since the mid-1990s, businesses in the world's more innovative economies have invested more in ideas than in bricks and mortar. Investment in R&D, branding, skills, design, software and content has outpaced investment in plant and machinery in the US, the UK, and several other developed countries, while intangible investment growth has been more robust to the global financial crisis than investment in tangible capital. Intangibles are different, as outlined by Jonathan Haskel and Stian Westlake in *Capitalism without Capital*, both in terms of how they can be measured, and the effect they have on the wider economy.

The shift to a more intangible economy has had a noticeable effect on productivity growth, industry structure and competition, as data across the world, and in Australia shows. Several exercises are being carried out to estimate intangible investment better across the OECD, and increasingly there are consistent ways of measuring and accounting for intangibles in the national accounts, and outside them. Applying these exercises to Australia is wholly possible – but would require some additional data collection, and a broader consideration of what intangible investment should be part of the national accounts, and how it can be included.

Session summary

In relation to the measurement of innovation, a good system is identified as one that reflects how innovation really happens (i.e. it goes beyond traditional manufacturing indicators), has a common unit of measurement that ties into national accounts, and can be developed from existing data and methodologies.

Investment and capital assets are changing. There is a move away from tangible investment (e.g. in buildings, computers, plant and machinery) to intangible investment (e.g. R&D, training, design, organisational development, brands and marketing, artistic originals, software and data). However, this change is hidden. Measures of GDP do not include most intangibles and neither do company accounts.

Intangibles have the characteristics of investment: they are made by a producer, costly to obtain and provide a benefit over time. Four key economic properties of intangibles are identified in the figure below.

As far as measurement in the Australian context goes, it is acknowledged that not all intangible investment is captured in the System of National Accounts, 2008 (SNA08), and what is captured is thought to be undervalued (see Table 1).

Table 1: Types of intangible investment and coverage in National Accounts

Type of investment	Captured in SNA08
Research & Development	Yes
Minerals exploration	Yes
Brands & Marketing	No
Design	No
Copyright	Yes
Software & Data	Yes
Organisational Development / Training	Partially
Skills & Training	No

Since it is estimated that 20% of productivity growth in Australia occurs from investment in intangibles, there is growing interest in developing methods to measure intangibles.[4]

Possible approaches to measurement include development of a satellite account or developing methods for inclusion of intangibles in the System of National Accounts. However, it is acknowledged with any approach there are significant measurement challenges that need to be resolved.

[4] Paula Barnes and Andrew McClure (2009), Investments in Intangible Assets and Australia's Productivity Growth, Productivity Commission Staff Working Paper, Canberra

Internationally, the SPINTAN project has completed a significant amount of research work in the space of intangibles and setting out measurement, as has the Office of National Statistics in the UK and the Bureau of Economic Analysis in the USA. In Australia there is already a trail of work dating back to Paula Barnes' work with the Productivity Commission in 2009.[5][6][7][8][9][10] It is recognised that further work is required. International cooperation and coordination of efforts should be the starting point so that research and Australia data collection is not conducted in isolation, and when completed these can be compared with research and estimates already made elsewhere.

Discussion

A feature of intangibles highlighted was that such goods are not able to be mortgaged but are heterogeneous and embodied in labour. A significant component is 'learning by doing'. No reliable methods currently exist to measure this aspect.

The rise of the services sector has significantly contributed to the rise of intangibles.

The measurement of intangibles in corporate accounts is currently imperfect. One question was 'if companies could not measure intangibles, how could it be measured in the System of National Accounts?' At the economy level, errors cancel, affording a reliable economy-wide estimate.

Key findings for the purposes of the Review

- Improved measurement of intangible capital represents a major opportunity for innovation measurement which could and should be pursued. There is currently a significant undercount.
- Learning by doing represents a large source of intangible capital but requires additional research to establish a method of measuring it.
- As a general principle, there has to be an identifiable relationship between any metric proposed and productivity.

[5] 'Beth Webster (2000), 'The growth of intangible enterprise investment in Australia', Information Economics and Policy, vol. 12, pp. 1–25.

[6] G de Rassenfosse (2012), "Intangible assets and productivity growth." Report for the Australian Government Department of Industry, Science, Research and Tertiary Education - Rassenfosse extends PC estimates for the Department of Industry, Innovation and Science

[7] Elnasri & Fox (2014), The Contribution of Research and Innovation to Productivity and Economic Growth, UNSW. http://research.economics.unsw.edu.au/RePEc/papers/2014-08.pdf .

[8] S Bucifal and F Bulic (2016), Updating investment estimates for Australia's organizational capital, Commonwealth of Australia. https://www.industry.gov.au/sites/g/files/net3906/f/May%202018/document/pdf/updating_investment_estimates_for_australias_organisational_capital.pdf.

[9] Paula Barnes and Andrew McClure (2010), Investments in Intangible Assets and Australia's Productivity Growth: Sectoral Estimates (July, 2010). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1802854 ,

[10] Paula Barnes and Andrew McClure (2009), Investments in Intangible Assets and Australia's Productivity Growth (March, 2009). Productivity Commission Staff Working Paper. https://www.pc.gov.au/research/supporting/intangible-investment/intangible-investment.pdf.

Session 8: Capability and Absorptive Capacity

Innovative Capabilities and Profiles: Examples Using European Innovation Survey Data

PRESENTER: PROF ANTHONY ARUNDEL

Abstract

The concept of an innovation profile refers to assigning innovative firms to unique categories based on the innovation capabilities of the firm, the novelty of innovation outputs, or on other characteristics such as sales of innovative products in non-domestic markets. Profiles are of policy interest because they disaggregate innovative firms into distinct groups. Several studies during the 2000s produced profiles using European Community Innovation Survey data. Currently there is renewed interest in profiles, in part due to the inclusion of profiles as a measurement goal in the 2018 fourth edition of the OECD/Eurostat Oslo Manual. Eurostat is currently funding research on the design of profiles, with the results tested using CIS data in several European countries. Profiles have been constructed at a high level of disaggregation, with one experiment including 24 discrete categories. These can be re-aggregated to produce smaller numbers of profile categories. The main variables used to construct the profiles for product innovators include the presence of in-house innovation capabilities, the characteristics of market innovations, and R&D status. Different variables are used for process innovation. The results are validated against other variables (change in turnover or profits etc.) to ensure that the profiles provide relevant results for policy.

Summary session

In considering the definition of innovation, the Oslo Manual focuses on the economic benefits of innovation on businesses that innovate. Does the definition for innovation set the bar too low? Should there be a requirement for a substantial technological step or creation of new knowledge? It was argued that several game-changing innovations did not require new knowledge or major technological steps. These included the Multiplex cinemas that staved off the oncoming introduction of home movie rentals. The introduction of the shipping container allowed mass transport of goods internationally and allowed China to play a significant role in the manufacture of goods.

Policy makers have long been dissatisfied with the key indicators such as the percentage of firms that innovate. The capabilities of innovators varies. On the lower innovation capability side of the equation, there are firms without any process innovations or ones that can still produce process innovation. On the high innovation capability end of the equation, there are firms with high-end R&D expenditures and also those that do not perform any R&D.

In response to this dissatisfaction of policy makers, work from the early 2000s was cited in classifying the 'innovation modes' of firms using the Community Innovation Survey 3 data (1998-2000) into the classifications of: 'Strategic', 'Intermittent', 'Modifier' and 'Adopter' using the two main criteria of:

- the level of novelty in the firms innovations
- the creative effort that the firms expend on in-house innovation activities.

Work is currently underway with Eurostat to create 'innovation profiles' with voluntary European participants of both small and large economies (11 in total). There is support for this type of classification in the fourth edition of the Oslo Manual (section 3.6.2.). The classification system can be substantially applied to existing innovation type survey questions based on the Oslo Manual. All firms are assigned one profile to get a distribution of innovation activities across all industries in an economy. There was also a suggestion that weighting by employment can be used to reduce differences in markets such as a comparison between Germany (an established, advanced economy) and Romania (whose economy is developing).

This type of classification allows for the success of policy intervention to be determined over the breadth of a country's activities if there are shifts in firms from being Adopters to Modifiers; from Modifiers to Intermittent innovators; and from Intermittent to Strategic innovators. This work should be undertaken at the Industry level in countries as a means to assess industry based policy intervention.

Discussion

Workshop participants discussed the extent to which the use of Big Data could replace expensive survey data that can take up to two years to be made available. The group expressed reservations about the use of Big Data, with issues noted including:

- self-selection of information by business that the business wishes to make public
- incompleteness of the information set available through Big Data that is of interest to stakeholders
- potential lack of representativeness in the data due to exclusion of members of the population that were less 'visible' than others.

New thinking about capabilities: Innovation and technologies and behavioral science

PRESENTER: PROF MARK DODGSON

Abstract

Scientists are using new tools and techniques to provide novel and often surprising insights into innovation capability. New innovation technologies not only intensify innovation, but through machine learning can create it: they are the capital goods of the modern economy. In a post-artificial intelligence (AI), service-based economy, innovation is increasingly a behavioural phenomenon. Behavioural science can explain, predict and change innovation capability at an individual and population level. Combining these new technologies and behavioural insights enhances our ability to improve and measure innovation.

Summary session

It was suggested that new thinking is required on capabilities in light of advances in innovation technologies and behavioral sciences. Scientists are using new tools and techniques to provide novel and often surprising insights into innovation capability. In a particular example by Armand Leroi, analysis of 17,000 Billboard Hot 100 songs was conducted using signal processing and text-mining to analyse musical properties, chord changes and tone. Evolutionary methodology was applied using digital analysis to determine the three revolutions of music (60's Rock, 80's synthesisers and 90's hip hop).

In a post-AI, service-based economy, innovation is increasingly a behavioral phenomenon. Various companies including PwC suggest that behavior matters more when innovation occurs at the point of consumption. Behavioral science can explain, predict and change innovation capability at an individual and population level.

There are increasing numbers of data sources and data technologies including analytical and predictive tools. Combining these new technologies and behavioral insights enhances our ability to improve and measure innovation.

Discussion

The UN Sustainable Development Goals were raised as worthy of using as a basis for impact measurement by Amanda Caples, and would serve to address social and environment issues. Although outside of the scope of the Review, it was thought that the Review could note these impacts and suggest the use of the UN goals as a basis for future work.

Text mining on the objects of innovation was raised as a possible way of further understanding innovation at the firm and product or service level. Any such attempt would require further validation.

Key findings for the purposes of the Review

- Innovation profiles offer a novel approach for identifying and communicating the diversity of innovation characteristics of firms at a sectoral level and across countries.
- The profiles are based on the Community Innovation Survey and are compatible with the Business Characteristics Survey, thereby allowing for international comparison.
- The UN Sustainability and Development Goals were identified as a useful basis for incorporating social and environmental impacts into the Roadmap of the Review.

Workshop wrap-up

Members were asked to identify breakthrough ideas and expectations from the workshop that could be pursued by the Taskforce and the Academy. The following is a summary of the key themes that emerged.

Policy and strategy

- New metrics considered should either:
  - contribute to the measurement of currently 'hidden' innovation, or
  - be policy relevant and have a straightforward conceptual basis.
- A clear link needs to be established in the Review's work between productivity, the conceptual framework and innovation.
- The Review should consider what the key drivers of productivity growth are; what metrics are available that are directly related to these components of productivity growth; and what policy levers affect them. If the above can be established, the Review should set out an evaluation schedule to assess the implementation of the Review recommendations.
- The innovation metrics roadmap component needs to consider up to a 10-year time horizon and differentiate between short and long-term goals.
- The long time to impact is concerning from a measurement and policy perspective. Any impact assessment should include short term policy interventions and be followed up.
- The Review recommendations should be outcome-centric rather than focussing on 'how to get there'.
- The Review needs to achieve a balance between pragmatism and ambition. There needs to be room for experimentation and citizen engagement.
- The use of advanced analytics is a priority area of government. Its implementation for innovation measurement should be trialled and should complement existing metrics.
- The Review needs to be inclusive of the full business population and not forget about SMEs.
- The act of the collection of metrics itself results in behavioural change from respondents. Requiring those receiving public funding to provide better data on how they are contributing to innovation would improve measurement.

Measurement opportunities and gaps

- More analysis of non-publicly available data is required. This would require better communication about the value of this data and its use to data providers.
- A coordinated approach to standardising centres or research institutes to focus on aspects of innovation including entrepreneurship would be helpful.
- The Review roadmap should be future-focused and consider behavioural innovation.
- The innovation profiles approach at the sectoral level should be pursued and could be expanded to incorporate longer term challenges including environmental issues.
- There is a need to track emerging technologies.
- Government needs to foster experimentation in relation to innovation measurement to realise the benefits of advances in innovation measurement theory.

Measurement approaches

- Use text data and mining techniques to turn data into a richer picture of innovation.
- Focus on short term metrics that are output-oriented and are internationally comparable.
- Expand the way we are measuring innovation by using qualitative and quantitative methods.
- Task growth centres to develop state of the sector reports including international comparisons. They would have qualitative components including case studies.
- Aim for intensity measures that can be measured at the firm level and aggregated to the sector and national level.

Appendix A – Workshop agenda

WEDNESDAY 13 MARCH 2019

Start time	Event	Speaker	Location	Duration
11.00 am	Pre-Workshop presentation: *Measuring Innovation: What have we learnt, and what does this mean for Australia?* All welcome (own transport required)	F Galindo-Rueda / A Arundel	ABS House Ground Floor, Knibbs Auditorium	1hr
12.45 pm	LUNCH	------	QT Bar/Grill	1hr
1.45 pm	WORKSHOP REGISTRATION	------	Ballroom Foyer	15min
2.00 pm	**MC opens workshop**	**M Cully**	**QT Ballroom 3**	**15min**
2.15 pm	Innovation Metrics Review context setting	C Williams / M Wenham	QT Ballroom 3	30min
2.45 pm	Session 1: *Entrepreneurship* [VIDEO CONFERENCE]	S Stern / A Charlton	QT Ballroom 3	45min
3.30 pm	AFTERNOON TEA	------	Ballroom Foyer	30min
4.00 pm	Session 2: *Innovation Metrics – state of play – a WIPO GII perspective* [VIDEO CONFERENCE]	S Wunch-Vincent / A Caples	QT Ballroom 3	45min
4.45 pm	**MC closes workshop (for Day 1)**	**M Cully**	**QT Ballroom 3**	**15min**
5.30 pm	DRINKS	------	QT Lounge	45min
6.15 pm	**Introductory address**	**A Finkel**	**QT Lounge**	**15min**
6.30 pm	OFFICIAL DINNER	------	QT Lounge	2hr

THURSDAY 14 MARCH 2019

Start time	Event	Speaker	Location	Duration
8.30 am	ARRIVAL/COFFEE	------	Ballroom Foyer	30min
9.00 am	**MC opens workshop (for Day 2)**	**M Cully**	**QT Ballroom 3**	**15min**
9.15 am	Session 3: *Hidden innovation in mining*	A Bye / M Thomas	QT Ballroom 3	45min
10.00 am	Session 4: *Measurement of R&D and innovation policies*	F Galindo-Rueda / T Spurling	QT Ballroom 3	45min
10.45 am	MORNING TEA	------	Ballroom Foyer	30min
11.15 am	Session 5: *Creative inputs into innovation | New data for R&D policy*	J Mateos-Garcia / R Johnston	QT Ballroom 3	45min
12.00 pm	Session 6: *Knowledge diffusion and research commercialisation*	M Feldman / B Webster	QT Ballroom 3	45min
12.45 pm	LUNCH	------	QT Bar/Grill	1h15min
2.00 pm	Session 7: *Intangibles*	S Westlake / B Mitra-Kahn	QT Ballroom 3	45min
2.45 pm	Session 8: *Capability and absorptive capacity*	A Arundel / M Dodgson	QT Ballroom 3	45min
3.30 pm	AFTERNOON TEA	------	Ballroom Foyer	30min
4.00 pm	Key issues identified and closing	Chief Economist	QT Ballroom 3	45min
4.45 pm	**Workshop Close**	**------**	**QT Ballroom 3**	

Purpose

The purpose of the Innovation Metrics Review is to improve measurement of Australia's innovation system, to support better decision-making which will drive improved economic outcomes for Australia.

The purpose of the workshop is to inform the Innovation Metrics Review about international developments and share the thinking of international and domestic experts on how innovation measurement may be improved.

Structure

The workshop will open with context setting and then be followed by eight sessions. The workshop sessions will be presented by pairs of speakers. The first speaker will give a 20 minute presentation and the second speaker will give a 10 minute presentation on the same topic focussing on the Australian context. This will be followed by a 15 minute question and answer session involving the audience.

Audience

The members of the audience for the workshop are innovation metrics experts and innovation system stakeholders, and include most of the members of the Review's governance and advisory bodies.

Venue and Timings

The venue for the workshop event will be QT Hotel, 1 London Circuit, Canberra. The venue is located a 15 minute walk or a 5 minute drive from Industry House, or a 12 minute drive from ABS House (refer Attachment A).

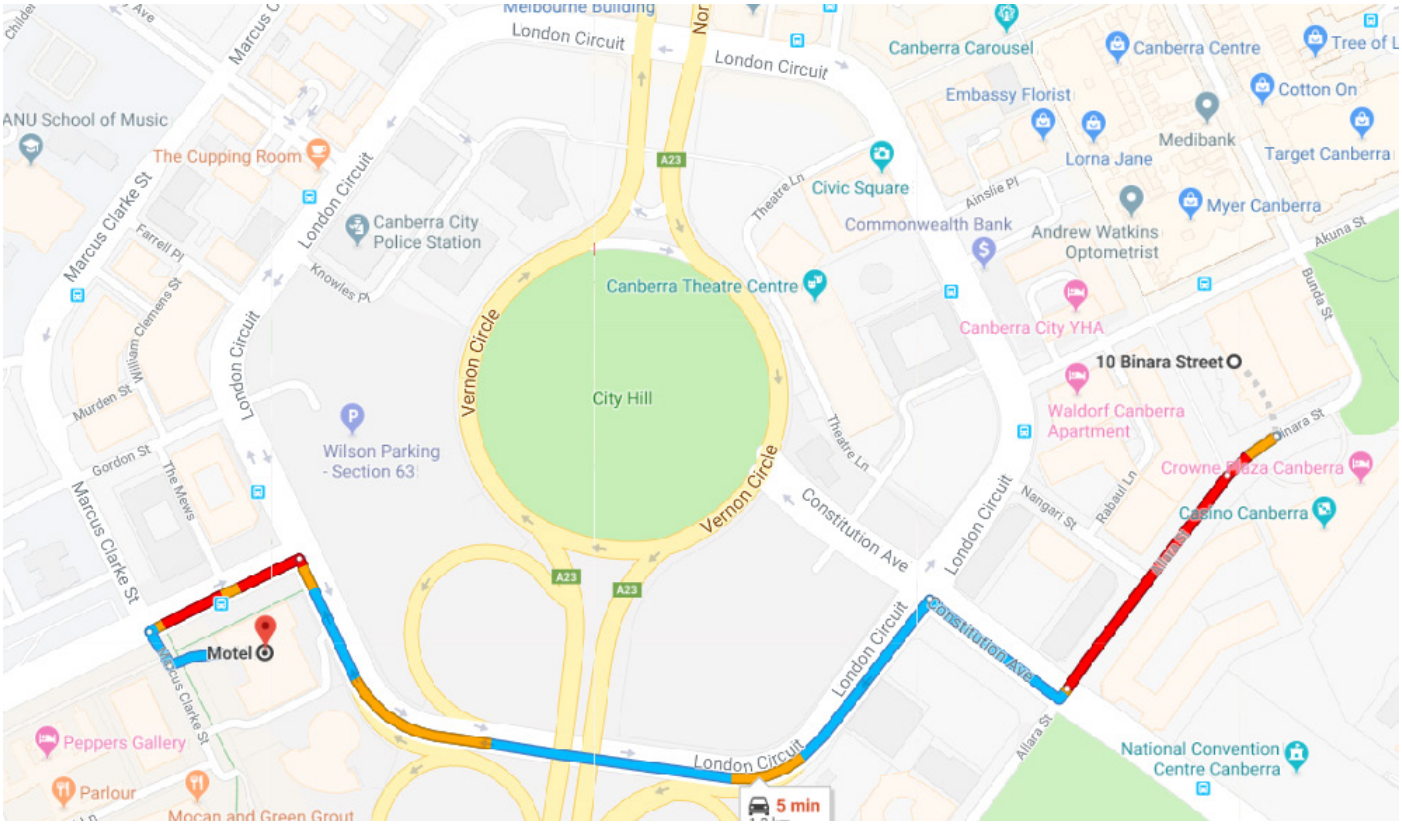
Within this venue, there are four locations where events will take place:

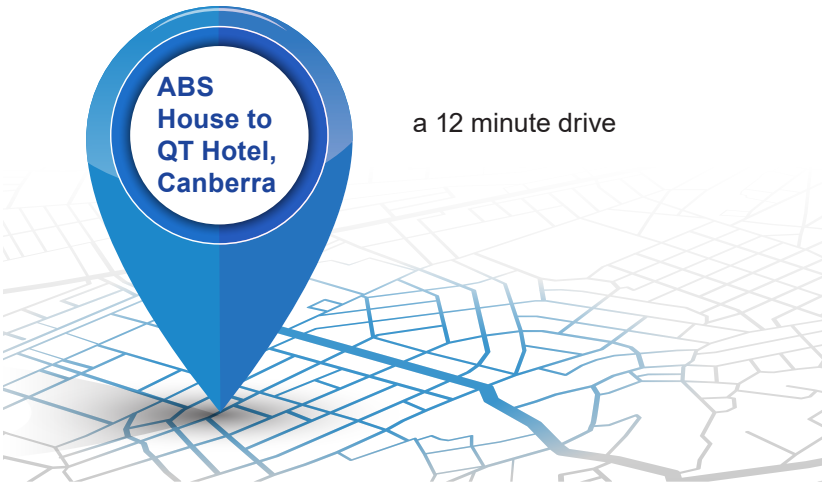
- **QT Capitol Bar and Grill**, which is located on the ground floor of the hotel. Seating for workshop participants will be provided in two long rows. While other hotel guests may be using this restaurant at the same time, the workshop participants are expected to account for the majority of patrons at that time
- **QT Lounge**, which is located on the top floor of the hotel and provides views of the city and lake. The QT Lounge will be the location for the workshop dinner and pre-dinner drinks
- **Ballroom 3**, which is located on the first floor of the hotel and accessible by steps from the lobby
- **Ballroom foyer**, which is the area immediately outside of the ballroom, for workshop registration, welcome tea and coffee, and morning and afternoon tea.

Outcomes and next steps

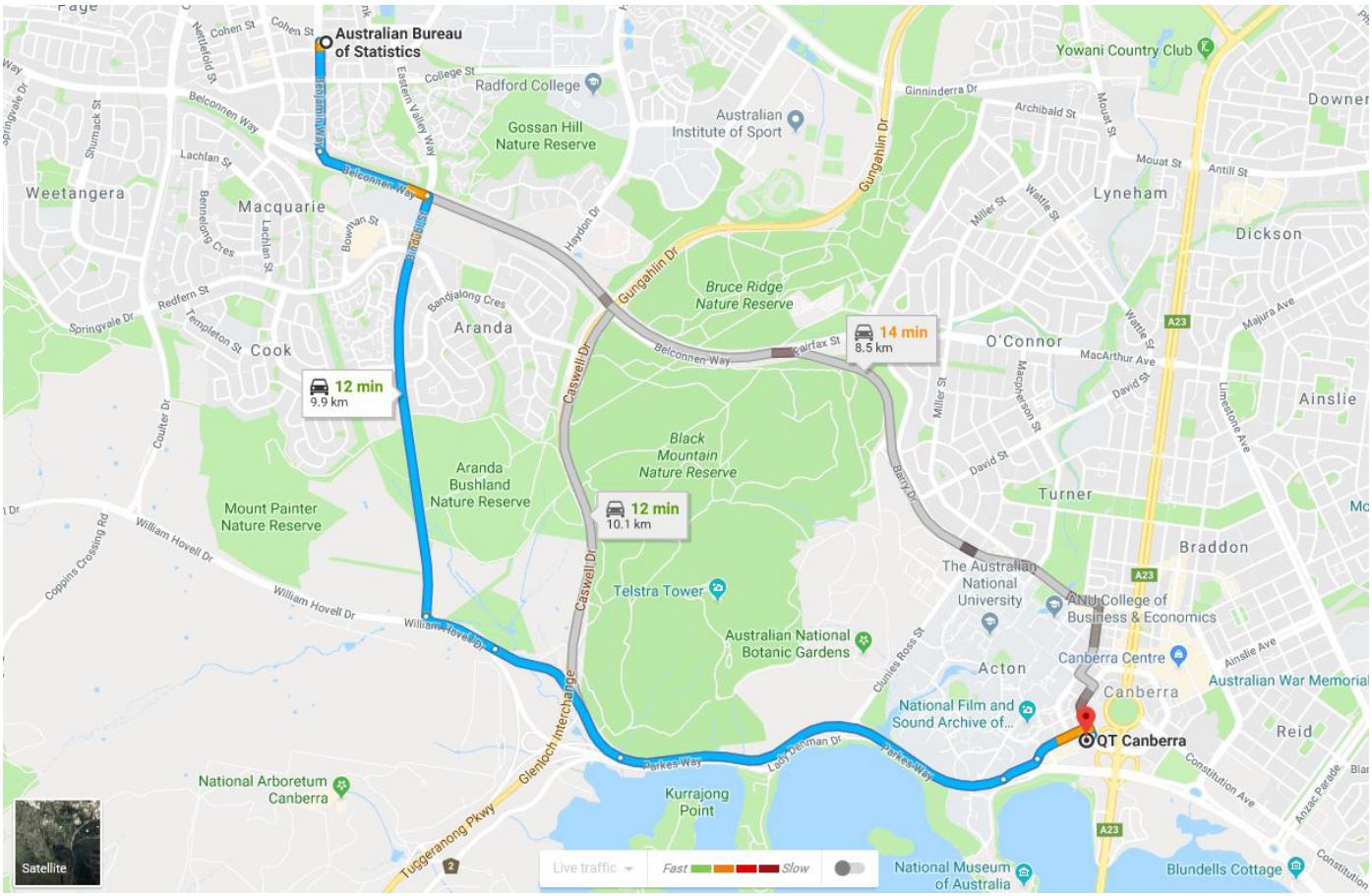
Detailed minutes of the presentations and discussions that take place at the workshop will be kept. These documents will also form part of the review's suite of final documents. A draft version of the report (including proposed findings and recommendations) will be made available for public comment after the Workshop and prior to June 2019.

Attachment 1 - Directions to meeting locations





a 12 minute drive



Attachment 2
Biographies of Speakers

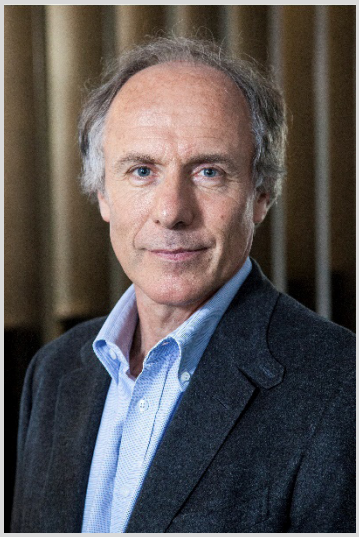
Mark Cully, Chief Economist, Australian Department of Industry, Innovation and Science

Mark Cully was appointed Chief Economist for the Department of Industry, Innovation and Science in 2012. In that role he oversees economic advice, analysis and forecasting published by the Office of the Chief Economist, as well as the department's evaluation activity, data governance and Bizlab, the department's policy innovation and design lab.

Mark has a first-class Honours degree in Economics from the University of Adelaide. From 1992-95 he was a British Council Commonwealth Scholar at the University of Warwick obtaining a Master of Arts, while working at the Warwick Business School.

In 1995 he was appointed head of research on employment relations for the UK Government, where he ran what was the world's largest survey of working life. He returned to Australia in 1999 as Deputy Director of the National Institute of Labour Studies, and was then General Manager at the National Centre for Vocational Education Research for six years, running its statistical then research operations. In 2009 he was appointed inaugural Chief Economist at the Department of Immigration and Citizenship and in that role chaired the OECD's Working Party on Migration. In 2017 he was a Special Guest of the Brookings Institution. He is a member of the Committee for the Economic Development of Australia's Council on Economic Policy.

Dr Alan Finkel, Australia's Chief Scientist



Dr Finkel commenced as Australia's Chief Scientist on 25 January 2016. He is Australia's eighth Chief Scientist. Prior to his appointment, he served as President of the Australian Academy of Technology and Engineering (ATSE), and for eight years as Chancellor of Monash University.

As Chief Scientist, Dr Finkel has led a number of national reviews, delivering the 2016 National Research Infrastructure Roadmap, the 2017 Review into the National Electricity Market ("Finkel Review") and the 2018 STEM Industry Partnership Forum report. He serves as the Deputy Chair of Innovation and Science Australia.

Dr Finkel has an extensive science background as an entrepreneur, engineer, neuroscientist and educator. He was awarded his PhD in electrical engineering from Monash University and worked as a postdoctoral research fellow in neuroscience at the Australian National University.

In 1983 he founded Axon Instruments, a California-based, ASX-listed company that made precision scientific instruments. After Axon was sold in 2004, Dr Finkel became a director of the acquiring company.

In 2006, he focused his career in Australia and undertook a wide range of activities including co-founding Cosmos Magazine. During his time at ATSE, he led the development and implementation of the STELR program for secondary school science.

Dr Matt Wenham, Executive Director, Policy at the Australian Academy of Technology and Engineering

Dr Matt Wenham is the Executive Director, Policy at the Australian Academy of Technology and Engineering, Australia's national academy for applied science and technology. Matt leads the Academy's policy team, which provides independent, evidence-based advice to government and industry based on the expertise of over 800 Fellows of the Academy.

Prior to joining the Academy in 2014, Matt was a Senior Policy Associate at the Mitchell Institute for Health and Education Policy, an independent think tank based in Melbourne, Australia. Prior to returning to Australia in 2013, Matt was Associate Director with the Institute on Science for Global Policy, a non-profit organization based in Washington, DC that aims to help improve and expand the dialogue between scientists and policy makers on key public policy issues impacted by science and technology. As Associate Director of the Institute, Matt was responsible for programs on emerging infectious diseases and biosecurity, food safety and security, and emerging technologies, and managed a team of staff and fellows located throughout the US and overseas. Before joining the ISGP, Matt was a postdoctoral research fellow in the National Institute for Diabetes and Digestive and Kidney Diseases at the US National Institutes of Health in Bethesda, Maryland.

Matt received his Bachelor of Science and Honours degrees in biochemistry from the University of Adelaide. In 2005, Matt was selected as a Rhodes Scholar for Australia-at-Large and moved to the University of Oxford to undertake his DPhil (PhD) in cell biology and immunology at the Sir William Dunn School of Pathology. Matt has served in the Australian Army Reserve and completed the reserve officer commissioning course at the Royal Military Academy Sandhurst, UK. In 2003, he was awarded the Australian Centenary Medal, for services to the community as chair of the South Australian Government's ministerial advisory council on youth affairs.

Christine Williams, General Manager, Innovation Metrics Review at the Australian Department of Industry, Innovation and Science

Ms Christine Williams is an Australian Bureau of Statistics (ABS) officer who is currently outposted to the Department of Industry, Innovation and Science, leading the Taskforce. Christine has worked in the private sector, academia, and the state and federal public sectors. Her previous roles relevant to the Review include: five years leading the Economic and Policy Research Branch of the Tasmanian Department of Primary Industries, Parks Water and Environment; and four years at the ABS in the roles of Assistant Statistician (branch head), Indigenous, Education and Cultural Statistics Branch, and Assistant Statistician, Education and Data Integration Branch, where she founded the ABS Centre for Data Integration.

Christine has over 20 years of experience as a non-executive director, is a Fellow of the Australian Institute of Company Directors (AICD), and has been an ACT AICD Division Councilor for the past four years.

Christine has a Bachelor of Economics with Honours, a Master of Business Administration, an Advanced Diploma in Financial Services (Financial Planning), and has completed the AICD Company Directors' Course (with Order of Merit), Mastering the Boardroom, and the International Company Directors' courses.

Session 1: Entrepreneurship

Prof Scott Stern, the David Sarnoff Professor of Management, MIT Sloan School of Management

Prof Scott Stern is the David Sarnoff Professor of Management at the MIT Sloan School of Management.

Scott explores how innovation and entrepreneurship differ from more traditional economic activities, and the consequences of these differences for strategy and policy. His research in the economics of innovation and entrepreneurship focuses on entrepreneurial strategy, innovation-driven entrepreneurial ecosystems, and innovation policy and management. Recent studies include the impact of clusters on entrepreneurship, the role of institutions in shaping the accumulation of scientific and technical knowledge, and the drivers and consequences of entrepreneurial strategy.

Scott has worked widely with practitioners in bridging the gap between academic research and the practice of innovation and entrepreneurship. This includes advising start-ups and other growth firms in the area of entrepreneurial strategy, as well as working with governments and other stakeholders on policy issues related to competitiveness and regional performance. In recent years, Scott has developed a popular new MIT Sloan elective, Entrepreneurial Strategy, co-founded the MIT Regional Entrepreneurship Acceleration Program, advised the development of the Social Progress Index, and served as the lead MIT investigator on the US Cluster Mapping Project.

Dr Andrew Charlton, Director, AlphaBeta Advisors

Dr Andrew Charlton has senior experience in business, government and international institutions. After commencing his career with the Boston Consulting Group (BCG), he received a Doctorate and Masters in Economics from the University of Oxford, where he studied as a Rhodes Scholar. From 2008-2010, through the period of the global financial crisis, he served as senior economic advisor to the Prime Minister of Australia and Australia's senior government official to the G20 economic summits. He was the prime minister's representative to conferences of the United Nations Framework Convention on Climate Change (UNFCCC) and the Major Economies Forum on Energy and Climate (MEF). From 2010-2014 he worked for Australian conglomerate Wesfarmers, including two years in corporate strategy (M&A and major group projects) and two years in operational roles (divisional Chief Financial Officer and General Manager). His academic research covering international economics, trade and development has been published in leading international journals including the American Economic Review, World Trade Review and World Economy. He is the author of two books, Ozonomics (2007) and Fair Trade for All (2005), co-written with Nobel laureate Joseph Stiglitz. In 2011 he was named a Young Global Leader by the World Economic Forum.

Session 2: Innovation Metrics – state of play – a WIPO GII perspective

Dr Sacha Wunsch-Vincent, Co-Editor Global Innovation Index & Head, Section, Economics and Statistics Division, World Intellectual Property Organization

Dr Sacha Wunsch-Vincent is Head of Section in the Economics and Statistics Division at the World Intellectual Property Organization (WIPO) and Co-Editor of the Global Innovation Index. He joined WIPO in 2010 to help set up WIPO's economics work under the Chief Economist. At WIPO, he is one of the main authors of the World Intellectual Property Report and the Global Innovation Index. His primary research foci and current area of work are concerned with the interaction of innovation, intellectual property, and economic development.

Before joining WIPO, he was an economist at the OECD Directorate for Science, Technology, and Industry for seven years. Earlier he was the Swiss National Science Fellow at the Berkeley Center for Law and Technology (University of California, Berkeley) and the Peterson Institute for International Economics (Washington, D.C.). He has served as advisor to organizations such as the World Bank and the World Economic Forum, and has testified before governments and parliaments. His recent WIPO-CUP book on "Innovation in the Informal Economy of Developing Counties – Hidden Engine of Innovation?" will be published by Cambridge University Press in September 2016.

Sacha holds a Master of International Economics from the University of Maastricht with a Masters Thesis at MERIT and a PhD in Economics from the University of St. Gallen, Switzerland. He teaches International Economics at Sciences Po Paris, and the World Trade Institute in Bern.

Dr Amanda Caples, Victoria's Lead Scientist

Dr Amanda Caples joined the Victorian public service in 2002 as the inaugural Director of Biotechnology and was appointed to the role of Victoria's Lead Scientist in mid-2016. Amanda brings broad experience in technology commercialisation, public policy development and governance of public and private entities. As Deputy Secretary, Sector Development and Programs, Amanda was responsible for the development of Future Industries strategic sector growth plans and for support of the Victorian science, innovation and entrepreneurial ecosystem.

After graduating from the University of Melbourne with a PhD in pharmacology, Amanda began her pharmaceutical industry career with Servier Laboratories Australia where she was responsible for local product development and the registration of new medicines for the treatment of diabetes and high blood pressure. Amanda progressed to business development roles first with AMRAD where she secured licensing deals and strategic alliances for the R&D portfolio before joining the Walter and Eliza Hall Institute to establish the Technology Transfer Office.

Session 3: Hidden innovation in mining

Dr Alan Bye, Vice President Technology at BHP Billiton

Dr Alan Bye is Vice President Technology at BHP Billiton. Alan and his global team are accountable for defining the Technology strategy and execution of innovation programs across the company covering both digital and extractive technologies. This includes responsibility for strategic partnerships, emerging technology, innovation labs, enterprise architecture and intellectual property management.

Prior to this Alan led the establishment and was CEO at the Cooperative Research Centre for Optimising Resource Extraction. A $100m venture involving 34 partners with the purpose of 'Transforming Mining into an Advanced Manufacturing Industry'. He was previously, Professor and Director of the Bryan Research Centre at the University of Queensland.

Alan has a mining operational background, spending 10 years with Anglo American where he held mining operational roles both in underground and open pit operations. Over his career Alan has worked in 15 counties covering 9 commodities. Alan was recently elected a 2018 Fellow of the Australian Academy of Technology and Engineering.

Mark Thomas, Group Manager Procurement and Information Services at Fortescue Metals Group.

Mark Thomas was appointed Group Manager, Procurement & Information Services at Fortescue Metals Group Limited in July 2017. He has previously held senior positions at Fortescue including: Group Manager, Infrastructure Services; Company Secretary, Group Manager Finance; and Head of Finance & IT. Prior to Fortescue Mark held senior finance and accounting positions with the Goldfields Australia Group and with a number of professional service providers.

With more than 20 years' experience in the mining and professional services industries, Mark has gained comprehensive experience in finance and accounting, governance and risk, information technology and business administration. He has a Bachelor of Commerce from the University of Western Australia, Graduate Diploma in Applied Corporate Governance, a Masters of Business Administration and is a Certified Practising Accountant and a Fellow of the Governance Institute of Australia. Mark is a Non-Executive Director and Chair of Risk Committee at ChemCentre.

Session 4: Measurement of R&D and innovation policies

Dr Fernando Galindo-Rueda, Senior Economist at the OECD Directorate for Science, Technology and Innovation

Fernando Galindo-Rueda is a Senior Economist in the Economic Analysis and Statistics Division of the OECD Directorate for Science, Technology and Innovation (STI). He leads the directorate's S&T and Innovation indicators and analysis unit and coordinates the work of the OECD Working Party of National Experts on Science and Technology Indicators (NESTI). He is responsible for the development of OECD statistical standards for the measurement of R&D and innovation (including the recent update of the Frascati and Oslo Manuals), the delivery of targeted analysis of science and innovation data and the dissemination of key OECD statistics, including the Main Science and Technology Indicators, the R&D Statistics and R&D Tax Incentives databases. He is also in charge of implementing the measurement agenda arising from the OECD Blue Sky Forum, which he co-organised in 2016.

Prior to joining the OECD in 2010, he was Deputy Director in charge of Business Economics at the UK Government's Department for Business, Innovation and Skills, where he was responsible for economic advice on and the evaluation of UK industrial policies, with particular focus on technology-advanced sectors and the impact of energy and climate change policies. He has also led the Economic Methodology branch at the UK Office for National Statistics and has been a research economist at the London School of Economics' Centre for Economic Performance and Centre for the Economics of Education. He has a PhD in Economics and an MSc in Environmental and Natural Resource Economics from University College London.

Prof Thomas Spurling, Professor, Innovation Studies at the Centre for Transformative Innovation, Swinburne University of Technology

Prof Tom Spurling is Professor of Innovation Studies at the Centre for Transformative Innovation, Swinburne University of Technology.

Tom is a scientist with experience in managing the process of translating research into commercial products. His current research interests include the use of social network analysis in understanding how best to commercialise public sector research, the use of economic analysis to understand why some firms invest in innovation, and the use of case studies to tell the story of Australian innovation.

Session 5: Creative inputs into innovation | New data for R&D policy

Juan Mateos-Garcia, Director of Innovation Mapping at Nesta

Juan Mateos-Garcia is Director of Innovation Mapping at Nesta.

Prior to joining Nesta, Juan worked as a researcher at SPRU (Science Policy Research Unit) at the University of Sussex, and CENTRIM at the University of Brighton.

Juan has a degree in Economics (with distinction) for Universidad de Salamanca (Spain), and an MSc (with distinction) in Science and Technology Policy from SPRU, University of Sussex.

Prof Ron Johnston FTSE, Executive Director, Australian Centre for Innovation at the University of Sydney (recently retired)

Professor Ron Johnston has recently retired after 26 years as Executive Director of the Australian Centre for Innovation (ACIIC) and is an Emeritus Professor in the Faculty of Engineering & IT at the University of Sydney.

Educated initially as a scientist in Australia, the UK and the US, he has devoted most of his career to develop a better understanding and application of the ways that science and technology contribute to economic and social development, of the possibilities for managing research and technology more effectively, and of insights into the processes and culture of innovation.

Session 6: Knowledge Diffusion and Research Commercialisation

Prof Maryann Feldman, Heninger Distinguished Professor, Department of Public Policy, University of North Carolina

Prof Maryann P. Feldman is the Heninger Distinguished Professor in the Department of Public Policy at the University of North Carolina, an Adjunct Professor of Finance at Kenan-Flagler Business School and a Research Director at UNC Kenan Institute of Private Enterprise.

Her research and teaching interests focus on the areas of innovation, the commercialization of academic research and the factors that promote technological change and economic growth. Maryann is an editor of the journal, Research Policy, and chairs an interagency working group on Science Policy. From 2014-2017, Maryann held a joint appointment at the National Science Foundation as the Science of Science and Innovation Policy (SciSIP) Program Director.

Maryann was the winner of the 2013 *Global Award for Entrepreneurship Research* for her contributions to the study of the geography of innovation and the role of entrepreneurial activity in the formation of regional industry clusters

Maryann has written extensively on the process and mechanics of the commercialization of academic research. Her most recent work explores emerging industries, entrepreneurship and the process of regional transformation. Currently, Maryann is actively engaged in researching the industrial genesis of the Research Triangle region. The project follows the development of the regional economy over a 50 year time period using a unique database of 3200 entrepreneurial ventures and attempts to understand the institutional dynamics that created a vibrant regional economy.

Prof Beth Webster, Pro Vice-Chancellor (Research Policy and Impact), Swinburne University of Technology

Professor Beth Webster is the Director of the Centre for Transformative Innovation at Swinburne University of Technology. She is also Pro Vice-Chancellor for Research Impact and Policy.

She holds a B. Economics and M. Economics (Monash University) and a PhD in economics (University of Cambridge). She has authored over 100 articles on the economics of innovation and firm performance and has been published in RAND Journal of Economics, Review of Economics and Statistics, Oxford Economic Papers, Journal of Law & Economics, Cambridge Journal of Economics and Research Policy. She has been appointed to a number of committees including the Bracks' review of the automotive industry; Lomax-Smith Base funding Review; CEDA Advisory Council; the Advisory Council for Intellectual Property; President, European Policy for Intellectual Property Association; and General Secretary, Asia Pacific Innovation Network.

Her research interests include: economics; innovation; R&D policy; firm performance; productivity; intellectual property policy; industry dynamics; knowledge spillovers; markets for technology.

Session 7: Intangibles

Stian Westlake, Executive Director of Policy and Research

Stian Westlake is a consultant on innovation and technology policy. He has worked as the adviser to three UK science ministers. Prior to that, he spent eight years as an Executive Director of Nesta, the UK's national foundation for innovation, where he led the organisation's think tank. Before that, he worked in social investment at The Young Foundation, as a consultant at McKinsey & Company in Silicon Valley and London (where his work focused on healthcare, private equity and infrastructure), and as a policy adviser in HM Treasury. He also founded Healthy Incentives, a healthcare social enterprise.

He is co-author of Capitalism Without Capital: the rise of the intangible economy (Princeton, 2017). He is a governor of the National Institute for Economic and Social Research, a senior fellow of Nesta, and a visiting researcher at Imperial College London.

His research interests include the measurement of innovation and its effects on productivity, the role of high-growth businesses in the economy, financial innovation, and how government policy should respond to technological change.

Stian was educated at the University of Oxford, Harvard University and London Business School.

Dr Ben Mitra-Kahn, Chief Economist, IP Australia

Dr. Mitra-Kahn has been the Chief Economist at IP Australia since November 2012, previous to which he was the senior economist at the UK Intellectual Property Office. In 2017 he was a joint winner of the Indigo Prize with Diane Coyle for work on re-imagining GDP.

His academic work has focused on the history of national accounting, CGE models, development, innovation and Intellectual property, and he has worked on intangible asset measurement as well as IP policy issues.

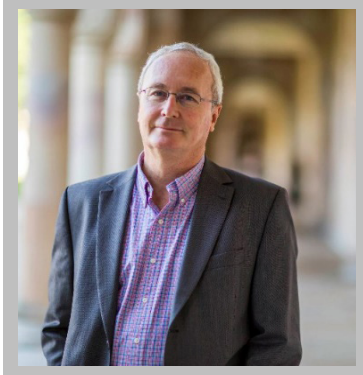
His background includes time as an academic, consultant and company director in the UK, US and Australia, and he is currently based in Sydney.

Session 8: Capability and Absorptive Capacity

Prof Anthony Arundel, Professorial Fellow at UNU Maastricht Economic and Social Research and Training Centre on Innovation and Technology

Prof Anthony Arundel is a Professor of Innovation at the University of Tasmania in Hobart, Australia and concurrently a Professorial Fellow at UNU Maastricht Economic and Social Research and Training Centre on Innovation and Technology (UNU-MERIT). He was previously a Senior Researcher at UNU-MERIT since 1992. Anthony specialises in the design, implementation, and analysis of innovation surveys. His research interests include questionnaire design and methodology, technology assessment, environmental issues, intellectual property rights, biotechnology, and knowledge flows from public research to firms.

Prof Mark Dodgson, Professor of Innovation Studies at the University of Queensland Business School



Prof Mark Dodgson is Professor of Innovation Studies at the University of Queensland (UQ) Business School, and Visiting Professor at Imperial College London His research interests are in the areas of corporate strategies and government policies for technology and innovation. He has previously worked as a Research Fellow at the Technical Change Centre, London (1983-85). He was Senior Fellow at the Science Policy Research Unit (SPRU) at the University of Sussex (1985-93), and was Professor of Management at the Australian National University (1993-2002). He was co-Founder of the National Graduate School of Management at the ANU and was its Executive Director. He has been on the Board and Advisory Boards of two multi-billion dollar companies and five start-ups.

Mark has contributed to the discussion about innovation in Australia for over 30 years. In 2019, he was appointed an Officer of the Order of Australia for distinguished service to education in the field of business innovation strategy, as a researcher, advisor and author.

He has written or edited 16 books on innovation, and his current major research interests include: innovation in large, complex projects; the playful work of entrepreneurs; philanthropy and entrepreneurs; innovation in China; the future of the innovative university; and innovation the 18th century English pottery and textile industries.

Appendix B – Workshop participants

Title	First Name	Surname	Position	Organisation
Dr	Renu	Agarwal	Associate Professor, Operations and Supply Chain Management	University of Technology, Sydney
Mr	Alex	Aitkin	Assistant Director	Australian Department of Industry, Innovation and Science
Prof	Anthony	Arundel	Professorial Fellow at United Nations University (UNU) Maastricht Economic and Social Research and Training Centre on Innovation and Technology	United Nations University - Maastricht University The Netherlands
Mr	Antonio	Balaguer	Assistant Director, Innovation Resource Section	Australian Department of Industry, Innovation and Science
Dr	Krisztian	Baranyai	Assistant Director	Office of Innovation and Science Australia
Mr	Pourus	Bharucha	Assistant Manager, Strategic Policy	Australian Department of Industry, Innovation and Science
Ms	Helena	Bujalka	Graduate	Office of Innovation and Science Australia
Dr	Alan	Bye	Vice President Technology (Strategy & Innovation)	BHP
Dr	Amanda	Caples	Lead Scientist	Victorian Department of Jobs, Precincts and Regions
Dr	Andrew	Charlton	Director	Alphabeta
Ms	Melinda	Cilento	CEO	CEDA
Ms	Jemma	Collova	APR Intern, Innovation Metrics Review Taskforce	Australian Department of Industry, Innovation and Science
Mr	Mark	Cully	Chief Economist	Australian Department of Industry, Innovation and Science
Prof	Per	Davidsson	Professor of Entrepreneurship	Queensland University of Technology
Dr	Ryan	Dawson	Assistant Director, Patent Analytics Hub	IP Australia
Dr	Charles	Day	Chief Executive Officer	Office of Innovation and Science Australia
Prof	Mark	Dodgson	Professor of Innovation Studies	University of Queensland, Business School
Prof	Maryann	Feldman	Heninger Distinguished Professor, Department of Public Policy	University of North Carolina
Dr	Alan	Finkel	Australia's Chief Scientist	Australia's Chief Scientist
Mr	Jason	Finley	Assistant Director, Science & Commercialisation Policy Division/ Innovation Metrics Review Taskforce	Australian Department of Industry, Innovation and Science
Dr	Cathy	Foley	CSIRO Chief Scientist	CSIRO

Title	First Name	Surname	Position	Organisation
Dr	Fernando	Galindo-Rueda	Senior Economist, Economic Analysis and Statistics Division, OECD Directorate for Science, Technology and Industry	OECD
Dr	Jenny	Gordon	Chief Economist	Nous Group
Dr	Margaret	Hartley	CEO	Australian Academy of Technology and Engineering
Dr	Erol	Harvey	Strategic Advisor	Bionics Institute
Ms	Jacky	Hodges	General Manager, Industry Statistics Division	Australian Bureau of Statistics
Mr	Ben	James	Acting Program Manager, Business Indicators Branch	Australian Bureau of Statistics
Prof	Ron	Johnston	Former Executive Director, Australian Centre for Innovation (recently retired)	University of Sydney
Ms	Lisa	Kerr	Senior Research Officer	Office of the Chief Scientist
Mr	Juan	Mateos-Garcia	Director of Innovation Mapping	Nesta
Mr	John	McGagh	Immediate Past President	Institution of Chemical Engineers
Dr	Ben	Mitra-Kahn	General Manager and Chief Economist	IP Australia
Dr	Char-Lee	Moyle	Office of the Chief Scientist	CSIRO
Prof	Pauline	Nestor	Vice-Provost of Research (retired)	Monash University
Mr	Emmanuel	Njuguna	Digital Economy Policy / Innovation Metrics Review Taskforce	Australian Department of Industry, Innovation and Science
Ms	Victoria	Savage	Assistant Director, Technology, Innovation and Business Characteristics Statistics Section	Australian Bureau of Statistics
Prof	Tom	Spurling	Professor of Innovation Studies	Swinburne University of Technology
Ms	Lauren	Stafford	Head of Innovation Partnerships	BHP
Prof	Scott	Stern	David Sarnoff Professor of Management, MIT Sloan School of Management	Massachusetts Institute of Technology (MIT)
Mr	Mark	Thomas	Group Manager, Procurement and Information Systems	Fortescue Metals Group Ltd
Mr	David	Turvey	General Manager, Insights and Evaluation Branch	Australian Department of Industry, Innovation and Science
Dr	Simon	Wakeman	Principal Advisor - Innovation Policy	New Zealand Ministry of Business, Innovation & Employment
Dr	Leonie	Walsh	Founder & Director	Productive Management Solutions
Mr	David	Waymouth	Director, Technology, Innovation and Business Characteristics Statistics Section	Australian Bureau of Statistics

Title	First Name	Surname	Position	Organisation
Prof	Beth	Webster	Pro Vice Chancellor (Research Policy and Impact), Director, Centre for Transformative Innovation	Swinburne University of Technology
Dr	Matt	Wenham	Executive Director	Australian Academy of Technology and Engineering
Mr	Stian	Westlake	Policy Adviser to the UK Minister of State for Universities, Science, Research and Innovation	UK Department for Business, Energy and Industrial Strategies (BEIS)
Ms	Christine	Williams	Principal Adviser, Industry Statistics Division	Australian Bureau of Statistics
Dr	Adam	Wright	Innovation System Policy	Office of the Chief Scientist
Dr	Sacha	Wunsch-Vincent	Co-Editor Global Innovation Index & Head Section, Economics and Statistics Division	World Intellectual Property Organization
Ms	Alix	Ziebell	Senior Policy Analyst	Australian Academy of Technology and Engineering