Session 1

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

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

Male Participant: [Indistinct]

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

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

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

Panel discussion 1:
Sarah Holden, Callaghan Innovation

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

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

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

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

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

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

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

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

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

Now, what do we do? We work closely with business. I said that our aim from a government perspective is to increase BERD; businesses don't care about that. What they want to know is what is it going to do for them? We try to phrase this in a language that's going to resonate with business. So our purpose, as we would explain it, is to help businesses succeed through technology. We have a big challenge with that because, as I said, most of our businesses are in the primary sector so they're not great users of technology compared to, say, the pharmaceutical industry. We've got few firms of scale. We have quite low management capability. We have relatively little competition. So we really don't have many of the factors within our economy that's going to make businesses want to invest in R&D. What we do, we try and phrase what we can do with businesses in terms of a value proposition for them: why would they want to do more with R&D? We say it will help them get their products to market faster, it will give them a market advantage because they'll be generating cool things that no-one else is producing and basically that will be good for their bottom line. We can actually come back and test whether any of those things are true. But that's certainly what we believe is our value proposition to business.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Panel discussion 2:

Professor Kaj Storbacka, University of Auckland

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

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

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

As you can probably hear from my accent, I'm not a Kiwi. I'm actually from Finland originally and that's why I like the first slide which had Finland on it. I don't know how much you know about Finland, but Finland is also a small economy and there's a really good story that explains the characteristics of Finns very well, which I will share with you because I think it's relevant. And it's a story about a French gentleman and a German gentleman and a Finn walking in the jungle. And then they found a really weird new animal that nobody had seen before, and started to discuss this and the French guy said "I wonder how this animal makes love?" [Laughter] And then the German said "I wonder how this animal functions and how can we improve it?" [Laughter] And the Finn said "I wonder what this animal thinks about me?" [Laughter]. And I think that's what small open economies often think. Or they are very focused on what other people think about them, and that's maybe one of the problems in terms of making progress, that we are too focused on what other people think about us.

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

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

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

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

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

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

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

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

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

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

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

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

And then obviously there's one element that is very obviously market innovation, which would be that you have a new technology or innovation or whatever you have, and then you start to build a market around that. There's lots of documented evidence around that if you look at innovation literature, so that's maybe not that dramatic.

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

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

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

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

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

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

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

The other thing which is important if you compare the stuff to the left with the stuff to the right here in the slide, is that if you look at the stuff to the right there's one big difference here. So if I open up so you can see: on the left-hand side I call this, or on the slide, it says "competitive strategy". So if you think product market share, automatically you think competitive strategy. You compete for market share. And I think that the whole notion of being focused on competitive strategy, which by the way, most small countries for some odd reason were really focused on. Finland and New Zealand are the only countries which are completely "Porterised". All strategy is based on Porter's Competitive Strategy from the 80s – from the 80s! It's quite a long time ago.

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

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

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

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

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

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

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

Another really good example which happens to be from New Zealand and which I particularly like is the New Zealand screw cap wine sealant initiative. How many of you know about that? Very few of you know. The reason why we see an increase in screw caps on wines at the moment is that these four guys started a movement around that which took them only four years to change the whole industry, which – and this is, by the way, there are three Johns here, so John Forrest, John Stichbury and John Belsham and Ross Lawson. They're burying the cork in Marlborough just as a symbolic action. And they used large scale events like this and fact-based arguments that actually wine with a screw top is as good as anything else. So a capability to understand, timing and understand how to involve central actors in the market to shape this.

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

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

Panel discussion 3:

Professor Shaun Hendy, University of Auckland

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

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

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

Where does innovation come from? Now I realise there's a few people in the room who are from overseas, who this won't be causing pain to, so let me explain why this is causing pain to New Zealanders in the audience.

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

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

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

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

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

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

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

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

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

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

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

> … larger cities produce more patents per capita.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Discussion

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

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

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

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

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

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

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

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

Patrick Nolan: Thank you. Kaj.

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

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

Patrick Nolan: Right, thanks. Shaun.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

…what can governments do to promote innovation[?]

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

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

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

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

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

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

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

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

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

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

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

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

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