Experiences using a science-based Lean LaunchPad program and its impact on national innovation system evolution

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Abstract: Innovation drives economic growth. At the level of countries, the national innovation system has a strong influence on the success of innovative activities within the region. However, it is often assumed that these systems evolve through policy innovation, in a top-down manner. This paper presents an exploratory case study of the introduction of a Lean LaunchPad program in Australia. It started as a small pilot then quickly grew to become a national program. The details of this case give insight into another way that innovation systems evolve: through an evolutionary process of variation, selection and replication.

Keywords: research commercialisation; lean start-up; technology transfer; national innovation system; NIS; Lean LaunchPad; entrepreneurship.

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1 Introduction

When Solow (1956) identified the link between innovation and economic growth, policy makers began to try to encourage the former in order to achieve the latter, with wildly varying results. Lundvall (1992) and Freeman (1995) subsequently demonstrated that much of this variance arose through differences in national innovation systems (NIS), defined here as the set of institutions that facilitate and support innovation. Subsequently, this approach has been extended to consider regional (RIS) (Saxenian, 1994) and sectoral innovation systems (SIS) (Malerba, 2005). These extensions emphasise that institutions that influence innovation do not exist at only the national level and that there are several different ways to measure and assess these collections of institutions and their interactions.

However, one of the primary goals of these systems approaches is to use them to encourage economic growth via innovation. This requires an understanding of how innovation systems (ISs) evolve. Kastelle et al. (2014) develop a framework that views ISs as evolving sets of rules. This leads to three key issues to consider.

First, where do new rules come from? The most common view is that changes to a NIS develop as top-down policy initiatives. However, both regions and industrial sectors lack governing bodies, and yet they have identifiable ISs. The new rules therefore must develop more organically. Another common issue is that simply copying ideas from other ISs rarely works. Both of these points mean that it is important to gain a better understanding of where new rules in ISs originate.

The second issue is that most NIS policy ideas are dominated by the linear model of innovation. Rothwell (1992, p.7) describes this as: "…a simple linear model that assumed a stepwise progression from scientific discovery, through applied research to technological development and production activities in firms, leading to a stream of new products in the market-place." He continues to outline several models that are based more on systems thinking, which include co-evolution and feedback. This is a Schumpeterian approach, concerned with both market outcomes and coordination across the innovation value chain, as opposed to those concerned with only the market or only coordination (Dodgson et al., 2014).

The third issue follows from the second – that IS problems are frequently described as failures along these linear models. For example, there have been multiple major reviews of the Australian NIS (including another that is happening as this is being written) (Dodgson et al., 2014). Nearly all of them identify a 'commercialisation gap' as one of the problems within this NIS. In other words, there is a consistent stream of high-quality inventions and scientific discoveries occurring, but with a limited commercial impact.

The outcome of these three issues is that the most common policy interventions when trying to develop a NIS are: increasing research funding in order to increase new technology outputs and providing Research & Development Tax Credits in order to increase the willingness of firms to invest in technology development and diffusion. However, while these are useful tools in improving NISs, the countries that have been most successful in evolving their NIS have adapted tools like these to local conditions, while also mapping out their own path forward (see Niosi, 2010; Dodgson et al., 2006).

This is consistent with the model of IS evolution laid out by Kastelle et al. (2014). That model is based on the micro meso macro framework of economic evolution (Dopfer et al., 2004). This framework defines three distinct levels of analytic structure in relation to 'generic rules' that compose the knowledge base of an economic system. An economy is made of knowledge and each generic rule forms a meso unit comprised of the rule and its population of carriers of that rule. Each micro agent, whether an individual or an organisation, is then a carrier of many such rules. The capabilities of each agent are a function of the rules they carry, but these are presumed to be in part subject to choice. Macro analysis, in turn, concerns the study of how all meso units – the rule populations – interact as a complex system as an industry, sector or national or supra national economic order (Dopfer and Potts, 2008).

Thus, in IS evolution, agents create, adopt and adapt meso rules that contribute to their effective innovation efforts. As these rules become more widespread, they subsequently contribute to the origin and growth of innovation-supporting institutions through the process of macro coordination. It is these processes of rule generation, adoption, and replication that lead to the evolution of the local ISs.

This paper presents an exploratory case study that illustrates how this can happen. We study the development of a research commercialisation program within the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Australia. It is based on the Lean LaunchPad (LLP) program in the USA. The authors adapted it on a trial basis for use within the CSIRO, and it has subsequently grown to become part of the larger Australian NIS. After fewer than two years, 17 universities and research organisations are now participating in a national version of the program.

2 Case setting

2.1 The CSIRO

The CSIRO is Australia's national science agency, playing a role in Australia similar to the Korea Institute of Science and Technology and The Industrial Technology Research Institute of Taiwan. It currently has nine business units; mineral resources, energy, manufacturing, land and water, agriculture and food, health and biosecurity, oceans and atmosphere, and a newly formed unit, Data61, which has a focus on digital innovation (CSIRO, 2016).

Following budget cuts in 2014, CSIRO developed strategy 2020, designed to increase the impact of their research. One of the key components of strategy 2020 is that CSIRO scientists must take a more active role in commercialising their research. Building on existing collaborative relationships, members of CSIRO Manufacturing and the University of Queensland Business School (UQBS) developed a plan to trial LLP to see if this could help the organisation meet its goals.

2.2 Lean LaunchPad

The trial LLP iteration was designed based on the innovation corps (I-Corps) LLP program used by the National Science Foundation (NSF) in the USA. This program has been very successful in increasing the research impact of NSF-funded research (Blank, 2012). The aim of this program is to provide an approach to increase the market– readiness of technology-based start-ups, thereby addressing the failure rates that they face. This failure rate of new ideas in the market is part of the reason that it is so challenging to use innovation to drive economic growth. Estimates vary, but failure rates are roughly:

- 98% in scientific research based on the number of patents in commercial use (Maulsby, quoted in Klein, 2005)
- 90% in start-ups, higher in technology-based potential high-growth start-ups (Blank, 2012)

- 80% in new product launches among established firms, higher in products that are not incremental (multiple sources summarised in Ulwick, 2016).

Lean start-up is a set of ideas originally developed for use in high-tech start-ups. This quote illustrates some of the key principles behind it: "The Lean Start-up methodology has as a premise that every start-up is a grand experiment that attempts to answer a question. The question is not "Can this product be built?" Instead, the questions are "Should this product be built?" and "Can we build a sustainable business around this set of products and services?." Ries (2011)

This outlines three areas of risk for new ideas: technical risk (can we build it?), commercial risk (should we build it?) and economic viability risk (can we build a business around it?). The premise behind LLP is that the failure rate in new product launches is high because the people launching the ideas tend to focus almost exclusively on reducing technical risk. They then build business plans to assess economic viability risk. However, the primary failure mode for new ideas is market risk – which is rarely addressed at all (Maurya, 2016).

LLP is a lean start-up-based program, designed to help build evidence-based business models for new ideas. There are three key components to the LLP approach (Blank and Dorf, 2012):

1 *Customer development:* this is an interviewing method designed to uncover customer problems that need solving. Doing so is the first step in reducing market risk. The goal of the program is to get teams to conduct 100 + interviews with potential users of their science, suppliers, and industry partners.

2 *Rapid prototyping:* once customer needs have been validated, the research teams build small-scale prototypes to test the whether or not their ideas are likely to solve the identified problems. This tool is harder to execute in science-based research LLPs, but still useful.

3 *Agile development:* this is primarily a software-development tool. In science-based LLPs this approach is modified to reduce development time as much as possible. This is harder in more regulated areas such as healthcare, but still an important part of the LLP process.

The process bears similarities to design-thinking approaches (see, for example, Liedtka and Ogilvie, 2011) in that both are abductive approaches to triggering growth through innovation (Dew, 2007). The lean principles behind it, including the rapid testing of business hypotheses with limited up-front investment, are also similar to those in effectuation theory (Sarasvathy et al., 2008).

All of these tools come together to develop a viable business model for the new idea/technology (Osterwalder and Pigneur, 2013). Teams start by building a proposed business model for their new idea using the business model canvas. They then convert this business model into a set of testable business hypotheses. Customer development, prototyping and agile development are then used to test and refine the business model by validating the customer problems to be solved by the new idea, thus reducing both market and economic viability risk. The process is similar to the scientific method, which is one of the reasons that it seems to work well with scientists, even if they lack a market orientation (Maurya, 2016).

2.3 The CSIRO LLP program

While the I-Corps program has been successful in the USA, it was not clear that it would be equally effective in Australia. The Australian entrepreneurial ecosystem is not as mature as that in the US. In particular, the amount of venture capital is much smaller (Cutler, 2008), the mentor network is not well-developed, and the structure of the economy is quite different (Hausman et al., 2011). Consequently, we started by running a small-scale trial of the LLP program at the CSIRO site in Melbourne. The trial was led by CSIRO manufacturing. Everyone involved contributed their time to the project in addition to usual duties. The trial LLP included the facilitation team, and the six project teams that volunteered, each with 3–6 members. The three questions we tested in the LLP trial were:

1. Can this approach also work in the Australian research context?
2. Would CSIRO scientists see value in this approach?
3. Would the scientists be able to do enough interviews to realise this value? The answer to the first two questions was definitely yes. The third was equivocal.

In early 2015, we ran a second trial in Brisbane with eight project teams, formally assigning mentor to each team, and with greater institutional support within CSIRO. This approach worked well, and we concluded that the answer to question three was also yes. This was an important part of the adaptation process. In the I-Corps program, particularly the early trial iterations, each team was mentored by venture capitalists with experience investing in the technical field of the researchers. This was part of the explicit goal of the program – to produce investible research-based ventures (Blank and Dorf, 2012). In Australia, we did not have a pool of mentors like that to draw from. Although we noted significant evolution from LLP pilot stage to early 2016 where CSIRO increasingly engaged externally with the business and start up community by reaching out to assign mentors to CSIRO teams. External mentors and facilitators have become a valued part of the program.

As the second trial was running, the new CEO of CSIRO, Larry Marshall, announced the launch of a program that was eventually called ON. As announced, it consisted of: an LLP-based commercialisation accelerator, the foundation of a technology landing pad in Silicon Valley to support the diffusion of CSIRO innovations globally, and establishing an internal venture fund to provide the equivalent of angel/seed investments in CSIRO technologies with spin-out potential.

Two of the authors participated in the design of and selection of teams for the accelerator, and one was co-lead facilitator of that program, which ran in Sydney from July-December 2015 with nine project teams, including two that had participated in the two previous LLPs, and two more that included team members with LLP experience on different projects.

The announcement of the ON program increased the interest in LLP among the business units. The four authors continued to work together on program design and administration, research team selection, and LLP facilitation. In the second half of 2015, we ran three more LLPs: a second in Melbourne (six teams), one in Sydney (seven teams), and one focusing on teams doing research in the coal industry in Brisbane (four teams).

In 2016, the administration of the program changed substantially. Ownership of the program within CSIRO was split between the learning and development team and the strategy team as part of the ON program. The strategy team took full responsibility for the accelerator as well. At the end of 2015 as part of the new National Innovation and Science Agenda (NISA) the federal government earmarked several million Australian dollars per year to CSIRO to run a national accelerator program open to all university-based researchers.

In the first half of 2016, the facilitation team for LLP was expanded, and three iterations were run simultaneously in Melbourne (seven teams), Perth (eight teams) and Canberra (11 teams). As well as experimenting with size, the Canberra cohort was also the first LLP iteration to include teams whose science focused on public-benefit research (e.g., climate change adaptation) rather than research into physical technologies. The public benefit teams were from the land and water and oceans and atmosphere business units, which meant that teams from all nine business units were participating in the LLP program.

In order to meet the national accelerator goals of the NISA funding, the strategy team engaged a Sydney-based commercial accelerator with national coverage, to run future versions of the ON Accelerator. The second of these ran in the middle of the year, with eight teams from CSIRO (including four that had gone through LLP), as well as research teams from Macquarie University and Flinders University. With the inclusion of the commercial accelerator, as well as the increase in teams with LLP experience, the activities and structure of this version began to resemble a more traditional technology accelerator program.

While engaging with the universities to discuss the ON Accelerator program, the strategy team learned that many universities were enthusiastic to participate, but felt that they did not have enough teams that were ready for that program. Consequently, the strategy team, with contributions from the lead author, designed ON Prime to address this gap. ON Prime is based on the internal CSIRO LLP program. The facilitation team was expanded again for this. In the second half of 2016, there have been two more internal LLP iterations in Melbourne (eight teams) and Canberra (eight teams), and five ON Prime iterations in Brisbane, Sydney, Melbourne, Canberra and Perth (eight teams in each, except Brisbane, with seven). The ON Prime research teams come from 16 different universities (with another ten that intend to participate in the program in the future), and there are also several CSIRO teams in the program. The outcomes include:

- 17 LLP iterations completed, including two LLP-based accelerator programs.
- 129 teams and over 700 people have participated.
- Two spin-outs and several successful new product launches.
- Contribution to significant culture change within CSIRO, supporting the customer-first strategy in CSIRO 2020.
- Rapid scaling to a national program open to all Australian researchers.

The overall outcome is that in less than two years, LLP technology-based and public good science has been successfully validated and become an important part of Australia's NIS.

3 Learning from the CSIRO LLP experience

The key points of learning cluster into three areas: adapting the LLP program to the local context, building successful innovation networks and ecosystems, and measuring success.

3.1 Adapting the LLP program to the local context

In testimony to the US Congress, Steve Blank outlined this rationale for building I-Corps:

> "The job of the I-Corps program is to teach our top scientists how to develop the many other essential components that make up an investable business (customers, pricing, sales channel, partners, marketing, manufacturing, etc.) and present them to private capital in a form that that articulates how investors can make money. And to do so in weeks, not in years.
>
> I-Corps is an educational program that is a bridge to private capital - not a replacement for private capital. Venture capitalists co-teach the class to prepare the teams so they can become fundable. Almost none of the entrants to the I-Corps cohorts could have attracted private capital." [Blank, (2012), p.4]

This illustrates several of the key differences between the I-Corps program in the US and the CSIRO LLP and ON Programs in Australia.

The first major difference is in objectives. In the US, I-Corps is designed to create investible companies. While this is part of the goal of the ON Accelerators, this target is much less prominent in the Australian programs. There are several reasons for this. The first is that the venture capital market is not nearly as mature in Australia as it is in the US. This was part of the rationale for building the investment fund (which is still in development at the time of writing) as part of the ON Program.

The second reason is that the overall innovation ecosystem is less dense. The Australian population and economy are both small relative to the US, while the land area is roughly the same. This makes even simple things like securing interviews more challenging, and larger issues like coordinating national programs are even more difficult.

Finally, and related to the first two issues, the mentoring pool is not as deep in Australia. In the I-Corps program, particularly the early trial iterations, each team was mentored by venture capitalists with experience investing in the technical field of the researchers. This aligned with the goal of producing investible technology-based business opportunities. Venture capitalists are involved in the ON program, particularly in the ON Accelerator, but there are not enough around to also support the LLP and ON Prime programs.

These issues have knock-on effects on the design of the programs in Australia. While there is a strong emphasis on increasing the velocity of developing the business side of research, the challenges in securing interviews, the less experienced mentoring, and the difficulty of accessing global markets make it harder to develop validated business models at the same speed. This is why the I-Corps program has essentially been split in two: with an LLP program as the kick-off, followed by further development in an Accelerator for the most successful teams from the LLPs.

A second design differences is in the delivery of the program. I-Corps is built around university-based delivery nodes, and facilitated by a combination of entrepreneurs and some academics. In the CSIRO programs, there are few universities equipped to facilitate such programs, and the ones that are tend to focus on building independent programs that are only available to internal staff. This isolation means that there is no consistent method for commercialising science-based research in Australia, and the CSIRO is probably the only organisation that can credibly coordinate a national program like this (Marceau, 2007).

3.2 Building successful innovation networks

Despite the challenges noted above, the LLP programs have been highly successful in contributing to the development of the innovation network within Australia. The Cutler Review of the NIS says:

> "In a globalised knowledge-based economy, patterns of innovation have evolved and shifted beyond the sole gifted inventor or scientist, or the adept researcher and technologist. They are more diverse and complex than just the picture of the creative entrepreneur with proven commercial acumen." [Cutler, (2008) p.28]

One of the goals of the ON Programs is to build these creative entrepreneurs, but just as important is developing the networks that enable their knowledge-sharing activities.

The raw numbers serve to illustrate the impact of these programs. The teams that have gone through them to date have conducted over 6000 customer development interviews, and secured more than 30 field trial partnerships. Within the CSIRO, the cross-disciplinary nature of nearly all of the LLP cohorts has served to build important collaborative bridges within the organisation. Furthermore, the ON Prime program has helped build similar bridges between and within CSIRO and the university sector within LLP cohorts. Many of the teams in the ON Programs in particular have also participated in start-up-based activities, such as pitching at SydStart 2015, and joining commercial accelerators after graduating from the ON Accelerator. All of these activities serve to integrate the Australian research community with the activities of normal commercial businesses, but domestically and internationally. While this is encouraging, it leads to the third area of adaptation: measuring success.

3.3 Measuring success

In the I-Corps program, success is relatively easy to measure. Since the goal is to develop investible business opportunities from science, then the frequency and size of investments are the desired outcomes, and are reasonably measurable. Longer-term outcomes from these investments include successful founding of businesses, job growth, and contributions to economic growth. Ancillary benefits for participants include accelerated and increased impact from their research, change in attitude toward commercialisation, and increases in entrepreneurial knowledge and skills.

While the CSIRO programs share these goals over the longer term, as discussed above, for the moment the objectives are of necessity a bit more modest. This has required us to develop an intermediate set of success measures to determine whether or not the program is working.

The key tool that we have used for this is the investment readiness level (IRL), first outlined by Blank (2014). The IRL is based on the technology readiness level (TRL) scale developed by NASA [see Dubos et al. (2008) for details]. The TRL is a scale from 1 to 9 that measures the technical maturity of new technology in terms of being ready to use in space flight. It is used both NASA and its suppliers to plan and track technology development. Many Research & Development-intensive organisations, including CSIRO, have adapted this scale to measure the technical maturity of their research as well. It is an effective tool to track and manage technical risk in research projects.

Blank designed the IRL to serve the same purpose for business model development in the I-Corps program. It is also a scale from 1–9 (Table 1) which parallels the levels in the TRL. As the TRL measures and manages technical risk, the IRL does the same for market and economic sustainability risk.

Table 1 TRL and IRLs

9	System 'flight proven' in successful mission operations	Identify and validate metrics that matter
8	System completed and 'flight qualified' through test and demonstration	Validate value delivery
7	System prototype demonstrated in space environment	Prototype – high-fidelity MVP
6	System model demonstrated in relevant environment	Validate revenue model
5	Component and/or breadboard validation in relevant environment	Validate product/market fit
4	Component and/or breadboard validation in laboratory environment	Prototype – low-fidelity minimum viable product (MVP)
3	Analytical and experimental critical function proof-of-concept	Problem/solution validation
2	Technology concept and/or application formulated	Market size/competitive analysis
1	Basic principles observed and reported	First pass business model canvas
Level	TRL	IRL

Using the IRL has proven intuitive for researchers that are already used to using the TRL to track their technical progress. Even in ON Prime, where few of the researchers were initially familiar with the TRL, the IRL has been an effective tool. During the first ON Accelerator, we developed an expanded version of the IRL scale to make it easier for the research teams to assess their progress through the program (Table 2)

The goal of the I-Corps program is to help the teams progress to IRL5, which is validation of product-market fit (Blank, 2012). This means that the right hand side of the business model canvas has been validated through customer development interviews and prototype feedback. This includes identifying the market segments for early adopters and subsequent growth, the value propositions that are effective for those segments, the channels through which the solution will reach the customers, and the strategy to get, keep and grow the customer pool (Blank and Dorf, 2012). After the early pilot I-Corps cohorts, 98% of teams felt that they had reached IRL5 at the end of the program. The outcomes from these cohorts also show that reaching IRL5 is in fact a good indicator that the project is ready to try to attract external funding (Blank, 2012).

Table 2 Expanded innovation readiness level

IRL 1 *Complete first-pass BMC*	*IRL 2* *Market size/competitive analysis*	*IRL 3* *Problem/solution validation*	*IRL 4* *Prototype low-fidelity MVP*	*IRL 5* *Validate product/market fit*	*IRL 6* *Validate revenue model*	*IRL 7* *Prototype high-fidelity MVP*	*IRL 8* *Validate value delivery*	*IRL 9* *Identify and validate metrics that matter*
BMC filled in	Detailed map of total addressable market	At least one potential market segment invalidated	Market hypotheses and tests developed to guide learning from MVP	Map of customer ecosystem and flow	Map money flow	Market hypotheses and tests developed to guide learning from MVP	Partnership ecosystem mapped	Key growth metrics identified
Describe assumptions that must be true for each entry into the BMC	Sub-sections of the market	First target segment identified (60–100 interviews)	MVP is built (sample data, financial model, etc.)	Get-keep-grow loop outlined	Revenue model validated *(20 + interviews)*	Actual market-based prototype is built	Funding and growth model built	Measurement system in place
Outline how each assumption will be tested and measured, and how success will be identified (test card)	First niche we will address (in terms of $ we can earn, not total value of each segment)	Customer problem validated (60–100 interviews)	Prototype solution validated *(20 + interviews)*	Market channels and customer relationships validated *(20 + interviews)*		Prototype solution validated *(20 + interviews)*	IP requirements identified and secured	Some customer acquired (may happen in IRL 6)
	Competitor map (petal diagram)	Solution validated *(60–100 interviews to do this)*					Assumptions in the left four blocks are tested/validated *(30+ interviews)*	Idea ready for launch/sale/license, etc.

This measurement approach has proven effective in the CSIRO programs as well, albeit with modifications. As the discussion above would suggest, the teams in the LLP programs right now are not getting as far as their counterparts in I-Corps. This is probably due to a combination of the constraints imposed by the Australian context, along with less experienced facilitation teams. Nevertheless, by combining team self-assessment with evaluation by the facilitators, the outcomes are encouraging. The ON Accelerator teams are reaching IRL5 at about the same rate that the I-Corps teams do. Given that, and with LLP and ON Prime designed as pre-Accelerator programs, the goal for these teams is to reach IRL3. Of the teams that have fully completed these programs to date, 86% have reached IRL3 or above.

One interesting point about IRL3: teams that reach this level of market knowledge now know enough to change their research programs to meet identified needs. In other words, the LLP programs enable the co-evolution of technical and market development.

Another measure of interest is that of the 14% of teams that have not reached IRL3, about half of those have decided to put the research project on hold. While this is not a desirable end point for the researchers, at the organisational level this is a great outcome. It allows researchers to make their own decisions about when to move on to other research projects that they are involved with, rather than having this decision imposed from above.

There is evidence of change on the part of the scientists as well. Some of the statements from participants in the first pilot LLP in Melbourne include:

> "LLP has given us the guts to have conversations that usually we would feel too risk averse to have."
>
> "There is a risk with Platform IP that the market applicability is a mile wide and an inch deep – and the risk is that we don't actually do anything with it."
>
> "I thought we knew what we were doing – it turns out we don't. LLP doesn't stop for us next week."

A small survey of that group (n = 16) also showed that among those participants in the group that did more customer development interviews, they were more likely to strongly agree with these statements:

> "We will use the information collected for LLP as part of commercializing our project."
>
> "The LLP program has changed my approach to research projects."
>
> "I will continue to use the ideas I learned in the LLP program in my projects."

These outcomes are consistent with those observed in participants in the I-Corps program.

4 Discussions and conclusions

This case study has several important implications for research on the evolution of ISs.

The first is that local context is very important. Nearly all of the first year of the LLP programs in CSIRO was primarily concerned with successfully figuring out how to adapt the program to work effectively within the Australian NIS. Compared to the country of origin of the program, the US, the Australian NIS is relatively weak in areas such as venture capital, density of entrepreneurial firms and mentors, size of the economy, and access to international markets.

These factors combine to make it difficult to adapt the LLP program without change. The primary change is in scaling down the initial primary objectives of the program. Ultimately, I-Corps and the CSIRO Programs have very similar goals. However, the current state of the Australian NIS means that it will take longer to reach these goals. In addition, the development of the CSIRO Programs is an important part of building the networks required to enable this evolution of the NIS.

This leads to the second important point: NISs both function and evolve along nonlinear paths. As the CSIRO programs become more embedded in the Australian NIS, the system itself will change in response to the actions of those participating in the programs. This is an example of the Schumpeterian view of ISs (Dodgson et al., 2014), which emphasises the dual roles of market impact and economic coordination. Even though the LLP was originally conceived to primarily influence market impact, in the Australian context the LLP-based programs have served an important role in supporting the coordination of innovative activities within the NIS. In this instance, the relatively small size of the Australian innovation ecosystem works in its favour as it makes it easier for one central institution, CSIRO, to play that coordinating role.

Similarly, at the level of research projects, co-evolution is also highly important. The interaction between technical development measured by the TRL and business model development measured by the IRL is one of the most striking elements of the case study. One consistent observation is that as the research teams engage more deeply with external stakeholders, the nature of their research changes. Often, teams will come in with technology that they believe is at TRL6, but after going through LLP, they realise that to meet the needs that they have identified they have to go back to earlier stages of technical development. This means that the traditional model of researchers doing their work then handing it off to Business Development to take to market is unlikely to be as effective as LLP-based programs.

Finally, this is an interesting example of where new economic rules within an NIS originate. This case started with four people that wanted to experiment with LLP in response to the changing economic conditions facing the CSIRO. The initiative was not only not top-down from a policy level, it wasn't even top-down within the organisation. While the program was being adapted to fit the local context, the ON Program was launched in a more top-down manner. As the two programs have been merged, it has turned into a national program as the idea continues to spread. This illustrates by the type of IS evolution outlined by Kastelle et al. (2014). The new economic rules were adopted from an international innovation system. The first task was to work out how to make the rules work at the local level – the micro adaptation. Once this was done, the frequency of the rule in use increased, leading to a re-coordination of NIS rules at the macro level. This case is a reminder that big ideas often start out very small.

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