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Submission on the Productivity Commission's Issues Paper,

"New Zealand firms: reaching for the frontier"

On Behalf of The MacDiarmid Institute for Advanced Materials and Nanotechnology

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The MacDiarmid Institute for Advanced Materials and Nanotechnology is one of New Zealand's Centres of Research Excellence. The Institute is funded by the Tertiary Education Commission (TEC) and hosted by Victoria University of Wellington. This submission represents the Institute's 40 Principal Investigators, who are world-class researchers distributed among 7 partner institutions across the country; in addition to approximately 200 affiliated researchers from postgraduate level upwards.

Summary.

The MacDiarmid Institute welcomes the opportunity to make a submission on this Issues Paper. The Institute was founded by Sir Paul Callaghan in 2002. Since then, we have extensively promoted research-led economic transformation in NZ, helped to build NZ's innovation ecosystem, and commercialized our own research. We have produced hundreds of highly-skilled and knowledgeable research graduates in the physical sciences, and built the pathway from the lab into NZ industry for these people. Our main points of feedback are:

- The primary importance of people can easily be lost when considering the performance of firms. To host productive frontier firms NZ must train, attract /retain, support, and inspire talent. This should be a top priority.
- For a post-Covid economy with clear sustainability challenges, we think that a values-led approach to innovation is the way to bring intergenerational prosperity to NZ. This approach resonates with key characteristics of the Māori economy, as well as with deep tech research.
- It is good that the full value of research and innovation (including spillovers, economic complexity etc.) is recognised at times in the Issues Paper. However, this serves to highlight that NZ's low R&D investment (by both government and industry) remains a standout weakness in the policy framework.
- We applaud efforts to improve the culture of innovation within NZ firms by promoting a global outlook and knowledge intensity. Firms in the tech sector (especially deep tech) have these characteristics, and the recent progress of this sector in NZ is notable.

In this document, we first discuss a series of **general points** (labelled A-H) relevant to the Issues Paper; this is followed by **responses to the questions posed**; and a discussion of the Landfall Strategy Group paper [1] is included as an **Appendix**. We welcome follow-up from the Productivity Commission, including any opportunity to discuss our response in person.

General Points

A. Putting people at the centre. The Issues Paper recognizes that a skilled workforce is an important driver of productive, frontier firms, but the requirement to support people is underemphasized.

- Frontier firms require people who have a combination of deep domain expertise (especially in science, research and technology) and a range of soft skills such as problem solving, digital and communication skills, and often entrepreneurship. This goes beyond narrow vocational training, and matches the profile of graduates produced by the MacDiarmid Institute and similar research organizations [2].
- Many outstanding innovators and business leaders make a transition from research. However, pathways for early career researchers in NZ are chronically under supported. See point G.
- Sir Paul Callaghan portrayed NZ as "a place where talent wants to live". NZ can attract and retain talented people (at any career stage) and indeed companies not only by providing interesting, lucrative work, but by emphasizing innovation which aligns with our values. At the MacDiarmid Institute, where we have chosen to focus our materials science research on sustainability applications, around two-thirds of our PhD students come from overseas, but only one-third move offshore on completion of their degree [3].
- NZ's comparatively successful response to the Covid-19 pandemic has given us a particularly strong opportunity to attract and retain talent in the near future.

B. We are particularly interested in the high value opportunities provided by "deep tech", which can be defined as technology and associated IP that is characteristically hard to replicate, may have long developmental timeframes, is knowledge intense, and increases complexity in the economy [4-6]. Deep tech may be distinguished from innovations which are easily copied, which provide marginal productivity gains (p.16-17), or which provide quick but short-lived advances in highly competitive sectors. We have recently written about the importance of deep tech for values-led innovation in sustainability and the Māori economy [7], and for the economic recovery from a Covid-driven recession [8].

C. Contributions of R&D and innovation to productivity. It is good to see an overall focus on innovation in the Issues Paper. The Commission should continue to emphasize the important special characteristics of knowledge economics (spillover benefits associated with complexity, increasing returns to scale, etc.), and the non-exclusive nature of knowledge. These characteristics motivate public research funding and mechanisms for IP protection [9]. We further encourage thinking about the different types of links between innovation and productivity growth, for example:

- Innovations which create new products will produce different growth dynamics to innovations which improve firm processes. E.g. new products can create new high-

productivity firms, which may not be captured when measuring productivity growth of established firms.

- Deep tech innovations provide stronger, longer-term competitive advantages alongside benefits such as increased economic complexity and knowledge intensity [4-6]. This is in contrast to innovations which are easily adopted or copied, so that productivity growth is shared through an industry.

D. Recent trends should be considered. Economic transformation will take time and persistence, and some important developments in the past ~5 years are not necessarily reflected in macroeconomic data sets. Recognition of these trends is notably absent from Landfall's report [1].

- The Technology Investment Network (TIN) reports [10] record the significant scale and growth of NZ's tech sector. 2019 sector revenues ($12.1 bn) grew by more than $1bn (10%) for the second year in a row. Export earnings of $8.7bn place this sector third behind dairy and tourism; ahead of meat and forestry.
- Societal acceptance of the idea that R&D can lead to a more diverse, productive economy has become embedded in NZ over the past couple of decades. This is reflected in the policies of successive governments, and in a proliferation of analytic reports (many are cited in the Issues Paper). The impacts of structural and funding changes have emerged over the past few years in particular. We particularly note the increasingly cohesive role of technology transfer offices (TTOs), Return on Science, Kiwinet, incubators and investors in the University commercialization pipeline. Following extended setting-up periods, Callaghan Innovation and the "Science for Technological Innovation" National Science Challenge are also contributing well. Funds made available to businesses to support R&D seem to be becoming more widely-used.
- BERD (Business Enterprise expenditure on R&D) doubled between 2012 and 2019 [11], benefitting from schemes such as R&D Growth grants and R&D tax credits, as well as focussed agency support from MBIE and Callaghan Innovation – see also point G.
- This maturing of processes is reflected in the MacDiarmid Institute's commercialization experience: of 19 affiliated start-up companies (that have a MacDiarmid Institute member as a founder), 16 have emerged since 2011. Our recent alumni are working in at least 13 different NZ start-up companies [3].

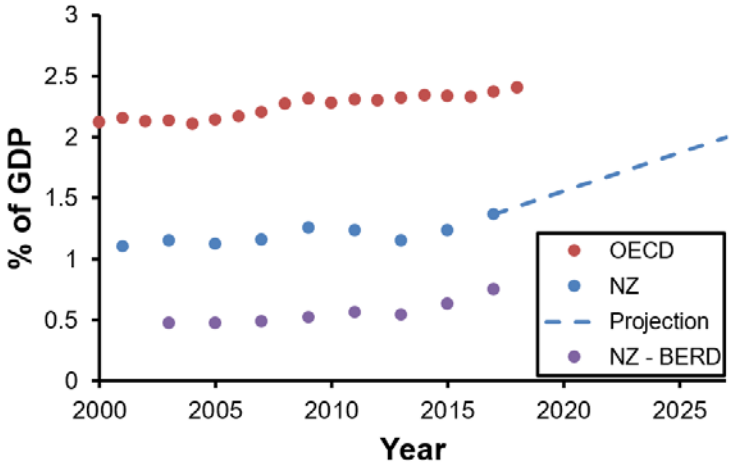
E. The Covid-19 pandemic brings additional challenges; although NZ also faces issues which are potentially even more important such as climate change, and the sustainability of primary production and tourism. The pandemic recovery should not be driven by fossil fuels, as it was following the GFC. Notably, the pandemic also brings an opportunity for creative destruction (i.e. reorganization of capital and labour). Similar opportunities are provided by energy-sector developments in Taranaki and Southland. Importantly, these dynamics should not affect our long-term vision for (and investment in) the role of R&D in the economy. Now is actually the time to double down on those efforts [7,8].

F. The importance of sectors and clusters for productivity is particularly emphasized in Landfall's report [1], which suggested focusing on two sectors (primary production and the weightless economy). We submit:

- Sectors are defined inconsistently on p.24-25 of the Issues Paper, in the Landfall report, and in TIN data. This is important - for example, high-value manufacturing (HVM) is prominent in the Issues Paper (Fig. 3.5) and TIN data, but does not appear in Landfall's report.
- The two sectors identified by Landfall illustrate important differences in cluster dynamics. The primary sector is a vertical, with products ranging from commodities to complex technologies enabled by deep tech. Some spillover benefits reach adjacent industries. The weightless economy ("digital, creative, and other knowledge-based services" [1]) can have a presence in many industries. To us, it makes sense to encourage the latter type of cluster. Deep tech is a key example of this, with the added benefits of knowledge intensity in comparison with the weightless economy.
- The TIN reports describe the tech sector as our 3rd biggest, dominated by ICT and HVM firms, but the range of industry verticals involved is wide and complex.
- Notwithstanding the importance of scale pointed out by Landfall, we suggest that high and sustained productivity growth can be supported through high quality research and innovation that is well-connected within NZ and/or internationally, regardless of the specific industry.
- Knowledge-intense, deep tech clusters in NZ may be based on geography (Level 2 in Parnell; East Tamaki; Gracefield; aquaculture in Marlborough), existing industry verticals (primary, medical technologies, rockets), or broader emerging opportunities (environmental sustainability, the Māori economy, energy infrastructure in Taranaki and Southland). The examples here are not designed to give an exhaustive picture, but each has strong R&D links.

G. Innovation and development of a skilled workforce are not well supported or incentivized in NZ, despite being universally recognized as key drivers of prosperity. Sir Paul Callaghan's observation that in 2010 that New Zealand was spending ~1% of GDP on science, research and development (about half the OECD average) has become the most prominent political measure of research investment. The current Government's strategy commits to 2% of GDP by 2027, following the dashed line on the chart below [12]. Government's spend is increasing (under $1bn in 2017 and budgeted at over $1.5bn next year), but progress towards 2% of GDP was being questioned late last year [13]. Reaching this target by 2027 looks very difficult to achieve if business as usual prevails during the pandemic recovery - BERD is supposed to make up around half of the 2027 target.

We suggest that growth in government investment (still well below the OECD average) is required to stimulate stable, deeper flows of knowledge, which will in turn stimulate greater BERD.



Research and Development Spend. Source: OECD Science, Technology and R&D Statistics: Main Science and Technology Indicators (14 May 2020)

H. Pilot plants for scale up. The MacDiarmid Institute is currently seeking to stimulate discussions around more co-ordinated support for firms which require pilot plant facilities in their product development pathway (from lab to factory). We see this as a critical area of shortfall in NZ's R&D landscape – particularly for industrial processes relating to energy and sustainability.

Responses to Questions in the Issues Paper

Chapter 1

Q1. How should the inquiry define frontier firms? What data are available to enable the study of frontier firms under your suggested definition?

- Any discussion on frontier firms should account for R&D intensity. Notably, the central role of innovation was unclear in Chapter 3, which used the existing definition of frontier firms.
- R&D intensive companies may be small, and are not necessarily identified by raw measures of productivity – see especially bullet points 2 and 3 on p.7 (Māori frontier firms, those that have potential for high productivity in future). For larger companies, R&D intensity is indicated by employee profiles, investment in R&D, and participation in government grant schemes.
- Flows of R&D active people into and out of NZ and firms could be monitored, as we have done on a small scale with our alumni survey [3].
- The TIN reports are very useful for identifying innovative high-growth firms. Any available data relating to firms accessing Vote RS&T funds would be useful, particularly for identifying collaborations between firms and the research sector. Other potential sources of information (perhaps confidential, at an aggregated level) include University technology transfer offices, incubators, Kiwinet, Callaghan Innovation, and those tertiary organizations

(including CoREs) which study the employment destinations of STEM-trained research alumni.

Chapter 2

Q2 Do you think the OECD framework is useful to guide the Commission's thinking in this inquiry? Are there other frameworks the Commission should consider?

We do not see an issue with using this framework as a starting point, especially for comparisons across the OECD. It does not capture the following, which we would treat as priorities to add greater insight:

- The role of people in productivity growth: skills, values, wellbeing, training, incentives, motivations, etc. These are critical to all three drivers of productivity growth (p.12), and Treasury's Living Standards Framework [14], for example, gives weight to the importance of human capital. It is vitally important to support the people who do the R&D – point A.
- Different types of links between innovation and productivity measures – point C.

The commission could consider the Global Innovation Index [15], a regularly updated database and report which has a framework for evaluating innovation inputs and outputs as a means to develop supportive policies.

Q3 What do you think are the most important drivers of the productivity of New Zealand's frontier firms?

- It is encouraging to see the focus on innovation and new knowledge among the drivers of productivity growth (Table 2.1), and particularly the recognition that knowledge generates increasing returns to scale and spillovers – point C.
- Diffusion is an interesting driver because of the importance of knowledge exclusivity and IP. In a practical sense, we endorse formats such as Return on Science panels for innovators to access expertise, mentorship, and training in a confidential environment.
- The discussion of skills development is centred on firms, rather than people. As Landfall's report [1] notes, a culture of innovation and aspiration to international success are as important as policy settings. See Q2 and point A.
- We agree with Landfall's report that international focus, scale, and clustering are important drivers. However, we question direct support for these, and particularly for specific sectors – see point F and the Appendix.
- Regarding reallocation and specifically entry of firms to market, we've identified a key barrier around pilot plants for scale up (point H).

Q4 What makes frontier firms different? What do they do differently, or have that other firms don't?

In our experience with industry engagement and deep tech start-ups, frontier firms have:

- Developed a distinctive product or IP which has a (usually global) market.
- Talented and committed employees with entrepreneurship and R&D skill-sets, formed into an effective team (for smaller companies) and/or well led (for larger companies).
- Good access to investors and capital, regardless of the initial innovation. Investors use the adage that they are more interested in an "A" team with a "B" idea than vice versa.
- Received critical input and advice, particularly for global strategy, often from an investor.
- Often had some kind of 'leg up' into international markets. E.g. Rocketlab and Engender successfully pitched to large US investors at an early stage.
- Often directly benefitted from policy around R&D subsidies, regulatory barriers, etc.
- A culture of innovation combined with an aspiration to be globally competitive. These are essential if companies are to go the extra mile.

Q5 Can the success of frontier firms be replicated? For example, how much of their success is down to highly motivated and talented individuals, good timing, or even just good luck?

- Market readiness and the emergence of competitors can be a matter of timing or luck – but the development and availability of 'motivated and talented individuals' working at innovation frontiers is emphatically not. Notably, a good team with a deep knowledge base can usually regroup or change direction in response to a changing landscape [16]. This reinforces the importance of skilled and motivated individuals (see Q3, point A).
    - In April this year, Orbis Diagnostics (a MacDiarmid-affiliated start-up) announced that they would target a coronavirus antibody sensor, drawing on their core expertise in 'lab-on-a-disc' technology used in the dairy industry [17].
- Motivation, a crucial ingredient, can be encouraged through networks and a well-resourced innovation ecosystem. Similarly, talent can be nurtured with the right resources.
    - Brendan Darby, CEO of tech start-up MaramaLabs and a Kiwinet awards nominee, is commercializing fundamental research from his PhD. MacDiarmid has provided an internship to keep Brendan in NZ following his PhD, seed funding for the company, and various networking and personal development opportunities. We have a number of similar examples of development pathways for outstanding entrepreneurs.
- Connectedness (to investors, knowledge networks, and facilities/infrastructure) is probably just as important when considering replication of success.

Q6 What are the most important drivers of the diffusion of technology, ideas and business practices from frontier firms to other firms in New Zealand?

- Well-connected, skilled, entrepreneurial individuals who are able to drive communication and uptake of ideas and technologies.
- Willingness and ability of non-frontier firms to innovate. Landfall's paper [1] (p.26) gives a good description of the reasons for NZ companies having a reputation for being conservative.
- For diffusion, it is specifically worth considering IP (in its various forms), which plays a role in limiting diffusion and securing competitive advantage.
- Direct (person-based) networks (e.g. Return on Science, Kiwinet) which actively support knowledge sharing and aspire to compete globally rather than only locally (and hence more adversarially).

Q7 How easily do resources flow from lower to higher productivity firms and vice versa? What are the most important drivers of the reallocation of labour, capital and other resources between firms in New Zealand?

- Labour reallocation in NZ faces the challenge of our high rates of low productivity employment. This highlights the importance of high quality training involving transferrable (rather than purely vocational) skills – point A.
- There has been a notable improvement in capital flows towards frontier firms in recent years. E.g. see investment figures in the TIN reports [10].
- Allocation issues can arise when companies attempt to "do it all themselves" rather than using niche original equipment manufacturers (OEMs). This results in both low productivity due to lack of expertise, as well as a lost opportunity for resource sharing. Use of OEMs can deliver high value components and free firms up to focus on their core value-add.

Q8 In your view, what are the key ingredients that would lead to a successful New Zealand economy, and what would success look like?

- More people, firms and investors engaging in deep tech, rather than being satisfied with tech adoption. This is not only consistent with high productivity and prosperity, but also values such as sustainability which are especially prominent in the Māori economy [7,8].
- More people, firms and investors exhibiting behaviours associated with high productivity; especially, taking an international outlook. These behaviours should be actively nurtured.
- Overcoming our obvious challenges (geographical isolation, a transition away from unsustainable and low value activities, and addressing the upcoming recession) - using

innovative approaches, or otherwise. Solutions which leverage our shared values, distinctiveness and natural advantages would be particularly beneficial.

- Incorporating Māori values of long term planning and intergenerational wealth development ahead of short term planning.

The successes described here imply bold action and international leadership – doing things in ways that other countries have not.

Chapter 3

Q9 Does the Commission's description of New Zealand's frontier firms and the performance of frontier and non-frontier firms seem accurate?

- In this Chapter there was little emphasis on R&D intensity (e.g. TIN data were not used p.23-25), and interesting emerging firms may have been excluded (see Q1).
- Descriptions of tech uptake should include 'deep tech' (point B) rather than focusing on ICT implementation and business models.
- On p.18: what proportion of the top 10% of firms in NZ (or comparator countries, Fig. 3.3) would qualify for the OECD top 10%? While we understand the need to avoid small numbers (p.21), this probably means that the comparison between frontier firm performance in the OECD and individual countries is not direct. It would also be good to indicate the spread of data in the Tables.
- There is inconsistency in the way sectors are defined e.g. on p.24-25, in the Landfall report, and in TIN data; see point F.

Chapter 4

Q10 To what extent do you agree with the Commission's tentative picture of why New Zealand's frontier and non-frontier firms are underperforming?

We are in broad agreement with many of the issues raised – see Q11-12 for further detail.

Q11 In your view, why does it appear that the productivity of frontier firms in New Zealand has not grown faster than non-frontier firms, unlike the situation globally?

- The report has noted the possible dominance of large multinationals when it comes to the global statistics; see also Q9 regarding direct comparison between NZ firms and the OECD.
- See also our answers to Q12-22.

Q12 What explains the research finding of a weak connection between innovation and productivity growth among New Zealand firms?

The nature of the innovation being carried out, which may not be picked up by productivity measures, or may not be at the global frontier. To study this, we encourage closer inspection of the ways in which innovation drives productivity (point C):

- Re: p.28 "The impact of innovation on firm performance". R&D (especially deep tech) may result in a highly productive new firm (e.g. in HVM) rather than strong productivity growth for an existing firm.
- On p.28, the Issues Paper identifies especially strong growth for 'new to the world' product innovations – this is a good example of insight from more granular data, and it highlights the importance of good international networks and knowledge intensity. It would be interesting to see similar data focusing on organizational processes, adopted technologies, etc.
- The idea that "firms need to reinvent many aspects of their operation" is important, but we think that innovation relating to operational models is somewhat 'business as usual' - an ongoing management challenge, dependent on support and diffusion from the ecosystem, but different to a primary stimulus such as introduction of a new product.
- On p.26-27: clearly organizational, service, and IT innovations do improve productivity; as does fast adoption of these methods ("new to the firm"). We would encourage thinking about the extent to which such innovations are non-exclusive, add to knowledge intensity, and provide sustained competitive advantage - in comparison with deep tech.
- Innovation takes time and perseverance to have a measurable effect – consider the history of firms like F&P Healthcare or Douglas Pharmaceuticals. Relative newcomers like Carbonscape may take many years of persistent innovation to reach high levels of success. Repeated policy changes and low levels of R&D funding are likely to have hampered long-term development for some NZ companies.

Q13 What are the main challenges for New Zealand firms that aspire to reach the performance of the best firms globally?

The 'drivers' identified on p.31 are useful, and align with Landfall's paper [1]. We would add a focus on people - point A. Some other considerations:

- Historic and geographical factors are noted, but we agree with Landfall that fatalism should be avoided. The question is how NZ firms can act as if they have the international connectivity and scale seen elsewhere? We think that this can be achieved by emphasizing people, economic complexity and deep tech, with a related focus on connectivity and stable research funding (points A, B, F, G).

- Domestic markets in NZ are usually of sufficient quality to act as a test-bed for world-leading technologies (e.g. medical devices), but lack scale, so companies should aim for international entry rapidly after success in NZ markets.
- Lack of R&D investment leads to lack of access to valuable IP. The challenge to get firms investing more in R&D is well recognized (e.g. p.26). However, growth in public investment may be the starting point, see point G.
- With respect to capital markets, there have been improvements (see Q7).
- Management and governance: in Q12 we mentioned differences between adoption, organization, and more meaningful innovation. We see very little technical or scientific input on Boards or in management of NZ companies, which would help to understand these differences.

Q14 Are New Zealand firms ambitious about growing and scaling up? If not, why not? If they are, what's getting in their way?

- We would particularly like to highlight point H – lack of a mechanism for funding or accessing scale-up pilot plant facilities is a significant logistical barrier.
- More generally, the Issues Paper is consistent with our experience, and we note that Landfall's paper [1] (on p.26) gives a good description of reasons for NZ companies being relatively conservative.
- However, we are seeing improvements over time (point D); if the key motives for not innovating are a lack of time, money and skills (p.28), then the former two factors are increasingly less problematic (perhaps in contrast to skills).
- Many NZ companies prefer to remain relatively generalist, with a relatively wide range of products. The alternative is to specialize in a niche, and collaborate with similar companies with complementary capability. To encourage successful SMEs with a focus on quality in this way, it may be valuable for NZ to emulate the German concept of Mittelstand [18].

Q15 How do New Zealand's frontier firms learn about, adapt and adopt cutting edge technologies and practices?

Note that cutting edge technologies and practices, rather than being gained by diffusion, can be developed by firms themselves. Principally this is achieved through investment in R&D, and hiring and training people.

- This type of activity also increases the speed of adoption.
- Diffusion and innovation both benefit from a strong local ecosystem, or clustering (as mentioned p.28-29).

- Highly qualified, NZ-educated graduates can undertake complex R&D. They should have a clear and well-supported path to employment that uses their skills, rather than needing to move out of their chosen area early in their career.

IP considerations are important here due to the non-exclusive nature of knowledge. We encourage regulatory clarity, building opportunities for cluster-type behaviour within a trusted confidential setting, and discussion of the types of IP (formal or otherwise) that are most appropriate for different types of innovation - point C.

Q16 What types of international connections make the biggest difference for diffusion from the global to the domestic frontier? What could be done to improve these kinds of connections?

- International connectedness of scientists, technologists and other researchers (including with international companies) is important for placing our R&D capability at the global frontier. In turn, this ensures that business innovations can be at that frontier.
- Attracting people who are working on the global frontier from overseas – point A.
- Technology due diligence – often available through incubators and investors, and therefore well-connected to capital.
    - At least one of our major start-ups was stimulated by an investor who put together a list of specific technical problems identified by their global connections. A scientist recognized they could solve the problem; global investors and end-users were already lined up to work with them. In contrast, opportunities identified by government agencies can be unspecific, and appear difficult to take to market with significant benefits to NZ.
- Encouraging an international focus during early stage triage of ideas (e.g. in proposals for government funds, or at forums such as Return on Science).

Q17 Do frontier firms have a problem sustaining their performance? What is needed to maintain high productivity over the long-term?

- Ongoing commitment to (and investment in) R&D and innovation.
- Effective scale-up and international connectivity.
- Policy certainty over longer time horizons than the usual political cycle allows.
- Absolute productivity may be more important than productivity growth for companies entering the market in high-productivity sectors – point C.

Q18 Why don't other firms follow the example of frontier firms? What's holding them back?

See Q13 and Q14.

Q19 How could the lessons from New Zealand's frontier firms be better shared?

Diffusion has been covered (Q15, Q16), but some specific potential improvements:

- More, and clearer, opportunities for showcasing best practice and new innovations.
- Identification of clusters, and/or promotion of cluster-like activities.
- A culture of innovation driven from management and Board level.
- Consideration of IP best-practice (see Q15).
    - We have struggled to work with some NZ companies because they are wary of (i) sharing IP in any way, often as a result of IP theft (usually offshore) or accidental dissemination, and (ii) difficulties setting up agreements with University TTOs.
- Adequate resourcing and support for direct collaborations between research organisations and companies - e.g. such collaborations could be an explicit criterion on Callaghan Innovation grants.

Q20 How do different types of corporate form and ownership structure affect firms' incentives to innovate, grow and internationalise?

- Our experience is focussed on the importance of setting up the right team within a start-up. One important aspect is setting up an ownership structure which gives the team clear incentives for success, and which gives that appearance to investors.
- We found Landfall's comments about issues relating to structures such as co-operatives to be instructive.

Q21 What are the pros and cons of the standard corporate governance model for stimulating business growth, innovation and productivity?

- Corporate Boards are often formed around skill sets, yet scientific and technical knowledge is often absent or underemphasized among Board members and management in NZ firms.
- It is widely acknowledged that corporate Boards would generally benefit from increased diversity of ideas and people (gender, age, ethnicity, nationality, international experience, and educational backgrounds). NZ still has a relatively small, thinly spread pool of governance professionals from relatively homogeneous backgrounds. It is not unheard of for a director to be on 15 or more boards.

Q22 Are there particular barriers to innovation, diffusion and reallocation that the Commission should focus on?

- Developing, retaining and incentivizing the people who can enable these activities. Encouraging a culture where commercial aspiration is applauded while leading with societal values – thereby making NZ a place where talent wants to live, point A.
- Building IP which gives sustained, hard-to-replicate competitive advantage and economic complexity (e.g. deep tech). In particular, by supporting R&D intensity – points B, G.
- Developing clusters without being constrained by vertical sectors; replicating clustering behavior despite challenges of geography and scale – point F and Q13.
- Having an international focus.

Chapter 5

Q23 How should this inquiry think about and define a Māori frontier firm?

We are not overly concerned about definitions; being on the frontier implies some distinctive aspect to the product offering or aspiration of the firm.

BERL's Ganesh Nana has made a distinction between "being a Māori business" and "being a Māori doing business". The former model addresses the question posed at the start of Chapter 5 (whether non-Māori firms can learn from Māori frontier firms) by asserting that Māori bring an innovative, sustainable way of doing business that can be replicated.

Q24 What resources/opportunities and constraints/barriers are unique or greater for Māori frontier firms, compared to non-Māori firms?

Our thinking around opportunities for the Māori economy has been published [7]. We see an important resonance with innovation – and specifically deep tech – with respect to the distinctive elements identified in the Issues Paper, such as: (p.37) an intergenerational focus, a multiple bottom line, reinvestment into development of people, (p.39) unique or hard-to-replicate products, and the "value of cultural connections" including between first-nations peoples.

- The Issues Paper did not emphasize material/environmental sustainability, which is a key part of kaitiakitanga and a potential area of opportunity for Māori frontier firms.
- International focus is perhaps less of a challenge for Māori than for others, as the idea of national borders is not so constraining, and there are strong and direct connections with first-nations peoples elsewhere.
- There is an interesting parallel between Māori firms and so-called 'family firms' elsewhere (notably Japan and Germany [18]) which have a knowledge-intensive, intergenerational focus.

In terms of constraints and barriers, there is a well-established skills shortage linked to lack of educational opportunity, and geographical isolation can be exacerbated for businesses in the regions.

- Conservatism (p.37-8) and geography have historically driven a focus on primary industries and resources - industries listed (top p.41) do not include manufacturing or high value goods.
- Financial opportunities may have been historically limited (p.40), but we note a current enthusiasm among deep tech investors for distinctive offerings from the Māori economy.
- The difficulty of engagement with innovation providers as well as business services (p.40).

- **How do these opportunities and constraints vary by the organisational form of the Māori entity?**

We have found umbrella or sector clusters to be very effective for driving innovation within the Māori economy. Examples include Nuku ki te Puku, Wakatū, FOMA Innovation, and Poutama Trust. These groups are likely to support activities recognized as (p.39) "Innovative and entrepreneurial", to have an outlook dominated by international markets, and to enhance knowledge diffusion and promotion of people and ideas.

- **How do Māori firms maximise opportunities within these constraints?**

- Building on existing momentum – Māori innovators can further act as a 'cluster' to share methods and success stories.
- Clarity around IP is important – see Q15, and notably the outcome of the Wai 262 claim will have a significant impact on Māori innovation.
- Further engagement in R&D through available dedicated funds.

What would help mitigate barriers or enable Māori firms to better maximise their potential?

Engagement between research organizations and Māori is improving in historically weak areas such as the physical sciences and engineering. Lines of communication between iwi organizations and researchers have been limited due to lack of bandwidth on both sides, and lack of cultural competency – noting the high number of immigrants among research staff at CRIs and Universities.

In terms of mitigation, the MacDiarmid Institute (for example) is promoting a range of key strategies relating to deep tech R&D:

- Our DiscoveryCamp and Discovery Scholarships aim to inspire, support, and build a non-leaky pathway for emerging Māori research leaders in secondary and tertiary education (addressing the "Importance of education and training", p.41).

- Our Te Kōmanawa workshop (developed with Victoria University, FOMA Innovation and Kiwinet) supports Māori investors to develop confidence in research-intensive technology ventures, and to develop entrepreneurial rangatahi.
- Recognising the importance of research co-design and embedded expertise, we have recruited Māori Principal Investigators (PIs), ensured representation in the Institute's leadership, and included Mātauranga Māori as one of four themes in our science plan.
- Working on cultural competency for those of our PIs who are unfamiliar with tikanga.
- In our outreach and industry engagement activities, an emphasis on building trust and relationships with Māori organisations showing interest in deep tech.

"An accessible database of expertise" (p.41): this is a good idea that can go some way to overcoming barriers to engagement with experts. Such a database would need to be kept up to date, and used in a fair and transparent way for the benefit of NZ Inc.

Q25 How are knowledge, technology and practices diffused from Māori frontier firms to other Māori and/or non-Māori firms? In what ways does this differ from diffusion from non-Māori firms? How can these diffusion mechanisms be strengthened?

- Diffusion is strongly enhanced by activities of umbrella/sector groups, and related events like Te Kōmanawa (see Q24).
- Diffusion can be strengthened by skills development, and clear understanding of IP (Q15).
- Diffusion to non-Māori firms is more difficult but could be improved by sharing values-led success stories from the Māori economy, by increasing diversity on Boards, and by explicit inclusion of Māori when building innovation clusters.

<u>Chapter 6</u>

Q26 Which policy levers matter the most and would have the largest potential impact in:

- **helping New Zealand frontier firms get closer to the global frontier?**

For all the focus on innovation in this Issues Paper, 'innovation' is the penultimate listing on Table 6.1 and R&D expenditure rates poorly on Table 6.2. This undercuts any argument that NZ has optimized policy settings for increasing productivity - see point G.

- **helping diffusion from New Zealand frontier firms to other New Zealand firms?**

- Policy to support people: building a skilled, flexible workforce – point A.
- Clarity regarding IP policy (Q15).

- Support for innovative clusters in areas with scale or high growth potential – point F.
- Shared infrastructure such as pilot plants – point H.

- **supporting resource reallocation from lower to higher productivity firms within New Zealand?**

- On this topic, we currently have two highly relevant case studies in the energy sector (in Taranaki and Southland).
- A flexible and skilled workforce is important, so we again emphasize education and supporting people.
- Policy could support effective repurposing of equipment and infrastructure, noting that some innovative activities are restricted to certain types of premises by the RMA.

Q27 What measures could the business sector take to help New Zealand frontier firms get closer to the global frontier, improve diffusion from frontier firms, or support resource reallocation from lower to higher productivity firms?

- Greater investment in R&D, and interaction with the research sector.
- Greater diversity and technical knowledge in management and on Boards (Q21).
- 'Start global': innovations should address international frontiers (Q8, Q24).

<u>Chapter 7</u>

Q28 Do you agree with the Commission's proposed approach to the inquiry? Where would you like to see the Commission put the most emphasis? Are there modifications to the proposed approach that would better fulfil the inquiry's Terms of Reference in your view?

- We thoroughly support collection of more data around this topic.
- The 3-step approach (p.47) may be overcautious when it comes to practically addressing known, systemic issues such as low R&D investment levels.
- Emphasis should fall on developing R&D intensity, skills, and the values driving these activities; as well as promotion of innovative ways to take international perspectives and realise benefits of clustering / scale in NZ.

Q29 Is there any other research underway of relevance to this inquiry that the Commission should be aware of? How could the Commission best engage with this work?

We encourage engagement with data and the knowledge base from the research commercialization ecosystem, although we're not specifically aware of research underway.

Q30 What are the top three things you would like to see come out of this inquiry?

1. Greater support for human capital, including by raising levels of investment in R&D (GERD and BERD). This is the key enabling step for other changes.

2. Increased emphasis on future-facing, productive areas of the economy which align with our values and existing strengths. In particular: sustainability, the Māori economy, and deep tech.

3. Improving the culture of innovation within NZ firms, especially by encouraging a global outlook and knowledge intensity.

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<u>Appendix:</u> Discussion of the Landfall Strategy Group paper [1]

The paper is generally thought-provoking and useful. We particularly agree with themes such as:

- Behaviours and attitudes, which were not clearly addressed in the Issues Paper. There has been an improving culture of aspiration (p.26). We favour promoting a values-led mission to increased prosperity for NZ.
- Arguments relating to the importance of scale, skills, and incentives.
- Being ambitious and not fatalistic about NZ's prospects for increased economic prosperity.
- Suggesting a bold and timely agenda for action.
- We endorse the detailed description of reasons for conservatism in NZ firms (p.26).

Pre-conceived ideas of "high quality policy foundations" (p.1) may be misplaced (point G). The report suggests that policy has "far less explanatory power" for poor performance than international orientation (p.8), and that other countries have "inferior policy foundations" (p.17). These statements ignore clear gaps identified in the Issues Paper (Table 6.2), in particular relating to R&D expenditure.

We note that the report's suggested quantum of funding for building clusters, which would contribute primarily to private-sector gains, is several billion dollars – compared with Government's entire annual R&D spend ($1.5 bn).

Progress. We disagree that NZ has not made much progress (p.2) and "not strengthened meaningfully" (p.3). Progress takes time, and there have been recent indications of tech sector growth (point D). Indeed, the report suggests:

- That there has been no significant change NZ's export mix, and that exports remain low relative to GDP.
- "Directly knowledge or technology-intensive exports remain a relatively small part of New Zealand's export structure despite recent growth" (p1-2).
- That "two decades of debate about economic transformation" have not produced progress.

These items deserve examination and reconciliation with recent TIN report data, developments in the Māori economy, new investment pathways (p.26), etc.

Regarding support for R&D and people. We agree with the paper's emphasis on sustained investment in skills and innovation to build knowledge intensity for international-facing sectors

(p.8), productivity growth (p.9), 'stickiness' or retention (p.21), and 'economic transformation' (p.22-23).

We agree with calls for greater investment and focus (p.14,28), and the idea (p.23) that "a deep pool of human capital" is "a key missing element" in NZ.

The paper calls for R&D funding that is "mission-led", aligned with clusters, and supports R&D by firms (p.24). The latter exists, is underutilized, and supports private sector profits. Recent history in the R&D sector provides good lessons about funding mechanisms which work particularly well (e.g. tech-savvy investment, incubators with the right incentives, deep research, CoREs). Specifically regarding CoREs and the performance of NZ Universities (p.24), we note that the MacDiarmid Institute consistently ranks among entire NZ Universities on the *Nature* index, highlighting the potential and importance of distributed networks.

We disagree with the idea of "supporting business education" (p.27) exclusively. The best tech entrepreneurs have a broad skills base associated with research (point A).

Comparisons with other small advanced economies can provide some insights (p.6), but clearly NZ will have to be innovative, tread its own path, and accept that change may be slow.

Regarding **3 characteristics derived from small economy experience**:

1. Internationally-oriented sector performance is critical to productivity. We agree with this well-established concept, while noting exceptions (mentioned on p.18) such as firms with high potential in the Māori economy, or those which use NZ as an early-stage test bed prior to scale-up.

NZ can indeed try to be more internationally competitive (p.26); a global perspective is often under-emphasized. Examples from our experience:

- Mission-led research funding in NZ often emphasizes local impact; R&D is seen a solution to domestic issues first and foremost. The larger picture includes benefits accruing from a global market. Note that investigator-led research funding is characteristically at an international frontier of knowledge.
- Current discussions around renewable energy tend to focus on NZ's own energy systems – neglecting the global economic potential associated with innovations in renewable energy, and the large green investment funds available to support such innovations.

On p.19, there is an interesting point about globalization and need to strengthen the domestic economy. This activity is valid when it comes to improving tech capability (e.g. manufacturing PPE or vaccines) which improve complexity, tech adoption, workforce skills, etc.

Failure of outward investment (p.14) has notably involved companies that are not particularly knowledge-intensive (excepting Fonterra). This is likewise a probable reason for failure of 'NZ champion' construction firms (p.16).

2. Larger firms have higher levels of productivity and are more likely to innovate. Scale is clearly important in various ways, and the point about this (top p.17) is well-made. There are some caveats:

- NZ data in the Issues Paper seem to contradict the trend that large companies are innovative; this could be studied or resolved.
- Scale also brings risks, such as commitment of a large fraction of resources to a particular sector, in the hope of ongoing high growth. The risks of focussing on a small number of sectors, and the need for balance (p.13) are underplayed in this paper.
- NZ's under-representation of large firms cannot be changed quickly. To remedy this, NZ should look to medium-sized firms that are growing, or those which have potential to reach large scale through innovation. Examples such as Rocketlab or Lanzatech (although the latter company itself is now offshore) are good examples of emerging MNCs which clusters are forming around.

3. Frontier firms are part of deep clusters. This idea reinforces the importance of established concepts such as NZ's innovation ecosystem. Landfall is concerned that we only have a handful of internationally oriented clusters. While NZ (as a small nation) does have finite capacity, this point does not recognise recent trends in NZ (point D) or the breadth of NZ's emerging clusters with strong R&D linkages (point F). It would be good to see an analysis of the scale and potential of such clusters.

- To work around a lack of large firms or clusters in the medium term, we can form clusters that act like big companies, and encourage innovative ways of achieving this.
- To anchor clusters, we encourage promoting areas of particular opportunity and aspiration: sustainability and the Māori economy are good examples.

The idea of picking winners, or backing winners, is specifically addressed (p.21). Backing winners is backwards-facing. The report suggests looking for areas with "global competitive strength or potential", but does not seem to have engaged with the latter.

While we can agree with some "thickening up" (p.21), there should be a balance between supporting winners and taking a more even approach. How big should a cluster be, and how well developed, in what timeframe, before it is supported?

Small economies may be "doomed to choose", but the extent to which that choice should be made by policymakers is unclear. Support for firms in targeted clusters is difficult to distinguish from direct subsidies for private enterprise.

There are further issues with the identified 'key filters' for decision-making (p.19), such as the fact that sectors and clusters (p.20) may not be well-defined (point F). Spillovers into adjacent spaces (p.11) are important, as is economic complexity.

Overall, we suggest a broad approach to cluster support, with people and knowledge intensity front and centre. These characteristics are consistent with, for example, deep tech research and the exemplar economic transformation in Finland.

Selection of favoured sectors, primary production and the weightless economy**.** See point F.

This selection does not account for sector-specific challenges and risks until they are briefly mentioned on p.28. The threat of emissions to the primary sector receives a rare mention on p.22. Sustainability, commodity pricing, and a lack of clear competitive advantage based on deep IP are all important issues.

This selection also underplays the benefits of economic diversification (knowledge spillovers), such as an "opportunity … to grow technology-intensive activities in adjacent spaces" (p.24).

If NZ does not "have innovative, high-growth clusters around its major areas of historical comparative advantage" (p.17), is it sensible to look to those areas for change? The primary sector has been previously identified as a 'winner' for productivity growth in NZ, including in the 2001 knowledge wave. Actual productivity gains have been underwhelming, driven by a focus on commodity production as much as organizational structure (p.16) or domestic markets. R&D spending and levels of innovation are low (p.23). There is potential for productivity growth, but tellingly most improvements would rely on deep tech research.

Looking forwards, accounting for progress. The report is overly dismissive of potential – that is, the ability of other clusters to "make a material difference" (p.20), primarily because of scale. The report suggests they do not have "global competitive strength or potential" (p.21), but this ignores evidence of progress (point D).

The report identifies key characteristics for a cluster, of "strong research institutions that are linked to commercial activity; evidence of innovation; a high quality advisory ecosystem; the attraction of foreign investment and talent inflows." In NZ, this is entirely consistent with our tech sector.

The report's description of success outside the primary sector as idiosyncratic rather than systematic ignores the tech sector. The contention (p.21) that previous broad policy approaches "… have not delivered the outcomes we want … A thousand dead flowers" will be news to firms on the TIN200 list.

There is significantly less downside risk in development of high-tech, deep IP than the identified sectors. Manufacturing was also identified in the report as an important internationally-facing sector (p.7-8).

In summary, if looking for clusters to support, NZ should look to emerging clusters of various types (point F), and particularly firms engaged in deep tech (point D).