NEW ZEALAND
PRODUCTIVITY COMMISSION
Te Kōmihana Whai Hua o Aotearoa

Focused innovation policy: Lessons from international experience

Working paper 2021/03

Author: Ron Crawford

Focused innovation policy: Lessons from international experience

The New Zealand Productivity Commission

Te Kōmihana Whai Hua o Aotearoa[1]

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How to cite this document: Crawford, Ron (2021) *Focused innovation policy: Lessons from international experience* [NZPC Working paper No. 2021/03]. NZPC. Available from www.productivity.govt.nz

Date: April 2021

Author: Ron Crawford

Acknowledgments: This Working paper was completed as a contribution to the Productivity Commission's *Frontier Firms* inquiry. The author benefited greatly from discussions with and input from members of the inquiry team and from Commissioners. He thanks Jo Smith and Geoff Simmons for the use of figures and text that were produced for the inquiry report.

ISBN: 978-1-98-851962-3

[1] The Commission that pursues abundance for New Zealand

Abstract

Focused innovation policy is a means for governments to work with industry, knowledge institutions and other stakeholders to realise the potential for productivity growth and export success in chosen areas of the economy. Governments in most small advanced economies (SAEs) take a more deliberate approach to such policy than does New Zealand. They typically draw on decades of experience in using and adapting such a policy to changing circumstances.

Lessons that New Zealand can take from other SAEs include using high-level multistakeholder governance to develop and oversee the implementation of strategy (including choice of areas for focus); devolving governance of policy implementation in chosen areas of focus to independent multistakeholder bodies, and, together with other participants, marshalling sufficiently large and enduring resources to "shift the dial" on the outcomes sought.

Areas of focus do not necessarily or usually correspond to standard industry classifications. They could, instead, be technologies spanning more than one industry, diverse technologies serving specific industries, or innovation in linked upstream and downstream industries.

Governments employ focused innovation policies with a variety of objectives. For instance, mission-oriented policies address societal challenges such as those arising from climate change, technological disruption and social inequality. Focused innovation policies to enhance productivity will only be durable if they are also consistent with environmental and social objectives.

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Overview

Key points

- Small advanced economies (SAEs) like New Zealand develop by finding new areas of specialised production that give firms a competitive advantage in international markets. Firms find these new areas by building on existing capabilities in their innovation ecosystems that make successful and impactful innovation more likely. With scope for only a limited number of specialisations in a small economy, governments of SAEs can assist by bringing public resources to bear in areas of promise.
- Potential gains exist from better coordinating public and private investments to support innovation. Focused innovation policy creates multistakeholder institutions and processes to develop shared views about where available public and private resources are best applied.
- Governments in most SAEs focus some support for innovation in areas of potential export strength. These could, for instance, be technologies spanning more than one industry, diverse technologies serving specific industries, or innovation in linked upstream and downstream industries. To focus support, these governments create platforms of research, and make associated investments in skills and the national science system. They also help build links between firms and researchers.
- Governments employ such focused innovation policies with a variety of objectives that sometimes overlap. Mission-oriented policies address societal challenges such as those arising from climate change, technological disruption and social inequality. Focused innovation policies to enhance productivity will only be durable if they are also consistent with environmental and social objectives.
- Governments can employ adaptive processes to elicit information from firms and other economic actors about emerging possibilities for innovation, in chosen areas. Through such processes, stakeholders can identify ways of collaborating and making complementary investments that will get the ball rolling faster and overcome bottlenecks and barriers.
- Focused innovation strategies require effective governance, implementation, monitoring and evaluation, and sometimes new institutions, if they are to succeed.
- Government must be patient and stay the course with its investments, but also be prepared to cease support for initiatives that are clearly unsuccessful. This will require rigorous, independent and transparent monitoring and evaluation.
- New Zealand's past and present attempts at focused innovation policy have lacked enough scale, resources and durability to be effective. They have also tended to arise out of government-driven processes, whereas shared design and governance with multiple stakeholders would likely generate greater momentum and make better use of dispersed knowledge and capabilities.
- The Government should learn from SAE experience and set up a high-level multistakeholder strategy body to help set strategic directions for its focused innovation policy. It should commit substantial long-term funding to support the strategy, and devolve governance in chosen areas of focus to independent multistakeholder bodies.

1 Why focused innovation policy in New Zealand?

For the last 25 years or more New Zealand's GDP per capita has remained around 70% of average GDP per capita in the top half of OECD countries (Nolan et al., 2019). New Zealand's position among OECD countries would be even weaker, if it were not for its relatively strong performance in hours worked per capita. Improvements in GDP per hour worked have made only a weak contribution to aggregate economic growth (Skilling, 2020). "New Zealand is … just one of a small number of OECD countries who have had both low levels and growth of labour productivity since 1996" (Nolan et al., 2019, p. 4).

Explanations for New Zealand's weak labour productivity performance (often measured as the level of and growth in GDP per hours worked) revolve around the small size of its domestic market and its extreme distance from large international markets (Boulhol et al., 2008; McCann, 2009). These disadvantages are reflected in weak international connections and knowledge flows; and weak domestic competition in non-tradable industries. Aggregate data shows capital shallowness partly explained by high off-the-shelf cost of capital goods, and, at least in the last two decades, fast population growth (Nolan et al., 2018).

New Zealand's framework policy settings relevant to productivity performance are generally but not uniformly good. New Zealand has for 30 years maintained an open external trading environment, has a flexible labour market and robust competition policy. By OECD standards its regulation of foreign direct investment is in some areas (acquisition of land) relatively restrictive. Its workforce is relatively well-educated and accesses further education and training at high rates. Government and business spending on research and development (R&D) is low by OECD standards – in part reflecting an industrial structure that lacks R&D intensive industries and very large R&D intensive firms (Crawford et al., 2007).

New Zealand policy differs from other small, advanced economies

Based on comparison with other small, advanced economies (SAEs)[2], good framework conditions are arguably necessary for strong productivity performance, but not sufficient (Skilling, 2020). New Zealand shares a small domestic market as a key factor influencing economic performance of such economies. Even so, many SAEs (particularly those in Europe) are, unlike New Zealand, close to and integrated with large, global markets and centres of production (Boulhol et al., 2008).

New Zealand looks very different to high-performing, SAEs. Exports are low as a share of GDP, R&D expenditure is low, New Zealand has no Forbes Global 2000 companies (Skilling, 2020), and its exports are relatively less specialised in areas specific to New Zealand (as measured on an economic complexity index) (Leong, 2016). Distance from markets and centres of production may be part of the explanation, but, as this working paper shows, New Zealand has over the last forty years set a policy course that differs significantly from that of comparator SAEs.

Skilling (2020) argues that New Zealand should learn from the more successful small, advanced economies. In particular, he recommended a focus on internationally oriented clusters in areas of the economy with significant scale (such as the primary sector) or service industries where distance from markets is less of a barrier. Policy should tackle areas where there are "binding constraints" on growth in key firms. These could include "focused investments" in skills (including management capability) and innovation involving firms, research institutions and universities.

Put another way, Skilling is recommending policy that focuses on and works with the circumstances of selected clusters[3] of economic activity, rather than (or in addition to), policies that provide the

[2] Skilling (2020) defines small advanced economies (13 number) as those identified by the IMF as advanced economies with populations above one million and below 20 million people, and with a per capita income above US$30 000.

[3] "Clusters" does not necessarily refer to groups of firms in close geographic proximity; rather the term refers to groups of firms and other entities (such as tertiary institutions) with close economic relationships – for instance as suppliers of inputs or of ideas and technology, or as customers.

framework conditions for all firms. This paper examines the rationale for such a policy approach (Chapter 2); looks at examples of how such policies have been applied in SAEs internationally and in New Zealand (Chapters 3 and 4); assesses current and proposed New Zealand industry policy, and draws out lessons for future policy (Chapter 4).

1.1 What is innovation?

Innovation drives long-term growth in productivity, incomes and well-being. Innovation involves far more than developing new products or new production technologies. It includes productive changes in supply chains, distribution networks, marketing and markets, and in the network of relationships among researchers, firms and other economic actors.

> Innovation is …doing something new. An innovation may be a new or improved product, process, or function. Innovation is a process that leads to new or better ways of creating value for society, business and individuals. The value of innovation arises from [how an idea is used]. The value …may be commercial, social, or environmental. Innovation may be unplanned or even accidental…(MBIE, 2019b, p. 17)

A firm has many ways to innovate, ranging from how it organises its business, through what it offers, to how it services its customers' ongoing needs (Table 4.1).

Figure 1.1 Ten types of innovation - the Doblin framework

Source: Keeley et al. (2013).

The Doblin framework stresses the importance of complementary innovations as a basis for success. Keeley et al. (2013) claim that product innovation on its own provides the lowest return on investment and the least competitive advantage. Sometimes competitive advantages involve incremental technological innovation, combined with innovations in business processes and models, and in marketing.

Innovation is collaborative, cumulative and pervasive and requires complementary government-funded inputs

Focused innovation policy builds on the complex, non-linear and uncertain character of innovative activity in the economy. Insights about the nature of innovation help identify the role that government has in supporting innovation in an economy (Haskel & Westlake, 2018; Mazzucato, 2018; Rodrik, 2004; Smith, 2006; Warwick, 2013).

- Innovation is pervasive across industries (and not just a characteristic of high-tech or R&D intensive industries). Even so, innovation in low-tech industries often relies on the use of complex scientific knowledge bases.
- Innovation does not usually proceed in a simple linear fashion from a new idea or research result to commercialisation. Ongoing collaboration between firms, research institutions (including universities) and customers and suppliers may help refine ideas as they are being implemented. Innovation may involve the fruitful combining of ideas and technologies from very different sources.
- Government agencies also provide essential inputs for innovation, as a complement to private investments. For instance, tertiary institutions supply new or updated skills. Other agencies supply physical and social infrastructure; adjust regulations to reflect new technologies; or tackle trade

frictions. Government agencies may incentivise innovation through procuring new goods and services.

- Commercial development of new approaches may sensibly exploit scale economies (for instance through the provision of common physical infrastructure, research infrastructure or shared international marketing), that requires coordination of plans across firms and with government agencies. Private and public actors need confidence in the intentions and capabilities of counterparts before committing to their own investment plans.
- Innovation is cumulative over time, both at a firm level, and through complex linkages across an economy. This creates benefits of scope and scale in innovation effort, that go beyond what individual firms consider in making their investments. The increasing role of intangible investments in modern economies has strengthened the importance of scale economies, spillovers and synergies across innovation effort.[4]
- Innovation has uncertain outcomes, so risk and failure is an inherent feature of the innovation process – though even failure can produce learning that contributes to future success.

1.2 Focused innovation policy seeks gains from better coordination of economic activity

Innovation policies are policies that are designed to influence the rate and direction of innovation. A broad set of government activities is potentially in scope. Focused innovation policies intend to increase innovation in chosen areas of the economy and so improve economic outcomes. The gains available from better coordination of innovative activity is the most compelling rationale (Chapter 2).

Areas for focus can be defined in many ways (Chapter 2 and Chapter 3). They could be standard industrial sectors for instance. They could be technologies or platforms serving many industries. Or they could be groups of businesses operating in specialised niches but perhaps linked across supply and distribution chains.

Countries use focused innovation policies in ways that are adapted to their own history, institutional arrangements, industry structure and culture (Chapter 3). Broadly, focused innovation policies entail institutions and processes to set and sustain strategic directions, select areas for focus, and to implement initiatives in chosen areas. They usually place a strong emphasis on improving networking and coordination among researchers, businesses and other actors contributing inputs into innovative activity. Details differ across countries, though common challenges exist (Chapter 2 and Chapter 3). The Canadian Innovation Superclusters Initiative illustrates one approach (Box 1).

[4] Haskel and Westlake (2018) describe "intangible investment" as things like complex firm-specific software, agreements with trading partners, internal know-how, organisational capability, and brands.

Box 1 **Canada's Innovation Superclusters Initiative**

Canada's Innovation Supercluster Initiative (ISI) aims to realise Canada's potential as a global leader in innovation. The ISI is an experimental approach with devolved administration centred on five areas of existing technology strengths in the Canadian economy. These areas of strength often span a range of industries.

Each of the five Superclusters is led by an independent, not-for-profit corporation with its own board of directors that is accountable for its operations and activities. Each Supercluster sets its own strategy and funds projects to support this strategy. Members include businesses, academic institutions and not-for-profit organisations. The Canadian Government will monitor outcomes for effectiveness and alignment with policy objectives.

Innovation, Science and Economic Development Canada ran a process in 2017 to select Superclusters from industry-led applications, using expert reviewers. Criteria for selection included the potential contribution to innovation and competitiveness outcomes, growth in jobs and output and planned increases in women's participation in Supercluster leadership and skilled work. The ISI aims to build connections between large and small businesses.

The five selected Superclusters were:

- The Digital Technology Supercluster based in British Columbia, with a focus on improving service delivery and efficiency in the natural resource, precision health, and manufacturing sectors.
- The Protein Industries Supercluster based in the Prairie Provinces, including a focus on plant genomics to improve nutrition, plant-based meat alternatives, and novel processing technologies.
- The Next Generation Manufacturing Supercluster based in Ontario, including a focus on building manufacturing capabilities through advanced robotics and 3D printing.
- The SCALE.AI Supercluster based in Quebec on the Montreal-Waterloo corridor with a focus on building intelligent supply chains across the retail, manufacturing, transportation, infrastructure and ICT sectors.
- The Ocean Supercluster, based in Atlantic Canada, covering marine renewable energy, fisheries, aquaculture, oil and gas, defence, shipbuilding, transportation and ocean technology, with a focus on improving efficiency, sustainability and safety.

The Canadian Government funds the ISI with up to C$950 million (NZ$1.03 billion) over five years to 2023. Industry must at least match this funding with cash and in-kind (up to 25%) contributions. Superclusters may use this funding for administration and for specific projects. With some exceptions (because of Covid-19 initiatives) project funding is only for new initiatives (not business as usual) and is awarded to consortia rather than individual companies. All consortia must include a small or medium enterprise. In practice over 50% of project partners are SMEs.

The ISI sees Superclusters as entities that will build on the critical mass and innovation networks of existing clusters, to strengthen connections and build global brand recognition. Superclusters, like clusters, share a reliance on specialised inputs, including technologies, talent and infrastructure. They will aspire to be a magnet for ideas, talent, and capital. While centred in identifiable locations, the Superclusters will involve networks across Canada and even globally.

The ISI has innovation and economic outcomes as its major focus. These include fostering start ups, commercialising R&D and participation in global value chains. It is not primarily focused on fundamental research but draws on the outcomes of such research in its innovation efforts.

Source: Beaudry & Solar-Pelletier (2020); Government of Canada (2020a, 2020b).

Focused innovation policy is an aspect of industry policy

Focused innovation policy is one type of industry policy. Governments and academics have used the terms "industry policy" or "industrial policy" to mean different things (Warwick, 2013). Historically the term "industry" referred to "manufacturing" in contrast to "services". Yet Aiginger and Rodrik (2020, p. 191) noted

> As the world economy turns increasingly towards services, it is clear that we will need a conception of industrial policy that addresses the need to nurture and develop modern economic activities more broadly, including but not limited to manufacturing. The appellation "industrial policy" may be even misleading insofar as it clouds this broader mission. Other alternatives such as "productive development policies," "structural transformation policies," or "innovation policies" do exist.

Lane (2020, p. 210) recently used the term "industrial policy" to mean "intentional political action meant to shift the industrial structure of an economy" (reflecting his interest in evaluating historical examples of industry policy and prevailing definitions).

Warwick went beyond this relatively narrow definition to provide one that encompasses a wide range of applications. Warwick's definition is broad enough to encompass focused innovation policy in the sense used in this paper.

> [I]ndustrial policy [is]…any type of intervention or government policy that attempts to improve the business environment or to alter the structure of economic activity toward sectors, technologies or tasks [eg, particular stages in the value chain such as design or logistics] that are expected to offer better prospects for economic growth or societal welfare than would occur in the absence of such intervention. (2013, p. 47)

Warwick (2013) develops a comprehensive typology. Industry policy can vary by the domain it aims to influence (product markets, labour and skills, capital markets, land, technology, or systems/institutions). It can also vary by whether it is horizontal (applying across the whole economy) or selective (applying to defined sectors, technologies, or tasks) (p. 27).[5]

Focused innovation policy can have multiple objectives

This working paper is a contribution to the Productivity Commission's Frontier Firms inquiry. Consequently, its primary focus is productivity-enhancing industry policy that could lift New Zealand's economic performance closer to global productivity frontiers. Yet governments typically have a range of objectives for industry policy, many of which have goals other than raising productivity at the frontier (Fagerberg & Hutschenreiter, 2020; Mazzucato et al., 2020; Meyer-Stamer, 2005). Examples exist where policy intends to:

- increase employment in declining regions;
- increase the size of the national or regional economies;
- encourage the development of new industries to stem potential employment losses from the adoption of new technologies;
- tackle the effects of population aging on economic and social outcomes; and
- promote the adoption of "green" (eg, climate-change-mitigating) technologies.

Synergies likely exist between objectives Moreover, policies to enhance productivity will not be durable if they do not, at the same time, meet environmental and social objectives, and increase wellbeing overall. Countries typically reflect these interactions by designing industry policy to simultaneously achieve several objectives (Chapter 3).

[5] Rodrik (2008) argued that even "horizontal" policies have selective effects.

Focused innovation policy complements generic innovation policy

Focused innovation policy is a complement to generic innovation policy. Bloom et al. (2019) identified the primary rationale for broad government support for innovation:

> Knowledge spillovers are the central market failure on which economists have focused when justifying government intervention in innovation. If one firm creates something truly innovative, this knowledge may spill over to other firms that either copy or learn from the original research – without having to pay the full research and development costs. Ideas are promiscuous; even with a well-designed intellectual property system, the benefits of new ideas are difficult to monetize in full. There is a long academic literature documenting the existence of these positive spillovers from innovations. (p. 166)

Bloom et al. (2019) find strong evidence that tax incentives to raise firms' R&D are effective both in increasing private sector effort and in raising productivity. By their nature these incentives apply to all firms that engage in qualifying R&D effort, irrespective of the nature of their economic activity.

Evidence also exists for the effectiveness of government research grants in increasing innovation. Grants may be provided to universities and research institutions, or directly to firms. The high share going to universities reflects a view that spillovers generated by basic academic research are likely larger than those from near-market applied research. Even so, there is evidence that research grants to firms (eg, for health research) increase private investments in such research. Research grants to private firms raise success in attracting venture capital funding and increase firms' revenues and patenting rates.

Government grants to firms require government agencies to select firms to receive grants. Selection may be on the quality of research proposals, or it may also reflect government preferences for research around some technologies or in some areas of economic activity, or to tackle societal challenges (eg, in environmental, health or military research) (Mazzucato, 2018). Governments also typically fund (or partly fund) public sector research institutes to carry out research in defined areas. New Zealand's Crown Research Institutes are an example.

Government funding for basic academic research or public research also raises the question of "how to design complementary policies that enable the resulting discoveries …to be translated into technologies that benefit consumers" (Bloom et al., 2019, p. 173). In the United States, for instance, legislation in the 1980s gave universities an ownership share in the intellectual property developed there, providing an incentive to commercialise their research.

Governments also support R&D through measures that increase the supply of skilled researchers (through universities and through immigration), and through intellectual property (IP) protection laws. Bloom et al. (2019) find that evidence for the importance of skilled migration is high, and for university supply of skilled workers moderate (evidence is likely particularly influenced by the experience of the United States). Evidence on IP protection is mixed, reflecting the balance it must strike between providing rewards to innovators and not unduly hampering the dissemination of new technology.

Government support for R&D favours industries that are R&D intensive. While innovation is pervasive across the economy, R&D effort is not. There are likely significant spillovers to non-R&D innovation effort, and governments need to find ways to support such innovation.

Many forms of government support for innovation apply across the economy (ie generically). The case for focused innovation policy rests on it being an effective complement to, rather than replacing, generic support for innovation. Chapter 2 looks at evidence on spillovers from innovation including and beyond R&D and the argument that government should focus attention on capturing them in selected areas of the economy.

2 Arguments for focused innovation policy – and lessons for policy design

This chapter looks at the main rationales for focused innovation policy and lessons from the literature for policy design. Gains from coordination arising from the complex, non-linear and uncertain nature of innovation are the most compelling.

Rationales for focused innovation policy reflect an increasingly broad and nuanced understanding of how innovation happens in an economy (Chapter 1). This understanding synthesises various strands of economic thought. For instance, new growth theory pointed to "learning by doing" that, at an economy-wide level, could potentially explain the East Asian "growth miracles" (Lucas, 1993). Evolutionary economics built on Joseph Schumpeter's insights around firms' searching for new products and new processes to establish competitive advantage (Nelson & Winter, 1982). In each case, path dependence and scale economies in innovation effort implied the availability of gains from focused effort.

2.1 Gains from focused innovation policy

Gains from better coordination of investment plans provide the strongest rationale for focused innovation policy in advanced economies. Related rationales include capturing spillovers from learning from doing, and from learning about where an economy can best specialise.

Gains from better coordination of investment plans

Rodrik (2004) considered both standard and novel rationales for focused innovation policy.[6] He concluded that the most compelling arise from the existence of coordination externalities in the presence of scale economies involving non-tradable inputs or geographic proximity. Scale economies typically arise from the need for, and high fixed costs of, shared research, transport and other infrastructure and for activity-specific regulation and marketing.

To illustrate, Rodrik provided an "extreme" (2004) example from Taiwan, in which the government worked with industry and other interests to establish an orchid industry using private land previously used for the almost defunct sugar-cane industry. Support included providing a research laboratory (investigating orchid genetics), a phytosanitary quarantine site, packing and shipping areas, new local infrastructure (roads and electricity lines for greenhouses), an exposition hall and low-interest credit to farmers to build greenhouses.

> An individual producer contemplating whether to invest in a greenhouse needs to know that there is an electrical grid he can access nearby, irrigation is available, the logistics and transport networks are in place, quarantine and other public health measures have been taken to protect his plants from his neighbors' pests, and his country has been marketed abroad as a dependable supplier of high-quality orchids. All of these services have high fixed costs, and are unlikely to be provided by private entities unless they have an assurance that there will be enough greenhouses to demand their services in the first place. This is a classic coordination problem. Profitable new industries can fail to develop unless upstream and downstream investments are coaxed simultaneously. The Taiwanese government's investments upstream aim precisely to overcome this obstacle. (pp. 12-13)

Rodrik noted that this "extreme" example might have ended in failure (but was in fact successful). He also recognised that well organised industries could successfully coordinate investments without government input.

Hausmann and Rodrik (2006) outlined in more detail the complex combinations of non-market inputs that could underpin successful product innovation. They argued that governments have no choice but

[6] Rodrik (2004) uses the term "industrial policy" but, in essence, is discussing what this paper defines as "focused innovation policy" (Chapter 1).

to provide many of these inputs. Moreover, limited resources means that governments must choose areas of economic activity for more intensive attention.

> …the requisite degree of interaction between governments and markets is much deeper and complex than is often assumed and requires a structure and a culture of cooperation between the public and the private sector. (p. 26)

Signalling intentions helps coordinate investments

Government signalling its intended support can give private investors the confidence that a new activity is viable. Rodrik (2004) noted that the logic of coordination externalities means that *ex post* there is no need to provide subsidies. "Pure coordination" among private actors might be enough; or action might require an ex-ante subsidy, such as an investment guarantee, that does not need to be paid out in the event of success.

Warwick (2013) also pointed to the possibility that

> the process of setting an industrial strategy may be important in itself as a means of aligning private sector efforts and governmental priorities. On this view, articulating a clear industrial strategy of vision is of value even in the absence of specific policy initiatives or incentives…(p. 22)

Geographic clusters may increase opportunities for gains from coordination

Geographic proximity might help realise the benefits of better coordination of investments across private firms and government and research and education institutions. Also, researchers have long identified that geographic proximity can raise firms' productivity through so-called agglomeration economies. A vast literature has developed on the basis of these ideas, which is largely beyond the scope of this research note (see eg, McCann & Van Oort, 2019).

The potential productivity benefit of geographic proximity has stimulated different versions of an emphasis on "clusters". One strand, sometimes favoured by urban planners, has looked to promote agglomeration (the geographic concentration of production and employment) as a path to higher productivity. Even so, the productivity benefits of higher density urbanisation are relatively modest. For instance, Maré and Graham (2013), in a study of agglomeration effects in New Zealand, found that the level of multi-factor productivity was an average 0.7% higher across industries for every 10% increase in employment density. At rates of population growth in New Zealand's urban centres, agglomeration could have made only a small contribution to the actual increase in New Zealand's productivity over the 30 years to 2012 (NZPC, 2017).

Another strand of the "clusters" literature draws on the existence of notable examples of geographically concentrated entrepreneurial activity, employing rapidly evolving technologies that stimulate productivity growth. California's Silicon Valley is the archetype. Yet the world is littered with examples of failed government attempts to engineer such clusters (Lerner, 2013). It is far easier for academics to identify the conditions under which such clusters develop than it is for governments to work out how to bring them into existence.

Porter (1985) represented an influential and systematic attempt to set out the conditions and policies that would shape a nation's success in innovation. In addition to the availability of competitive inputs, firm strategy, and competitive pressures he identified the existence of related and supporting industries as an important factor for success, with obvious implications for promoting gains from collaboration and coordination.

> A firm that is operating within a mass of related firms and industries gains and maintains advantages through close working relationships, proximity to suppliers, and timeliness of product and information flows. The constant and close interaction is successful if it occurs not only in terms of physical proximity but also through the willingness of firms to work at it. (Czinkota, 2016)

Geographic proximity is important for innovation. For instance, rates of patent citations fall off with distance (Jaffe et al., 1993); and distance also reduces the propensity to participate in global value

chains (GVCs) and so the opportunities for product specialisation (De Backer & Miroudot, 2014). Even so, the relevant physical distance will certainly vary by the mechanisms operating and geographic location.

Proximity also has other dimensions. Learning from a firm's R&D is more likely to spill over to firms in technologically related industries, than those in technologically more distant industries (Jaffe, 1989). Borders and related regulatory, cultural and language barriers can take the shine off the benefits of geographic proximity (see for instance McCallum, 1995). The most relevant dimension of distance for innovation in particular products may best be discovered through exploration of possibilities. Firms, government agencies and other economic actors may, through such a process, identify where constraints are most likely to be hindering successful innovation.

Warwick and Nolan (2014) evaluated the evidence on the effectiveness of different approaches to policy to promote clusters and networks linking businesses and other economic actors. While high-quality evidence on the effectiveness of cluster policies was lacking, and identified effects were often modest, policies aimed at improving the benefits of networks "appear[ed] to give more positive outcomes" (p. 35). Geographic proximity may aid collaboration across networks; but obviously more distant linkages can also play a key role in promoting innovation. Beaudry and Solar-Pelletier note that "…geographical proximity …is neither sufficient nor necessary for successful collaboration" (2020, p. 9).

Innovation ecosystems can become self-reinforcing and path dependent. As the depth and breadth of their innovation activity grows, the greater availability of knowledge and other inputs attracts new related businesses to join; and makes existing members of the network keen to remain connected. Network scale matters and government agencies can play a useful role in tackling some of the coordination issues that might limit scale.

Gains from learning by doing

Economists have long recognised learning by doing on the job as an important contributor to raising human capital and productivity in an economy. In a seminal study, Rapping (1965) found that productivity in building identical ships in wartime conditions in the United States grew strongly with the cumulative volume of ships produced; and that the effects were present within single ship-building yards.

Building on this evidence, Lucas (1993) developed models to help understand the "miracle" of rapid economic growth and structural change in developing East Asian economies. These models needed to go beyond learning for a single line of production within firms, to explain productivity growth through workers and managers progressively extending production to new "higher quality" products. Lucas noted that countries specialise (have a competitive advantage) in products that are often "invisible in even the finest industrial statistics" (p. 266).[7]

Experience in producing a good near the productivity frontier, made it less costly to produce a technically close but even higher-quality product. In turn, this process required large-scale exporting so that there was an increasing divergence between the mix of products consumed in an economy and the mix that was produced.[8] As noted below, this idea has since been taken up in the study of the way in which, as countries develop, the economic complexity of their exports rises.

Lucas used this model as a potential explanation of developing East Asian tiger economies enjoying periods of rapid economic growth. Consistent with this, these economies typically used policies (such as export subsidies and import protection) that provided temporary protection to industries until they developed the capabilities to be fully competitive internationally.

Yet New Zealand's development and circumstances are very different from those of the East Asian tigers prior to their growth spurts in the 1970s and 1980s. New Zealand is a high-income country that

[7] Hausmann and Rodrik (2003) similarly identify that countries specialise in very particular products as they develop – they use six-digit classifications to demonstrate this.

[8] Lucas in part builds on models like that of Grossman and Helpman (1991) in which learning arises from experience in production and firms compete for temporary increases in market share by successively increasing the quality of their products.

has specialised in relatively sophisticated land-based production[9]; international trade agreements now prevent the sorts of measures used then to protect newly developing industries. Developed country experience suggests growth is likely to be through incremental upgrading of capabilities rather than through dramatic leaps.

Acemoglu et al. (2012) applies "a learning by doing" model to mission-driven technical change – in this case the development of technologies to reduce greenhouse gas emissions. Under certain assumptions, initial government support for development of such technology (both through research subsidies and emissions pricing) drives a process of learning and increasing use of the new technology. This process eventually makes the technology competitive against "old" technology, without ongoing government support. The rapidly falling prices of renewable electricity generation over the last two decades (now competitive with fossil fuels) suggests that this process is not just a theoretical possibility (NZPC, 2018).

Learning where to specialise successfully

The literature on innovation, economic complexity and productivity growth provides further insights. As countries develop, the products they produce and export increase both in diversity and their uniqueness (Hidalgo & Hausmann, 2009). Hidalgo and Hausmann argued that the pattern of international trade between countries, analysed at a 4-digit product level, reflects the underlying economic capabilities that each country has developed. A resulting measure of economic complexity is strongly correlated with GDP per capita.

Hausmann and Rodrik (2006) had earlier illustrated the complexity of complementary inputs and markets that an economy needs to have in place, or to create, if entrepreneurs are to move into new areas of production. The combination of inputs required is specific to narrowly defined products

Hidalgo and Hausmann (2009) went on to argue that as countries develop, they are likely to do so by extending production to areas where they already possess many of the productive capabilities (eg, skills, experience with particular technologies, existence of potentially relevant supply chains, and knowledge of relevant markets). They identified such closely related or "adjacent" product areas from the propensity of countries to export such products as part of their overall export mix. They show that a country's productivity and incomes will grow faster when its current export mix is in a "product space" that has many adjacent possibilities. Even so, their methodology does not identify the relevant capabilities – rather their existence is inferred from a country's place in the detailed pattern of international trade.

Spillovers from learning where to specialise successfully in a developing country

Hausmann and Rodrik (2003) argued that a firm learning what a *developing country* will be good at producing involves both a surprising degree of specialisation, and also spillovers to other entrepreneurs and workers in the economy. They noted from their evidence that "the specific product lines that eventually prove to be hits are typically highly uncertain and unpredictable" (p. 623). Adopting new technologies involves both serendipity (eg, the presence of an overseas firm using relevant technologies) and acquiring tacit knowledge through experience.

Hausmann and Rodrik drew on case studies to show how new successful lines of production disseminate across a developing economy through transfer of personnel (some setting up their own businesses) and through imitation. As a result, a firm quickly loses the advantages of discovering a new line of production, as competitors enter the market and compete profits away (in their model, by bidding up input prices). Without government support for discovery, firms will be reluctant to take on the costs and risks of trying something new – if they are successful, they carry the cost while many other firms benefit; if they are unsuccessful, their time and money is lost.

Hausmann and Rodrik argued that an effective policy solution was for a government to offer pioneers some sort of reward (such as export subsidies, public sector credit or guarantees) for a period that will

[9] Even so, as one reviewer put it, New Zealand commentators and policy makers have long sought the means to move from a narrow, agriculture-based economy to a more diverse, higher value one historically expressed as the desire to develop manufacturing.

provide a payoff to their investment in learning. A corollary is that support should be only for new activity and not offered to copycats; and should not continue if evidence of poor performance emerges. Such an approach in effect provides some time-limited protection for pioneers against competition.

Building on existing capabilities in small, advanced economies

The policy problem for a small advanced, economy (SAE) like New Zealand differs from that facing a developing country. In the Hausmann and Rodrik's model, developing countries are adopting and adapting technologies to produce (at lower cost) things already being produced elsewhere, and for which IP protection is not possible. The problem is to provide a reward for the time and effort expended in learning what best to produce.

The economic complexity literature discussed above suggests that the problem for an SAE is to find some areas of specialisation that build on its existing capabilities but which few other countries, if any, produce. Entrepreneurs who discover such areas of specialisation are unlikely to be bothered by local input prices (such as for skilled labour) being bid up. They will seek means to protect their investment in learning, from both local and international imitators. New Zealand examples include patents and trade secrecy (Fisher & Paykel Healthcare), plant-variety protection and licensing (Zespri); a difficult to replicate lead in herd breeding (a2 Milk); and unique geographic advantages combined with global frontier technology (Rocket Lab).

One way that small economies can support greater specialisation (and higher productivity) is through their firms' participation in global value chains (GVCs). A "value chain" refers to "the range of activities that firms undertake to bring a product or a service from its conception to its end use by final consumers" (De Backer & Miroudot, 2014, p. 1). World trade and production have become increasingly organised in GVCs over recent decades. New technologies, falling transport and communication costs, and trade policy reforms have encouraged firms to disaggregate production processes to better use the comparative advantage of locations. Weta Group is a high-profile New Zealand example of a firm participating in a GVC (Bealing & Krieble, 2017).

Distance makes it difficult (but not impossible) for firms to participate in GVCs (De Backer & Miroudot, 2014). This likely means that New Zealand is even less specialised in its goods and services than small countries closer to global production centres.

The data on export goods specialisation supports this proposition. Compared to other small countries such as Denmark, New Zealand has very few areas of specialisation in the goods that it exports (OECD, 2017a). Among a group of seven SAEs, New Zealand had the least complex mix of exports in 2014 (Leong, 2016). Yet Weta, Xero and Orion Health are counter examples of New Zealand companies that demonstrate the possibilities, using digital technologies to participate in GVCs.

This analysis suggests that, for economic success, entrepreneurs in New Zealand need to be alert to possibilities for specialisation. At the same time, the suppliers of other inputs to innovation (eg, governments, research institutions, tertiary institutions) need to work collaboratively with entrepreneurs to overcome barriers to realising those specialisation possibilities.

2.2 Broad lessons for design and operation of focused innovation policy

Strong arguments exist for governments in SAEs to choose areas of focus for their innovation policies to complement broad-based innovation policies (Chapter 1, section 2.1). SAEs lack the resources and expertise to support intensive innovation effort across the whole economy and specialisation is key to finding new areas of competitive advantage in exports.

Yet governments undertaking focused innovation strategies (or industry policy) with firms, workers, and academic and research institutions face significant challenges (Lerner, 2013; Mazzucato, 2018; Rodrik, 2004). These challenges revolve, for example, around how governments can acquire information about where best to use resources to promote innovation, while avoiding the creation of incentives for the

private sector to engage in unproductive lobbying to support existing interests. This section briefly reviews the historical record and then draws out the lessons from the literature about designing and implementing policy to tackle these challenges.

Focused innovation policy has a mixed history

Focused innovation policy (often in the guise of industry policy), has a long history (Chang, 2002). Berg and Bruland (1998), for instance, document how 19th century Scandinavian governments played a key role in supporting and encouraging (including through financing) acquisition of new technologies from more developed countries. Around the same time, the government of the Meiji restoration in Japan, also played a central role in that country's rapid industrialisation (Hausmann & Rodrik, 2003).

The role of industry policy in supporting development in East Asian economies such as South Korea and Taiwan during the second half of the 20th century is keenly debated (Lin & Chang, 2009). These countries typically used policy instruments (such as import protection and export subsidies for favoured industries) that are now inconsistent with international trade agreements; and are no longer employed extensively in developed economies.

Critics have pointed to examples of past policy failures. They ascribed such failure to

- government agencies lacking capability and adequate information on conditions affecting development (which leads to misapplied effort and resources); and
- private sector rent-seeking and corruption undermining the ostensible intent of policies (Lerner, 2013; Rodrik, 2004; Warwick, 2013).

For these reasons, many economists, and some mainstream international development organisations such as the IMF and World Bank, have warned against sector-specific industry-support policies. The so-called Washington Consensus has advocated instead for improvements in "framework conditions" such as competition policy, openness to trade, flexible labour markets and strengthening the rule of law as the main route for developing countries to raise productivity (Rodrik, 2004).[10]

Yet Rodrik (2004) points out that in practice most countries have adopted some sort of industry policy:

> The reality is that industrial policies have run rampant during the last two decades – and nowhere more so than in those economies that have steadfastly adopted the agenda of orthodox reform. If this fact has escaped attention, it is only because the preferential policies in question have privileged *exports* and *foreign investment* – the two fetishes of the Washington Consensus era…Anytime a government consciously favors some economic activity over others, it is conducting industrial policy. (pp. 28-29)

Developed countries offer numerous examples of employing focused innovation policy as a means (amongst other objectives) to improve economic performance (Warwick, 2013; Warwick & Nolan, 2014). Chapter 3 discusses recent experience in selected SAEs.

Choosing areas for focus

Identifying areas where focused innovation effort will have the highest chance of commercial success poses a challenge. Uncertainty abounds. Innovators typically proceed by trial and error, selecting from variations in design that sometimes occur by chance and through bringing together (recombining) different technologies (Ridley, 2020). Low-tech innovation (eg, containerisation or prefabrication) may have as much or greater impact as hi-tech innovation on productivity and firm-level competitive advantage.

[10] It is important not to over-simplify the advice provided by these institutions. They also continued to recognise the key role of governments in publicly funding and providing education and health services and infrastructure, and support for R&D, so contributing both to economic outcomes and the wellbeing of populations. And some economists in these institutions, or working for them, were taking a more in-depth look at the processes surrounding adoption of new technology, and development of new lines of production, as a way to explain variations in growth experience across different developing countries (De Ferranti et al., 2003; Hausmann et al., 2005; Klinger & Lederman, 2004).

Focused innovation policy is a process of discovering opportunities and tackling challenges to realising those opportunities (Rodrik, 2004). It makes sense, as a result, for governments to choose relatively broad areas for attention and, with industry and other partners, to design institutions, processes and funding arrangements from which the more promising opportunities can emerge.

Each country has specific circumstances of history, culture, geography and economic structure that will shape its choice of institutions and processes (Chapter 3). Denmark, for instance, has given more shape to a relatively open process of geographic cluster development, by focusing on areas of economic strength. Within those areas, it is encouraging the competitive emergence of collaborative cluster-based innovation approaches. In Sweden, the universities have worked closely with firms on applied research over many decades. Singapore's approach appears broad-based in intention, but in practice is focused on a subset of industry sectors, and relies on a relatively compact set of enduring linkages across government, industry, and research and education institutions.

Processes and institutions

Implementing an effective, focused innovation strategy requires political and stakeholder leadership and capable administration. Much of the value of a strategy lies in its ability to coordinate action around promising lines of innovation, but in the face of uncertainty and complexity. Multiple actors are involved, including researchers, innovators, educators, consumers and the suppliers of inputs to business. And innovation happens through iteration, trial and error that further multiplies the interactions that underlie success. Processes need to elicit information about promising opportunities and conditions affecting their realisation, and to provide incentives for firms to increase their innovation effort.

Many SAEs have well-developed processes and institutions for implementing focused innovation strategies, but the designs differ in ways that reflect history, geographic circumstances, economic structure and culture (Chapter 3). Researchers studying focused innovation strategies suggest that they need to have several broad features (Hausmann & Rodrik, 2006; Lerner, 2013; Rodrik, 2004, 2008; Warwick & Nolan, 2014, Wilkes, 2020). These features follow.

Experimental, adaptive, collaborative processes

- A focused innovation strategy needs to be experimental and adaptive. It should aim to build a portfolio of initiatives that has net overall benefits, while allowing for some to fail.
- Engagement among government, industry, research and educational partners should seek a shared view of what is needed, and use governance arrangements and processes that match the scale of the prospective initiatives (see below).

A focus on innovative activity with clear measures of success

- The strategy should focus on innovative activities and not on "business as usual", and should recognise the wide and interacting scope of innovations that shape firm success (section 2.1). Support should target activities and investments that have the clear potential to provide spillovers and demonstration effects, or to solve coordination problems.
- Clear measures of success and monitoring will help shape the strategy as it adapts over time. For instance, success can be measured by assessing firm-level productivity, exporting success, and diffusion of successful innovation.
- Innovative effort requires enough time to play out and demonstrate success. On the other hand, the Government needs to be willing to cease supporting clearly unsuccessful initiatives.

A commitment to action shared across government and other parties

- Clear high-level commitment from government, industry, and research and educational institutions will speed the channelling of investments and other resources to where they will have most effect. This requires government arrangements that can cut through the long-established agendas and priorities of individual government agencies.

- Government investments should be guided by where private parties are willing to risk their own investments. A shared and grounded picture of opportunities and risks increases the probability of success, while reducing incentives for unproductive lobbying.
- Firms engaging in focused innovation strategies are likely to better identify areas where they can beneficially collaborate with other firms (through "coopetition") for purposes such as developing a shared R&D base, or pooling international marketing resources.

Transparency, evaluation and review

- The nature, quantity and target of any government assistance should be regularly and promptly published (again as a spur to accountability and a brake on lobbying).
- Periodic review will encourage the participating agencies to adapt themselves and the strategy to inevitable changes in circumstances, and to evidence of what has worked and what has not.
- The parties should ensure that specific initiatives are rigorously evaluated against the outcomes sought, and that all evaluations are made public. This requires prior planning for data collection and evaluation before commencing initiatives (Warwick & Nolan, 2014). Evaluation should inform decisions on continuing or adjusting initiatives. Political incentives may work counter to publishing evaluations, but shared governance arrangements and stakeholder ownership of intiatives will mitigate this risk.

Multistakeholder high-level and devolved governance

Successful focused innovation policy requires effective high-level multistakeholder governance (Fagerberg & Hutschenreiter, 2020; Mazzucato et al., 2020). A "therapeutic dose" of focused innovation policy involves not only discovery and coordination mechanisms (as described above), but the ability to apply government and private resources and effort at the right time, and where they will have the most effect. Governance arrangements need to have enough authority and clout to prise open the bureaucratic doors behind which resources are often locked. They also need to incentivise private sector participation and cooperation.

Mazzucato et al. (2020) liken the required governance arrangements to the exercise at the national level of the "dynamic capabilities" that underlie a firm's strategic ability to innovate (Teece, 2019). What is required, they argue, is "an organizational structure capable of learning and of adjusting behaviour to what is learned" (p. 428, citing Nelson & Winter (1982)). Wilkes (2020) tempers this perspective by warning against an 'investment board game' model of industrial strategy:

> Government investment is not big enough, relevant enough or sufficiently skilfully deployed on its own to wrestle the economy in the 'right' direction. Business incentives are much more significant. (p. 9)

Typically, even within government, multiple objectives are at play. Each government agency has its line of responsibility to its own minister. Each agency has its own performance requirements, and is usually reluctant to relinquish direct control of the resources that parliament has allocated it to carry out its functions.

To overcome these barriers, some SAEs (for instance, Finland, Sweden and Singapore) have governance arrangements for innovation policy (and focused innovation policy) that are led from the highest level of government and of other partners (Chapter 3. This leadership serves both as a signal of the importance of innovation for national prosperity and wellbeing, and to provide a guide to where government and private sector resources are well applied.

Some countries complement high-level multistakeholder governance with devolved governance in selected areas of focus (Chapter 3, Box 1). They design these bodies to promote collaboration among stakeholders to identify, jointly fund and oversee specific initiatives. This recognises that no one party has a complete understanding of relevant interests, possibilities and developments and that multiple government and non-government agents need to interact to develop a shared view of how to pursue opportunities for innovation.

Hausmann and Rodrik (2006) argued that government agencies in these circumstances need to foster

> …more network-like arrangements that may deliver what is required without any single node of the network being fully aware of all the things that are going on at any point in time … many of the existing organizations, whether private or public, may be acting as part of an institutional tissue that identifies opportunities, creates the incentives to act and coordinates the outcome. (p. 35)

"Self-organisation" of counterparts to government, in devolved governance arrangements, will also guard against an overly "top-down" approach in which the government makes all the running and stakeholder ownership is weakened.

Comparator SAEs often have a long history of implementing versions of focused innovation policy. They have developed complementary institutions, social norms and informal networks across industry, higher education, research institutions and government that ease the process of reaching a common view about where to apply effort (Chapter 3). New Zealand will need to take a more deliberate approach to building high-level and devolved governance arrangements to underpin an effective and enduring focused innovation policy.

2.3 Is focused innovation policy effective?

The effectiveness of industry policy (at an overall national level) is, by its nature, hard to evaluate. Countries each adopt their own mix of governance arrangements and interventions, to reflect judgements about effectiveness and on where effort is best targeted. Policies may aim to improve productivity, to counter the effects of sectoral shocks, or to tackle challenges such as climate change. As a result, each of the two main approaches to broad evaluation has its limitations.

- Country case studies run the risk of being selective to favour the evaluators' prior beliefs and it is often difficult to say what would have happened in the absence of intervention; or if the interventions had been applied in another country.
- Cross-country econometric studies suffer from poor and inconsistent specification of interventions. Also, because countries may select such interventions precisely because an economic sector is experiencing difficulties, interventions may be associated with relatively poor outcomes even if they improve those outcomes (Lane, 2020; Rodrik, 2008; Warwick & Nolan, 2014).

Despite these difficulties, evidence on effectiveness is still available. First, numerous studies, with a wide variety of designs, provide evidence for the effectiveness of specific types of interventions within national strategies. Here are two examples.

- Government research grants, both to research institutions and to firms, have (on average) positive effects on innovation and productivity, both in general and in selected sectors (Bloom et al., 2019; Warwick & Nolan, 2014).
- Policies focused on strengthening business networks, and links with research institutions (often in a defined geographic area) have positive impacts on firm-level collaboration and innovation (Warwick & Nolan, 2014).

Researchers do not usually include the effects of transport infrastructure, land-use planning, migration policy and skills acquisition in evaluations of industry policy. Yet, these policies can clearly have positive local and sectoral effects (NZPC, 2017; Warwick & Nolan, 2014).

A second source of evidence comes in the form of "natural experiments" – events (largely) outside the control of participants that create a difference in treatments across firms, sectors or regions. Lane (2020) pointed to two persuasive European examples.

- After the Second World War, the Soviet Union required Finland to make reparations by supplying heavy industrial goods (ships, locomotives, cables, and engines) that it had little experience in producing. The Finnish government provided short-term support to develop these industries. The

requirement had long-term intergenerational impacts, both directly on growth in production and employment in the targeted sectors (compared to other sectors), and also through skills acquisition in higher learning and through earnings (Mitrunen, 2019).

- Also after the Second World War, a Marshall Plan project in Italy provided credit for firms to purchase advanced American capital goods, and promoted modern management practices. After inviting applications from any firm in a region, the administrators eventually targeted assistance only to firms in selected provinces within regions. This enabled Giorcelli (2019) to compare long-term outcomes of firms in the provinces that benefited with the outcomes of those applicants in other provinces that did not. She found that firms that received assistance were more likely to survive after 15 years, and had significantly more sales, employment, and productivity than comparable firms that did not receive assistance.

Of course, while these studies demonstrate that focused innovation policies can be successful, some are not (Lerner, 2013).

Third, many OECD countries periodically commission broad reviews of innovation policy and the place of focused innovation policies within this broader picture (Independent Experts Panel, 2019; OECD, 2014, 2015, 2016, 2017c, 2017b). Typically, experts with a good knowledge of international innovation policy and practice undertake such reviews. They bring together a range of evidence (for instance, detailed empirical studies of specific interventions; case studies of institutional practice; socio-economic and political assessments of national governance arrangements; and international comparisons of innovation outcomes). Reviews identify opportunities for improvements in policy, institutions and practice, rather than making judgements about whether focused innovation policies as such have net benefits. Such reviews are consistent with the idea of innovation policy being experimental and adaptive, with system-level learning playing a key role in improving outcomes over time.

3 Selected international practice

Most small, advanced economies (SAEs) employ some version of focused innovation policy. The governance, duration and focus of such policies varies, influenced by country-specific factors such as history, existing institutional arrangements, and the structure and performance of the economy. Some northern European economies have employed such policies for over 100 years, originally as a stimulus to industrialisation. This chapter looks in some detail at the experience of selected countries to draw lessons on the design of successful policies and the issues that such policymakers need to tackle.

The countries have been chosen because they have a similar scale to New Zealand, and because (in most cases) recent English language reviews of their innovation policies are available. Their small scale means that they have been selective around where to focus innovation policy effort.

A changing innovation landscape requires changing innovation policies

The examples of focused innovation policy in this chapter have all changed significantly over the last decade. Responses to economic events (such as the global financial crisis (GFC)) and/or changes of government with different preferences are part of the explanation. Learning from the experience of other countries is also evident.

Beyond these influences, changes in the international innovation landscape also require country policies to adapt (Independent Experts Panel, 2019):

- private innovation effort as measured by R&D is increasingly concentrated in big multinational companies;
- emerging markets (especially China) are rapidly developing as new centres of innovation that compete with those in Western countries;
- competition in innovation is growing in importance as one of the currencies of geopolitical conflict;
- the cost of getting successful outcomes from R&D is increasing (which partly explains increasing concentration);
- many new technologies favour large markets to scale business applications quickly; and
- governments are increasingly turning to innovation policy to address societal challenges.

These changes mean that approaches that worked well in the past will not necessarily be fit for purpose in the emerging environment. Countries need to review and adapt policy to maintain strategy consistent with progress towards an enduring ultimate goal.

3.1 The Netherlands

History and context

The Netherlands is a high-income country with traditional strengths in trade, transport, logistics, and financial services, and in food processing, chemicals, petroleum refining and electrical machinery. It is relatively less R&D intensive than other high-income small advanced European economies but has strong links between research universities and large businesses. Both universities and large businesses are well connected internationally. The Dutch economy experienced a protracted "double-dip" recession following the GFC (OECD, 2014)

The Netherlands has adopted varying approaches to innovation policy over the last 50 years. In the last 20 years it has shifted from a generic approach to one that aims to build critical mass in selected areas of the economy and technologies. In the 2000s, the Government focused attention on 10 "innovation programmes" including "flowers and food", "high-tech systems and materials" and "chemistry".

Scope and scale of focused innovation policy

From 2010, a new Government adopted the "Top Sectors policy" to strengthen competitiveness through innovation, internationalisation, and human capital development. The policy aimed to achieve this through better coordination among business, government and public research and education institutions in the chosen areas of the economy.

The Top Sectors comprised Agri-food, Horticulture and propagation materials, High-tech systems and materials, Energy, Logistics, Creative Industry, Life Sciences, and Chemicals and Water (OECD, 2014). Public support for business R&D was simplified and shifted from direct support to tax incentives.

The Netherlands government notionally allocated over €1 billion (roughly NZ$1.7 billion) a year to the Top Sectors policy in the period 2013 to 2016. Most of this was existing funding in relevant portfolios (eg, education, innovation and foreign policy) that the Government intended to align with the Top Sectors approach. The notional total also included R&D funding dispensed by ministries with responsibilities for the chosen sectors. Businesses made investments in research that, across the Top Sectors, were a similar amount to public funding (OECD, 2014).

Up to €130 million (NZ$222 million) a year of the total identified by the Government, was new funding to support the development and operation of 19 "top consortia for knowledge and innovation" (TKI) that underpin the Top Sector policy. Funding for TKIs under the Top Sector initiative is intended to reward business funding for the Top Sector agendas. In 2013, private funding for TKIs was roughly four times as large as public funding. Some public funding exists to support participation of SMEs in the TKIs.

Some of the Top Sectors cover more than one TKI and some TKIs (eg, on ICT, nanotechnology and the bioeconomy) are cross-cutting (OECD, 2014; van der Wiel & van der Kroon, 2014). More recently the Netherlands Government has introduced mission-oriented approaches to tackling societal challenges (such as reducing greenhouse gas emissions) within the Top Sectors framework.

High-level governance of research and innovation policy

The Netherlands does not have a single high-level body responsible for the governance or steering of science and innovation policy. Several sometimes-long-standing advisory councils exist, with oversight of different parts of the research and innovation policy system. Among these the Advisory Council for Science and Technology Policy has existed since 1990. The council comprises individuals from research institutes and business-sector organisations acting in their individual capacity. It mostly responds to requests for advice from the Ministry of Education, Culture and Science (OCW) or the Ministry of Economic Affairs (EZ).

As with other northern European countries, the Netherlands has a strong tradition of consensus-oriented policy making. Consensus emerges bottom-up through consultations among academics, business organisations and trade unions. "The process tends to work against attempts at "top-down" steering and instead provides for "negotiated change" in innovation policy and its governance" (OECD, 2014, p. 185). The development of the Top Sectors approach illustrates this process.

Funding industry-focused innovation policy

The Netherlands Enterprise Agency (created as part of EZ in 2014) is the primary agency for funding business R&D and innovation. Most of its funding is through the administration of R&D tax credits, but it also administers direct financial support often on behalf of other ministries.

Governance of collaborative innovation initiatives, and choice of areas for focus

The nine "top sectors" chosen by the Netherlands government are very broad, covering around 90% of business R&D and 30% of value added and of employment. The development of TKIs provided the opportunity for more focus in particular areas and technologies. The chosen sectors often had a history

of public and private collaboration initiatives to strengthen innovation, sometimes from the 1980s (OECD, 2014).

"Top teams" comprising high-level representatives from industry, public research and government developed draft "knowledge and innovation agendas" for their sector. Agendas included a strategic plan and proposed instruments to make progress against the plan. The Government evaluated the agenda against criteria such as level of ambition, commitment of stakeholders, openness, the balance between social and economic objectives and the extent to which progress could be monitored and evaluated. The sectoral agenda and plans and relationships among stakeholders form the formal basis for the TKIs.

Evaluation and adaptation of strategy

The Netherlands ranks first among 28 European countries in commitment to evaluation of individual innovation programmes and its innovation system as a whole (Borrás & Laatsit, 2019). A strong evaluation culture exists, "with a tradition of sophisticated evaluation of policy instruments …[and] policy is generally responsive to the findings of evaluations" (OECD, 2014, p. 186).

Evaluators in 2017 found that the Top Sectors approach had improved networking and cooperation within and across the top sectors. It had generated more demand-driven research and skills, but had been less successful in developing new markets or stimulating radical innovation (Fagerberg & Hutschenreiter, 2020).

3.2 Finland

History and context

Finland has for many decades had strong institutions and substantial government funding to foster collaborative research between public agencies and the private sector in technologically significant areas of the economy (such as forestry and forestry products, mobile communication and digital technologies) (Finnish Forest Cluster Research Strategy, 2010; OECD, 2017b). Education policies complemented these developments with a highly educated and technologically literate workforce.

Finland's export strengths historically have mostly been in a combination of raw materials, production machinery and capital investment goods (eg, ships) that are subject to changes in business demand. The 1990s and early 2000s saw the rapid growth and global market dominance (for a period) of Nokia in mobile telephony. The advance of smart phone technology then dramatically reduced Nokia's global lead in mobile handsets from the early 2000s.

The GFC and other economic shocks (eg, an ongoing recession in the Russian market, and declining demand for paper) compounded the effect of Nokia's decline on the Finnish economy. GDP fell by over 9% in 2009 and, after a brief recovery in 2010 continued to decline till 2015. Between 2008 and 2016 exports fell by 20%, with the share of high-technology exports falling from 23% in 2005 to 6% in 2016. With this dramatic change in the composition of production, total factor productivity fell more strongly than in most other OECD countries over the period

From around 2010, a new government responded to these adverse shocks by substantially reducing and reconfiguring public support for private sector research and innovation. The OECD (2017b) argued that these changes reflected a loss of confidence in previous arrangements but were not guided by a clear strategy or view about how the Finnish economy would likely evolve into new areas of competitive advantage. Subsequent governments have been reshaping innovation policies and governance in a way that corresponds to the OECD's recommendations.

Large firms (such as Nokia) have been the main drivers of research links between business and higher education institutions. Among public research institutes, the largest, the Technical Research Centre of Finland (VTT), has played a significant role in industry-oriented research. VTT, in 2015, had a turnover of €251 million with external funding of €163 million. Private R&D is concentrated in a relatively few large

companies. In 2010 Nokia alone accounted for 50% of business expenditure on R&D, but by 2015 this had fallen to 20% (with an additional 10% in Microsoft Mobile which took over part of Nokia's business).

Scope and scale of focused innovation initiatives

Prior to the 2008 crisis, the Finnish Funding Agency for Innovation (Tekes) had partly funded several public sector and private sector collaborative innovation initiatives, and had a long history of funding technology development programmes.

From 2008 to 2015, Tekes funded six industry-research collaborations (strategic centres for science, technology and innovation – known as SHOKs). Annual public funding was €100 million (NZ$173 million) at its peak, and combined total funding over the life of the programme was €1.1 billion (NZ$1.9 billion). Participating companies contributed about one-third of total funding. The programmes included bioeconomy, energy and metals, and focused on relatively near-to-market technology innovation. At its inception, the SHOK programme was in essence the Finnish government's "flagship" approach to promoting innovation to achieve international competitiveness (Lähteenmäki-Smith et al., 2013).

Evaluation found that the SHOKS faced multiple and often conflicting objectives, weak governance, lacked an adequate cross-disciplinary scope, and tended to focus on incremental innovation within existing models. As a result of the evaluation, the government phased out direct public funding. Some programmes have continued, drawing on other sources of public funding (OECD, 2017b). Ironically, the continuing and apparently successful Swedish strategic innovation programmes were modelled on the Finnish programmes (OECD, 2016).

Tekes has since financed an industry-based non-profit company, DIMECC (Digital, Internet, Materials and Engineering Co-Creation Ltd.), to build a networked ecosystem of digital innovators to speed time to market. DIMECC was formed in 2016 from the amalgamation of two of the SHOKs (focused respectively on metals and engineering and on the internet economy). The network currently comprises over 2 000 R&D and innovation professionals, 400 organisations, 69 shareholders, and 10 co-creation facilitators. In 2016 DIMECC achieved a €50 million (roughly NZ$86 million) research portfolio (DIMECC, 2020).

More recently, the Government has developed collaborative mission-led strategies to find knowledge-based solutions to societal challenges, including climate change (OECD, 2017b). Some of these have an economic and competitive advantage dimension (such as in health technology and in biotechnology) while also addressing societal challenges.

High-level governance of research and innovation policy

The Research and Innovation Council (RIC) (and its predecessors), chaired by the Prime Minister, has taken the lead in shaping overall strategy. Yet the RIC fell into abeyance for some years following the economic crises of the mid-2000s and a new government's loss of confidence in the then current research and innovation policy settings. The RIC had promoted the unsuccessful SHOKs initiative.

The government reconstituted the RIC in 2016. The RIC has five members chosen from leading participants in the research and innovation system, joined by ministers from relevant ministries. The RIC operates in a context where close networking across academic, government and industry players, and shaping of policy through representative councils is the norm. Historically the RIC has set the broad research and innovation policy agenda, with detailed implementation falling to the relevant ministries. Its influence depends greatly on the interest that the Prime Minister gives it (OECD, 2017b). Most, recently, and consistent with OECD advice, it has developed a roadmap for strategic innovation policy (Research and Innovation Council Finland, 2020). The Council meets bi-monthly.

Funding industry-focused innovation policy

Tekes had, since, 1983 been the primary agency for public funding of industry-relevant technology development. It was modelled on the corresponding Swedish agency (now Vinnova). An example of its approach was the programmes to strengthen the capabilities of the IT supply chain, complementing Nokia's then success. Tekes provided funding to large companies on condition that they passed

support upstream to research institutions and smaller companies., strengthening their innovation ecosystems. Tekes funding was substantially reduced after the 2008 crisis (in favour of more support for academic research), and its activities redirected to supporting start-ups and entrepreneurship, rather than technology development.

In 2018 Tekes merged with Finland's former export promotion agency to become Business Finland. Business Finland is responsible for funding "to promote the competitiveness of Finnish industry and the service sector by assisting in the creation of world-class technology and technological know-how" (Business Finland, 2020).

Governance of collaborative innovation initiatives

The SHOKs were set up as limited liability companies with shares held by participants in the collaboration. Each SHOK developed technology development programmes for funding approval from Tekes. In an important sense, SHOKs represent an attempt to move beyond Tekes traditional technology development programmes, to a model that put much greater emphasis on building creative, self-governing innovation collaborations (Lähteenmäki-Smith et al., 2013).

Choosing areas for focus

Finland has long-established areas of focus for innovation policy, reflecting strengths, for instance, in forestry and downstream industries, in materials and production machinery, and in digital industries. These areas of focus have endured (with some reconfiguration) over successive policy cycles. Even a recent significant shift to a focus on "societal challenges" has retained an emphasis on enhancing international competitiveness in some, at least, of these areas of the economy.

The SHOKs initiative was largely built on previous cluster initiatives (Lähteenmäki-Smith et al., 2013). The RIC proposed the SHOK approach, with Tekes primarily responsible for implementation based on the establishment of business and research innovation collaborations set up as limited liability companies. Of the six SHOKs, one (covering real estate and construction) resulted from bottom-up proposals for inclusion.

A revived RIC has recently issued a "vision and roadmap" for Finnish innovation policy. Amongst other initiatives, the RIC envisages the identification and development of "competence platforms and growth ecosystems" to accelerate the development of "new solutions". The RIC intends to develop principles and procedures for making strategic choices of areas for focus (Research and Innovation Council Finland, 2020)

Evaluation and adaptation of strategy

Finland historically has had a very comprehensive approach to monitoring and evaluation of funded programmes of technology development; and of strategies (such as the SHOKs) and governing bodies (including the RIC), and overall innovation policy (OECD, 2017b).

3.3 Sweden

History and context

Sweden has a long history of state support for chosen industries through tariff protection, subsidies, public R&D to aid adoption of new technologies and direct acquisition of such technologies (Berg & Bruland, 1998; Chang, 2002). Public-private cooperation in the development of chosen industries endured through the 20th century, associated with the emergence of large world-class firms such as Ericsson (telecommunications) and ASEA (specialising in railway equipment and electrical engineering, and now part of the multinational Swedish-Swiss firm ABB).

Since the 1940s, Swedish universities have played a central role in applied industrial research involving cooperation with firms. Much of the effort was focused on so-called "development pairs" in which substantial university research served the needs of large technologically advanced Swedish companies. In contrast, Swedish research institutes have played a relatively minor role in applied industrial research,

providing in specialised areas not covered by university research (and lacking large research-intensive firms) (OECD, 2013, 2016).

Until recent decades, Sweden has enjoyed a pre-eminent global position in R&D intensity and other measures of success in innovation. Yet increasing globalisation of large Swedish companies and a shift in the geographic location of some private research has been associated with an erosion of Sweden's leading position on innovation measures (OECD, 2016).

Over the last decade, the Swedish government has introduced policies to reinvigorate Swedish innovation. These include:

- the identification and funding of strategic research areas (SFOs) in universities that would enable them to build strength in chosen areas, typically those of existing strength, reinforced by an increase in core university funding;
- the identification, development (through "bottom-up" processes involving industrial, academic and research institute stakeholders) and funding of areas of strategic importance to Sweden (SIOs);
- initiatives (often overlapping in focus with SIOs) to tackle identified "societal challenges"; and
- governance and funding policies to consolidate and strengthen the contribution of research institutes to Swedish innovation.

An OECD 2016 review of these policies found that they had had limited success initially. In particular, the SFO initiative had made little difference to specialisation in universities, often thwarted by weak university governance and poor links with industry and other stakeholders. While successful in reinforcing high-quality research-based innovation activities, funding for SIOs was modest and programmes lacked critical mass. Some SIOs tended to focus unduly on strengthening existing industrial activity in areas of established importance (OECD, 2016).

Scope and scale of focused innovation initiatives

From 2012, the Swedish Government invited universities, firms, and other actors to propose SIOs to contribute to growth in productivity, income, and jobs. The funding agencies set budgets for SIOs and, subject to criteria, fund strategic innovation programs (SIPs) under the SIO umbrella.

The first SIOs were in fields where Swedish industry was already strong, such as mining and metallurgy. Later SIOs extended to areas such as aerospace and bioscience. The current focus is on "programs [that] will contribute to creating the conditions for sustainable solutions to global societal challenges and increased international competitiveness" (Vinnova, 2020) These include future healthcare, the information society and competitive production. The SIOs aim to build collaboration across players in the innovation ecosystem (including small and medium-sized firms) to develop commercial solutions and promote diffusion of technology. Evaluation of the SIOs suggest that they have been successful in achieving these objectives (Vinnova, 2020)

The government budget for the 17 SIPs has been around SEK600 million (or NZ$107 million) a year (OECD, 2017b). Total funding for 12 years is around SEK8 bn (or NZ$1.3 bn) (Vinnova, 2020).

High-level governance of research and innovation policy

In 2015 the Swedish Government established a National Innovation Council (NIC), headed by the Prime Minister, to achieve better coordination among the public actors involved in innovation policymaking and delivery (Fagerberg & Hutschenreiter, 2020). The Council has wide representation from unions, industry, and research and educational institutions, though the 10 external members participate in their personal capacity.

The Council has a wide remit covering innovation policy beyond research policy, though it also considers research policy relevant to innovation. As a result, there is some overlap with the work of the longstanding Swedish Research Policy Council. Other policy areas relevant to innovation include labour

markets, public procurement, energy, transport, health care, environmental and regional policies (Edquist, 2019).

The NIC meets four times a year and operates informally to consider briefly defined agenda items. The Prime Minister has a close involvement in setting the agenda, with input from both government and other council participants. Discussions are not formally recorded, but members are free to speak about them publicly.

The Council's role is advisory. Government participants meet subsequently under the leadership of the Prime Minister's office to decide which ideas to implement and assign responsibility for implementation. The NIC may further consider policy initiatives as they are being implemented. A major role for the NIC is to provide a platform for identification and rapid bureaucratic response to the most salient issues for innovation policy (Edquist, 2019).

Funding industry-focused innovation policy

Three agencies, Vinnova (the Swedish Government Agency for Innovation Systems), the Swedish Energy Agency and Formas (the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning) jointly fund the SIPs, reflecting the wide coverage of the SIO initiatives. Industry sources and universities contribute a significant proportion of overall funding (OECD, 2016).

Vinnova, founded in 2001 is the successor to previous Swedish technology funding agencies that have existed since the 1940s (OECD, 2013). Vinnova's current mandate is to support innovation for sustainable growth, with a particular emphasis on collaboration to support experimentation and testing of ideas before they become profitable. Vinnova employs 200 people and disburses SEK 3 billion (NZ$500 million) in funds annually (Vinnova, 2021).

Governance of collaborative innovation initiatives

Each SIP has its own board and management team, located in one of the collaborating partners – usually a university, industry association or private company. Board chairs similarly come from different stakeholder backgrounds. Boards have a substantial role in defining the scope of SIPs and in bringing forward projects for funding under criteria established by the funding agencies. Much of the traditional role of the funding agencies is devolved to the Boards of SIPS (OECD, 2016).

Choosing areas for focus

While Vinnova had the main responsibility for oversight of the SIO, the Government used a bottom-up process to shape the choice of strategic innovation areas for funding. Vinnova's roles were to

- encourage potential participants to define strategic areas and provide seed funding to support this;
- develop a process that facilitated stakeholders to propose SIPs within these strategic areas;
- facilitate a selection process for SIPs involving independent experts making assessments against defined criteria;
- allow stakeholders to set up their own governance and management arrangements for SIPs in each strategic area; and
- facilitate a process (primarily initiated by SIP management teams) for selecting particular projects within SIPs, again vetted by external experts (OECD, 2016).

The funding agencies retained the final decision on funding for SIPs and projects within SIPs. The OECD noted that this devolved bottom-up approach was revolutionary for Vinnova.

Stakeholders sometimes went through an iterative process to define SIPs, in some cases involving amalgamation of initially separate proposals, as they worked to develop proposals that the funding agencies were likely to accept (OECD, 2016).

Evaluation and adaptation of strategies

Independent experts evaluate the SIPs every three years. The first focuses on evaluating the forming of the SIPS, while subsequent evaluations assess outcomes in terms of collaboration, international links, competitiveness and contribution to the Government's defined missions (Vinnova, 2020).

The Swedish Government commissioned OECD reviews of its innovation policies in 2012 and 2016 (OECD, 2013, 2016). The second review recommended significant adjustments to policy and governance which have subsequently been acted upon in part.

3.4 Denmark

History and context

The Danish economy has export strengths in transport, ICT and pharmaceuticals, with Danish and foreign-owned multinational corporations accounting for two-thirds of exports. While recent productivity growth has been slow, Denmark rates highly in various innovation rankings including R&D intensity and GDP per capita. Business R&D is increasingly concentrated in a small number of large Danish companies (eg, in pharmaceuticals, wind energy and robotics). Questions exist around how well Danish firms translate R&D into practical innovation (Independent Experts Panel, 2019) and around overall slow productivity growth in the last decade (OECD, 2019).

The Ministry of Higher Education and Science (MHES) and Ministry of Industry, Business and Financial Affairs (MIBFA) together support knowledge-driven innovation and its translation into commercial results. There is a wide range of institutions for collaborative research and innovation, including universities, other higher education institutions, and seven research technology organisations (RTOs), enjoying both public and private sector funding support. The Danish approach has included a focus on innovation networks and clusters and Denmark ranks well on measures of multi-stakeholder collaboration for innovation. Over the last decade, the Danish government has been consolidating its innovation policies by reducing redundancy in policy instruments and institutional scope (Independent Experts Panel, 2019).

Scope and scale of focused innovation initiatives

The Danish Government currently funds 17 national innovation networks that link knowledge institutions and businesses in areas of economic strength such as energy, food, and ICT, and in emerging industries. Central government funding for cluster secretariats in recent years has been around €30 million (NZ$52 million) each year in total. The clusters rely on other sources of government and private funding for programmes conducted under the cluster umbrella.

In 2018, and separate to the cluster initiatives, the Danish Government launched its Strategy for Digital Growth to build on existing strengths in digital technology (Danish Ministry of Industry, Business and Financial Affairs, 2018). The strategy sets out six complementary initiatives aimed at businesses and individuals realising the potential for growth from digitisation. These include:

- a public-private hub to facilitate business access to expertise and cooperation in developing new business models;
- promoting research in digital technologies;
- consultancy and training initiatives targeted at small and medium enterprises;
- reviewing regulation to make it easier for businesses to experiment with new business models; and
- strengthening cybersecurity in businesses; and developing broader digital skills and awareness in the population.

Funded by MIBFA, the focus is more on business applications of digital technology than on basic research (Independent Experts Panel, 2019). Funding for the strategy is currently DKK 125 million (NZ$28 million) each year.

High-level governance of research and innovation policy

Over the last decade, the Danish Government has set up and received advice on innovation policy from a short-term Productivity Commission (operating from 2012 to 2014), and the Danish Disruption Council (operating from 2017 to 2019 with a focus on policies to tackle the labour market effects of new technology). Denmark's innovation policy lacks lasting high-level strategic governance arrangements spanning stakeholders across industry, knowledge institutions and government (Independent Experts Panel, 2019).

A recent independent expert review of Danish innovation policy recommended that the Government develop a comprehensive innovation strategy. This should involve high-level political commitment, broad engagement with stakeholders and an all-of-government approach. The strategy should focus on "systemic dialogue and collaboration across the entire innovation system" and "systemic integration of individual innovation policy tools towards common goals" (Independent Experts Panel, 2019, p. 15). The review identified the option of "a powerful national innovation council as a strategic decision-making body" to pursue such a strategy (p. 116). The review framed this as a way of building on the strengths of an already "highly sophisticated and well-developed support system for innovation" (p. 39).

Funding industry-focused innovation policy

Denmark does not currently have a dedicated innovation agency. Instead, the MHES funds "knowledge-driven" innovation policy, while MIBFA focuses on commercialisation of innovation.

Private foundations, such as the Novo Nordisk Foundation (NNF), account for a significant share of innovation funding. The NNF, for instance, aims to contribute about €671 million (NZ$1.12 billion) in 2023. Collectively the foundations fund a major share of private R&D and invest in research networks, prizes and events. The foundations tend to specialise in particular areas – for instance the NNF invests mostly in life science R&D and innovation projects.

Governance of collaborative innovation initiatives

Each of the 17 cluster initiatives has its own independent secretariat, operating under the auspices of one of the stakeholders (eg, a university, or RTO); or a cluster organisation established for the purpose.

Choosing areas for focus

There were previously a much larger number of regional networks and clusters which developed through competitive bottom-up intiatives. The government has been reducing the number of publicly funded clusters, by concentrating on areas of economic strength (determined by the Danish Board for Business Promotion under the auspices of MIBFA). Within these "strongholds", the MHES uses a competitive process to choose the best clusters for promotion (Independent Experts Panel, 2019).

Evaluation and adaptation of strategies

Denmark rates well among European countries for its commitment to evaluating individual innovation programmes and for taking a systemic approach to evaluating innovation policy (Borrás & Laatsit, 2019; Independent Experts Panel, 2019).

3.5 Singapore

History and context

Singapore has developed rapidly since its independence in the 1960s to reach its current position as a high-income SAE. Its rise was built on its position as a major port, a strong emphasis on education, and active state involvement in supporting economic development. Manufacturing accounts for up to 25% of Singapore's GDP with strengths in electronics, chemicals, biomedical sciences, logistics and transport engineering. These strengths are complemented by its rapid growth as a regional financial services centre.

Singapore is geographically concentrated and, though a multi-party democracy, has been governed by a single party throughout the period since independence. These factors have created strong and enduring networks across industry, government and knowledge institutions that help the formation of widely supported agendas for economic and social progress. Singapore has regularly (at five to ten-year intervals) refreshed an economic strategy that includes a focus on industry sectors.

Scope and scale of focused innovation policy

In 2017 the Committee on the Future Economy, led by economic Ministers and reporting to the Prime Minister, set out an approach to economic development that included six cross-economy strategies and one focused on industry sectors. The cross-economy strategies cover international connections, skills, digital capabilities, city vibrancy and opportunity, and partnerships for innovation and growth (Singapore Committee on the Future Economy, 2017).

The current sector approach intends to produce 23 industry transformation maps (ITMs), eventually covering 80% of the economy. Singapore has developed ITMs for a range of industries, including retail, professional services, food services, hotels, precision engineering, logistics, sea transport and food manufacturing. In essence, the ITMs are a device for collaboration across industry interests (employers and workers), universities and other research and training institutions, and the government. Together they will identify how the cross-economy strategies are coming together in a particular area of the economy and decide how to tackle barriers and realise opportunities (including those involving innovation and technology).

In 2016, the Singapore Government allocated S$4.5 billion (NZ$4.9 billion) to the ITM programme over a period of five years. This funding is separate to funding for research, and detailed expenditure is to be decided as the ITMs develop (Lee, 2016; Singapore Ministry of Trade and Industry, 2020b).

Governance and institutions

In pursuing its economic agenda, Singapore has adopted a "cluster" approach for the governance of ITMs. Industries are grouped to look for synergies and spillovers (for instance, in common technology supply chains or skill requirements) across related industries (Singapore Ministry of Trade and Industry, 2020a). Subcommittees of the Future Economy Council (the successor to the Committee on the Future Economy) lead the development of ITMs within the cluster approach. The Future Economy Council includes representatives from the government, unions, industry and universities.

Choosing areas for focus

The Singapore ITM and cluster approach covers a large part of the economy and so, in itself, is not selective. Even so, the detailed development of ITMs provides scope for particular areas of focus (for instance on skills or infrastructure, or on particular technologies) within industries.

Evaluation and adaptation of strategies

The Singapore Government favours a pragmatic approach of taking "calculated bets", pursuing promising results vigorously but cutting losses when they become apparent (Singapore Committee on the Future Economy, 2017, p. v).

3.6 Common themes from country experience

While each country studied has its own history, institutions and culture, common themes arise from their recent experience.

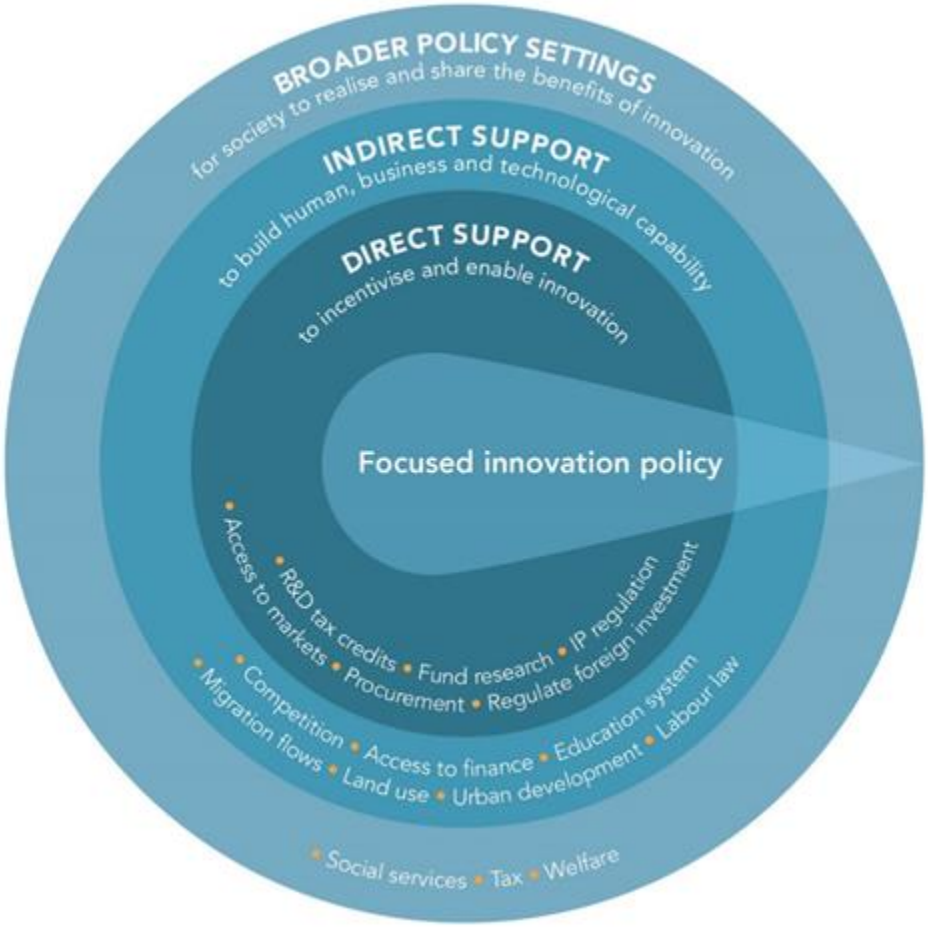
Scope and scale of focused innovation policy

At a broad level, countries vary considerably in how selective they are in choosing areas for focus. Singapore and the Netherlands have each chosen sectors that together cover sizeable chunks of the economy. Even so, governance arrangements mean that in practice they implement projects or initiatives that focus more narrowly on chosen technologies, subsectors, or policy instruments (such as training or regulation).

Countries also vary in the scope of policy instruments brought to bear in the focus areas. Some are centred on support for R&D and its translation into business and societal applications. Others (Singapore and the Netherlands) use a broader range of policies (eg, skills, regulation, international relations, physical infrastructure) that contribute to successful outcomes in chosen areas. Others (eg, Denmark) take a mixed approach across different strategies.

Figure 3.1 shows how focused innovation policy potentially includes policies that both directly and indirectly affect innovation. Governments are most likely to devote direct support for science and innovation to their chosen areas for focus. Yet SAE experience shows that they also bring wider support to areas of focus, including, for instance, developing skills, migration and labour market policy settings, and providing infrastructure.

Figure 3.1 The policy scope of focused innovation policy



Consolidated data on resources devoted to focused innovation policy are not always available. Where data are (eg, the Netherlands and Singapore), such resources appear substantial with annual expenditure in the order of NZ$1 billion. Even so, these totals include existing expenditure located in related portfolios and signal an intention to focus this expenditure in chosen areas (subject to suitable proposals coming forward). Across all countries, and within the broad aggregates, programmes focused in given areas receive substantial multiyear funding.

High-level governance of research and innovation policy

The governance of broad innovation policy sets the context for the governance of focused initiatives. Finland has long had a peak body for this purpose, headed by the Prime Minister. A main purpose of the Finnish Council is to bring together government leaders, industry experts and researchers to prioritise areas of the economy, technologies and societal challenges for focused effort. Multiple stakeholder peak bodies of this type give transparency to and broad ownership of strategic decisions, and so sustain effort across electoral cycles (Fagerberg & Hutschenreiter, 2020).

Sweden adopted such a model in 2015 and the Singaporean Future Economy Council plays a similar role. The countries described have long histories of collaborative relationships across government, industry partners, and research and education institutions. As a result, informal networking reinforces the role of more formal institutional arrangements (Independent Experts Panel, 2019; OECD, 2015).

High-level governance arrangements often play a central role in generating stakeholder consensus around choice of areas for focus. Some countries (eg, Sweden) use explicitly designed "bottom-up" processes to generate proposals; other countries (eg, the Netherlands and Singapore) rely on multi-stakeholder forums backed by informal networks to gain acceptance for choices.

Governance of collaborative innovation initiatives

The countries studied usually govern focused innovation initiatives through multi-stakeholder bodies. These are sometimes established as independent entities, governed by boards led by non-government parties (industry partners and research institutions), and with contributions of substantial non-government resources. These bodies are responsible for developing "bottom-up" projects that normally entail substantial industry co-funding. Government agencies often retain final decisions on public funding for such projects, with advice from expert panels.

In most of the countries covered here, collaboration among firms and research agencies is a prerequisite for proposals for areas of focus and for specific initiatives to receive public funding. Some schemes require collaboration between large firms and small and medium enterprises.

Evaluation and review

Most, if not all, of the countries studied have a strong commitment to evaluating initiatives and reviewing strategies. Evaluation is important as a guide to amending or discontinuing unsuccessful initiatives, and reviewing strategies regularly helps keep them on track.

Societal challenges

All of the countries have moved in recent years to adopting mission-oriented, government-led innovation strategies to tackle societal challenges. These sometimes take the form, as in the Netherlands, of a dimension added to existing focused innovation strategies; or they may take the form of an innovation focus in particular areas of the economy of importance to the mission. An example of the latter is a focus on low greenhouse-gas-emissions technology in the energy sector.

Recurring issues in implementing focused innovation policy

Reviews of country experience identify common tensions in the design and operation of modern industry policy (focused innovation policy). Usually, resolving these tensions requires stakeholders to come to shared judgments about matters which intersect, such as:

- the selection criteria for areas for focus,
- the selection and funding of initiatives within these areas,
- the time horizons for funding,
- the range of policy areas that are brought into focus (eg, skills formation, regulation, infrastructure as well as more direct policies to accelerate technology development),
- the degree of focus on market outcomes and on other impacts (such as those that tackle societal challenges),
- how deeply initiatives reach into long-range scientific research effort,
- how to design processes and governance arrangements that generate initiatives that have wide support among stakeholders, but which are not overly cumbersome and slow,

- how to strike a balance between generating many bottom-up initiatives and achieving sufficient focus and critical mass to achieve strategic objectives,
- the degree to which decisions on public resources are devolved to stakeholder entities,
- the balance between incremental innovation (building on existing technologies close to market), and the search for more disruptive sources of innovation
- the balance between large and small firms in fostering innovation effort.

Working through these issues at a national level requires clear and widely supported strategic objectives, and high-level governance arrangements involving major stakeholders to achieve this. It also requires a skilled public sector that is willing and able to develop shared judgments and decision making with other stakeholders; and to be flexible and adaptive as evidence on success emerges. Experience in the countries studied shows that these skills and orientations develop over time as they are exercised.

Each of the countries studied has made its own judgments around the scope and design of focused innovation policy, though some have learnt from the experience of others. Most have commissioned independent expert reviews of their innovation policies that aid judgments about system architecture.

4 Focused innovation policy in New Zealand

Chapter 2 set out a strong rationale for SAEs choosing promising areas of focus for innovation policy, to complement broad economy-wide innovation policy. This chapter briefly reviews recent New Zealand experience with such policies (sections 4.2 and 4.3) and then draws out lessons for future policy (section 4.3).

4.1 Past and recent initiatives

The idea of focused innovation policy is not new in New Zealand, as the concentration of Crown Research Institutes (CRIs) on land-based industries demonstrates. These include Plant and Food, AgResearch, Scion, and Manaaki Whenua – Landcare Research (Te Pae Kahurangi Review Panel, 2020).

A past focus on agricultural innovation encouraged technology development, diffusion and adoption. Research institutions such as the Department of Agriculture Research Farms (like those at Ruakura), Lincoln Agricultural College and Massey University investigated leading-edge, science based agricultural practices. From this, the Department of Agriculture's "farm extension service" identified and spread good practice.

Currently a substantial cluster of research institutions is focusing on research in food products (Box 2).

Box 2 **The New Zealand food and beverage innovation ecosystem**

The food and beverage sector has an extensive array of R&D institutions and funding for innovation.

Research institutions include CRIs (Plant & Food and AgResearch), the Riddet Institute (a CoRE), two Regional Research Institutes (Bragato Research Institute and PlantTech) and the Food Innovation Network (NZFIN). NZFIN comprises four open-access food and beverage pilot and scale-up facilities. In addition, FoodHQ in Palmerston North is a food research and innovation hub. It is an open collaborative partnership that includes partners from CRIs, universities, Economic Development Agencies and Industry Training Organisations.

The Sustainable Food and Fibre Futures is a co-investment fund that resulted from a merger of two pre-existing funds: the Primary Growth Partnership and the Sustainable Farming Fund. The fund aims to support the development of sustainable products in New Zealand's food and primary sectors. The National Science Challenges include a focus on primary sector productivity and exporting. In particular, the High-Value Nutrition Science Challenge focuses on developing high-value food products.

Palmerston North has a substantial geographic cluster of research institutions, including the Riddet Institute, AgResearch, Plant & Food Research, Massey University's School of Food and Advanced Technology, and the New Zealand Food Safety Science and Research Centre. It also has the R&D centres of firms such as Fonterra and Synlait, and the headquarters of FoodHQ. A joint AgResearch, Massey University and Riddet Institute building opened on the Massey campus in 2020. This has enabled all AgResearch's food-focused researchers from across New Zealand to be co-located with Massey and Riddet Institute staff.

Source: Lewis et al. (2021).

New Zealand's Primary Growth Partnership programme had the scale and other characteristics of some of the SAE's focused innovation initiatives covered in Chapter 3. Yet it lacked a clear strategic context and fully devolved governance of funded initiatives (Box 3).

Box 3 **The Primary Growth Partnership**

The Primary Growth Partnership (PGP), established in 2009 and now replaced by the Sustainable Food and Fibre Futures Fund, demonstrated some, but not all, of the features of focused innovation policy as deployed in other SAEs (Chapter 3) and in Canada (Box 1). At its peak, the PGP provided public funding of over $40 million each year to a portfolio of primary sector innovation programmes. The purpose of the PGP was to incentivise a shift to higher value products while meeting the Government's economic, environmental and social objectives.

Industry participants developed proposals for funding in a largely bottom-up process. To be funded, programmes had to attract 60% private funding (with a minimum of $500 000 spread over seven years), have a clear path to market, be beyond business as usual, and be for a maximum of seven years. Proposals often included activities beyond R&D, such as skills development, regulation, collaboration along supply and distribution chains, and marketing, that were prerequisites for eventual commercial success.

A high-level industry-led body (the Investment Advisory Panel or IAP) advised the Ministry for Primary Industries on its broad investment decisions (about which programmes to fund, assessed against eligibility criteria including ability to deliver spillover benefits). The IAP met with the Minister for Primary Industries four times a year, and otherwise met monthly to consider proposals and business cases.

A Programme Steering Group (PSG) including representatives from investing companies and MPI and having an independent chair, oversaw each funded programme. Oversight included monitoring and managing risks, commissioning independent reviews at midpoint and on finalisation of the programme, and deciding on adjustments to how resources were being deployed. The PGP had a "fast fail" philosophy that provided flexibility to redeploy resources if elements of a programme turned out to be a dead end. MPI undertook financial audits.

A 2018 independent evaluation of the PGP judged that it had already delivered substantial additional economic, environmental and social benefits. Even so, the evaluation recommended improvements to address weaknesses.

- Opportunity existed to adopt a more strategic approach to meeting high-level objectives, as a complement to the largely bottom-up process for generating programme proposals.[11]
- The PGP could be more actively marketed to tackle a fall-off in interest from larger companies, At the same time, larger companies could be encouraged to submit further programme proposals, subject to additional barriers (such as increasing their R&D effort) that recognised the benefits they had already received through participation.
- Further steps could be taken to clarify the role of the IAP and to strengthen the governance capability of PSGs.

Source: Battell (2018).

[11] The Primary Sector Council subsequently developed a strategic vision, *Fit for a better world*, that will serve as an umbrella for relevant parts of the Government's industry strategy (Primary Sector Council, 2020). The vision should equally assist in shaping funding decisions for primary sector innovation programmes.

Recent initiatives have often lacked scale and durability

Leaving aside New Zealand's primary sector initiatives, other SAEs have typically been much more ambitious than New Zealand in pursuing economic outcomes from focused innovation policies across different areas of the economy (Chapter 3).

In recent decades, New Zealand's broad government economic development strategies have included sectoral approaches.

- The Growth and Innovation Framework (GIF) (2002–2008) targeted the information and communication technology, biotechnology and creative sectors (especially screen production and design) on the grounds that they were "core competencies needed to drive success across the economy, including in our traditional primary industries" (New Zealand Government, 2019, p. 13).
- The Business Growth Agenda (2012–2017) included initiatives that targeted the "high-value manufacturing and services", health, food, and primary sectors (MBIE, 2012).

Yet, the resources, attention and effort applied to these strategies pale beside those applied previously and currently to the primary sector. Skilling (2020) memorably characterises most of these sorts of sector initiatives (including current initiatives) as delivering a "sub-therapeutic dose" (p. 22).

> To make progress, the right materiality of ambition is required (percentage points of GDP, not a few extra million dollars of exports); a focus is required on the cluster as opposed to very specific activities; and a structural, whole of government policy agenda is needed (skill, infrastructure, research, FDI attraction, and so on) rather than some financial support. This should be done properly or not at all. And importantly, choices will need to be made in terms of what not to do. (p. 22)

The 11 National Science Challenges set up from 2014 represent another approach to focused innovation policy that shares some characteristics with policies in other SAEs (Box 4).

Box 4 **The National Science Challenges**

The National Science Challenges (NSC) are collaborative, cross-disciplinary, mission-led approaches to tackling issues important to New Zealanders (MBIE, 2018). Investment in them will be just over $680 million over 10 years from 2014. Principles include purposeful collaboration across research providers, stakeholder engagement (including with business), public participation, and Māori involvement and mātauranga. MBIE has developed a performance framework for monitoring and evaluating each Challenge and the overall NSC policy (MBIE, 2019a).

Like some of the SAE initiatives and the Canadian Innovation Superclusters Initiative (Box 1), the National Science Challenges employed a devolved governance model.

> Each Challenge has established a governance entity that is responsible for managing the delivery of the research and funding to address the Challenge research goals. This entity is accountable for the fulfilment of contractual and performance requirements as agreed with the Science Board (MBIE, 2020c).

Several Challenges have some focus on economic applications. For example, Callaghan Innovation leads the Science for Technological Innovation Challenge. With $106 million over 10 years, it aims "to enhance the capacity of New Zealand to use physical and engineering sciences for economic growth" (MBIE, 2018, p. 34).

Yet overall, the Challenges appear to focus more on scientific research and less on near-market innovation and economic outcomes than the SAE strategies discussed in Chapter 3. The Ministry of Business, Innovation & Employment's Science Board is responsible for broad decisions on funding of the NSCs (MBIE, 2021).

New Zealand also experimented with high-level multistakeholder governance of its innovation policies associated with the GIF. These arrangements did not endure across a change of government and struggled to provide an effective voice for non-government participants (Box 5).

Box 5 **The Growth and Innovation Advisory Board**

The Growth and Innovation Advisory Board (GIAB) existed from 2002 to 2009. The GIAB's purpose was to provide ministers with high-level, independent strategic advice on growth and innovation issues, including the implementation of the Government's GIF.

The Board consisted of around 15 government-appointed members, including from BusinessNZ, the New Zealand Council of Trade Unions, leaders from major New Zealand businesses, New Zealand Trade and Enterprise and universities. Chairs included business leaders Stephen Tindall and Rick Christie.

The Board met bi-monthly. It worked through action groups tackling issues of interest. The Ministry for Research, Science and Technology first provided secretarial support, followed by the Ministry of Economic Development. The Government provided $110 million over four years to implement GIF initiatives (OECD, 2007).

GIAB sponsored a forum in 2002, involving the Prime Minister, senior ministers and business stakeholders, to find ways to accelerate economic growth. In 2003 a similar forum focused on the contribution of infrastructure to meet growth goals. It also completed work on agribusiness, on the cultural underpinnings of growth and innovation, and on skills.

Some members of GIAB were disappointed that the Board did not have a stronger influence on policy. The then Opposition argued that the advice of GIAB would have been more influential if it had been made available to the public (Oliver, 2004).

4.2 Current focused innovation policy

Potential areas of focus for innovation policy are numerous, and different ways of defining focus areas in the economy are available. Most commonly, commentators and governments look to build on existing strengths in their economies and emerging areas of success, where potential for innovation is evident. Choices are not only a matter of science; they are equally a matter of judgement informed by a range of factors.

- Skilling (2020) points to two broad areas of the New Zealand economy with the potential to build competitive strength given the country's starting point and distinctive circumstances – primary production and weightless industries.
- The Government's draft research, science and innovation (RSI) strategy suggested a focus in about five areas that build on existing strengths and advantages, and provide the opportunity to shift from "volume to value", while being consistent with:
  - work under way to build depth and scale in the RSI system;
  - RSI portfolio efforts focused at the global frontier of innovation and knowledge; and
  - the focus areas in the Government's industry strategy.

Any choice of focus needs to account for a range of objectives for focused innovation policy. This section concentrates on the objective of raising the productivity and exporting performance of frontier firms.

The draft RSI strategy signalled an intention to focus RSI effort on building scale "in areas of emerging opportunity, disruption, or critical need to New Zealand" (MBIE, 2019b, p. 34). The strategy outlined

and sought feedback on possible areas for focus. These included the sectors marked out for industry transformation plans (ITPs) in the Government's industry strategy (see below), but also identified aerospace, renewable energy and health technologies as possibilities.

The Government's industry strategy

The Government has refreshed its industry strategy in 2020 and is developing ITPs (MBIE, 2020b, 2020a). The strategy aims to "lift aggregate productivity and enable the scaling up of highly productive and internationally competitive clusters based on New Zealand's comparative advantage" (Minister for Economic Development (Hon Phil Twyford), 2020, p. 2). A subset of ITPs focuses on "high potential" sectors that "could become a highly productive and internationally competitive cluster of businesses" (p. 2) (Box 3).

A wide range of policy instruments can contribute to successful innovation

The industry strategy envisages using instruments such as active labour market programmes, targeted trade policy, regulation, investment support, government procurement, emissions reduction pathways, capability building, and tax measures (such as accelerated depreciation). "Appropriate actions and initiatives …will be identified and developed in partnership with industry" (p. 7). Even so, only modest provision has yet been made for resourcing such initiatives.

Governance of the strategy rests with the Economic Development Ministers Group. A Tripartite Oversight Group (currently involving the Government, Business New Zealand, and the New Zealand Council of Trade Unions) provides advice across the strategy. The Government is seeking a way for Māori interests to join the Oversight Group.

Box 6 **High-potential sectors under the Government's industry strategy**

The Government has identified five "high-potential" areas of focus as part of its industry strategy, with the intention of enabling "the scaling up of highly productive and internationally competitive firms". The initiatives are at different stages of developing ITPs. Officials are partnering and engaging with industry to develop ITPs that have a shared vision, identify issues holding the sector back and agree on actions needed to transform these sectors.

Advanced manufacturing

MBIE staff are in the early stages of partnering with key stakeholders in the sector to develop the scope and direction of an ITP. The focus is on assisting New Zealand manufacturers and the manufacturing workforce to adopt advanced manufacturing skills, business models and technologies that will improve productivity and international competitiveness. This work follows on a Budget 2019 initiative: the "Industry 4.0 Demonstration Network". Current year funding for this initiative is $1.9 million.

Agritech

The agritech sector covers manufacturing, biotechnology and digital-based technology companies that add value in agriculture and horticulture. In partnership with Agritech New Zealand, the Government published an ITP for Agritech in July 2020. A focus of the ITP is scaling up the size of the sector. The ITP sets out a range of actions across six workstreams, and includes three "high-impact" projects. Budget 2020 appropriated a further $11.4 million for the Agritech ITP initiatives over three years. MBIE is the lead agency for this ITP.

Digital technologies

MBIE has established a sector reference group and issued an update on progress towards an ITP in August 2020. The sector covers firms whose core activity is creating and selling digital solutions. The Government has indicated a strong focus on promoting weightless digital exports. Budget 2020 allocated $5 million to implement initiatives under the digital technologies ITP.

Food and beverage manufacturing; and forestry and wood processing

The Ministry for Primary Industries is the lead agency for developing the Food and Beverage Manufacturing ITP. Te Uru Rākau (Forestry New Zealand) is the lead agency for developing the Forestry and Wood Processing ITP. The intention is to find ways to increase the value of output in these two domestic and export sectors that are already large. The ITPs are "nested within" the Government's response to the Primary Sector Council's vision and strategic direction for the agriculture, food and fibres sector. Detailed ITPs are being scoped with industry partners. At the same time, agencies have undertaken work on development of the forestry and wood processing workforce and on opportunities to add value in wood fibre technologies.

Source: Minister for Economic Development (Hon Phil Twyford) (2020); New Zealand Government (New Zealand Government, 2020c, 2020a, 2020b); Bio Pacific Partners (2020); The Forestry and Wood Processing Workforce Action Plan Working Group(2020).

Assessment of focused innovation policy in New Zealand

The Government has both implicitly and explicitly selected areas of the economy and technologies on which to focus innovation effort. Generally, these areas reflect existing strengths and concentration of innovative activity, consistent with the literature on focused innovation policy and SAE practice (Chapter 2 and Chapter 3). Yet, weaknesses exist in current policies.

Areas of focus for innovation policy are not consistently defined

New Zealand policy focuses innovation effort, deliberately or otherwise, in areas relevant to promoting competitiveness and export success. For instance, New Zealand has always, as noted, had a strong focus on innovation in the primary industries. Even so, it is not clear how well the many separate initiatives are connected. Researchers tend to work separately on related topics, often incentivised by a need to compete for and control their share of available funding, creating a fragmented approach overall.

Other areas of science effort are also relevant to components of the Government's industry strategy. Callaghan Innovation, for historic reasons, has an in-house science and engineering capability covering advanced materials, advanced manufacturing, the internet of things, data science and biotechnology. Callaghan uses sector teams to engage with individual firms in selected sectors, currently including digital, health, food and beverage, agritech, and manufacturing. The MacDiarmid Institute, another CoRE host, has a focus on advanced materials. One of the NSCs has a focus on using advanced technologies for economic growth.

Consistency of focus across various areas of innovation (and economic development) policy is partial at best. The draft RSI strategy has signalled an intention to focus funding for innovation in areas where New Zealand "has, or will be able to build, a sustainable competitive advantage on the world stage" (MBIE, 2019b, p. 35). Yet, the draft RSI strategy only briefly mentions the possibility of focusing on the high-potential areas selected with the same objective in the Government's industry strategy, and raises alternatives to consider.

Weak stakeholder involvement in selecting areas of focus and their governance

Other countries have used high-level stakeholder advisory boards to help governments select areas for focus. Some have also relied on inviting proposals that engage consortia of stakeholders in setting out strategic directions for the areas of innovation in which they are engaged. Crucially these arrangements link firms seeking to innovate with knowledge institutions and other researchers, and involve a substantial commitment of private resources to at least match public funding. These consortia then form the entities that oversee the development and implementation of the funded initiatives (Chapter 3).

New Zealand has used elements of these approaches in past initiatives, but has not ever brought them coherently together as a complete policy package. For instance, MPI approved competitive funding proposals under the Primary Growth Partnership (PGP) based on the independent advice of an Investment Advisory Panel. Each of the funded programmes was overseen by a steering group involving officials, participating firms and sometimes an independent chair. Yet the PGF lacked a clear strategic context and fully devolved governance of funded programmes (Box 4). The National Science Challenges employ a devolved funding structure; yet they are not strongly focused on market outcomes and do not require substantial private sector cofunding (Box 4).

The current government also set up the Primary Sector Council (with a life of two years), comprising senior independent industry experts, to develop a high-level strategy for innovation in the sector. The outcome was the *Fit for a better world* vision and roadmap that forms an umbrella for developing two of the ITPs (Primary Sector Council, 2020). An earlier government established a cross-sectoral Growth and Innovation Advisory Board (GIAB), led by senior industry figures (Box 5).

If the Government had with other stakeholders put together a complete package of focused innovation policy institutions and processes, something like the areas chosen in the current ITPs may have been the result. Yet a complete package would have generated much more momentum towards achieving the stated policy objectives and given stakeholders much greater confidence in participating in and investing in the strategy.

Even so, the time and resources required for a complete package would only be justified if the Government were itself bringing substantial resources to play.

The Government's industry strategy has limited access to resources

The Government has allocated a relatively small resource to support the operation of its industry strategy for "high-potential" sectors (Box 6). The strategy envisages that Ministers can seek further resources through future budgets as opportunities for worthwhile investments emerge (Minister for Economic Development (Hon Phil Twyford), 2020).

Other resources (for instance in the RSI portfolio) may currently be available to support initiatives identified through the ITP processes. Yet, the processes by which this could happen and how relevant decision makers would respond to requests for support are not clear, given that the draft RSI strategy and the industry strategy are not yet aligned in their areas for focus.

The broad scope of policies relevant to implementing ITPs is a further issue (see above). Education, infrastructure provision, capital market development or immigration could all be in scope. Yet a well-defined and efficient mechanism for bringing these policies and resources to bear within ITPs is lacking. Industry partners risk spending time and resources engaging with officials to develop ITPs and plan their own investments only to be disappointed if complementary government investments and initiatives are not forthcoming. Industry partners will be less likely to participate unless they see that the Government has committed a substantial and durable resource to support initiatives.

Some SAEs (eg, Singapore and the Netherlands) pre-commit substantial resources (in the order of $1 billion each year) for focused innovation policy. This includes existing resources in relevant portfolios which are nominally tagged to support initiatives. The resources are released to fund initiatives that meet agreed criteria. This approach has the advantage of signalling the Government's intent to other stakeholders and is therefore likely to elicit a stronger response in support of initiatives.

Participation by a senior member of the Government in governance arrangements would help speed the allocation of resources for investments as opportunities emerge. Some other SAEs (eg, Finland, Sweden and Singapore) employ such governance arrangements in their focused innovation policies (Chapter 3). Effective governance also needs active participation from senior industry leaders (firms and workers) and Māori interests, with a commitment to making investments in innovation work.

Commitment to review industry strategies and evaluate initiatives appears weak

Provision for monitoring, review and evaluation is a core part of designing a successful focused innovation strategy. By their nature, such strategies are exploratory. Government works with industry partners to identify areas for productive investment and barriers to successful investment. Transparent information and reviews of progress are key to keeping strategies on track over time. Strategies are experimental and not all initiatives will be successful. So it is important to evaluate the outcomes of initiatives and improve understanding about what works and what does not (Chapter 2).

Publicly released summary documents on the Government's industry strategy do not reference the monitoring, review and evaluation of the overall strategy. The Agritech ITP describes indicative measures of outcomes that could be the basis for evaluation, and signals an intention to develop a detailed approach (MBIE, 2020b).

More widely, the Government has recognised the importance of evaluating impact in its innovation policies. The Government's draft RSI strategy signals an intention to monitor progress towards achieving the Government's vision and towards achieving targets (such as raising all R&D expenditure to 2% of GDP). MBIE has produced a companion position paper setting out its framework for measuring the impact of research. The paper also sets expectations on public research funders, public research organisations and researchers to measure impact. The paper notes that currently "New Zealand makes only limited use of impact in performance evaluation" (MBIE, 2019c, p. 9).

The possibilities for evaluating business-led innovation investments in New Zealand have been illustrated by the evaluation of the former PGP programmes (Battell, 2018). Each of the constituent programmes had its own evaluation at mid-point and on completion. The summary evaluation drew on these to assess the benefits and outcomes of individual programmes and the overall success to that point of the partnership, and made recommendations for increasing its impact.

4.3 Insights for future policy

Insights for New Zealand policymakers emerge from the rationale for focused innovation policy (Chapter 2), the experience of other SAEs (Chapter 3) and New Zealand's own attempts to introduce such policies.

A successful strategy requires effective leadership and a large step up in resources and focus

Currently, public resources allocated to the Government's industry strategy are very small as a proportion of RSI and economic development expenditure. New Zealand has a history of small-scale, sector-focused initiatives that often fade away without any clear idea of what they have achieved. Rather than being transformational, the current initiatives risk a similar fate.

Figure 4.1 Success requires a large step up in resources, leadership and focus

If New Zealand is to achieve innovation-driven export success on the scale of comparator SAEs, it must be similarly bold in identifying the most promising areas for focus, establishing effective governance institutions and processes and allocating substantial resources to chosen areas over a sustained period of time . A repeat of past "sub-therapeutic doses" will achieve little or nothing. Only strong and committed senior leadership across government, industry, researchers and educators will achieve this.

Government should share the lead with industry and other stakeholders

A successful focused innovation strategy must have buy-in from the stakeholders that will drive it forward. Wilkes (2020) stresses the importance of a consistent, transparent strategy for success:

> People running companies do not want to have to refer to the government's constantly changing whim in making their plans …A strategy that communicates a direction is itself a tool, helping to align private sector behaviour with it. (p.24)

Other SAEs achieve this through engagement of senior and expert stakeholders in both high-level strategic governance arrangements and through devolved governance arrangements for specific initiatives (Chapter 3). These arrangements must be both transparent and genuine in sharing decision making across government, Māori, industry (firms and workers) and research leaders. Shared decisions should cover the choice of areas for focus, and the resourcing, implementation monitoring and evaluation of focused innovation policy.

Māori participation in decision making requires care in establishing a mandate from among iwi and Māori interests. Willingness to participate will be influenced by the weight given to the process by the Government and other stakeholders, and the potential value for Māori in terms of the economic, social, cultural and environmental outcomes sought. Adequate resources are needed to support meaningful participation.

Choosing, resourcing and implementing focused innovation policy

Section 4.2 found that to date New Zealand governments have not put in place a full package of focused innovation policies, institutions and processes likely to succeed in achieving stated objectives. The Government has not yet committed sufficient resources to its current industry strategy; nor has it put in place governance arrangements and policy processes to draw forth a substantial contribution from private sector counterparts.

European and Canadian focused innovation initiatives provide lessons for focused innovation policy in New Zealand (Chapter 3, Box 1). The relevant characteristics and a possible New Zealand approach follow.

- *A high-level process for bringing forward proposals to meet defined strategic objectives*. Independent experts assess proposals against established criteria, and proposals may be refined iteratively until they are accepted. In some cases, this process is governed by an independent high-level stakeholder national innovation council. New Zealand has already chosen areas for focus through the Industry Strategy. It would be opportune to confirm the relative importance and resourcing for these chosen areas through a deliberate high-level multi-stakeholder review.
- *Devolution of governance and resourcing of initiatives within each area chosen for focus*. Devolution is conditional on government providing substantial resources, and the private sector at least matching these. Typically, independent multi-stakeholder entities are set up for each broad area of focus to oversee and bring forward specific innovation initiatives. Entities may have an initial life of five to ten years and are subject to periodic performance reviews. Funding agencies audit the use of public funds against usual criteria. If the Government provides substantial resources for implementing ITPs, a devolved approach is likely to bring forth stronger stakeholder commitment and draw more effectively on dispersed expertise, knowledge and resources.
- *A strong commitment to monitoring, evaluation, review and adaptation of strategy and initiatives*. Focused innovation policy is necessarily experimental and should be designed to elicit learning and adaptation as it proceeds (Chapter 2). This requires a clear evaluation and review strategy to be established from the outset. The strategy should have pre-set review points and a transparent process for making indicated adjustments to governance, process, design and implementation of initiatives.

Focused innovation policy is difficult to implement…

International experience shows that countries often struggle to get the right institutions and processes in place, and, in any case, these need to adapt to a changing environment (Chapter 3). Effort risks being diverted into supporting established approaches and interests. Governments must also find ways to support the genuinely new and to harness the knowledge that they do not hold themselves. Broad strategies and international experience in reducing the risks of focused innovation policy are available (Chapter 2 and Chapter 3, Table 4.1).

Table 4.1 Risks of focused innovation policy and their mitigation

Risks	Consequences	Mitigation
Failing to make choices	Spreading effort and funding too widely and continuation of "sub therapeutic doses" – sub-scale investments that achieve little.	Make objectives and focus areas specific with well-defined "edges" and substantial funding.
Industry capture / funding business as usual	Funding is captured by business interests and used to fund activities that they would do anyway. This will simply pump up profits for incumbents instead of supporting genuinely new and innovative activities and "shifting the dial" on productivity.	Require some private investment in policy processes and projects. Funding decisions must be based on clear and transparent criteria (including additionality – a focus on new activities).
Lack of policy commitment and funding duration and stability	Innovation is complex, risky and non-linear, so impatience and a short-term focus could lead to premature closure, wasting stakeholders' time and resources, and generating distrust in government engagement processes. Premature closure would also fail to achieve the desired outcomes.	Give firms and researchers enough certainty and consistency of funding and policy (over long enough time horizons) to support investment in innovation. The Commission recommends funding horizons of around 10 years. Securing cross-party support for such a strategy would be helpful.
Lack of necessary public sector capability	Implementation is ineffective.	Consciously build capability and skills and apply them over a long enough time to create effective networks.
Being overly risk averse	Fear of failure creates an overly cautious approach, stifling innovation and failing to deliver the desired productivity gains.	Create the right institutions and processes (eg, the Innovation Council, devolved governance and expert assessment) to support an experimental and adaptive approach.
Being overly optimistic and ad hoc	Ad hoc political decisions lead to inappropriate projects, for example picking "superstar" technologies.	Ensure good institutional design with effective selection and evaluation processes to weed out poor ideas and shut down unsuccessful projects.

Source: Wilkes (2020)

Wilkes (2020) emphasises that ultimately any strategy will be "carried out by thousands of actors, acting under their own steam and the institutional structures put about them"(p. 25). Institutions include both the governance arrangements for a strategy and its implementation, and the "rules of the game" that constrain how firms and people behave. In turn "rules of the game" cover the wider legal framework (eg, competition law, and limits on state aid to private firms). They also cover specific design parameters for the operation of focused innovation policy.

Wilkes (2020) identifies the following as influential.

- Have clear criteria and objectives for areas of focus (eg, potential for positive change and for government involvement to make a significant difference to outcomes). This helps to "draw edges" around a focused innovation strategy.
- Choose objectives that go with the grain of non-economic goals, such as climate-change mitigation, or adjusting to the effects of population ageing. Objectives "must be a combination of bold; measurable and targeted; ambitious but realistic; able to encourage multiple interactions across sectors; involving multiple bottom-up solutions" (p.31).

- Keep a bias in favour of competition (as inconvenient as this may seem to politicians who want to take control). This includes adherence to "state aid rules, due process in the dispersal of government funds, procurement rules, controls on mergers and takeovers, and much more" (p. 33).
- Make challenge of ideas and proposals integral to implementing a strategy. The "ultimate constraint" is "a finite budget, which forces good ideas to compete against each other and introduces challenge naturally" (p. 38).
- Once decisions on initiatives are made, provide certainty and longevity for other parties. "This is why solid institutional arrangements are so important, as these outlast a political life cycle and can confer a degree of immunity to subsequent meddling" (p. 40).

Yet, inevitably, uncertainty exists about where to land on the many design choices available (Chapter 3). An experimental, adaptive approach with good monitoring, evaluation, and periodic review of strategy and of particular initiatives will help to reduce uncertainty over time, and to keep a strategy on track.

... and skills in the public sector and beyond will take time to develop

A key success factor for focused innovation policy will be to have officials with knowledge and experience of stakeholder engagement processes, who can gain the respect of those stakeholders and build a long-term relationship. Other SAEs have decades of experience in focused innovation effort across government, industry and research organisations. This experience means that their public sectors and people in the wider innovation system have built the capabilities and organisational cultures to engage successfully with each other.

New Zealand public sector agencies engaging in focused innovation policy need to give close attention to building the same workforce capabilities here. They would be wise to draw on available experience from various sources. Devolved administration of focused innovation policy calls into play a skillset beyond those typically employed in the central public service. New Zealand has people engaged in regional development policies, or who have engaged in implementing cluster policies in other countries, who could make valuable contributions.

4.4 Priorities for implementing effective focused innovation policy

This section draws together the three government actions that would do most to shift New Zealand to match the best approaches taken by comparator SAEs to focused innovation policy.

Figure 4.2 Three priorities for Government action

Set up an innovation council to run a collaborative process to confirm focus areas

The Government should set up a high-level strategy body (eg, an Innovation Council) with key stakeholders as members (from industry (firms and workers), government, Māori, researchers and educators). Government representatives should include senior government roles, such as the Prime Minister, so that resources can be unlocked across government. This high-level body would set the strategic objectives and criteria to use when selecting focus areas. The criteria would include contribution to future productivity growth and where collaboration with government could add most value. Clear criteria are essential to ensure that decisions are not ad hoc, or the result of lobbying or political calculations.

> The risks of policy failure are greatest when it is left in the hands of people keenest to pick technological winners, anoint favoured companies, pull up maps of the country and direct resources around. Political motivations often contradict commercial imperatives… There is nothing as quick or decisive as a market to weed out the worst ideas…. Any policy maker that embarks on an industrial strategy without clear awareness of these disadvantages will run the risk of a clumsy failure. (Wilkes, 2020)

The process should use the "high potential" ITPs as a starting point. The high-level body would invite proposals for focus areas from consortia of research institutions, firms and industry groups. The consortia would propose strategic areas of innovation that meet the specified objectives and criteria. Industry groups would be expected to commit to co-funding as part of their proposals. Proposals must be for new approaches that will enhance the relevant innovation ecosystem, not pitches in support of existing businesses undertaking existing activities.

The Council would then draw on independent expertise (eg, expert panels and officials) to assess the proposals and provide feedback. Once the proposals are fully developed, the Council would make recommendations to the Government about their preferred focus areas.

With the focus areas chosen and set up, the Innovation Council would have a continuing role to *oversee*:

- the resourcing, monitoring and evaluation of each focus area. The monitoring and evaluation would assess how well the plans and projects in each focus area are meeting their objectives;
- the finalisation of the RSI strategy including an emphasis on building stronger links between industry and researchers; and
- periodic, independent reviews of the entire innovation system.

Set up devolved, transparent governance for each focus area

Once a focus area is confirmed, an independent not-for-profit governance body would be established for that area. As well as other stakeholders, government officials would normally be members of these bodies. The bodies would confirm a long-term strategy for each of the focus areas. Based on the strategy, they would also select, design and implement projects/initiatives within the budgets devolved to them. Funding for the projects would come from both government and industry, and spending would be subject to the normal financial probity requirements for government expenditure.

The devolved governance bodies would be responsible for monitoring their projects and commissioning robust, independent and transparent evaluation of them – to inform adjustments to their design and delivery (including stopping projects that are clearly failing). Arrangements and funding for monitoring and evaluation should be built into projects from the outset.

In summary, two tiers of governance would operate: a high-level strategy body and then an implementation body for each focus area. These new institutions must provide a collaborative, cohesive approach to leadership and governance.

A need may also exist for a working group of "innovation related" Ministers to agree on and action priorities coming from the work of the Innovation Council.

Commit substantial long-term funding for the focus areas

To match the efforts of other SAEs, the Government will need to commit significant sums of money over a long period (eg, 10 years) to the focus areas. The Innovation Council would make recommendations to government about how to allocate funding across focus areas. Resources would not necessarily be equal across focus areas; the resource allocated should match the potential of that innovation ecosystem. Government funding is likely to come from a variety of pots – including from the RSI strategy pot – depending on the focus area.

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