



Australian Government
Productivity Commission

[pc.gov.au](https://www.pc.gov.au)

Guardrails for modern industry policy

Research paper



October 2025

Acknowledgement of Country



The Productivity Commission acknowledges the Traditional Owners of Country throughout Australia and their continuing connection to land, waters and community. We pay our respects to their Cultures, Country and Elders past and present.

About us

The Productivity Commission (PC) is the Australian Government's independent research and advisory body on a range of economic, social and environmental issues affecting the welfare of Australians. Its role, expressed most simply, is to help governments make better policies, in the long-term interest of the Australian community.

The PC's independence is underpinned by an Act of Parliament. Its processes and outputs are open to public scrutiny and are driven by concern for the wellbeing of the community as a whole.

For more information, visit the PC's website: www.pc.gov.au

© Commonwealth of Australia 2025



With the exception of the Commonwealth Coat of Arms and content supplied by third parties, this copyright work is licensed under a Creative Commons Attribution 4.0 International licence. In essence, you are free to copy, communicate and adapt the work, as long as you attribute the work to the PC (but not in any way that suggests the PC endorses you or your use) and abide by the other licence terms. The licence can be viewed at: <https://creativecommons.org/licenses/by/4.0>.

The terms under which the Coat of Arms can be used are detailed at:
www.pmc.gov.au/government/commonwealth-coat-arms.

Wherever a third party holds copyright in this material the copyright remains with that party. Their permission may be required to use the material, please contact them directly.

ISBN 978-1-74037-817-8 (online)

An appropriate reference for this publication is:
Productivity Commission 2025, *Guardrails for modern industry policy*, Commission research paper, Canberra

Publication enquiries:
Phone 03 9653 2244 | Email publications@pc.gov.au

Contents

Summary	1
1. About this research	3
1.1 Understanding modern industry policy	3
1.2 Scope	7
1.3 Organisation of the paper	7
2. Economic resilience and security	9
2.1 A three-step process for considering responses to supply chain risk	9
2.2 Case study: personal protective equipment for healthcare workers	16
2.3 Extending the framework to national security considerations	20
2.4 Iterative risk framework case study: communications hardware	23
3. Net zero transformation	28
3.1 The role of industry policy in the net zero transformation	28
3.2 Applying these principles	34
A. Policy options for economic resilience and security	36
B. Identifying vulnerable, essential and critical goods and services	41
C. Assessing comparative advantage	42
Abbreviations	44
References	45

Acknowledgements

The PC acknowledges and thanks the staff who contributed to this research paper, including Patrick Jomini, Cameron Eren, Paul Gardner, Jared Claxton, Anuraag Roy, Rusha Das and Hiran Gamlath. The PC acknowledges and thanks Commissioners Alex Robson and Catherine de Fontenay for their supervision of this research paper.

Summary

Governments around the world have launched a wave of industry policies over recent years. Examples include the Made in China 2025 plan, the Made in Canada plan, the United States (US) Inflation Reduction Act, the US CHIPS and Science Act, and the European Union's Chips Act, Net Zero Industry Act and Critical Minerals Act. In part, this reflects a desire to build economic resilience amidst rising geopolitical tensions and in the aftermath of the COVID-19 pandemic, and to progress national decarbonisation efforts.

Similar policy directions in Australia include the Future Made in Australia (FMIA) initiative, the development of a Critical Minerals List, and the creation of bodies such as the Office of Supply Chain Resilience. These interventions aim to strengthen economic resilience and security, encourage domestic emissions abatement, and position Australian industry to benefit from the transition to a global net zero economy.

Emissions reductions and economic resilience are important objectives. If poorly designed, however, industry policy can prove costly for taxpayers, act as a form of trade protection, and distort the allocation of Australia's scarce resources towards activities that we may not be best placed to undertake.

To deliver value for taxpayers' money, strong guardrails on policy interventions are essential. These guardrails should include sensible economic frameworks, decision making processes that are transparent and contestable, clear methods for measuring performance, and defined plans for ending interventions that fail to perform. Adopting such measures is crucial to ensure that these interventions are delivered at lowest cost.

Given these challenges, the Productivity Commission has developed a framework to help policy makers identify areas that may warrant support, those that may not, and to help determine appropriate policy responses for both. Specifically, the framework provides a multi-step process to assist decision-making with respect to industry policy settings aimed at supporting net zero-related industries, enhancing economic security, and responding to national security concerns.

For policy aimed at economic security, this process includes two decision trees – the first to assess whether there is a risk that could justify a policy intervention, and the second to help determine the best potential policy responses to that risk. A separate version of the second decision tree is also provided for some national security-related risks.

These decision trees do not aim to be definitive about when a particular good or service (products) should attract a policy response, but rather to highlight those considerations that can either increase or decrease the public policy case for the intervention.

The first decision tree asks policy makers questions such as 'Would a supply disruption have serious welfare impacts?' and 'Can companies manage these supply chain risks themselves?'. If that process identifies products that are essential to resilience and security, thought can then be given to which policy measures are best placed to manage those risks. The second decision tree asks questions such as 'Can we partner with other countries to manage these risks?', or 'Can we stockpile the product?'.

Importantly, the second decision tree also asks a final 'sense-check' question: 'How frequently, or with what probability, would a feared disruptive event have to occur to justify the policy measure?'. That is, would the costs of the measure be lower than the costs of the disruption itself? This is the same way that an individual, household, business, or government might decide whether to buy an insurance policy or not.

This indicator is not proposed as a determinative test, one that needs to be met to a pre-determined degree before a final decision to proceed with a proposal is made. The level of risk that a country is willing to bear is ultimately a choice for society, intermediated through government. This is true for all risks faced by a country, but is particularly apparent in the case of existential national security risks, for which countries may be willing to bear any costs to avoid once they begin to materialise. This test does, however, provide the opportunity to make decisions with ‘eyes wide open’, and provide a common metric by which alternative approaches to managing such risks can be compared.

Two illustrative case studies are included to provide worked examples of how these decision trees can be used.

A separate decision tree is provided for net zero-related industry policy, which asks policy makers to think about issues that can impact the case for providing policy support to individual greenhouse gas abatement activities. Factors include whether there are significant market failures that can be efficiently addressed by industry support; whether policy support can position Australia to more readily adopt new technologies; and whether support is likely to reduce the overall cost of the abatement task required to reach net zero by 2050.

The net zero decision-making process also considers which industries may have a sustained comparative advantage in a future net zero economy and thus have natural ‘off-ramps’ for support once they are self-sustaining, or once it becomes clear that Australia is unlikely to secure a comparative advantage in them.

Relationship of this work to Future Made in Australia and broader policy settings

A robust industry policy framework relies on a well-designed economic framework to target government support. The principles and decision-making structures outlined provide a foundation for such assessments. These elements are applicable across industries and could inform the development or expansion of frameworks while also addressing broader strategic policy considerations (appendix A).

One such framework is the National Interest Framework (NIF), legislated under the *Future Made in Australia Act 2024* (Cth) in December 2024. This Act provides a mechanism by which the Treasurer can ask Treasury to assess the extent to which a proposed FMIA sector is consistent with the associated NIF. The process will determine the sectors for investments but not necessarily the proportionate level of support for a given sector over another.

While designed to assist with thinking about the design of NIF Sector Assessments, the principles and decision-making tools presented here possess broader applicability. This includes to the broader range of policy settings that target similar objectives to FMIA without falling under the FMIA banner, and to the thinking of the Office of Supply Chain Resilience and the groups convened through the National Coordination Mechanism. Consequently, the framework outlined in this document offers a versatile structure suitable to evaluating a wider array of industry policy interventions across government.

1. About this research

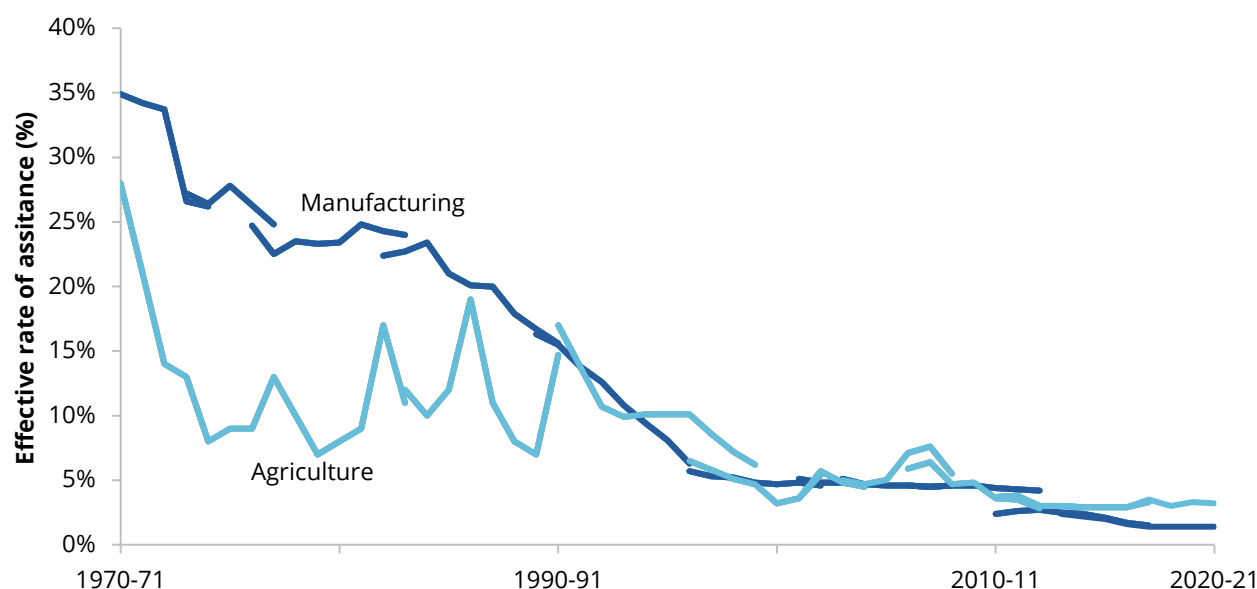
1.1 Understanding modern industry policy

Trends in modern industry policy

In recent decades, Australian industry and trade policy operated under a broad consensus favouring trade liberalisation and reliance on market mechanisms. This primarily came through the progressive dismantling of the system of quotas and tariffs that had protected domestic industry from international competition ‘at the border’.

As shown in figure 1.1, the approach of recent decades has marked a departure from earlier periods of significant industry protection. Over this period ‘behind the border’ assistance – such as domestic subsidies, government grants, local content rules and concessional finance – grew but did not offset falling assistance ‘at the border’.

Figure 1.1 – A long-run downward trend in effective rates of industry assistance^{a,b,c}



a. Effective rate of assistance represents combined tariff assistance and budgetary assistance as a percent of unassisted net output. **b.** ‘Agriculture’ refers to selected agriculture activities up to and including 2000-01. From 2001-02, estimates refer to division A of the Australian and New Zealand standard industrial classification, which covers agriculture, forestry, fishing and hunting activities (ABS 2013). **c.** Breaks and overlapping series represent a change of methodology and/or data sources.

Source: PC estimates.

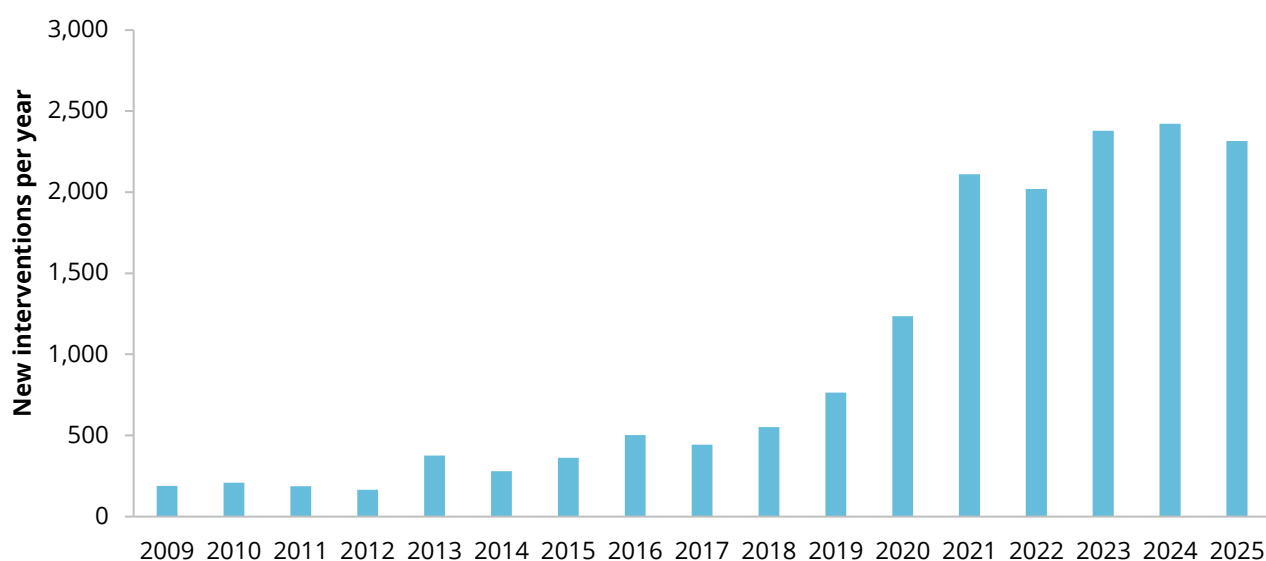
Many other countries behaved similarly over this period. As industry protections fell, the global economy became more integrated, with trade rising from only 26% of world Gross Domestic Product in 1970 to 59% in 2023 (World Bank 2025).

The widespread move towards falling industry protection globally and in Australia was primarily driven by the pursuit of higher living standards through productivity-driven economic growth. Governments and policymakers recognised that opening markets would stimulate competition, and encourage domestic industries to become more innovative (CIE 2017, pp. 5–7; Coelli et al. 2022). Trade liberalisation and other means of economic integration led to lower prices on a wider variety of goods and services due to increased import competition, access to innovations from around the world, and ultimately higher living standards as resources were allocated to more efficient uses (CIE 2017, pp. 15–16; World Bank 2023).

Recently, the trend towards declining industry protection has halted. Global Trade Alert (2025) has recorded a rising trend in trade distorting interventions globally, identifying 2,422 trade distorting interventions in 2024 and 2,315 in the first eight months of 2025 alone. This surge has many drivers, with industry and trade policy measures intended to address:

- **supply chain resilience:** the COVID-19 pandemic resulted in supply chain disruptions, prompting strategies to ensure reliable access to essential goods (PC 2021, pp. 17–21)
- **heightened geopolitical competition and fears of economic coercion:** growing rivalries have led to national security concerns over dependencies on potential adversaries for critical supplies (Channer et al. 2025)
- **technological supremacy:** the race for leadership in strategic technologies (e.g., semiconductors) has driven support for innovation perceived as vital for future economic strength (Bildt 2022)
- **decarbonisation:** the imperatives of climate change have seen industry policy increasingly used to help decarbonise economies (PC 2023b, pp. 20–30)
- **retaliation:** industry and trade policies spark retaliation (PC 2017, pp. 55–61) and mimicking by other countries (PC 2023b, pp. 52–58), and
- **concerns over the costs from globalisation:** exposure to international competition has resulted in social and economic harms in some communities (Autor et al. 2016).

Figure 1.2 – Since 2010 the number of new trade distorting policies each year has trended upwards globally^{a,b}



a. Distortionary interventions typically involved import tariffs, state loans, quotas and subsidies. **b.** Data for 2025 is as of 10 September 2025.

Source: Global Trade Alert (2025).

A substantial portion of these interventions reflect a shift towards what this paper calls ‘modern industry policy’. Distinct in positioning from traditional protectionism, this approach is premised on achieving societal goals such as economic resilience, national security or developing capacities in emerging net zero technologies. While not the subject of this paper, more traditional protectionism has also been on the rise, as exemplified by the recent economy-wide tariff increases in the US (The White House 2025b).

The first major theme of modern industry policy is countries intervening to minimise the perceived risks and costs of supply chain disruptions. Examples include the European Union’s (EU’s) focus on reducing strategic import dependencies for essential raw materials through initiatives like the Critical Raw Materials Act (McDonagh 2024). Likewise, the US CHIPS and Science Act authorises \$278.2 billion in funding towards domestic semiconductor manufacturing and public sector research and development up to 2027 (Cooper 2022; Library of Congress 2023).¹ The US has coupled these initiatives with trade restrictions on semiconductors going to China (Shivakumar et al. 2025).

The second major theme is industry policy being used as a tool to help countries achieve their net zero emissions goals and to position countries to capture the benefits of emerging industries. For example, the EU Green Deal Industrial Plan aims to enhance the bloc’s manufacturing capacity for net zero technologies through a simplified regulatory environment, faster permitting, skills development and facilitating finance (Dullien 2024). Similarly, the US Inflation Reduction Act provided extensive financial incentives,² including tax credits for renewable energy projects and domestic clean energy manufacturing, to accelerate industrial decarbonisation (US Treasury 2025).

Modern industry policy in Australia

The Future Made in Australia agenda

The Australian Government is pursuing similar modern industry policy initiatives. While maintaining commitments to free trade as an enabler of economic security,³ there is an increasing focus on industry policy designed to strengthen domestic supply chains and foster growth in strategic industries, particularly those related to the transition to a net zero economy.

Initiatives such as the ‘Future Made in Australia’ (FMIA) program exemplify this modern approach to industry policy. FMIA signifies a greater interest in targeted industry policy interventions in the Australian economy, aimed at leveraging public resources to build supply chain resilience, encourage emissions abatement, and position Australia to benefit from the emerging global net zero economy (Australian Government 2024, p. 3).

The Australian Government has adopted a clear conceptual framework – the National Interest Framework (NIF) – to assess proposed sectoral interventions and mitigate the risk of poorly targeted investment.⁴ The

¹ The CHIPS and Science Act is undergoing some administrative changes but remains law (The White House 2025a).

² As of writing the Inflation Reduction Act remains law but its scope, scale and composition moving forward is unclear. Columbia Law School’s (2025) IRA tracker records steps taken by federal agencies to implement, or rollback implementation of the IRA.

³ For instance Treasurer Jim Chalmers wrote in October 2024 that ‘free, fair and open trade is an important enabler of global economic security, not an obstacle to it’ (Chalmers 2024), and Prime Minister Anthony Albanese has echoed similar support for free trade despite a ‘changing geostrategic environment’ (Albanese 2025).

⁴ As outlined in the *Future Made in Australia National Interest Framework Supporting Paper* (the Supporting Paper) published in May 2024 and supported through the passing of the *Future Made in Australia Act 2024* (Cth) in November 2024 (Australian Government 2024).

PC welcomes the NIF and its operationalisation through Sector Assessments, which can play an important role in ensuring the FMIA objectives are met at best value to the Australian public.

The NIF provides for the allocation of FMIA funding under two streams: the net zero transformation stream and the economic resilience and security stream (Australian Government 2024).

A sector could qualify for support under the economic resilience and security stream if:

- some level of domestic production capability is judged necessary or efficient to deliver adequate economic resilience and security
- a disruption to supply of that good or service is judged to have unacceptably high impacts on safety, economic stability, or wellbeing
- the private sector would not invest in this capability without public investment
- public investment could address the risks to economic security and resilience in a way that represents ‘compelling public value’ (Australian Government 2024, p. 12).

A sector could qualify for support under the net zero transformation stream if:

- it is judged to have grounds for sustained comparative advantage in a net zero global economy
- public investment is judged to be necessary for the sector to make a significant contribution to emissions reduction at an efficient cost (Australian Government 2024, p. 9).

Whether the NIF is effective in managing these risks will depend on the final design of the sector assessments, and the extent to which they are used to guide FMIA support to industry.

Other initiatives to build supply chain resilience and support net zero industry

FMIA does not encompass all modern industry policy initiatives in Australia. The PC’s *Trade and Assistance Review 2021-22* noted the growing role of net zero industry policy well before the announcement of FMIA (PC 2023b, pp. 52–58). Many measures such as the Capacity Investment Scheme, Powering the Regions Fund and the Hydrogen Hubs Program which provide support for net zero industry and are not formally listed as part of FMIA, based on available documents (Australian Government 2025; Commonwealth of Australia 2024, pp. 62–72).

The Australian Government has also embarked on several initiatives aiming to promote economic security and resilience outside of FMIA. Examples include the implementation of the national medical stockpile, which was labelled as ‘deficient’ in the recent COVID-19 Response Inquiry (Albanese et al. 2024). Another example includes funding to upgrade Australia’s two oil refineries to improve fuel security (DCCEEW 2024). These fall outside FMIA’s remit, while promoting similar objectives.

The risks posed by modern industry policy

Modern industry policy addresses legitimate concerns, but all forms of industry policy present risks. Foremost among these is the potential for an inefficient allocation of scarce resources if governments attempt to ‘pick winners’ by favouring one firm or sector over another. Industry policy diverts capital, skilled labour and other resources from potentially more productive uses elsewhere in the economy, and imposes costs on taxpayers and unassisted sectors. While governments may pick an occasional winner, they can also ‘pick losers’ by propping up otherwise unviable firms, depriving other industries of those resources (Wood and Reeve 2024, pp. 6–7).

Industry policy also creates the potential for rent seeking and political capture. Broad-based industry policy objectives encourage firms to invest resources in lobbying for government favours, making ‘protection for sale’ (Goldberg and Maggi 1999). Such processes can also favour incumbents and discourage new entrants;

as support is directed more towards firms with a proven track record, better networks and more resources (OECD 2024, pp. 24–25).

These risks are heightened for small-to-medium sized economies like Australia. Smaller economies lack the market power to significantly affect global supply and demand factors, meaning the heavy-handed industry policies prosecuted by larger economies can be more difficult to manage, while delivering less of a result. Small economies will likely struggle to compete in a market crowded with much better resourced players. Instead, smaller economies are generally best served by continuing to focus where they are best placed to fit within global production patterns (Robson 2023, p. 6).

While this industry policy is modern in its scope, it is not ‘new’ and past mistakes must be learned from. For example, Australia’s extensive support for its car industry was often justified on national security grounds, stating that the industry would provide option value in a crisis allowing Australia to manufacture defence vehicles (Wood and Reeve 2024, p. 8). Likewise, governments have routinely invested in ‘emerging’ technologies, expected to be pivotal for future economic growth or security. For instance, the US Synthetic Fuels Corporation, which aimed at domestic fuel security, failed. Falling oil prices, high costs and technological hurdles led these projects to fail quickly despite investments worth over US \$1 billion by 1986 (McGillis 2021).

Given that industry policy always involves risks, strong guardrails are essential. These guardrails should include sensible economic frameworks, decision making processes that are transparent and contestable, clear methods for measuring performance, and defined plans for ending those that fail to perform. Adopting such measures is crucial to ensure that industry assistance genuinely serves the national interest and is delivered at lowest cost.

1.2 Scope

This paper presents a broad framework to address the risks associated with modern industry policy. The framework aims to provide some discipline to the industry policy making process. It is a set of principles, not prescriptions, to encourage policymakers to consider the costs stemming from disruptions or externalities required to justify a proposed intervention. The framework does not dictate or decide the level of risk that a country is willing to bear which is ultimately a choice for society, intermediated through government.

This framework is designed to both complement processes like the sector assessments under the NIF, and to be more broadly applicable to non-FMIA industry policy:

- It complements the NIF process by setting out questions that can help bring out some of the considerations that appear to be embedded within the NIF, and how these can be integrated into the broader policy design process.
- It can be applied to industry policy measures seeking to achieve similar goals whether they are listed as a FMIA measure or not. For example, some recent changes to strategic stockpiles for fuel, medical, items and other goods and some net zero industry policy measures do not fall under the FMIA umbrella.

1.3 Organisation of the paper

Chapter two examines the role of industry policy in addressing economic security and resilience concerns. This includes a framework for assessing special cases where national security is a driving motivation for intervention. A case study is provided for both cases.

Chapter three looks at the role of industry policy in decarbonising the economy. This is complementary to the PC inquiry titled *Investing in cheaper, cleaner energy and the net zero transformation* (PC 2025).

In addition, there are three appendices detailing policy options including ones that are complements or substitutes for industry policy supporting domestic production, followed by a summary of the PC's past work on supply chain resilience and work on empirically identifying comparative advantage.

2. Economic resilience and security

Key points

- * Supply chain disruptions can be costly and detrimental to the wellbeing of Australians. On this basis we propose a three-step process for considering responses to supply chain risks.
- * The first step is to assess the scale and nature of any potential disruption. This step examines whether a good is essential and critical to welfare, whether it is vulnerable or prone to disruption, and if government intervention is appropriate to protect welfare.
- * The second step is to assess the potential policy responses to mitigate these disruptions. Policy responses could include stockpiling, developing international partnerships to diversify supply chains and investing in domestic production capabilities.
- * The third step is to estimate the implied frequency of disruption (or length of disruption, or time to disruption) as a final sense check. This gives an indication of how significant and frequent a disruption may need to be for a given policy response to offer public value.
- * National security considerations are being increasingly embedded into industry policy decision making. Such decisions can be aided by this process. We modify the framework in these cases to iteratively update the perceived likelihood of an identified risk event as new information becomes available.
- * The process is intended to guide policymaking without being prescriptive. The level of risk tolerance (and therefore the appropriate cost incurred in mitigating the risk) is a social choice, made by elected governments.

2.1 A three-step process for considering responses to supply chain risk

Step one: assess the scale and nature of any potential disruption

Disruptions to supply chains can have major impacts on the wellbeing of the Australian community. The consequences of some of these disruptions can be particularly severe, for example if there are disruptions to the supply of medicines, petrol and other liquid fuels, or spare parts used in the supply of essential services.

However, not all supply chains are vulnerable to disruption and not all disruptions will have notable impacts on Australians' welfare. Moreover, businesses are often best placed to manage the risks associated with

their supply chains, as they generally have a better understanding of their production processes and better knowledge of available production alternatives than do policy makers.

As such, supply chain risks can be misidentified by policymakers, and only some of those risks are likely to have a material impact on the living standards of Australians if they eventuate. What may intuitively seem to be a risk at first glance could overlook important characteristics of the goods and services being considered (box 2.1), and initial policy instincts might not survive a data-based assessment of the perceived vulnerability.

Box 2.1 – Capital and consumption goods compared

Capital goods provide a stream of output over time. They differ from consumption goods which can only be used once.

Disruptions to the supply of capital goods are generally less impactful to welfare in the short term since people and firms can rely on an existing stock of the goods. For instance, if there is a temporary shortage of new farm equipment, farmers can continue to use existing machinery, repair it, and even recycle parts. Similarly, a shortage of new solar panels does not prevent existing solar installations from continuing to provide electricity to the grid.

In contrast, short-term disruptions are more likely to have a bigger impact on consumable products, which generally need to be regularly replenished. For instance, even with Australia's existing stockpiles there is only sufficient liquid fuel to supply Australia for 34 days without imports (as at March 2025). A short-term disruption to fuel imports would reverberate throughout the economy after only a few weeks.

Source: DCCEEW (2025a) and PC (2021, pp. 62–63).

The PC proposed a 'data with experts' framework to identifying supply chain vulnerabilities that would benefit from policy intervention in our report *Vulnerable supply chains* (2021). Under that framework, goods and services were described as 'vulnerable' if there was a material risk of supply chain disruption due to geographical concentration,⁵ 'essential' if they were material to living standards, and 'critical' if there was a lack of available substitutes (appendix B). This approach was later adapted and operationalised by Australia's Office of Supply Chain Resilience (DFAT 2023, p. 6).

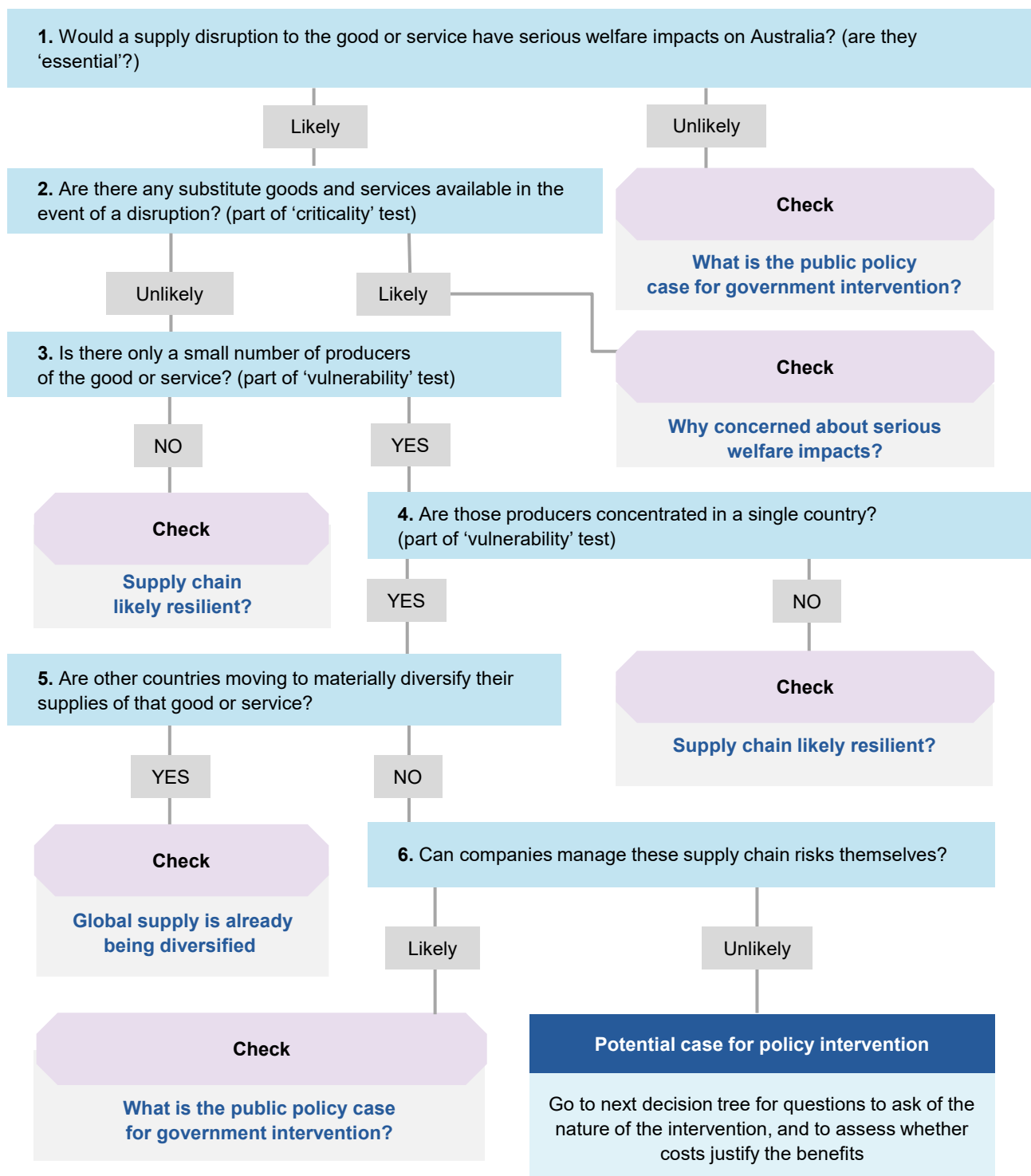
Building on previous work, this framework highlights the importance of country and firm-level concentration in assessing supply chain risks, and places these considerations within the emerging global context, where a range of countries have set about responding to similar supply chain concerns over recent years by building domestic production capability in those goods and services. To the extent they continue to do so, they are undertaking the supply chain diversification that supply chain resilience proponents might like to see, potentially reducing the value of Australia doing so through support for domestic production.

Decision tree 1 (figure 2.1) lays out these considerations to help policy makers identify goods and services that might warrant policy attention. This decision tree does not aim to be definitive about when a particular

⁵ The framework identified geographical concentration rather than firm concentration, to account for geopolitical risks and for the potential for natural disasters to affect transport routes, rather than vulnerability due to market concentration. However, future measures might also benefit from estimates of firm level concentration, potentially accounting for a number of supply risks that are relevant to the number of firms.

good or service should attract a policy response, but to highlight those considerations that can help determine the case for policy intervention.

Figure 2.1 – Decision tree 1: Questions to assess supply chain risks and the case for government intervention



Step two: assess possible policy responses

If the process set out in decision tree 1 identifies a good or service that might present policy concerns, further consideration can then be given to which policy measures are best placed to manage those risks. Appendix A provides more detail on some of the different policy options available.

There is a range of policy responses to perceived supply chain vulnerabilities, from building a domestic stockpile to working with other countries to manage shared concerns through a club goods arrangement. These options should be evaluated before considering likely higher-cost options such as providing policy support for a sector in which Australia has not yet demonstrated a comparative advantage.

Moreover, having a domestic production capability in a sector might not protect a country from shocks to the global supply of that good or service, particularly if the domestic supply of that good or service can simply be exported to take advantage of higher international prices during the shortage. Avoiding such scenarios may require well designed and targeted export controls being put in place during the course of the crisis. The potential domestic supply benefits of doing so, however, would need to be weighed against the loss of export revenue during such global shortages, and subsequent impacts on the willingness of businesses to invest in sectors subject to export controls.

In addition, policy support for one or more industries in response to supply chain concerns means reallocating resources away from other domestic industries, potentially creating other supply chain resilience concerns in the process. As a result, policy measures to reduce supply chain resilience concerns in one sector can simply open up supply chain vulnerabilities in others (appendix A).

To assess the most appropriate policy response, it can be helpful to distinguish between two broad classes of risk events. The first class of risk events offer little advance notice of their realisation, while the second can arrive with some degree of forewarning – as forward indicators of the risk rise and fall over time. Here the degree of advance notice is relative to the time that would be required to build resilience to the risk event.

Traditional supply chain risks (such as natural disasters) that do not impact national security can be thought of as being in the first class of risk events. While we know that such supply chain disruptions will occur from time to time, we do not know when they will occur, and they are likely to materialise with little advance notice. By contrast, some national security events can be thought of as being in the second class of risks. By observing the build-up of military capability by some countries over time, and/or growing tensions between countries in international diplomatic fora, for example, some national security events can arrive with some degree of advance notice.

Since the first class of events can materialise with little advance notice, it can be valuable to be prepared for their occurrence at any given point in time. However, the slower-moving nature of the second category of risk events allows resilience measures to be scaled as new information comes to hand.

Final step: Estimate the implied frequency of disruption (or length of disruption, or time to disruption) as a final sense-check

Finally, because even the least cost measure could exceed the expected cost of the disruption, a final benefit-cost assessment is crucial. For the first class of risk events, this benefit-cost assessment can then be expressed in terms of how frequently the risk event would have to occur on average, for the costs of the intervention to be lower than the cost of the disruption itself (the *implied frequency of disruption*). In this way, policy makers can consider the costs of intervention as being like an ‘insurance premium’, enabling explicit judgement of whether these costs are commensurate with the risks being insured against (box 2.2).

Box 2.2 – Estimating the implied frequency of disruption of a resilience measure

Supply chain disruptions commonly manifest as an increase in the price that must be paid to access an affected good at the time of the disruption, rather than an outright inability to access that good. The higher prices that need to be paid to access a good during a disruption, and the ongoing higher costs of a domestic production capability in that good, can be used to estimate the frequency of disruption that would be required to justify the costs of public support for that domestic production capability.

Specifically, the implied frequency of disruption of a particular measure can be estimated by comparing the net present value (NPV) of a situation subject to disruptions, with the NPV of that same situation once insurance measures are in place.

Adjusting the frequency of disruptions in the first scenario until it equals the net present value of the second scenario produces the implied frequency of disruption – the minimum frequency that would be required for the investment to cost less than the disruption itself.

This methodology can be applied to the supply chain resilience measures like government support for the development of a domestic production capability.

To illustrate, consider a sector that generates \$20 billion in welfare each year; using \$15 billion of inputs, and value adding \$5 billion per annum. In a ‘smooth sailing’ world (scenario one) there are no disruptions to the supply of inputs and the net present value of the welfare generated by the sector, assuming a 3% discount rate per annum, over the following 20 years is \$74.4 billion (assuming revenue and costs are incurred at the end of each year).

Scenario one



In time, however, supply chain concerns begin to materialise, and policy support is provided for a domestic production capability in the sector's input, in the hope that this will help the sector avoid any fallout from global supply chain disruptions. This comes at a higher cost to the sector though, with annual input costs rising from \$15 billion to \$16 billion per annum. These higher costs mean that less welfare is generated by the sector, the NPV of which falls to \$59.5 billion (scenario two).

Scenario two



This increase in input costs, and associated reduction in the net present value of the welfare generated by the sector, can be considered the insurance cost of avoiding the fallout. And by making assumptions about the cost of the feared supply chain disruption, and its duration, it is possible to calculate how frequently that assumed disruption would have to occur for the ‘insurance’ (the higher cost domestic production capacity) to be worth purchasing. This can be done by calculating the frequency of disruption required for the NPV of the periodic supply shock scenario to be equal to that of that of the domestic production scenario. For example, if we assumed that each supply side shock lasts for a year, and raised

Box 2.2 – Estimating the implied frequency of disruption of a resilience measure

input costs from \$15 billion to \$20 billion in that year, the feared disruption would have to occur at least once every five years for domestic production capacity to begin to make sense (scenario three).

Scenario three



In this example, the implied frequency of disruption of the domestic production plan would be at least once every five years. This means that for the investment in domestic production capability to be worthwhile, policy makers would have to believe that the assumed supply chain disruption would need to occur at a greater frequency than once every five years.

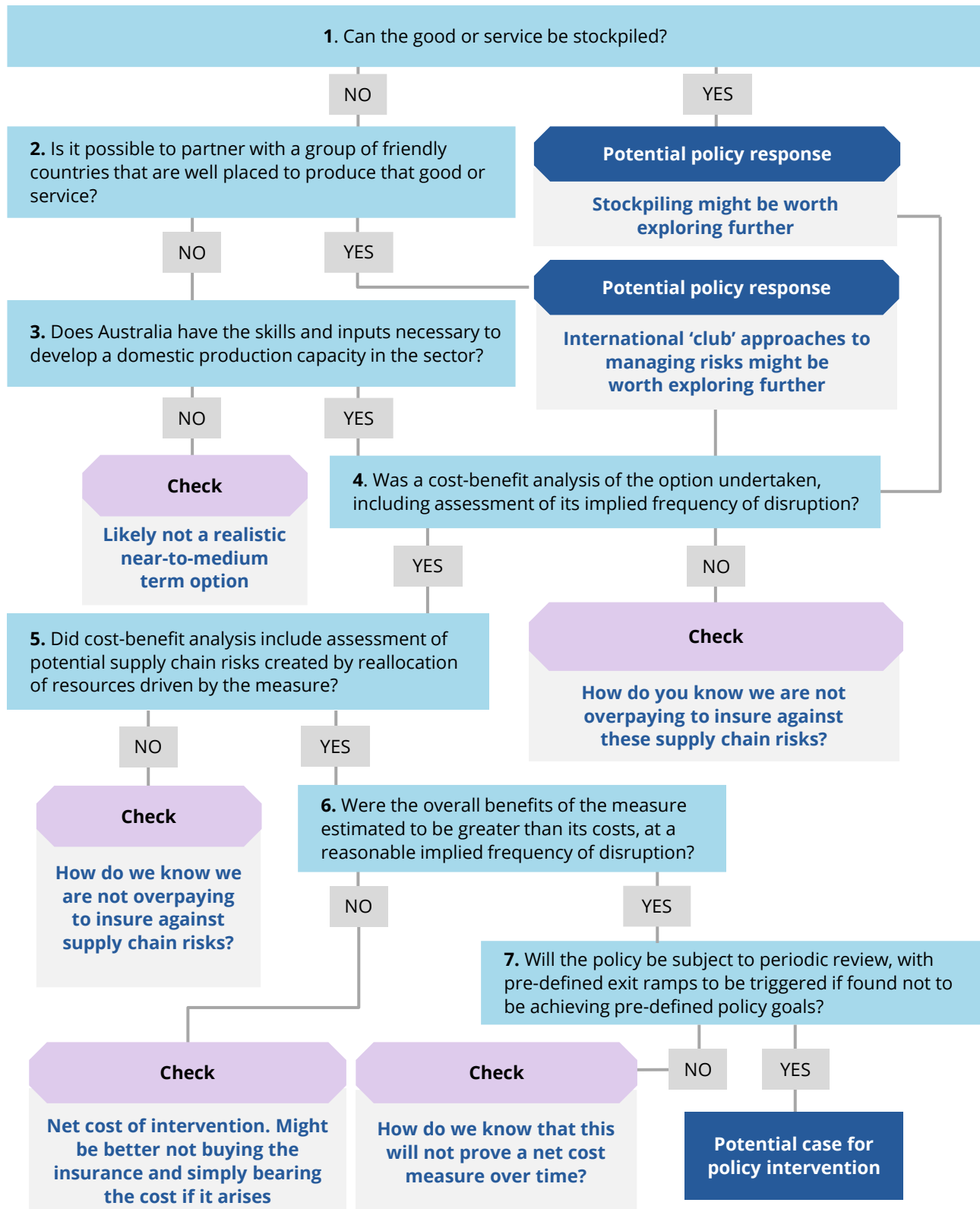
Estimating the implied frequency of disruption of a particular policy option need not be used deterministically (that is, to determine whether one specific resilience measure is worth undertaking or not). The level of risk borne by society is a collective social choice. The estimate simply provides a sense check for whether a particular measure is broadly consistent with the risk appetite of the community at any given point in time. It also provides a common metric to compare different available risk management options.

This analysis can also be extended to estimating the duration and severity of the risk event. This could provide an indication of how large a risk must be, and how long the disruption might need to be, to build confidence in the grounds for one policy measure relative to another.

The dynamic nature of the global economy means that such assessments should be reviewed periodically. It is likely that supply chain vulnerabilities will evolve over time alongside the structure of economies, or that the efficacy of measures to manage ongoing supply chain vulnerabilities change, or that the costs incurred as a result of the shock are not the same as predicted. Governments should include exit ramps in the initial design of these measures, to be triggered if review determines they are not achieving their objectives in a cost-effective way.

These considerations are set out in the following decision tree 2A (figure 2.2), which is designed to help policy makers identify those policy options that might have a greater chance of representing compelling value for money for the Australian community.

Figure 2.2 – Decision tree 2A: Questions to assess possible policy responses to supply chain risks identified through decision tree 1



Note: Implied frequency of disruption estimate assumes that domestic production not exported amidst global shortages.

2.2 Case study: personal protective equipment for healthcare workers

An illustrative case study, which provides a practical demonstration of how this process can be undertaken for the first class of risk events, is provided below.

Personal protective equipment (PPE) is widely used in healthcare settings to reduce the spread of infection. The COVID-19 pandemic presented a significant shock to global PPE supply. Demand rose substantially, and existing supply chains were unable to meet it in the short term, in part due to export restrictions in manufacturing countries. PPE prices rose and shortfalls were widespread. In response, governments intervened to secure PPE.⁶

Part of this response included releasing existing stockpiles, such as Australia's National Medical Stockpile, which contains PPE for distribution to essential health workers during a pandemic (ANAO 2021, pp. 14–15). However, national stockpiles in many countries, including Australia, had limited stocks of PPE to deal with the combination of high demand and long duration of disruption caused by the COVID-19 pandemic (PC 2021, pp. 124–126).

This example uses the PC's framework to examine Australian PPE stockpiling for hospital workers during pandemics. It is purely illustrative: while based on data, we have made assumptions that simplify real-world complexities. The existing National Medical Stockpile is ignored for simplicity. This example is meant to highlight relevant considerations, not to assess current policies or make policy recommendations.

Step one: assessing the grounds for intervention

1. Would a supply disruption to PPE have serious welfare impacts on Australia?

Yes. The COVID-19 pandemic demonstrated the importance of having access to medical PPE supplies. As a healthcare product that is effective in preventing the spread of infection, PPE helps protect individual and community health.

2. Are there any substitute goods that would be readily available in the event of a disruption?

No. There are few-to-no substitutes for medical PPE. The early stages of the COVID-19 pandemic demonstrated the very low price elasticity of demand for PPE. Despite up to six-fold price increases, demand for PPE continued to rise (The Global Fund 2021, p. 14), and insufficient supply meant that PPE was rationed, including in Australia (Aytton et al. 2022, p. 2).

3. Is there only a small number of producers of medical PPE?

No. There are a large number of companies that produce medical PPE.

4. Are the producers concentrated in a single country?

Some sources of PPE are concentrated, but the Australian Bureau of Statistics (ABS) data available is not sufficiently granular to assess for all products. According to ABS import data, China accounted for 57% of the value of Australia's PPE imports in FY22-23. The United States supplied 11%, and other suppliers include Taiwan, Germany, Singapore and Vietnam (ABS 2020, 2024).⁷ The PC's *Vulnerable supply chains*

⁶ OECD 2020, pp. 2, 6–8; Patel et al. 2023, p. 1898; The Global Fund 2021, p. 14.

⁷ The PPE under this data includes PPE for other uses including industrial and mining. While some PPE for these uses (such as N95 masks) may be substitutes, others are specific to certain sectors (ABS 2020, 2024).

report identified that at a more granular level, some (but not all) medical PPE product imports are highly concentrated with over 80% of those products sourced from a single country (PC 2021, pp. 67, 169).

While Australia may have been able to respond to a supply shock for some of these products, the experience of the COVID-19 pandemic indicates that a range of countries that produce PPE were unable to mitigate or fully meet the global demand shock, and therefore Australia's supply of PPE was vulnerable. Further investigation would be required to determine whether Australian supply or global supply remain vulnerable to global demand shocks post-pandemic – meaning the analysis proceeds with caution following this 'check'.

5. Are other countries moving to materially diversify their supplies of medical PPE?

Likely no. Supply diversity appears likely to return to pre-pandemic levels over the near future. During the COVID-19 pandemic, many governments (including Australia's) intervened to support the domestic manufacture of medical PPE (Andrews 2020; EOHSP 2020). However, governments internationally are now withdrawing support, which may return country-level production concentrations to pre-pandemic levels (Advisory Board 2023; Nelson Star 2023).

6. Can companies manage this supply chain risk themselves?

Uncertain. The COVID-19 pandemic disruptions indicated that private sector and public hospital inventories were insufficient to deal with the demand shock resulting in hospitals reusing or extending the use of PPE beyond the recommended timeframes in Australia (Ayton et al. 2022, p. 8). It is plausible that the public benefits of higher PPE inventories are greater than their corresponding private benefits to inventory holders. Further assessment would be required.

Step two: assessing available interventions

1. Can medical PPE be stockpiled?

Yes. PPE has many characteristics that make it suitable for stockpiling (appendix A). It is relatively durable,⁸ easy to store; consumable (meaning a short term disruption can have high costs), a mature technology (so unlikely to become obsolete within its shelf-life), and production can be scaled up relatively quickly (so a stockpile could help mitigate initial disruptions until new supplies come online (Bown 2022, pp. 118–120)).

The remainder of this example considers the costs and potential benefits of expanding stockpiles of PPE for hospital workers to address severe pandemic situations using the implied frequency of disruption framework.

2. Is it possible to partner with a group of nations that are well placed to produce that good?

Not applicable as we answered yes to question 1.

3. Does Australia have the skills and inputs necessary to develop a domestic production capacity in the sector?

Not applicable as we answered yes to question 1.

4. Was a cost-benefit analysis of stockpiling for hospital workers' PPE undertaken, including assessment of the implied frequency of disruption?

Yes. An example cost-benefit analysis and associated implied frequency of disruption estimate follows.

PPE is a relatively inexpensive intervention. The PC estimates that it is possible to supply a typical hospital worker with adequate PPE for just over \$110 per month. We estimate that a three-month supply of PPE to cover a COVID-19-like pandemic situation for Australia's entire hospital workforce would cost approximately

⁸ Shelf life of PPE is around 5 years (3M 2020, p. 1; Dow et al. 2020, p. 4; Greenawald et al. 2022, p. 1).

\$101.6 million to establish.⁹ The costs of overheads and to maintain (replacing expired stock, storage, logistics, and distribution) this stockpile amounts to \$23.4 million per year.¹⁰

The value of PPE during a pandemic event depends on the transmissibility of the disease, the severity of its impacts, the efficacy of PPE and the avoided disruptions to the economy. For simplicity, this example draws on studies of the cost-effectiveness of PPE in reducing COVID-19 transmission. Benefits are:

- health outcomes: an average spend of between \$100–\$7,500 on PPE for frontline health workers is required for each quality-adjusted life year (QALY) gained¹¹
- healthcare costs averted: a direct economic return for the healthcare system of five to eighty-fold over the costs of the PPE, from averted costs of medical care and the productivity losses from staff sickness and leave.¹¹

Combining these benefits, our mid-point estimate of the benefits of a stockpile of the size outlined above if all the PPE were used in a COVID-19 like pandemic immediately after being established would be around \$7.3 billion.¹²

Final step: Estimate the implied frequency of disruption (or length of disruption, or time to disruption) as a final sense-check

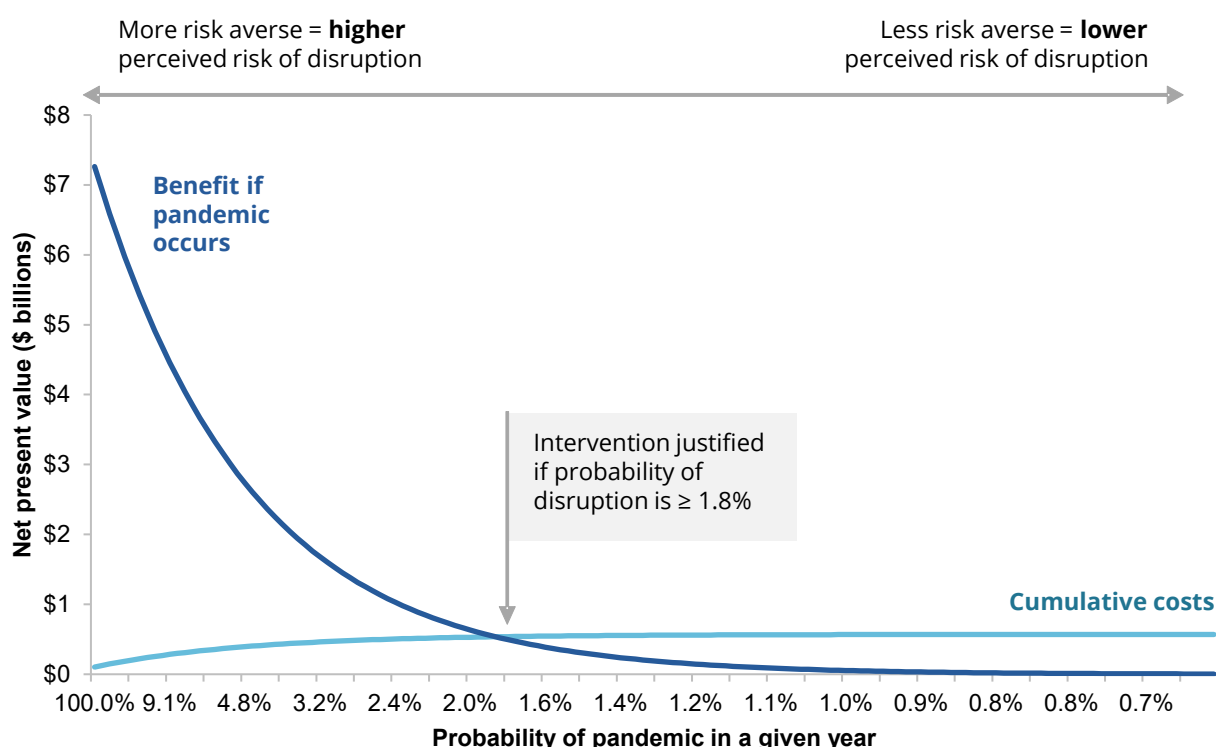
To estimate the value-for-money of a PPE stockpile in a simplified model, we project the benefits against the accumulated costs over time (applying a 5% discount rate as the Australian Government standard for health technology cost-benefit analysis (PBAC 2016)) (figure 2.3). The benefits of the intervention would outweigh its costs so long as the disruption occurred at least once every 55 years (at least a 1.8% chance of occurring in any given year). Were the expected frequency of the event, or the appetite to bear the costs of such an event, greater than once every 55 years (more than a 1.8% chance of occurring in any given year) then governments could feel more confident in the likely benefits of the intervention.

⁹ Calculation based on the size of Australia's hospital workforce as 302,727 full time equivalents in 2023 (DHAC 2024), and using the United States Government TRACIE PPE planning tool to estimate PPE volumes required for a hospital workforce in a respiratory pandemic situation (United States Government Assistant Secretary for Preparedness and Responsiveness TRACIE 2017). Average PPE costs sampled from Australian wholesale prices in December 2024: N95 respirator \$1.33 per unit; shoe covers \$0.06 per pair; gowns \$1.47 per unit; gloves \$0.16 per pair.

¹⁰ Calculation based on an average shelf life of 5 years for PPE, so 20% of stock will be renewed annually. This assumes no expiring stock can be used or sold. Overheads are modelled as 3% of the total stock value (Dow et al. 2020). For simplicity, the size of the health workforce is held constant.

¹¹ Based on a sample of the literature (McAndrew et al. 2024, p. 88; Risko et al. 2020, p. 4,6; Sharma et al. 2024, p. 8). A full literature review would be required to undertake a full cost-benefit analysis.

¹² Benefits calculated using the midpoint estimates from literature of \$4,000 spend per QALY gained for health outcomes and a 40-fold return on investment (ROI) for costs averted and converting to dollars. We used the benefit value of a QALY as \$126,000 in 2023 terms (PC 2024a). The calculation assumes that the stockpile would be the only practical source of PPE while it lasts – the counterfactual is that absent the stockpile, hospital workers would have to perform their duties without adequate PPE. This is an oversimplification – in reality other strategies could be used which may reduce the calculated benefits.

Figure 2.3 – Benefits and costs of a PPE stockpile at different probabilities of disruption

Source: PC calculations.

Table 2.1 presents the implied probability of disruption in a given year (from which implied frequencies can be calculated) required to justify a stockpile of this size under different discount rates, highlighting the best case, base case, and worst-case scenarios. The base case scenario is as presented above, while the ‘worst case’ and ‘best case’ scenarios diverge.¹³

The sensitivity analysis finds that in the best case an implied probability of disruption of at least 0.7% (or implied frequency of once every 142 years) may justify the intervention, depending on the policy maker’s assessment of the benefits of the stockpile. On the other hand, in the worst case the implied probability of disruption would need to be at least 5.3% (or implied frequency of once every 19 years) to justify the intervention.

¹³ In the ‘best case’ scenario (the one that has the highest assumptions for benefits and lowest for costs) it is assumed that a \$1,000 spend per QALY gained for health outcomes, while one QALY is worth \$239,000 and an 80-fold ROI for costs averted. Conversely, in the ‘worst case’ scenario (with the lowest assumptions for benefits and highest for costs), these values change to \$7,500 spend per QALY, \$75,000 value per QALY, and a 5-fold ROI for costs averted, respectively.

Table 2.1 – Sensitivity analysis for PPE stockpiling

Discount rate	Best case		Base case		Worst case	
	Probability ^a	Frequency ^b	Probability	Frequency	Probability	Frequency
2.5% discount rate	0.7%	142	1.2%	85	2.8%	36
5% discount rate	1.2%	85	1.8%	55	3.7%	27
7.5% discount rate	1.6%	62	2.4%	42	4.5%	22
10% discount rate	2.0%	49	2.9%	34	5.3%	19

a. Probability of event occurring in a given year b. Frequency is how often (in years) an event would need to occur. For example, '83' means event would need to occur once every 83 years.

Source: PC calculations.

5. Did the cost-benefit analysis include assessment of potential risks from reallocating resources?

Not applicable. This question is most relevant to club goods and domestic production. While stockpiling would involve some level of resource reallocation, it is likely to be small compared with industry-wide interventions.

6. Were the overall benefits of the measure estimated to be greater than costs at a reasonable implied frequency of disruption?

Further data would be required to determine whether the above implied frequency is reasonable. If the implied frequency of disruption is higher than suggested by the risk appetite of the community, policy makers might feel additionally confident that it was a risk management measure worth undertaking.¹⁴

7. Will the policy be subject to periodic review?

While only a hypothetical example, if this stockpile were adopted, regular review should be carried out to ensure estimated costs and uses of the stockpile are up to date and calibrated to the implied frequency of disruption.

2.3 Extending the framework to national security considerations

The supply chain risks considered in the preceding section can be thought of as being in the first class of risk events – those that offer little advance notice of their realisation. By contrast, some national security events can be thought of as being in the second class of risks: those that can arrive with some degree of forewarning, as forward indicators of the risk rise and fall over time.

An iterative risk assessment framework can be used to evaluate policy options

A framework that iteratively updates the perceived likelihood of a feared risk event as new information becomes available can be helpful in such cases. Investing in resilience measures that provide some option value allows countries to scale those resilience measures up and down as the perceived likelihood of the risk event rises and falls over time. This has the benefit of preserving resources for when investment in resilience measures is particularly relevant. It also provides flexibility for responses to national security risks that involve multi-stage interactions between a range of actors, where the optimal response of a country will depend on the actions, responses and counter-responses of others.

¹⁴ This analysis considers COVID-19 in isolation; it is probable that other epidemics such as influenza would also require resources from a national stockpile within the same timeframe, increasing its value further relative to cost.

Countries traditionally seek to build resilience against national security-related risks through a combination of domestic capabilities and international alliances, which can be viewed through the club goods lens explored in appendix A. In assessing the policy case for increased domestic capability in national security related sectors, it can be helpful to assess the extent to which domestic capabilities might be preferable to club good arrangements between allied countries. This can include assessing the extent to which Australia is able to develop that capability relative to other countries, whether that domestic capability could be delivered within a time frame that will help to mitigate the perceived threat, and whether other countries in the club may reverse relevant policies. For example, pursuing a domestic capability that requires ten years to build, when the feared risk event is judged to occur within the next five years, is unlikely to be effective.

And to consider value for money of intervention

The preceding section demonstrated the way in which implied frequency of disruption estimates can be used to sense-check proposed resilience measures and to compare them with other available options. The same approach can be used to sense-check proposed domestic capabilities for some national security events. This can be done by comparing the cost of a proposed resilience measure to the expected cost of a damaging event, and assuming that a country would rationally invest up to the cost of the event to avoid it.

For example, if the expected cost of a high impact event was \$10 billion over a chosen timeline, and a country was willing to spend up to \$1 billion over that timeline to avoid it, the implied probability of the event over that chosen timeline could be taken to be 10%.

The level of risk tolerance is a societal decision

As with supply chain resilience measures, the framework does not identify when a government should pursue national security-related spending. Such decisions reflect judgements of social risk tolerance, which are decisions for the broader community, through elected governments.

This is made particularly stark by differentiating between two different kinds of national security related events – the first damaging, the second existential. An example of a damaging event would be the kind of cyber-attack by a state actor which imposes costs on a country but does not threaten its existence as a sovereign state. By contrast an existential event is one that can come with high loss of life, or which threatens the sovereignty of the state. In other words, a damaging event is one that can be recovered from over time, whereas the existential event is one that permanently alters a society.

Existential national security events are so costly to society that it might be that governments are willing to invest in their avoidance even if there is a very small chance of them occurring. Even low probability events might be judged worth insuring against if their expected costs are very high, as can be the case with existential national security events. The same might apply to damaging events that have particularly acute impacts on human health, such as disruptions to the operation of medical support systems.

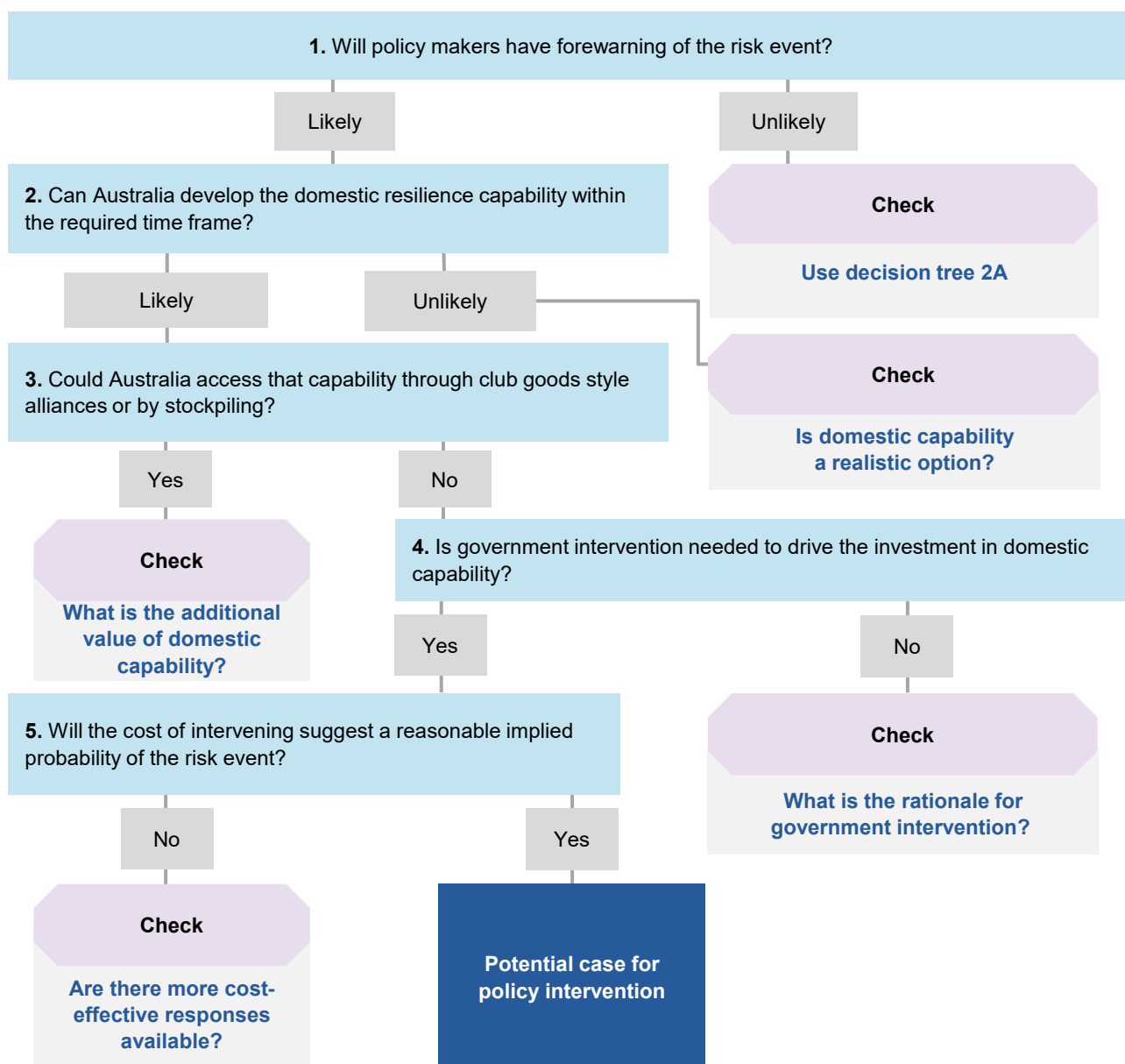
Nevertheless, this framework does help to provide a sense-check of proposed spending decisions for the degree to which they are consistent with those chosen risk tolerance levels. Such estimates allow policy makers to then reflect on the perceived likelihood of such a disruption, and society's willingness to bear it, and to subsequently judge whether that is a cost-effective insurance policy to take out against it.

The same logic can be used for the assessment of existential risks, though risk tolerance for such events is likely to be markedly lower than for damaging events. Rather than providing a blank cheque for any response to risks of a more existential nature, estimating their implied probability allows policy makers to use a common metric to compare alternative resilience measures. More cost-effective measures will generally have a lower implied probability needed to justify the policy. This includes extensive diplomatic programs and

planning that can not only help to reduce the risk of national security events, but also help with iterative assessments of the likelihood of national security events in the future.¹⁵

These considerations are set out in decision tree 2B below (figure 2.4).

Figure 2.4 – Decision tree 2B: Questions to assess possible policy responses to supply chain risks using iterative framework – for ‘advance notice’ risk events



¹⁵ In thinking about existential events, however, there is an important distinction to be made between the lead up to an event and the realisation of the event itself. Once realised, expenditure will shift to responding to the event, which may move to ‘war economy’ like settings where almost all of a society’s resources are directed to repelling the existential attack.

2.4 Iterative risk framework case study: communications hardware

Digital technologies reach into almost every corner of modern life. While they have many benefits, our increasing reliance on them introduces risks. Cybercrimes and disruptions to telecommunications services have a variety of impacts on the community. They can result in direct financial costs including disruption to business operations, information loss, intellectual property theft, productivity loss and costs of repairs and security measures (Australian Government 2015). Major cybersecurity events can disrupt or even cripple critical infrastructure and government systems, such as power grids and healthcare services,¹⁶ which can cause severe health and welfare impacts (US Department of Commerce and US Department of Homeland Security 2022, p. 9).

A variety of tools can be used to address cybersecurity including increased training, air gapping,¹⁷ encryption, and threat monitoring and detection. In the case of hardware, one intervention may be to ensure the security of supply chains for products with security risks, such as by producing particularly vulnerable hardware domestically, or only sourcing it from allied nations. This example applies the framework presented in the preceding section to risks that may arise from severe disruption due to insecure telecommunications hardware supply chains, to illustrate the application of the framework in a context where risks are assessed iteratively. While based on real-world concerns, the situation, details of the technology, and the figures in this example are fictitious (box 2.3).

Box 2.3 – Stylised scenario – ‘TeleWidget’

Countries A, B and C trade in a product called a ‘TeleWidget’. A TeleWidget is a hardware product that is essential for telecommunications. It sits behind banking, healthcare, defence systems and others. The TeleWidget has three stages in its supply chain: extraction and preparation of raw materials, manufacture, and distribution/export.

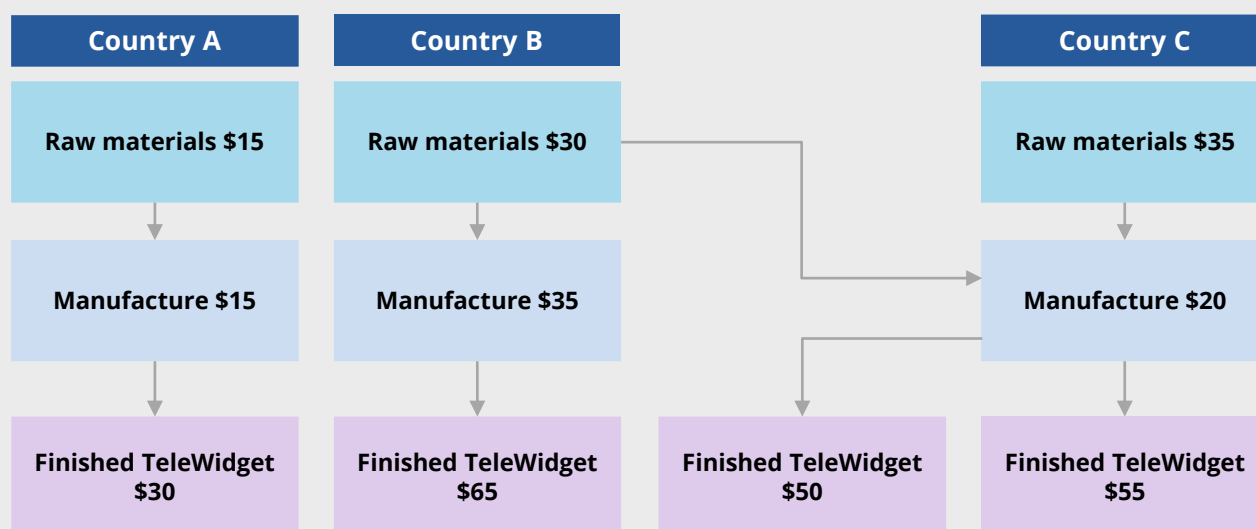
Country A has a comparative and absolute advantage in all stages of the supply chain. Countries B and C completely rely on country A for TeleWidgets, each buying 2,000,000 units a year at a cost of \$60 million. TeleWidget is a rapidly changing technology that is replaced with the newest model each year by users.

Countries B and C have identified risks with TeleWidgets from Country A, suspecting vulnerabilities that could compromise their communications networks. They are considering solutions to mitigate this risk.

Country B can produce raw materials at \$30 per unit, but it would take two years to develop capacity, and manufacturing costs are \$35 per unit with a four-year time-to-capability. Country C can manufacture TeleWidgets at \$20 per unit within two years, but raw materials cost \$35 per unit and require four years to develop. Another option is for countries B and C to collaborate to produce TeleWidgets at \$50 per unit (see figure).

¹⁶ For example, in June 2024 a hack on Synnovis pathology disrupted hospitals throughout the United Kingdom. National Health Service authorities had to postpone thousands of elective procedures and outpatient appointments while IT systems were being secured (Stacey 2024).

¹⁷ Air gapping is physically isolating telecommunication systems from networks to protect against remote attack.

Box 2.3 – Stylised scenario – ‘TeleWidget’**Production costs in stylised TeleWidget example^a**

a. Transport costs in this example are zero for simplicity.

Applying the first decision tree: the grounds for intervention

1. Would a disruption to the services enabled by TeleWidget have serious welfare impacts on countries B and C?

Yes. TeleWidget enables essential services, sitting behind banking, healthcare, defence and telecommunications systems.

2. Are there any substitute goods that would be readily available in the event of a disruption?

No. Both TeleWidget and the services it enables cannot be readily substituted. Despite being a capital good, and therefore not in principle one where supply disruption would be immediately damaging, TeleWidget poses a vulnerability because it can be exploited to disrupt the services that rely upon it.

3. Is there only a small number of producers of TeleWidget?

Yes. In this scenario there are only a small number of producers in country A.

4. Are the producers concentrated in a single country?

Yes. The producers are entirely concentrated in country A.

5. Are other countries moving to develop secure supplies of TeleWidget?

No. In this scenario no other countries currently produce TeleWidgets.

6. Can companies manage these risks themselves?

No. Country A is the monopoly supplier of TeleWidgets. As individual companies in countries B and C do not bear the full social costs of disruptions, including flow-on effects to welfare and national security, they do not have the incentive to support the development of TeleWidgets in other countries by bearing the additional costs of more expensive TeleWidgets.

Applying the iterative framework decision tree 2B

1. Will policy-makers have forewarning of the risk event?

Yes. While specific attacks cannot be predicted accurately, risk assessments can indicate an elevated risk of disruption due to the system vulnerabilities presented by TeleWidgets. The exact timing of disruption might not be foreseeable, but the likelihood and damage can be anticipated. In this example, we use the risk framework in table 2.2.

Table 2.2 – Risk framework for scenario

Risk rating	Perceived annual probability of occurrence	Implied frequency of disruption
Certain	100%	Every year
Expected	75%	Three times in four years
Probable	50%	Every second year
Possible	25%	Every four years
Not expected	0%	Never

Source: Adapted from Australian Government (2022).

Initially, with free trade between countries A, B, and C, the risk of disruption from TeleWidget vulnerabilities is ‘not expected’. However, countries B and C receive unverified reports suggesting that TeleWidget might contain hidden vulnerabilities. This potential threat prompts countries B and C to raise the risk rating of a disruption to ‘possible’. Later, countries B and C discover minor anomalies in the telecoms network using TeleWidget and escalate the risk rating to ‘probable’. At each point they assess policy options (below).

2. Can a domestic response capability be developed before a disruption event occurs?

Country B and country C have a ‘time to capability’ of four years for a full production capacity of TeleWidget to meet their domestic needs. With a threat level of ‘probable’, there is a 50% chance of a disruption each year equating to an approximate 94% probability that at least one disruption will happen within four years.¹⁸ In the interim the effects of the disruption might be reduced by having some limited capability.

3. Could the capability be accessed by other means such as club goods alliances or stockpiling?

Stockpiling would not be an appropriate policy response in this situation. If TeleWidgets produced from country A have vulnerabilities, stockpiling additional TeleWidgets from the same source will not reduce the risk. It is also updated annually due to technological improvements, reducing the benefits of stockpiling (appendix A contains more information on these policy responses).

Countries B and C can collaborate to produce TeleWidget using a club goods approach. This would be less costly per unit and have a faster time to capacity of two years (75% chance of disruption in this period).

Appendix A has more information about these policy options.

4. Is government intervention needed to drive the investment in domestic capability?

Yes. Manufacturers in countries B and C cannot compete with country A without subsidies because businesses in countries B and C are not willing to bear the additional costs to avoid disruption, as the social costs exceed the costs to individual companies due to flow-on effects to welfare and public health.

¹⁸ Probability of event occurring at least once is calculated as $1 - (1 - 0.5)^4$.

5. Are the overall benefits greater than costs at a reasonable implied probability of disruption?

The expected cost of each disruption to country B and country C is expected to be around \$500 million. Each time countries B and C update the risk level they evaluate the costs and benefits of policy solutions. An analysis, from country B's perspective, spans ten years with a 5% discount rate (table 2.3 and table 2.4).¹⁹

Table 2.3 – Assumptions in stylised model for country B

Assumptions	Domestic production	Club goods	Explanation
Units produced by country B	2,000,000 units	4,000,000 units	Number of units country B will need to produce or help produce (if club goods)
Direct cost	\$35 per unit	\$15 per unit	Financial cost of running the program
Indirect costs	\$15 per unit	\$10 per unit	Cost of resource reallocation as estimated by general equilibrium models or other tools
Upfront cost	\$200 per unit	\$50 per unit	Initial cost to establish facilities
Speed to capability	4 years	2 years	Years to reach full capability

When country B perceives the risk rating as 'possible' (25%, or an implied frequency of one event in four years), it considers that the cost of establishing domestic supply exceeds the benefits.

When the risk rating is perceived as 'probable' (50%, or an implied frequency of one event in two years), country B now considers that benefits of action outweigh the baseline of doing nothing for both interventions (table 2.4). A club goods arrangement with country C has a higher net benefit than domestic production, due to having a faster time to capability.

Table 2.4 – Net present value to the economy of country B over ten-year appraisal period of each policy option at varying risk levels²⁰

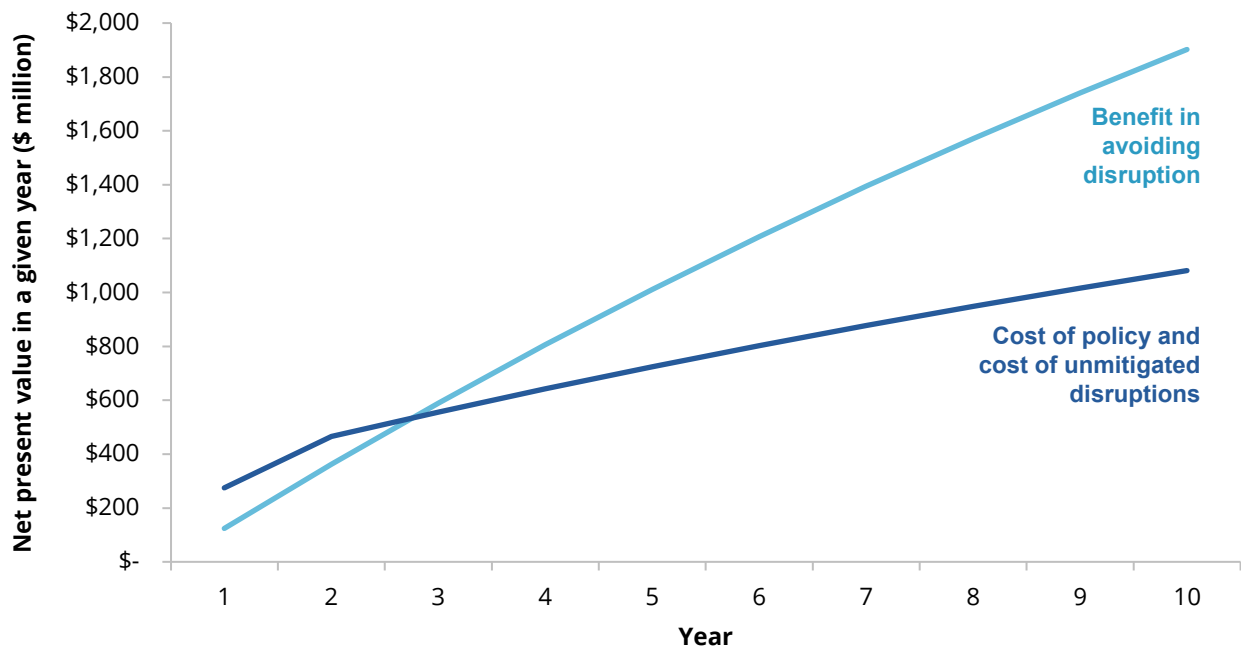
Scenario	Baseline – do nothing	Domestic supply	Club goods
Not expected	\$956,020,263	–\$1,037,812,186	–\$956,020,263
Possible	\$57,457,447	–\$387,571,438	–\$67,542,553
Probable	–\$1,070,935,156	\$262,669,310	\$820,935,156

Source: PC calculations. Note: the best response in each scenario is bolded.

Figure 2.5 illustrates the cumulative benefits and costs of a club goods partnership for country B over ten years at a risk rating of 'probable'. By the third year the accumulated benefits exceed the cumulative costs.

¹⁹ The policy options examined are not exhaustive. Alternatives, such as funding a portion of domestic production or reconfiguring the imported hardware to eliminate security vulnerabilities, could also be considered.

²⁰ For the baseline case, benefits are the avoided spending on the least costly intervention, while costs are the cumulative expected costs of disruptions over 10 years (calculated as the product of the risk level and the cost of disruption each year). In the intervention case, benefits are the savings from reduced disruption costs compared to the baseline. As production increases and reliance on country A decreases, disruption costs drop eventually reaching zero. Costs in the intervention case are as shown in table 2.3.

Figure 2.5 – Cumulative costs and benefits for country B of ‘club goods’ intervention

Source: PC calculations.

3. Net zero transformation

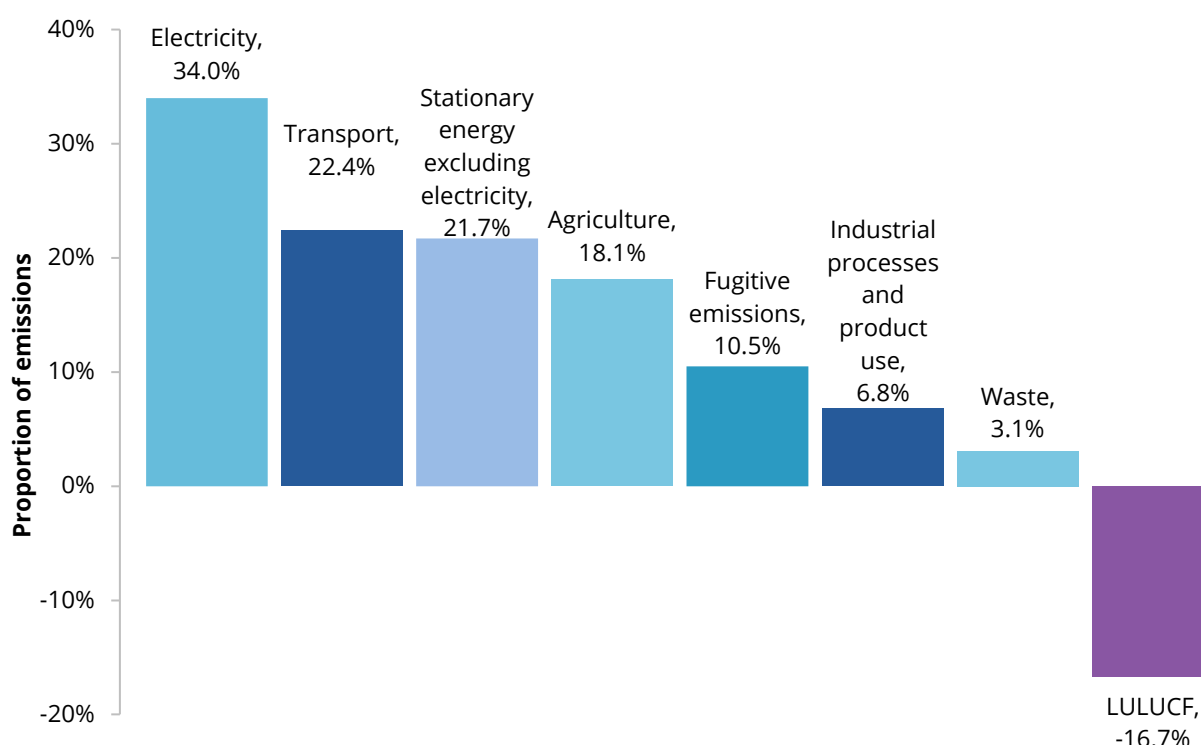
Key points

- * **Australia has committed to achieving net zero emissions by 2050, requiring action across many sectors. Policy coordination is required to achieve abatement at least cost.**
- * **Following marginal abatement cost curves helps prioritise the cheapest emissions reduction activities first, allowing time for more expensive technologies to become cost-effective.**
 - Market-based approaches (e.g., emissions trading) are generally more efficient for ordering abatement than government-targeted interventions, as businesses have better information.
- * **But policy support for currently higher-cost technologies can be justified in some cases to address market failures and lower long-term costs.**
 - This support aims to reduce overall abatement costs over time by fostering domestic knowledge and preparing sectors to use new technologies as they become cost effective.
- * **Support for emerging technologies should be proportionate, include clear exit strategies, and focus on developing local knowledge, particularly for modular systems.**
- * **The same principles largely apply whether support is aimed at domestic or international emissions reduction. The latter also requires consideration of global agreements and trade rules.**

3.1 The role of industry policy in the net zero transformation

Australia has a significant task to reach net zero emissions

Australia has committed to achieving net zero emissions by 2050, along with an interim target of 43% below 2005 emissions levels by 2030, and a target of 62–70% by 2035. Over coming years, Australia will be required to commit to corresponding 2040 and 2045 targets under the Paris Accord. Achieving these targets over the next 25 years will require significant emissions reductions across a range of sectors – electricity generation, transport, agriculture, waste, and industrial processes (figure 3.1).

Figure 3.1 – Australia’s emissions for the year to March 2025, by sectoral source

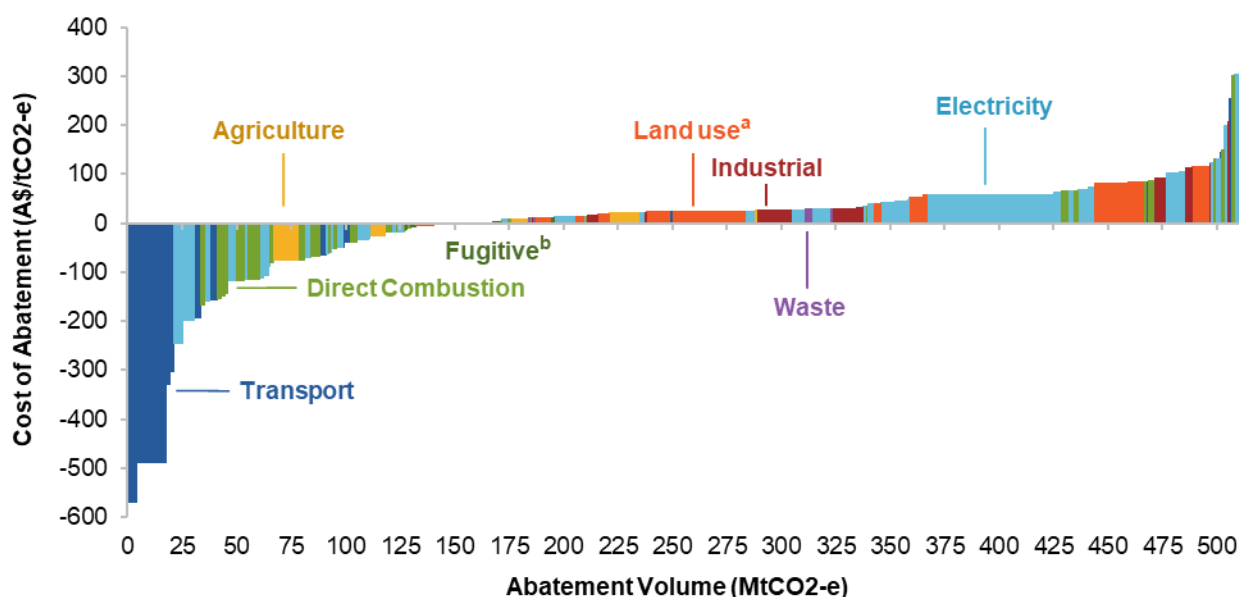
a. ‘Fugitive emissions’ refers primarily to emissions that occur during production, processing, transport, storage and distribution of fossil fuels. While technological interventions may be useful in reducing fugitive emissions, they are also likely to decline concomitantly with decarbonisation of other sectors if demand for fossil fuels decreases (CCA 2024, pp. 119, 121, 128, 134). Interventions targeting fugitive emissions would need to take this relationship into account when determining efficiency. b. LULUCF stands for Land Use, Land Use Change and Forestry.

Source: DCCEEW (2025b, p. 13).

Changes will be required in all these sectors and industries to decarbonise – both changes to industrial processes themselves, and to the manufacture of goods and technologies that enable other sectors to decarbonise. Many of the technologies and processes required to deliver emissions abatement from these sectors are deployment ready, others are not. This means that abatement is currently positioned to occur at a faster rate in some sectors and activities than in others, as indicated by the rising marginal abatement cost (MAC) curve.

Marginal abatement costs curves can guide least cost transition

As a general principle, the MAC curve is a good guide to prioritise abatement activities (figure 3.2). A least cost approach to abatement starts with low (or even negative) cost abatement options before pursuing higher cost options. Doing so provides time for currently higher cost technologies to mature and become cheaper as new technologies and processes develop, lowering prevailing carbon prices (direct or indirect) and reducing the overall cost of abatement in the process.

Figure 3.2 – Australia's estimated marginal abatement cost curve, 2030

a. 'Land use' includes land use change and forestry. b. Fugitive emissions defined as in figure 3.1.

Source: Reputex Energy (2019).

There are reasons to expect that businesses will be better placed than policy makers to accurately produce MAC curves. Businesses will generally have better information about their production processes and potential abatement options than will policy makers. Market-based approaches to emissions reductions create enduring abatement incentives for a broad range of businesses by imposing a carbon price (implicit or explicit). They can also support the ordering of emissions abatement and innovation activity in a way that gives scope for higher cost abatement to become less costly and drives productivity improvements over time. These approaches can thereby be expected to achieve emissions reduction goals at lower cost than government targeted approaches to abatement such as technology specific subsidies and regulations. For this reason, governments should continue to make progressive steps towards market-based approaches to decarbonisation, and design interim policy interventions in ways that are consistent with this policy path over time. This topic has been explored in more depth in the PC's current inquiry into *Investing in cheaper cleaner energy and the net zero transformation* (PC 2025).

If countries choose to impose market-based approaches to emissions reductions like emissions trading schemes or carbon taxes, company level MAC curves can help firms to order their own abatement efforts in response to existing and expected future carbon prices. Alternatively, if countries choose to pursue sector-specific policy interventions, economy-wide MAC curves can help guide government interventions towards cost-effective abatement options, with policies targeted at sectors and activities being calibrated to target consistent carbon price benchmarks, while also recognising the value of other social benefits generated by the supported activity.

Policy support may be appropriate for technologies that are currently higher cost

That said, policy support for higher cost abatement activities should not necessarily wait until all other lower cost abatement options have been exhausted. Indeed, support for these higher cost abatement options will generally have their strongest rationale where commercial incentives do not yet exist for their deployment – where market failures might be most apparent. These market failures can extend beyond unpriced negative externalities (greenhouse gas emissions) to include the public good nature of innovation and learning, coordination challenges, and information asymmetries that can constrain abatement even with a direct or indirect carbon price in place (box 3.1).²¹

Beyond helping to order abatement activities in ways that are broadly consistent with the least cost achievement of national emissions reduction goals, MAC curves can highlight frontier technologies that might face additional market failures beyond unpriced carbon externalities. Related policy support could come in the form of R&D support for frontier technologies, public funding for pilot trials, or support for the deployment of emerging technologies that are yet to reach mass deployment viability.

Box 3.1 – Market failures that can constrain the net zero transition

There are several market failures that can impede Australia's progress towards net zero, and which provide a potential rationale for government intervention. A non-exhaustive selection is listed below.

Underpriced negative externalities

Market activities that produce carbon emissions create a negative externality – the environmental and economic costs associated with additional greenhouse gases in the atmosphere. Without government intervention, businesses might fail to account for these broader social costs when deciding whether or how to produce their goods and services. To address this, carbon pricing mechanisms, such as carbon taxes and cap-and-trade systems, are commonly pointed to as a way of ensuring that businesses internalise the broader social costs of their production choices, and thereby produce an incentive for businesses to reduce their emissions. This pricing can also be imposed indirectly, by mandating the use of higher cost technologies or by subsidising lower emissions technologies.

For decarbonisation of sectors of the economy where underpriced carbon externalities are the dominant constraint, efficient abatement might be defined as that estimated to be below or equal to a benchmark cost of carbon that is consistent with the achievement of Australian abatement targets (PC 2023a).

For technologies and investments that provide returns over time, consideration would need to be given to the pathway of such a benchmark cost of carbon, consistent with achieving Australian net zero targets. For a range of reasons, appropriate costing of carbon externalities might not be fully reflected in current market or other mechanisms.

²¹ In addition, some emissions abatement activities may simultaneously generate co-benefits to emissions abatement that are distinct from reductions in abatement itself, such as reforestation-based carbon sequestration projects that are designed to also promote ecosystem restoration in addition to carbon sequestration (although many do not), or transport electrification technologies that simultaneously improve local air quality. Providing additional policy support in order to capture these co-benefits is also another possible reason to pursue abatement options that are higher on the MAC curve relative to other options.

Box 3.1 – Market failures that can constrain the net zero transition

Innovation and knowledge have public good properties

Innovation and knowledge are public goods. Because one business might find it hard to prevent another business from using knowledge it develops, knowledge is 'non-excludable', and because one business incorporating that knowledge into their production processes does not prevent another from doing the same, it is 'non-rival'. This can make investments in R&D subject to free-riding, where one business waits for another business to undertake R&D rather than making the investment in R&D themselves. Because firms cannot capture all the benefits of their R&D activity, businesses might choose to underinvest in the R&D that could otherwise accelerate the net zero transition, compared to what is socially optimal. This can create a role for government to produce intellectual property protections for the R&D activity of businesses and/or to provide subsidies for them.

Coordination failures

Coordination failures occur when agents cannot coordinate decision-making to achieve the socially optimal allocation of resources. For example, consumers might avoid purchasing electric vehicles without adequate charging infrastructure while producers might avoid investing in charging infrastructure without a sufficient consumer base. In some cases, policy interventions can help address these failures.

Information asymmetries

Information asymmetries can impact the net zero transition in a number of ways. First, by standing in the way of businesses knowing what low or zero emissions technologies best suit their needs; second, by standing in the way of consumers knowing which goods and services are emissions-intensive; and third, by standing in the way of investors seeking to provide financing to climate friendly businesses (Stern and Stiglitz 2021). Governments can help to address information asymmetries through support for information dissemination mechanisms with industry, product labelling measures for consumers, and reporting provisions for financial markets.

Support for emerging technologies could reduce the cost of the overall abatement task

The case for policy support for abatement technologies further up the MAC curve rests on the expected benefits of that activity being greater than the costs of the support to enable it. Benefits would include the extent to which support for such activities stand to reduce the overall cost of the abatement task over the period to 2050.

This might be the case where policy support can position Australian businesses and governments to more readily adopt new technologies as they become available. Support could help to develop an understanding of what will be required to integrate those technologies into current production and sector wide coordination mechanisms (either market or regulatory), and to begin to build the domestic human capital required to do so.

The policy case for related public support might be further strengthened by the relatively near-term nature of our 2030, 2035 and 2050 emissions reduction targets, which means that there is value in sectors being in a position to pursue abatement soon after cost-effective options become available to them. If done well, this can also reduce the likelihood of costly disruptions that can arise when sectors undergo large changes on compressed timelines, costs that are not accounted for in MAC curves.

In this way, we can think of two dimensions of abatement efficiency. The first is at a point in time (static) and involves choosing those abatement options that come with the lowest cost at each point in time. This generally supports the sequential deployment of abatement technologies, following the MAC curve from lowest to higher cost technologies. The second, dynamic, can involve activities that might lower the overall cost of achieving Australia's abatement task over time, by helping to position businesses to more readily deploy lower cost technologies in the future. This could be achieved in a cost-effective way by addressing market failures beyond unpriced externalities (box 3.1).

While there should be a relationship between the two, with pursuit of the least cost abatement options at each point in time leading to the least cost achievement of the overall abatement task over time, uncertainty about the future path of zero emissions abatement technology and processes can complicate this picture.

Especially where there are local knowledge spillovers

Earlier engagement with technologies that are currently on the higher cost side of the MAC curve could build local knowledge capable of lowering the overall cost of a country's abatement task over time.

Here the distinction between local and global knowledge is important. There is less of a policy case for supporting abatement technologies that are likely to come to Australia from other countries. Because global knowledge can be transferred to Australia there is less to be gained by supporting domestic R&D into that technology. Local knowledge, however, can only be generated through domestic experience, presenting a greater *prima facie* case for policy support.

Examples might include production processes that are influenced by local conditions, and learnings for coordination systems that all firms in a sector rely on. An example of the latter could include National Electricity Market operators learning how to integrate intermittent and distributed renewable energy technologies into the system. Examples of the former could include scenarios where local geology could be material to the production of electricity, such as geothermal, or to the low emissions processing options that might be practically available to a country given the characteristics of mineral ores in that country.

An important caveat applies to policy support for local knowledge development, however. Local firms can have a greater incentive to invest in local knowledge, to the extent that they provide a source of competitive advantage over foreign firms that might seek to enter the domestic market. In such cases, R&D-related market failures might be more limited than for R&D into technologies that are globally transferrable. For this reason, the policy case for support will be strongest where this knowledge accrues to a broad range of local incumbents, not just to the firm making the investment in local knowledge, where traditional R&D free-riding concerns might be still present.

But support needs to be proportionate and have built in off ramps

Given the uncertainty about future technology development paths, public support for building local knowledge should generally focus on modular systems that can be scaled up once lower cost technologies become available, creating real option value. Government support for investments in option-value scale technologies and processes, and clearly defined off-ramps, would help avoid the risk of locking-in higher cost abatement technology in advance of lower-cost technologies becoming available, running the risk of requiring ongoing industry assistance rather than minimising the overall cost of abatement over time.

Green steel production potentially provides an illustrative example. Steel production contributes around 10% of global CO₂ emissions, the majority arising from the iron refining part of the process. Research suggests several possible routes to decarbonisation, but the best technology is not yet apparent. In addition, some of the most promising technological options have path-dependencies on other emissions-reduction

technologies, such as renewable electricity and green hydrogen production (Brooks 2024). As such, investing in green iron technologies at this stage would be best undertaken on a technology-neutral basis. Such support could take the form of investment in local knowledge (such as the best technologies for low-carbon processing of any unique geology of Australia's iron ore), and modular systems that can be scaled up as the most promising technologies make themselves apparent over time.

Another reason to keep support proportionate is that the goal should be for sectoral interventions to transition to broad market-based signals over time. Many of the market failures outlined above and in box 3.1 are time specific, and the technologies should be expected to successfully compete within a broad-based market mechanism in future. This provides a natural off-ramp for support as targeted policies can be wound down as market mechanisms are developed, and industries that remain uncompetitive and should not be supported in the future environment would become readily apparent.

Support for technologies contributing to international abatement should be subject to the same criteria, and structured as part of cooperative and reciprocal arrangements

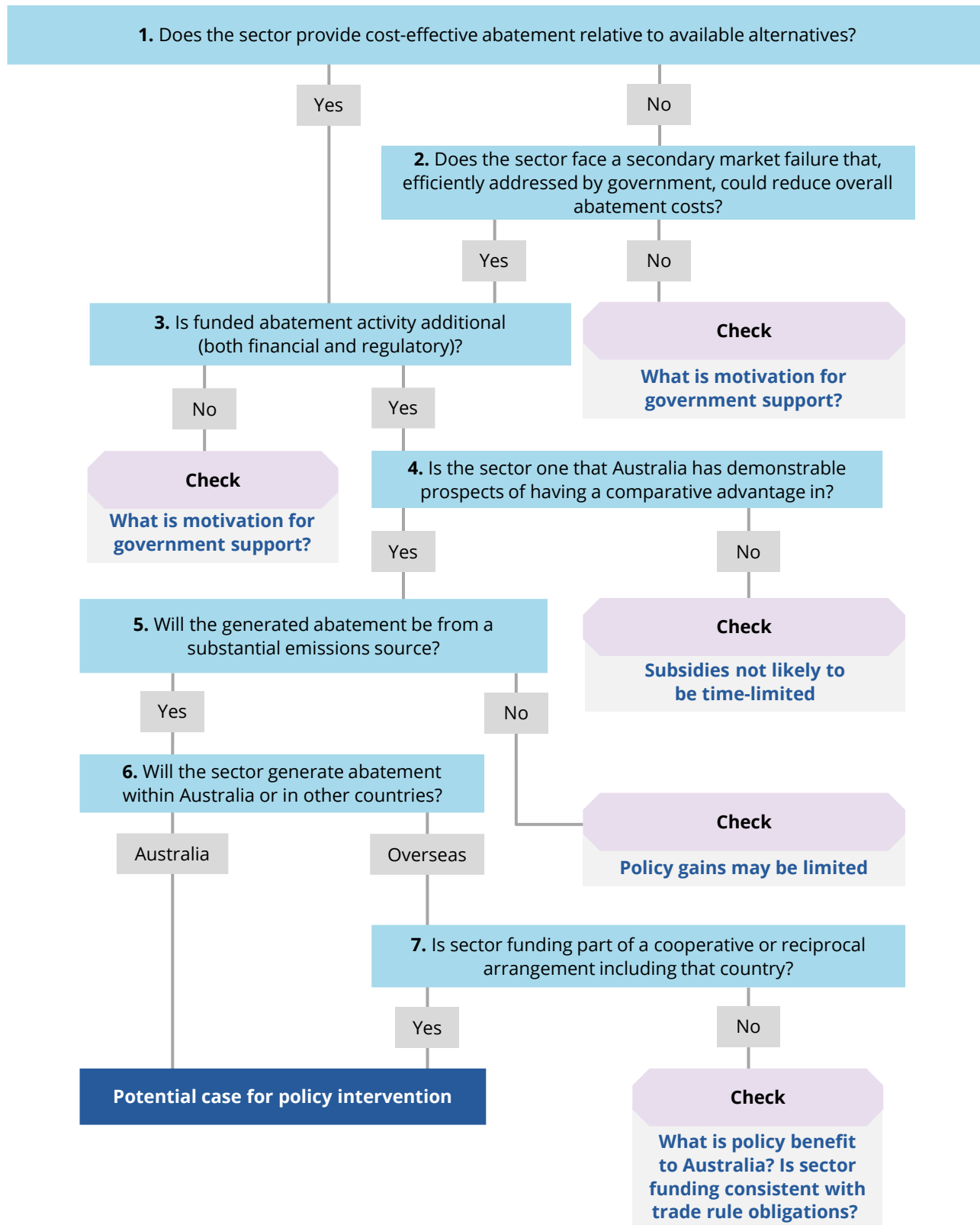
These principles naturally apply to those sectors that are capable of generating emissions abatement within Australia, helping to ease the decarbonisation of the Australian economy. Governments may also seek to support sectors capable of contributing to emissions abatement internationally, however.

The considerations for this kind of support are similar to the domestic considerations. Are there market failures? Is industry support an efficient way of reducing global emissions (bearing in mind global market costs of carbon)? And is there a prospect of the industry having a comparative advantage in the future global economy (appendix C)? To the extent that support for these projects rests on criteria associated with the net zero transformation, the presence of cooperative and reciprocal arrangements with countries that are thereby being assisted to decarbonise is an important consideration.

3.2 Applying these principles

The following decision tree (figure 3.3) sets out how these principles can be operationalised. It is designed as a tool to help decision-makers identify the value of possible industry support in achieving net zero goals at least cost.

Figure 3.3 – Decision tree 3: Questions for industry support to achieve emissions reduction goals



A. Policy options for economic resilience and security

Potential policy: Domestic production

It can seem intuitive that onshoring manufacturing will reduce supply chain vulnerability in a particular good or service, because it protects that country's supply of that good or service in the event of a global disruption. However, that basic intuition can overlook some important considerations that limit the desirability of onshoring to fully manage supply chain vulnerabilities. Creating or maintaining some limited manufacturing capability might be a more efficient option.

Domestic industry is not a guarantee of secure supply

Investment in domestic industry to manage supply chain risks may simply shift a vulnerability rather than reduce it. Many complex goods have globally integrated supply chains with components sourced from all over the world. Onshore processing or assembly of these goods may just move supply chain risks upstream to where the components of those goods are produced.

Global integration means that even without supply constraints, domestic production capability may fail to provide enough domestic supply if the good can simply be exported during the supply shock to take advantage of higher global prices. Moreover, domestic supply may itself be insufficient to avoid shortages. An example is the recent shortage of intravenous fluid for medical use, despite 75% of Australia's intravenous fluid supply being made domestically (Robinson and Panagopoulos 2024).

Finally, domestic production capability will still be subject to its own disruptions, if impacted by natural disasters, input availability and industrial action. This is particularly acute if onshore manufacturing is concentrated in a small number of locations.

And supporting domestic production can be costly

These factors, plus the high costs of supporting an otherwise uncompetitive domestic industry in perpetuity, mean that industry support as a resilience measure needs to be carefully evaluated. Below are some factors that may increase the benefit/cost ratio of supporting a domestic production capability in a particular good.

- Investing in domestic industry to make a particular product may be more effective in managing a vulnerability if that investment enhances the vertical integration of the end-to-end supply chain in the Australian economy (i.e. results in multiple steps in the product's supply chain being onshore, if several unsubsidised steps in the supply chain were already onshore). This would reduce the likelihood that risk will be simply moved upstream.
- Interventions may be cheaper if the supported industry has production or capital requirements that are similar to sectors in which Australia has a revealed comparative advantage (Hidalgo et al. 2007).
- Interventions may also be less costly if they result in spillovers for existing sectors, or relate to a sector that is only relevant to Australia (for example antivenom for Australian snakes).

- Resilience may be strengthened if governments have some degree of control over the distribution of locally-made products to ensure these products remain available in a crisis. This could be through, for example, export controls; regulation; procurement arrangements; or supply requirements as a condition of funding.

Domestic capability as a ‘real option’

‘Option value’ refers to the value placed on (and therefore willingness to pay for) maintaining an asset or capability even if it is not being immediately used, so as to have the option of using it in future.

Investment in domestic capability for resilience does not need to be an ‘all-or-nothing’ measure, but can provide some option value. In some areas where Australia would be uncompetitive at scale, a relatively small capability that covers just a fraction of Australia’s regular demand may still provide worthwhile option value. It could support economic resilience and security if that capability can be used effectively in the event of a shock to meet otherwise unmet demand. To do so, production would need to be rapidly and efficiently scalable. Government costs may also be reduced if there is some baseline demand for the Australian-made product outside the ‘shock’ scenario, as this would help maintain the industry.

Potential policy: Club goods

Club goods are goods that are ‘excludable’ and ‘non-rival’. A good that is ‘excludable’ is one that people can be excluded from using, and a ‘non-rival’ good is one that is not less available to another, just because someone else is using it.

A swimming pool owned by a swimming club is an example of a club good. Non-members are prevented from using the swimming pool, and one member using the club pool does not prevent another club member from using it. Clubs form to share costs, like making a swimming pool more affordable for all who wish to use it (Buchanan 1965). What is true for clubs made up of individuals can also be true for clubs that are made up of countries. Countries can share the costs of common challenges and benefit from the range of capabilities and endowments that allow each country to contribute to the club (Kinne and Kang 2023).

Many of the challenges and concerns that modern industry policy initiatives address are shared by a range of countries (Aiyar et al. 2023). These include supply chain diversification, security of supply over goods and services that are collectively judged to be ‘critical’, and securing access to the inputs and technologies required to support the net zero transition. Club goods style partnerships might assist in sharing the cost of our common challenges.

When is forming international clubs potentially beneficial?

In forming a club, countries work together to create alternative sources of supply. Each country would contribute an element of the supply chain that it is best placed to do under its comparative advantage (appendix C) rather than taking on the whole production capability on its own, and the resultant goods would be available to all club members. While the cost of the goods produced by the club may be higher than the lowest-cost global supply, by leveraging comparative advantage, it would be lower than supporting end-to-end domestic production capability in each country. Industry support to deliver these supply chain elements may be thought of as the ‘cost of entry’ to the club for each country.

Another ‘cost of entry’ into a club-style arrangement may be the adoption of agreed technology or other standards between club members that could limit trade with non-club members who don’t adhere to those standards. The benefits and limitations of adopting such standards would need to be factored into any cost-benefit analysis for adopting a club goods approach. If the following four conditions are met, club goods style partnerships might be effective.

1. Shared interests – clubs are more likely to succeed if members share common objectives, and where achievement of those objectives can be prohibitively expensive to pursue alone.
2. Benefits generated by the club are excludable – if a country cannot be excluded from benefiting from club activities, then countries will have an incentive to free-ride and not have an incentive to join the club. This requires some enforcement mechanism, which may simply be the benefits of future cooperation between countries themselves.
3. The cost of membership is less than the cost of not being in the club – in a sustainable club, each country's contribution provides access to the club good at a lower cost than they could achieve alone.
4. The contribution of each club member is observable – when the contribution is highly observable, it reduces the chances of not living up to the agreement as members can see that everyone is contributing fairly, and that each member is receiving what they expected to when joining the club.

Potential policy: Stockpiling

Government stockpiling is one option to manage supply chain vulnerabilities. It involves accumulating a reserve of goods to ensure availability during supply chain interruptions or sudden surges in demand. A stockpile manager's primary goal can be viewed as minimising the costs of a disruption and the cost of managing the stockpile, including maintenance costs and refreshment of supplies (Oliveira et al. 2023). Depending on the good, stockpile managers may achieve this goal by giving stock directly to a specific user (such as emergency support staff) or by selling it to alleviate supply shortages and reduce prices (NEMA 2024; Newell and Prest 2017).

When is public stockpiling suitable?

Stockpiling can effectively address short-term disruptions, providing time for production to scale up, mitigate short term price rises, and for disrupted markets to normalise (Newell and Prest 2017; Oliveira et al. 2023). The private sector may hold stockpiles to address supply risks; governments may consider establishing their own stockpiles or incentivise more private stockpiling when the private sector undervalues the public benefits of supply stability. However, they should be cautious to minimise inadvertently reducing the incentive for businesses to maintain their own inventories.

A variety of factors can influence the viability of government stockpiling and guide product selection (table A.1). These factors should be considered as part of an overall cost-benefit analysis of any stockpiling proposal.

Table A.1 – Factors influencing the viability of government stockpiling

	Description	Example application
Product-related factors that are likely to reduce stockpiling costs		
Shelf life	Longer shelf life means stockpiling is cheaper than it would otherwise be.	Crude oil does not expire, unlike many petroleum products.
Storage costs	Storage requirements influence the total capital and operating costs of stockpiling.	Some vaccines have strict cold temperature storage requirements.
Consumable	Consumable products have higher turnover than capital goods and are therefore more vulnerable to short term disruptions.	Short term disruptions will quickly impact petrol. In March 2025 Australia had only 34 petrol consumption cover days.
Immutability	Products that are technologically mature or that do not require updating are unlikely to become redundant.	Some vaccines are updated infrequently, while others are regularly updated (like influenza vaccines).

	Description	Example application
Versatility	Stockpiling a versatile product can lower costs, as the stockpile can alleviate different potential shortages and may be easier to sell before expiry.	Crude oil is stockpiled in part due to its flexibility or versatility to be processed into many refined products to address specific market fluctuations.
Factors that are likely to increase efficacy of stockpiling		
Preventable product diversion	Authorities may need to impose restrictions on how released stocks are used, to prevent stockpiles from simply being exported.	Government restricts the use of released medical stockpiles to frontline hospital staff to prevent exports or resale.
Avoidable market price distortions	Stockpile purchasing activity should aim to minimise market distortions.	Government gradually purchases fuel reserves to avoid local price increases.
Additional considerations		
International cooperation opportunities	When incentives align, governments can coordinate stockpiles, reducing panic buying risks and boosting their impact on global supply.	The International Energy Agency coordinates the release of members' oil stockpiles to mitigate price sudden rises.
Call options or offtake agreements (if enforceable)	A contractual right, secured by the stockpile manager to purchase an agreed volume of a good at a set price at a future date.	The government secures an option to buy cobalt at a fixed price; it can later exercise this option to acquire the cobalt for the stockpile.
Opportunity cost of resources	The value of the best alternative use of the resources.	Policy makers consider whether money could be better spent elsewhere.

Sources: DCCEEW (2025a), IEA (2022), NSW Health (2024), US CDC (2022), Albanese (2025) and US Department of Energy (2022).

It should be noted that domestic production supported by tariffs has been excluded as a proposed option as they are less flexible and less likely to be World Trade Organisation (WTO) compatible than other methods like subsidies (box A.1).

Box A.1 – Targeted subsidies are preferable to tariffs to support domestic production

Tariffs have key limiting factors impacting their suitability for achieving specific security objectives.

Under certain conditions, targeted subsidies can be less distortionary than an equivalent tariff

Tariffs and domestic production subsidies both distort markets and create deadweight loss (DWL) by encouraging domestic production that costs more than importing. However, they are not equivalent in their overall DWL impact. DWL represents the value of transactions that do not happen, meaning nobody benefits from them, due to market distortions like taxes. A tariff raises the domestic price for consumers creating DWL from two sources:

- inefficient production (as those goods could be imported more cheaply) and
- reduced consumption (as consumers buy less due to the higher price).

In contrast, a production subsidy (in a small open economy) primarily creates DWL from inefficient production. It does not directly raise consumer prices, which are determined by the world price, thus avoiding the additional welfare loss associated with distorted consumption decisions (Jordan 2024,

Box A.1 – Targeted subsidies are preferable to tariffs to support domestic production

pp. 159–162; Krugman et al. 2022, p. 228). This can be especially true for small countries that are unable to raise their terms of trade through tariffs, reducing any potential welfare gains from tariffs (Krugman et al. 2022, p. 202).

Production subsidies may result in additional DWL arising from the government needing to raise additional taxes or cut spending to pay for the subsidies. These introduce their own distortions which could result in a subsidy causing a greater DWL than an equivalent tariff.

Tariffs themselves create supply chain disruptions

Tariffs have the potential to create negative spillovers that complicates their use to achieve targeted goals. Tariffs on upstream products can hurt downstream users of those products that use imports. For instance, Amiti et al (2019, p. 37) analysing the 2018 US tariffs found that the primary channel through which these tariffs increased US producer prices was by raising costs for domestic manufacturers reliant on global supply chains of upstream products.

High tariffs may be incompatible with World Trade Organisation rules and norms

International trade rules also present different challenges: while tariffs exceeding agreed WTO-bound rates typically face clear non-compliance issues, the WTO compliance of domestic subsidies often depends more on their specific design and demonstrable effects on trade partners, with certain types being prohibited but others potentially permissible if not causing adverse effects.

Source: Krugman et al (2022); Jordan (2024) and Amiti et al (2019, p. 37).

B. Identifying vulnerable, essential and critical goods and services

The PC's framework for assessing supply chain risk in its 2021 *Vulnerable supply chains* report defined vulnerable, essential and critical supply chains as follows. The report proposed a 'data-with-experts' approach to managing supply chain risks (PC 2021).

A vulnerable supply chain was defined as having characteristics that make it susceptible to disruption, primarily due to the lack of flexibility and geographic clustering of the supply chain.

In practice, this was identified through sequentially applying three filters to Australian imports.

- The main supplier (country) accounts for more than 80% of Australian imports.
- Products are sourced from a concentrated global market (based on commonly used measures of market concentration, or if the main supplier accounts for over 50% of global exports).
- Australia sources its supply from the main global supplier.

Essential industries were defined as those producing goods and services that meet the 'basic needs' of Australians. The following industries were considered essential based on the 'basic needs' test: banking, health, water services, communications, energy, logistics and government. The PC noted that a broader view might focus on goods and services that are essential to the functioning of the economy, especially if they affect the incomes of many Australians, nationally or regionally (e.g. the mining and construction industries), though erred on the side of the 'basic needs' approach.

Finally, critical goods and services were defined as those that cannot be substituted easily, or the production process cannot be adjusted in the short term (i.e. six months) to avoid their use. The PC proposed consultation with experts for this part of the framework as they are most familiar with the relevant production processes.

This approach included a few simplifications that could be addressed with better data over time.

For example, the identification of vulnerable imports at a country level overlooks the number of firms in that industry. That is, while a product imported into Australia could be mostly provided by a single country, this could be through a large number of producing firms. This may carry less risk than if there were only one or two producers within the country. As such, focusing on just geographical concentration could overstate risk by not factoring this added diversification.

The identification of vulnerable imports is based on import-export data. As such it cannot identify vulnerabilities from high concentration further up the supply chain, as occurs in some medical supply chains (PC 2021).

The definitions of vulnerability and essentiality are based on an assumed level of baseline demand. However, there could be instances where access to a good or service is not impacted by a reduction in global supply, but due to a global demand shock that instead requires greater supply to address. The ability to scale supply up may be limited. Expert consultation might be required to identify how easily a process might be scalable.

C. Assessing comparative advantage

Assessing the sectors in which a country is likely to enjoy a comparative advantage is not straightforward. The *Trade and Assistance Review 2022-23* (PC 2024b) reviewed methods to assess which sectors individual countries enjoy a comparative advantage in. This exploration revealed a number of challenges for assessing comparative advantage in the future. Mainly, these empirical assessments are backward looking and changes in comparative advantage over time mean that backward looking metrics are likely to be unreliable predictors of comparative advantage in the future.

Nevertheless, these methodologies can give a sense of the magnitude of the task facing policy makers wishing to support a sector until Australia enjoys a comparative advantage in it. If an existing Australian sector is being considered for funding, these methodologies can give policy makers a sense of the increase in sectoral productivity that would be required for Australia to enjoy an enduring comparative advantage in that sector. Producing these estimates across the three comparative advantage assessment methodologies explored in the *Trade and Assistance Review 2022-23* – the Balassa index, the Ricardian index, and the Costinot index – would provide some information to support decision-making.

More recent methodologies developed by Hidalgo and Hausmann (2009) have been offered as a way of addressing the ‘backward-looking’ limitations noted for the methods mentioned above. The authors assert that comparative advantage can evolve in sectors that are adjacent to areas already identified as having a comparative advantage. Such adjacency might take two general forms.

‘Horizontal adjacency’ refers to activities that are similar to activities in which a country already has a revealed comparative advantage. For example, having a revealed comparative advantage in one mining sub-sector might suggest the ability to have a comparative advantage in another mining sub-sector. This is because both activities would rely on resources in both the existing and prospective mining sectors being easily transferable, including skilled labour and technologies.²²

‘Vertical adjacency’ identifies activities that might be required upstream or downstream of an activity. For example, where there is a comparative advantage in a particular industry, this could flow through to upstream or downstream products if there are high transport costs for the intermediate goods. These costs

²² The paper introduces the idea of a ‘product space’ network showing the relatedness between products based on the skills, technologies and infrastructure needed to produce them. More sophisticated products are found in the densely connected core of this network, while less sophisticated products are in a less connected periphery. Economic growth is linked to a country’s ability to move towards producing more sophisticated products. This occurs through comparative advantage – countries with a comparative advantage in certain products are likely to develop new products that are closely related in the product space, as they can more easily adapt their existing capabilities. As such, the paper suggests that understanding the structure of the product space and the proximity between products is crucial for identifying future comparative advantages.

could outweigh an absolute comparative disadvantage for the intermediate goods if produced in isolation. These requirements would likely only apply to some segments of the vertical supply chain, however.²³

To date, the PC has not undertaken empirical work to test the predictive power of adjacency for comparative advantage assessments. Efforts to assess comparative advantage on this basis should be transparent about the methodology and data used to make the assessment.

Sector assessments could supplement their analysis by undertaking competitiveness assessments that would evaluate whether Australia could produce output at a comparable or lower price than international competitors in the sector, both currently and under likely future cost reduction scenarios. The cost assumptions underlying these assessments, and their sources, should be made public to increase transparency and public confidence in the competitiveness assessment.

While all imperfect, a combination of these approaches could help to build a stronger evidence base than simply relying on the observation that the production of a sector undergoing a sector assessment is intensive in a relatively abundant input. Cost advantages presented by these endowments can dissipate over time as activities move between countries to take advantage of those initial cost differentials, requiring new sources of comparative advantage to ensure ongoing competitiveness.²⁴

Nevertheless, given the dynamic nature of the net zero technological space, these assessments should be revisited periodically and exit ramps should be triggered if the path towards an enduring comparative advantage for the sector was found to be narrowing.

²³ Paul Krugman's work on the role of increasing returns to scale in establishing localised industry clusters is an example of these kinds of dynamics. According to Krugman, a small concentration of firms in a region, even one arising from 'accidents of history,' can attract additional firms – including those integral to the industrial 'core' through their production of required intermediate goods (Krugman 1990).

²⁴ Under the Heckscher-Ohlin theorem both the traded and non-traded inputs of countries will equalise as a result of international trade over time. Empirical evidence suggests that the predictions of H-O theorem are particularly relevant for small open economies like Australia (Leamer 1995).

Abbreviations

ABS	Australian Bureau of Statistics
DWL	Deadweight loss
EU	European Union
FMIA	Future Made in Australia
MAC	Marginal Abatement Cost
NIF	National Interest Framework
NPV	Net present value
PC	Productivity Commission
PPE	Personal Protective Equipment
ROI	Return on investment
QALY	Quality-adjusted life year
R&D	Research and Development
US	United States

References

- 3M 2020, *Frequently Asked Questions: 3M Health Care Particulate Respirator and Surgical Masks Storage Conditions and Shelf Life*, 5 February.
- ABS (Australian Bureau of Statistics) 2020, *Imports of Personal Protective Equipment (PPE)*, <https://www.abs.gov.au/articles/imports-personal-protective-equipment-ppe> (accessed 5 August 2024).
- 2024, 5368.0 - International Trade in Goods and Services, March 2024, Data release, Australian Government, Canberra.
- Advisory Board 2023, *Why is 'made in America' PPE shutting down?*, <https://www.advisory.com/daily-briefing/2022/04/13/ppe-manufacturing> (accessed 4 November 2024).
- Aiyar, S, Chen, J, Ebeke, CH and Gracia-Saltos, R 2023, *Geoeconomic Fragmentation and the Future of Multilateralism*, IMF, <https://www.imf.org/en/Publications/Staff-Discussion-Notes/Issues/2023/01/11/Geo-Economic-Fragmentation-and-the-Future-of-Multilateralism-527266> (accessed 6 December 2024).
- Albanese, A 2025, Albanese Government to establish critical minerals strategic reserve, <https://anthonyalbanese.com.au/media-centre/albanese-government-to-establish-critical-minerals-strategic-reserve> (accessed 2 May 2025).
- , Chalmers, J and Butler, M 2024, *Release of the Covid-19 Inquiry Report*, Prime Minister of Australia, <https://www.pm.gov.au/media/release-covid-19-inquiry-report> (accessed 22 May 2025).
- Amiti, M, Redding, S and Weinstein, D 2019, *The Impact of the 2018 Trade War on U.S. Prices and Welfare*, March, w25672, National Bureau of Economic Research, Cambridge, MA, p. w25672, <http://www.nber.org/papers/w25672.pdf> (accessed 24 April 2025).
- ANAO (Australian National Audit Office) 2021, *COVID-19 Procurements and Deployments of the National Medical Stockpile*, Auditor-General Report, 27 May, 39 of 2020-21, <https://www.anao.gov.au/work/performance-audit/covid-19-procurements-and-deployments-the-national-medical-stockpile> (accessed 5 August 2024).
- Andrews, K 2020, Growing Australia's PPE capability, <https://www.minister.industry.gov.au/ministers/karenandrews/media-releases/growing-australias-ppe-capability> (accessed 5 December 2024).
- Australian Government 2015, *The cost of cybercrime to Australia*.
- 2022, National Terrorism Threat Advisory System, <https://www.nationalsecurity.gov.au/national-threat-level/threat-advisory-system> (accessed 23 October 2024).
- 2024, *Future Made in Australia – National Interest Framework supporting paper*.
- 2025, *Future Made in Australia*, <https://futuremadeinaustralia.gov.au/> (accessed 27 March 2025).
- Autor, DH, Dorn, D and Hanson, GH 2016, *The China Shock: Learning from Labor Market Adjustment to Large Changes in Trade*, January, w21906, National Bureau of Economic Research.
- Ayton, D, Soh, S-E, Berkovic, D, Parker, C, Yu, K, Honeyman, D, Manocha, R, MacIntyre, R and Ananda-Rajah, M 2022, 'Experiences of personal protective equipment by Australian healthcare workers during the COVID-19 pandemic, 2020: A cross-sectional study', *PLOS ONE*, vol. 17, no. 6.
- Bildt, C 2022, The great chips war, *The Strategist*, 23 October, <https://www.aspistrategist.org.au/the-great-chips-war/> (accessed 9 May 2025).
- Bown, CP 2022, 'How COVID-19 medical supply shortages led to extraordinary trade and industrial policy', *Asian Economic Policy Review*, vol. 17, no. 1, pp. 114–135.
- Brooks, G 2024, *The green steel revolution or evolution?*, *Mining Magazine Australia*, 3 June, <https://miningmagazine.com.au/the-green-steel-revolution-or-evolution/> (accessed 28 January 2025).
- Buchanan, JM 1965, 'An Economic Theory of Clubs', London School of Economics, Wiley, London School of Economics and Political Science, Suntory and Toyota International Centres for Economics and Related Disciplines, *Economica*, vol. 32, no. 125, pp. 1–14.
- CCA (Australian Government Climate Change Authority) 2024, *Sector pathways review*, Climate Change Authority, Canberra.
- Chalmers, J 2024, *Opinion piece: More engagement in uncertain times, not less*, Treasury Ministers, <https://ministers.treasury.gov.au/ministers/jim-chalmers-2022/articles/opinion-piece-more-engagement-uncertain-times-not-less> (accessed 2 May 2025).
- Channer, H, Edmonstone, G and Barrett, T 2025, *Australia's economic security outlook: Expert perspectives on challenges facing Australia in 2025*, United States Studies Centre, <https://www.ussc.edu.au/australias-economic-security-outlook-expert-perspectives-on-challenges-facing-australia-in-2025> (accessed 4 June 2025).
- CIE (Centre for International Economics) 2017, *Australian Trade Liberalisation: Analysis of the economic impacts*, October, Prepared for Australian Department of Foreign Affairs and Trade.
- Coelli, F, Moxnes, A and Ulltveit-Moe, KH 2022, 'Better, Faster, Stronger: Global Innovation and Trade Liberalization', *The Review of Economics and Statistics*, vol. 104, no. 2, pp. 205–216.
- Columbia Law School 2025, Inflation Reduction Act Tracker, Inflation Reduction Act Tracker, <https://iratracker.org/actions/> (accessed 1 May 2025).
- Commonwealth of Australia 2024, *Budget Paper No. 2: Budget 2024-25*.
- Cooper, V 2022, Explainer: The CHIPS and Science Act 2022, United States Studies Centre, <https://www.ussc.edu.au/explainer-the-chips-and-science-act-2022> (accessed 8 May 2025).
- DCCEEW (Australian Government Department of Climate Change, Energy, the Environment and Water) 2025a, Australian Petroleum Statistics - Data Extract March 2025, energy.gov.au, <https://www.energy.gov.au/publications/australian-petroleum-statistics-2024> (accessed 2 December 2024).

- 2025b, National Greenhouse Gas Inventory Quarterly Update: March 2025, 27 August, <https://www.dcceew.gov.au/climate-change/publications/national-greenhouse-gas-inventory-quarterly-update-march-2025> (accessed 25 September 2025).
- 2024, *Australia's fuel security*, Department of Climate Change, Energy, the Environment and Water, <https://www.dcceew.gov.au/energy/security/australias-fuel-security> (accessed 22 May 2025).
- DFAT (Australian Government Department of Foreign Affairs and Trade) 2023, *IPEF Supply Chain Agreement Policy Impact Analysis*.
- DHAC (Australian Government Department of Health and Aged Care) 2024, Health Workforce Data Portal, <https://hwd.health.gov.au/webapi/jsf/login.xhtml?invalidSession=true&reason=Session+not+established>. (accessed 22 August 2024).
- Dow, W, Lee, K and Lucia, L 2020, *Economic and Health Benefits of a PPE Stockpile*, 12 August, <https://laborcenter.berkeley.edu/economic-and-health-benefits-of-a-ppe-stockpile/> (accessed 22 July 2024).
- Dullien, S 2024, 'European Industrial Policy in the 2020s: Rationale, Challenges and Limitations', *Intereconomics*, vol. 2024, no. 5, pp. 249–253.
- EOHSP (European Observatory on Health Systems and Policies) 2020, *What strategies are countries using to find new Personal Protective Equipment (PPE)?*, [https://eurohealth.observatory.who.int/monitors/hsm/analyses/hsm/what-strategies-are-countries-using-to-find-new-personal-protective-equipment-\(ppe\)](https://eurohealth.observatory.who.int/monitors/hsm/analyses/hsm/what-strategies-are-countries-using-to-find-new-personal-protective-equipment-(ppe)) (accessed 8 February 2024).
- Global Trade Alert 2025, *Global Trade Alert – Monitoring Policy Changes That Affect Global Trade, The World's Trade and Industrial Policy Watchdog*, <https://globaltradealert.org/> (accessed 1 May 2025).
- Goldberg, PK and Maggi, G 1999, 'Protection for Sale: An Empirical Investigation', *American Economic Review*, vol. 89, no. 5, pp. 1135–1155.
- Greenawald, LA, Moore, SM, Kilinc-Balci, S and Yorllo, PL 2022, *Performance of Stockpiled Level 3 Surgical Gowns Sampled from Six Stockpile Facilities*, 19 October, United States Government National Institute for Occupational Safety and Health.
- Hidalgo, C and Hausmann, R 2009, 'The building blocks of economic complexity', *PNAS*, vol. 106, no. 26, pp. 10570–10575.
- , —, Barabasi, A-L and Klinger, B 2007, 'The product space conditions the development of nations', *Science*, vol. 317, no. 5837, pp. 482–487.
- IEA (International Energy Agency) 2022, IEA Member Countries agree to new emergency oil stock release in response to market turmoil – News, IEA, <https://www.iea.org/news/iea-member-countries-agree-to-new-emergency-oil-stock-release-in-response-to-market-turmoil> (accessed 2 September 2024).
- Jordan, K 2024, '6.3 Comparing an Import Tariff with a Production Subsidy', *International Trade Finance* (Part 1), eCampusOntario, pp. 159–162.
- Kinne, B and Kang, S 2023, 'Free Riding, Network Effects, and Burden Sharing in Defense Cooperation Networks', *International Organization*, vol. 77, pp. 1–35.
- Krugman, P 1990, 'Increasing Returns and Economic Geography', *National Bureau of Economic Research*.
- Krugman, PR, Obstfeld, M and Melitz, MJ 2022, *International Economics: Theory and Policy*, 12th edn, Pearson Education.
- Leamer, EE 1995, 'The Heckscher-Ohlin model in theory and practice', *Princeton Studies in International Finance*, No. 77.
- Library of Congress 2023, Frequently Asked Questions: CHIPS Act of 2022 Provisions and Implementation, legislation, <https://www.congress.gov/crs-product/R47523> (accessed 8 May 2025).
- McAndrew, F, Abeysuriya, RG, Sacks-Davis, R, Sammann, M, Lister, DM, West, D, Majumdar, S and Scott, N 2024, 'Admission screening testing of patients and staff N95 masks are cost-effective in reducing COVID-19 hospital acquired infections', *Journal of Hospital Infection*, p. S0195670124002366.
- McDonagh, N 2024, Critical Minerals and the Race for Economic Security, *Australian Institute of International Affairs*, <https://www.internationalaffairs.org.au/australianoutlook/critical-minerals-and-the-race-for-economic-security/> (accessed 16 May 2025).
- McGillis, J 2021, *Remembering Synfuels, 35 Years Later*, IER, 25 August, <https://www.instituteforenergyresearch.org/biofuel/remembering-synfuels-35-years-later/> (accessed 20 May 2025).
- Nelson Star 2023, *Rise and fall of Canada's domestic PPE market blamed on government policy*, <https://www.nelsonstar.com/business/rise-and-fall-of-canadas-domestic-ppe-market-blamed-on-government-policy-4911640> (accessed 2 August 2024).
- NEMA (National Emergency Management Agency) 2024, *Goods and services ready for emergencies*, <https://www.nema.gov.au/about-us/media-centre/goods-and-services-ready-emergencies> (accessed 2 December 2024).
- Newell, R and Prest, B 2017, *Informing SPR Policy through Oil Futures and Inventory Dynamics, 21 October*, Resources for the Future.
- NSW Health 2024, *Vaccine storage and cold chain management – Immunisation programs*, NSW Health, <https://www.health.nsw.gov.au/443/immunisation/Pages/cold-chain-management.aspx> (accessed 2 December 2024).
- OECD (Organisation for Economic Co-operation and Development) 2020, *The Face Mask Global Value Chain in the COVID-19 Outbreak: Evidence and Policy Lessons*, 4 May.
- 2024, *The return of industrial policies: Policy considerations in the current context*, OECD Economic Policy Papers, 31 May, vol. 34, 34, OECD Economic Policy Papers, https://www.oecd.org/en/publications/the-return-of-industrial-policies_051ce36d-en.html (accessed 4 June 2025).
- Oliveira, FS, Zahur, NB and Wu, F 2023, 'Analysis of the optimal policy for managing strategic petroleum reserves under long-term uncertainty: The ASEAN case', *Computers & Industrial Engineering*, vol. 175, p. 108834.
- Patel, R, Ali, M, Bleasdale, SC and Mena Lora, AJ 2023, 'Cost of personal protective equipment during the first wave of the coronavirus disease 2019 (COVID-19) pandemic', *Infection Control & Hospital Epidemiology*, vol. 44, no. 11, pp. 1897–1899.
- PBAC (Australian Government Pharmaceutical Benefits Advisory Committee) 2016, *PBAC Guidelines | 3A.1 Overview and rationale of the economic evaluation*, Australian Government Department of Health and Aged Care, <https://pbac.pbs.gov.au/section-3a/3a-1-overview-and-rationale-of-economic-evaluation.html> (accessed 4 December 2024).

PC (Productivity Commission) 2017, *Rising Protectionism: Challenges, threats and opportunities for Australia*, Commission Research Paper, Canberra.

— 2021, *Vulnerable Supply Chains*, Study Report.

— 2023a, *5-year Productivity Inquiry: Advancing Prosperity*, Inquiry report no. 100, 1, Canberra.

— 2023b, *Trade and Assistance Review 2021-22*, Annual Report Series, Canberra.

— 2024a, *Advances in measuring healthcare productivity*, Research paper, Canberra.

— 2024b, *Trade and Assistance Review 2022-23*, Annual Report Series, Canberra.

— 2025, *Investing in cheaper cleaner energy and the net zero transformation*, Interim report.

Reputex Energy 2019, *The Cost of Net-Zero Emissions Under Paris: A Marginal Abatement Cost (MAC) curve for Australia*.

Risko, N, Werner, K, Offorjebe, OA, Vecino-Ortiz, AI, Wallis, LA and Razzak, J 2020, 'Cost-effectiveness and return on investment of protecting health workers in low- and middle-income countries during the COVID-19 pandemic', Di Gennaro, F (ed), *PLOS ONE*, vol. 15, no. 10, p. e0240503.

Robinson, N and Panagopoulos, J 2024, 'A shortage of intravenous IV fluid bags is dubbed "the ultimate example of poor procurement policy" as claims of a widespread global shortage is contradicted', *The Australian*, 16 August, <https://www.theaustralian.com.au/nation/politics/intravenous-scandal-the-excuses-are-fluid/news-story/38999b95d4d630922e7a4cf87492a88f> (accessed 16 August 2024).

Robson, A 2023, *Optimal industry policy*, Productivity Commission Deputy Chair's Speech, 30 August, CSIRO Innovation for Impact Summit.

Sharma, M, Sra, H, Painter, C, Pan-ngum, W, Luangasanatip, N, Chauhan, A, Prinja, S and Singh, M 2024, 'Cost-effectiveness analysis of surgical masks, N95 masks compared to wearing no mask for the prevention of COVID-19 among health care workers: Evidence from the public health care setting in India', Iktidar, MA (ed), *PLOS ONE*, vol. 19, no. 5, p. e0299309.

Shivakumar, S, Wessner, C and Howell, T 2025, 'The Limits of Chip Export Controls in Meeting the China Challenge', <https://www.csis.org/analysis/limits-chip-export-controls-meeting-china-challenge> (accessed 16 May 2025).

Stacey, S 2024, 'NHS England probes data leak after cyber attack on Synnovis blood-test provider', Financial Times, 21 June, <https://www.ft.com/content/a54f9c2e-bf5a-464d-94d2-8b08285a148d> (accessed 28 October 2024).

Stern, N and Stiglitz, JE 2021, *The social cost of carbon, risk, distribution, market failures: an alternative approach*, National Bureau of Economic Research.

The Global Fund 2021, *Transforming the Medical PPE Ecosystem*, August.

The White House 2025a, Fact Sheet: President Donald J. Trump Establishes the United States Investment Accelerator, The White House, <https://www.whitehouse.gov/fact-sheets/2025/03/fact-sheet-president-donald-j-trump-establishes-the-united-states-investment-accelerator/> (accessed 4 June 2025).

— 2025b, *Regulating Imports with a Reciprocal Tariff to Rectify Trade Practices that Contribute to Large and Persistent Annual United States Goods Trade Deficits*, The White House, <https://www.whitehouse.gov/presidential-actions/2025/04/regulating-imports-with-a-reciprocal-tariff-to-rectify-trade-practices-that-contribute-to-large-and-persistent-annual-united-states-goods-trade-deficits/> (accessed 21 May 2025).

United States Government Assistant Secretary for Preparedness and Responsiveness TRACIE 2017, *Hospital Personal Protective Equipment Planning Tool*.

US CDC (United States Government Center for Disease Control) 2022, *How Flu Viruses Can Change: 'Drift' and 'Shift'*, Centers for Disease Control and Prevention, <https://www.cdc.gov/flu/php/viruses/change.html> (accessed 2 December 2024).

US Department of Commerce and US Department of Homeland Security (United States Government Department of Commerce and United States Government Department of Homeland Security) 2022, *Assessment of the critical supply chains supporting the US information and communications technology industry*, 24 February.

US Department of Energy (United States Government Department of Energy) 2022, *SPR FAQs*, Energy.gov, <https://www.energy.gov/ceser/spr-faqs> (accessed 23 August 2024).

US Treasury 2025, *The Inflation Reduction Act's Benefits and Costs*, U.S. Department of the Treasury, <https://home.treasury.gov/news/featured-stories/the-inflation-reduction-acts-benefits-and-costs> (accessed 30 April 2025).

Wood, T and Reeve, A 2024, *How to forge a Future Made in Australia*, November, Grattan Institute.

World Bank 2023, *Trade has been a powerful driver of economic development and poverty reduction*, World Bank, <https://www.worldbank.org/en/topic/trade/brief/trade-has-been-a-powerful-driver-of-economic-development-and-poverty-reduction> (accessed 20 May 2025).

— 2025, *Trade (% of Gross Domestic Product)*, <https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS> (accessed 20 May 2025).