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Understanding effects of supply disruptions on globally and locally focused economies

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Executive summary

COVID-19 has highlighted the potential impact that disruptions to supply chains can have on production and trade. Agriculture was not immune to these disruptions. However, for Australian agricultural producers and food consumers the impacts were much less significant than seen in other areas of the economy. The early stages of the pandemic identified challenges in international transport of goods, highlighting risk in Australian businesses' exposure to overseas suppliers. These topics were explored in a recent OECD report (OECD 2020). The key finding of that report was that policies that attempt to reduce exposure to overseas shocks actually led to lower economic activity and actually made economies more vulnerable to shocks.

Policy makers in Australia and across the world are exploring whether it is possible to insure against potential international supply chain risk during times of significant global disruption by increasing local production of goods. Such discussions have focused on specific areas of concern and vulnerabilities, and have also extended towards a general questioning of the benefits from the integrated global trading system. For the Australian agricultural sector, for example, there have been discussions around domestic production capacity for several significant imported agricultural inputs, such as chemicals and fertilisers. In the short term, and particularly in the midst of a crisis, it can be attractive to think that with more local production the risk of supply chain disruptions is reduced. However, such a shift is not without cost over the longer term and may also expose supply chains to different forms of risks associated with a narrower supply base.

Assessing the range of potential policy responses across specific supply chains and production activities is both difficult and pre-emptive of more detailed assessments that are required to inform specific policy responses to the COVID-19 pandemic. However, it is possible to assess whether at a more general level less participation in integrated global supply chains could reduce the impacts of disruption. Given this, this paper explores the more general issue related to a greater focus on domestic production across traded goods to reduce economic risks from global or country-specific shifts. To do so, the costs, or "insurance premium", of shifting more generally towards a domestic supply base is assessed. For example, economic outcomes such as gross domestic product (GDP) and value-added agricultural production, can be assessed under different states of the world across time. The differences in the values of economic outcomes inform policymakers about the relative costs and benefits from a policy shift to establish localised supply chains. These can be used to help frame the analysis for individual supply chain interventions.

Building on the OECD (2020) work, this paper uses ABARES' global computable general equilibrium model (Cao et al. 2020) to further investigate the costs and benefits of shifting towards localised supply chains. Similar to the OECD study, this research considers two global policy choices: i) the existing interconnected world of global value chains (GVCs), and ii) a hypothetical localised world where protectionist measures (higher tariffs and subsidies) are adopted and substitution between imported goods and locally produced goods is less common. Additionally, a range of different disruptions are explored to provide wider insights into the trade-offs from different policies.

The effects on Australia and its major trading partners of a global pandemic-like event are explored, along with country-specific disruptions in the two largest economies—China and the United States—under the two global policy scenarios. The country-specific disruptions are used to represent more localised disruptions, like regional disease outbreaks, natural disasters or other general negative production shocks.

A key finding is that an interconnected global world with GVCs is better for Australia and the world in terms of real GDP compared to a more localised world. This finding also holds for the Australian agricultural sector. This is because attempts to localise supply chains come at a real cost to economic growth and income. In other words, there are significant long-term costs with trying to avoid disruptions caused by global shocks, like the COVID pandemic, which far exceed the costs incurred during the actual shock.

Furthermore, should a global pandemic occur, the costs in a localised world remain significant and are similar to those seen in a more globalised world, casting doubt over the utility of such a policy shift in insuring against such events. This is driven by the nature of the modelled pandemic, which assumes that no one country is immune to the spread of the disease and, as such, domestic production is disrupted regardless of trading links. This result means that there is very little benefit for the economy from more localised production. Furthermore, the insurance cost of this shift is also very high – for Australia around $1 trillion in present value terms. Given the small savings associated with less disruption in localised production settings, global pandemics are likely to have to be expected very often for such a policy to yield benefits.

This paper has several key messages that help inform the policy debate around the organisation of supply chains following the COVID-19 pandemic:

- Australian agricultural value-added and Australia's GDP are higher in the long term under interconnected GVCs than under localised policies.
- Losses from foreign shocks to agricultural value-added and GDP are not substantially different under interconnected GVCs or localised policies, meaning that localised policies do not actually insulate Australia.
- Adopting localised policies as insurance against adverse shocks would come at a long-term cost to the Australian economy of around $1 trillion (the difference between the net present value of Australia's GDP under interconnected GVCs and that under a localised policy scenario between 2020 and 2050).

The results from this paper highlight that while a globalised world can transfer supply shocks to Australia, it also creates significant benefits. Maintaining GVCs following the COVID-19 pandemic will help global recovery and bring the greatest benefits to Australian agriculture.

The results do not suggest that policy makers should ignore consideration about reducing possible disruptions from global shocks. Instead, where disruptions have affected sectors, other policies that help directly manage the risks are likely to represent a better response than attempts to localise supply chains. Policies aimed at promoting a globally competitive industry are desirable, such as those that reduce the costs of doing business, reduce trade costs and promote innovation. Further, exploring other means of ensuring supplies during global uncertainties could also be considered where it is found that private risk management dictates a higher risk appetite than is socially desirable. This could make the case for holding stocks of particular products, as is already done with the National Medical Stockpile. These more targeted

policies should be designed at a supply chain level and in relation to the frequency and size of the shocks. The results presented here suggest that using protectionist trade policies or domestic subsidies to address these issues is unlikely to yield net benefits.

1 Global value chains and COVID-19

Reductions in trade barriers globally over the longer run in the lead up to the COVID-19 pandemic have created an interconnected global production system that has spurred economic growth and development. The freer trading environment has allowed countries to specialise in what they produce best and brought significant benefits to Australia through promoting income growth and lowering prices for households.

However, reliance on GVCs that come with free trade means that Australia is at risk of disruptions in overseas value chains that supply production inputs. This was evident during the COVID-19 pandemic. As the pandemic spread, potential challenges to cross-border trade arose, including congestion at ports and constrained supply of some imported inputs (such as agricultural chemicals) whose production was concentrated overseas.

These real and potential disruptions raised questions around whether it is less risky for Australia to produce inputs locally rather than rely on international suppliers. Although local production could lead to more stable economic outcomes in the event of a pandemic or other overseas supply chain shocks, it would also likely lead to lower prosperity. This is because producing more products locally would cause local resources to shift away from what they are used for now, potentially reducing the efficiency of resource allocation in Australia. The cost of the shift to local production can be considered as an insurance policy: paying more now to avoid a potentially adverse outcome later.

In their paper examining the effects on prosperity and economic resilience in the face of COVID-19, the OECD (2020) compared the performance of interconnected economies and inward-looking economies by simulating responses to COVID-19-like shocks. The OECD assessed the relative costs and benefits by looking at the transition away from current levels of trade openness following a pandemic and measuring the costs and benefits of the policy shift in conjunction with the impact of the pandemic. This paper seeks to add to that work by using a separate baseline for different policies. This allows for the decomposition of COVID-19's economic effects under each of those policies.

This paper uses ABARES' computable general equilibrium model (Cao et al. 2020) to build on the OECD work. It examines the resilience of the Australian economy and that of key trading partners to shocks like COVID-19 under two different policy settings: interconnected global value chains or inward-looking protectionist policies delivering localised supply lines. This paper attempts to broadly mimic the OECD scenarios and extends the OECD research by:

i) constructing a separate and appropriate baseline for each policy setting[1]
ii) running a dynamic model over a long time period to show the paths of economic recovery from shocks under each policy setting
iii) running other shocks in addition to COVID-19 and
iv) simulating Australia-specific policy settings.

[1] A baseline is a standard set of model projections with prevailing policies continuing. A baseline is used as a starting point to which counterfactual scenarios are compared.

2 Modelling and data

The model and data sources are outlined in Cao et al. (2020). The model is a computable general equilibrium model incorporating global trade with a disaggregation of 27 goods/services groupings and 14 international regions.[2] Details of the disaggregation are available in Appendix A. Baselines are constructed under different global trade policy settings: interconnected global value chains (representing the current global trade situation), and an inward looking, or "localised", policy setting supported by protectionist trade policies.

To create modelling scenarios, shocks are applied to these baselines. Several shocks are explored, including a pandemic-like shock in 2020 and non-simultaneous negative productivity shocks in Australia and in the two largest economies (China and United States), which are also Australia's major trading partners. Simulations are also run for scenarios where Australia chooses different policies to the rest of the world. That is, Australia chooses free trade policies while the rest of the world turns inward, or Australia turns inward while the rest of the world remains interconnected.

2.1 Countries face a choice of policies

2.1.1 The status quo of interconnected economies

The aim of this baseline is to represent the pre-COVID-19 state of the world. The simulation is conducted using pre-COVID-19 trade costs. This means that current trade policies and degrees of openness are maintained.

Baseline 1

Interconnected global value chains: the pre-COVID-19 state of the world.

2.1.2 Economies turn inward and protectionist

The aim of this baseline is to represent a situation where countries turn inward and become less reliant on global value chains for intermediate inputs as well as for final consumption. These scenario specifications affect broad groupings of products rather than individual products (as explained in footnote 2). This baseline is modelled in a similar way to OECD (2020):

- increasing global tariffs uniformly to 25% for all tradable commodities for any bilateral trade where the existing tariffs are less than 25%; tariffs remain unchanged if they are higher than 25%
- halving the elasticity of substitution between imported and locally produced goods used in the interconnected world.[3] This means that consumers and firms using

[2] Due to database limitations, computable general equilibrium models generally do not provide insight on specific sub-sectors at a sufficient level of disaggregation, but for broad sectors, which are referred to as goods/services. These goods/services are listed in the appendix.

[3] A possible shortcoming of this approach is that certain modelling results may appear to be achieved simply by assumption. This approach has been used in this study in an attempt to i) mimic as closely as possible the scenarios in OECD (2020) and ii) use this model to gain additional insight on top of the OECD study, as discussed on page 6.

intermediate inputs are less willing to substitute imported for domestically produced goods

- adding subsidies for capital and labour inputs for "local industries", which include processed foods (vegetable oils and fats, sugar, other food products), pharmaceuticals, chemical products, manufactured products and other services (warehousing, communication, financial services, insurance, real estate activities, business services and dwellings). The subsidy is 10 percentage points. In the case of a pre-existing tax, a 7% tax would become a 3% subsidy. This subsidy would offset some distortions to each economy caused by existing taxes on labour and capital if the existing rates are higher than 10%, as the final tax rates are lowered with the subsidy. Discussion on efficiency of taxes is beyond the scope of this paper.

All these policy changes are introduced from 2014 onwards, reflecting 2014 as the base year of the GTAP version 10a database (Aguiar et al. 2019) used in this modelling. This gives the economy time to adjust to the new policies before experiencing the shocks from 2020 onwards.

Baseline 2

Localised economies: all regions turn protectionist and inward-looking. Tariffs rise, subsidies rise, and consumers and firms become less willing to substitute locally-produced goods for imports.

2.1.3 Australia goes it alone

The above baselines assume that all countries and regions uniformly choose either interconnected policies or localised policies. But what if Australia chooses a different policy approach to that of all its trading partners? To examine this issue, two more baselines for Australia were constructed:

i) other countries choose interconnected GVCs, but Australia chooses a localised economy; and

ii) other countries choose localised policies, but Australia chooses interconnected GVCs.

Baseline 3

Only Australia chooses a localised economy: all other regions choose interconnected global value chains but Australia turns protectionist and inward-looking.

Baseline 4

Only Australia chooses interconnected global value chains and keeps its current open trade policy stance: all regions turn protectionist and inward-looking except Australia.

These additions of Baselines 3 and 4 will help to understand whether the benefits from interconnected trade policies largely flow from keeping one's own economy open or as a result of the openness of trading partners. For simplicity, it is assumed that Australia's policy choices do not influence those of other countries/regions.

2.2 Modelled economic disruptions

2.2.1 A pandemic-like shock similar to COVID-19

A global pandemic-like event is simulated through adverse effects on labour productivity and global demand, and higher trade costs in 2020.[4] This is implemented in the model by:

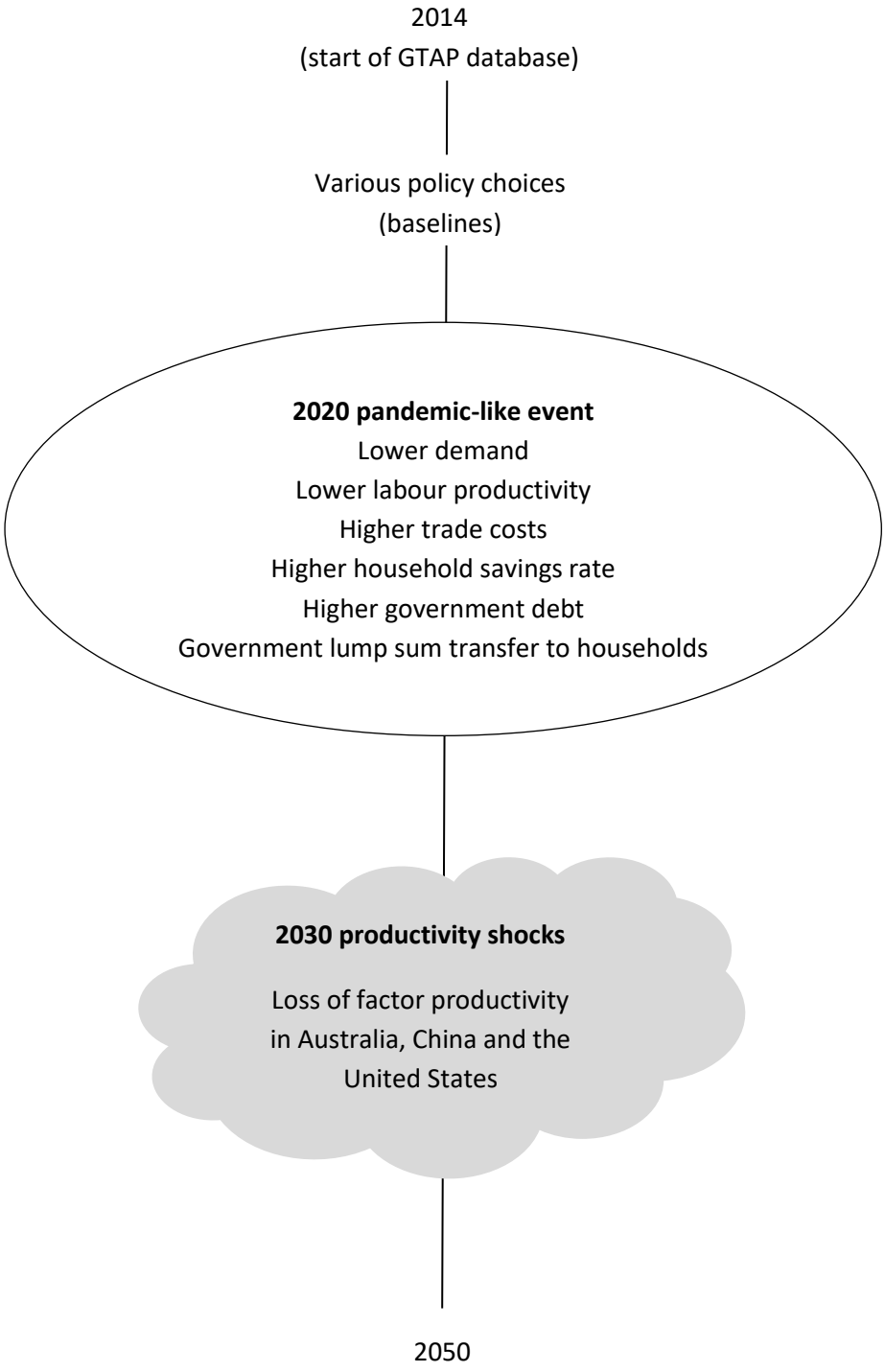
- reducing the expenditure share of households on tourism and other services by 50%
- reducing the expenditure share of households on education by 10%
- reducing labour productivity in all industries by 20%
- reducing productivity of inputs for air, water and road transport by 30%, 10% and 10% respectively, effectively increasing the cost of transport
- increasing households' savings rate by 10 percentage points
- introducing a lump sum transfer from government to households equal to 10% of wage incomes
- allowing government debt to increase to make lump sum transfers while maintaining its pre-COVID expenditure share of GDP in 2020. In all other years, the assumption that the government budget is balanced is maintained.

The above pandemic shock is simulated as illustrated in Figure 1 for both the interconnected GVCs and the localised policies (Baselines 1 & 2), as well as for "Australia goes it alone" scenarios (Baselines 3 & 4). The shock lasts for only one year but the expected ongoing reverberations are modelled out to 2050.[5]

[4] These effects are qualitatively similar to those in OECD (2020) but are implemented differently. For example, OECD simulates a fall in demand by raising a consumption tax whereas in this research the fall in demand is simulated by reducing households' expenditure shares on certain goods/services and raising savings rates by 10%. Additionally, this research incorporates the effects of government payments to households.

[5] The magnitude of the shocks can be considered as an average of the effects over the year, given the model has an annual time step. Firms re-optimise instantaneously but with adjustment costs. The model is recursive dynamic, so reactions occur across time. A valuable extension to the work would be to use a half-year time step, which would provide insight on the interim period in which adjustments occur.

Figure 1 Shocks are simulated on comparable baselines



It is important to note that this shock is not intended to model the potential impact of the current COVID-19 pandemic. Rather, it is an illustrative shock of such an event. Additionally, this shock does not strictly represent absolute blockages. As a result, the situation where firms cannot obtain inputs at any price for one year is not included, because this paper attempts to follow the scenarios in OECD (2020). Nonetheless, any absolute blockages could last for a period within a year. As the modelled shocks in this study are annual, the scenario presented here could be interpreted as an averaging over a year of a blockage that lasts several months.

2.2.2 Production shocks in Australia and major trading partners

To broaden the analysis across different policy settings, the impact of the hypothetical shocks on production are implemented in 2030 for Australia, China and the United States (Figure 1).[6] Real world examples of such shocks might be natural disasters, contained regional disease outbreaks, or internal macroeconomic crises. Such shocks are likely to occur more frequently than events such as global pandemics and are thus potentially more relevant to possible policy shifts towards a more localised economy. In each of the production shock scenarios, the country experiencing the shock has a reduction in economy-wide productivity of 10% for all factors (capital, labour, land and natural resources) and the shocks are again assumed to last for one year.[7]

These scenarios can be considered as a broad test of the effects on the Australian economy of a shock in a location where input supply is highly concentrated. Essentially, this approach tests the idea above of whether it matters that input supply is concentrated in certain regions under the specifications of the shock.

[6] This provides some basic insight on the effects on the Australian economy over time in the face of such shocks under different policy settings following a pandemic-like shock. While this does provide valuable insight, a future extension of this work would be to model a large shock occurring every ten years. Another valuable future extension of the scenarios is to look at shocks occurring with a certain probability in each country, and with a much lower probability of a global shock. The introduction of such probabilities would allow for the provision of insights on more sophisticated policy problems.

[7] See footnote 5.

2.3 Policy and shock scenarios

In order to understand how the two different policy settings perform with COVID-19-like shocks, a number of scenarios are simulated. These scenarios allow for sensible assessments of the effects of the policies on their own and when they are affected by shock. The combination of the different policies (Baselines 1 & 2) with the pandemic-like shock, production shocks, and Baselines 3 & 4, lead to the modelled scenarios in Table 1.

Table 1 Scenarios of baseline policies and shock combinations

Name	Description
Interconnected GVCs	Baseline 1
Localised policies	Baseline 2
Interconnected GVCs + pandemic	Baseline 1 with pandemic-like shock in 2020
Localised policies + pandemic	Baseline 2 with pandemic-like shock in 2020
Interconnected GVCs + CN shock	Baseline 1 with a pandemic-like shock in 2020 and a negative productivity shock to China in 2030
Localised policies +CN shock	Baseline 2 with a pandemic-like shock in 2020 and a negative productivity shock to China in 2030
Interconnected GVCs + US shock	Baseline 1 with a pandemic-like shock in 2020 and a negative productivity shock to United States in 2030
Localised policies + US shock	Baseline 2 with a pandemic-like shock in 2020 and a negative productivity shock to United States in 2030
Interconnected GVCs + AU shock	Baseline 1 with a pandemic-like shock in 2020 and a negative productivity shock to Australia in 2030
Localised policies +AU shock	Baseline 2 with a pandemic-like shock in 2020 and a negative productivity shock to Australia in 2030
Only Australia chooses localised policies	Baseline 3
Only Australia chooses localised policies + pandemic	Baseline 3 with pandemic-like shock in 2020
Only Australia chooses interconnected GVCs	Baseline 4
Only Australia chooses interconnected GVCs + pandemic	Baseline 4 with pandemic-like shock in 2020

3 Results and policy implications

The modelling results are explored in the context of the two differing types of shocks used in the analysis:

1) Pandemic response of GDP and agricultural performance under different policies. In other words, should countries interconnect with GVCs or go local?
2) Responses to country-specific shocks under different policies. In other words, do the more common country-specific shocks have a smaller effect under localised policies?

These two categorisations of results are discussed below, followed by a discussion about the question of "What is the cost of choosing localised policies as a potential insurance policy?"

3.1 Households and the agricultural sector are better off under interconnected GVCs in a stable world

To achieve insight on the performance of GDP and agricultural value-added (i.e. the contribution of agriculture to GDP) under different policies (in the absence of shocks), model results are examined relative to the status quo, which is interconnected GVCs.

A comparison of the modelling results for policies favouring interconnected GVCs and policies favouring localised production in the absence of shocks demonstrates that the Australian economy is better off in interconnected GVCs. This is also the case for Australian agricultural value-added. In contrast, if food processing industries are included in Australian agriculture, the results show that Australian agricultural value-added would be higher under localised policies. This is because food processing industries would be subsidised under localised policies. However, the subsidies to the food sector come at a cost of economic activity elsewhere, which is higher than the increase seen in food sector value-added in absolute value terms.

The modelling results show that localised policies reduce aggregate production in the economy. This occurs through increased costs for final and intermediate consumers, increased tariffs and other barriers and a diversion of production activities away from the highest value activities. In essence, capital and labour are diverted to less productive industries. This leads to lower income and consumption for households. Australian households are materially worse off in a localised world than they would be in an interconnected world.

The economy also continues to need to import and export goods in a localised world despite the high tariffs and other disincentives to trade. Because there are limits to diversification within the economy, trade remains necessary despite the high trade costs that exist in a localised world. In this way, the policies supporting a localised economy add significant costs to doing business in Australia and elsewhere. In contrast, greater trade exposure in the interconnected GVC setting provides a means through which the economy can import more cheaply and export more profitably.

The results show that Australia is always better off by choosing to remain connected to GVCs and keeping its open trade policy stance (Table 2). For Australian agriculture, the result is even stronger given Australia's comparative advantages and significant export exposure. Indeed, the effect on Australian agriculture's performance with policies that promote localised supply chains

is significantly negative. This excludes any trade retaliation that could result from Australia's isolated decision to place barriers on imports from other countries. It is clear that Australian agriculture benefits more than the rest of the economy in general from the interconnected GVC policies. This holds regardless of other countries' policy choices to move to localised supply chains.

Table 2 Policies supporting localised economies reduce GDP and agricultural value-added in a stable world: net present value (NPV) 2020-2050

Country/variable	Policy	% deviation
Australia GDP	Localised policies **a**	-2.94%
	Australia goes it alone with localised policies **b**	-0.71%
	Australia goes it alone with interconnected GVCs **c**	0.67%
China GDP	Localised policies **a**	-3.28%
	Australia goes it alone with localised policies **b**	-0.22%
	Australia goes it alone with interconnected GVCs **c**	0.18%
United States GDP	Localised policies **a**	-0.58%
	Australia goes it alone with localised policies **b**	-0.05%
	Australia goes it alone with interconnected GVCs **c**	0.04%
Australia agricultural value-added **d**	Localised policies **a**	-6.67%
	Australia goes it alone with localised policies **b**	-20.45%
	Australia goes it alone with interconnected GVCs **c**	13.04%

Note: This table shows percentage deviations of net present values of GDP and Australian agricultural value-added under different policies from a comparable policy baseline. **a** 'Localised policies' is compared to Baseline 1 (i.e. interconnected GVCs). **b** 'Only Australia chooses localised policies' is compared to Baseline 1. **c** 'Only Australia chooses interconnected GVCs' is compared to Baseline 2 (i.e. localised policies). **d** Agricultural value-added includes value-added of crops and livestock (including live animals and wool).

Given the relatively small size of the Australian economy, Table 2 shows that when Australia chooses to 'go it alone' there is only a marginal effect (positive or negative) on the large economies of China and the United States. For example, when the world uniformly operates under the policies supporting localised economies, China is 3.28% worse off over the period examined, compared to the whole world operating under interconnected GVC policies. Should Australia choose to remain with its current open trade policy stance while all others choose policies supporting localised economies, the fall in China's GDP over time would be marginally less at 3.10%, making it 0.18% better off, compared to when all countries choose localised economies.

3.2 Shocks have smaller effects in a localised economy, but the pie is smaller too

To gain insight into how the different policies limit the effects of a pandemic-like shock, the results for each scenario are compared to those that model the same policies without shocks. Such comparisons abstract from the relative costs of shifting between policies, which is discussed later in the context of an insurance premium.

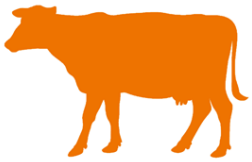
3.2.1 A simulated pandemic has smaller effects for a localised economy

The negative effect of the pandemic (in terms of percentage change in GDP from its respective baseline) is generally smaller under the localised policies than under interconnected GVCs for most regions included in the model. However, the difference is relatively small. The lower impact from a pandemic-like event is due to lower trade exposure under localised policies. For Australia (Figure 2), the percentage loss to GDP from the pandemic-like shock is marginally bigger under interconnected GVCs than under localised policies.

Figure 2 Localised policies marginally lessen the impact of a pandemic-like event but at a cost to Australia's GDP and agriculture in 2020

Effect of pandemic-like event
Australian GDP

Interconnected GVCs	-12.22%	(compared to interconnected GVCs everywhere without pandemic)
Localised policies	-12.20%	(compared to localised policies everywhere without pandemic)
	-13.53%	(compared to interconnected GVCs everywhere without pandemic)
Only Australia goes localised	-0.53%	(compared to interconnected GVCs everywhere, with pandemic)
Only Australia stays interconnected	+0.47%	(compared to localised policies everywhere, with pandemic)



Effect of pandemic-like event
Australian agricultural value-added

Interconnected GVCs	6.33%	(compared to interconnected GVCs everywhere without pandemic)
Localised policies	2.62%	(compared to localised policies everywhere without pandemic)
	2.70%	(compared to interconnected GVCs everywhere without pandemic)
Only Australia goes localised	-17.26%	(compared to interconnected GVCs everywhere, with pandemic)
Only Australia stays interconnected	+11.93%	(compared to localised policies everywhere, with pandemic)

The model results suggest that Australian agricultural sector gains from the pandemic-like shock. This is driven from the assumption in the model that resources from the most affected sectors, such as tourism and education, can move into agriculture. The greater supply and lower

cost of these resources then promotes growth in agricultural production. However, such a shift in resources is not likely to occur in the short term and these results are likely an overestimate of the positive impact for agriculture and an underestimate of the negative impact on other sectors. In many cases the shift in resources between sectors will not be costless and in some cases not feasible. For example, unemployed workers in Sydney are unlikely to quickly shift to rural Queensland even if there were greater employment opportunities in agriculture – as what has been seen in response to labour shortages in Australia's horticulture sector during the COVID-19 pandemic. Despite this shortcoming, as the assumptions remain constant between the scenarios they do not affect the evaluation of the policies. Furthermore, the simulated pandemic scenario is not intended to estimate the impact of the current COVID-19 pandemic, in which there were restrictions to people movements and government policy responses such as the Jobkeeper payment that influenced economic outcomes throughout 2020. Rather, this scenario is used to assess broad economic and trade policies and their specific influence on results in a pandemic.

If Australia were to act independently and choose to 'go it alone' with localised policies, it would be worse off in a pandemic-like shock. However, if others choose localised policies to ward off the potential impact of a pandemic-like event, Australia would be better off by choosing to 'go it alone' and keep its open trade policy stance and connections to GVCs. The Australian agricultural sector in particular is significantly better off under interconnected GVCs, regardless of other countries' choices between interconnected GVCs and localised policies with the pandemic-like shock.

Despite localised policies performing slightly better in a pandemic-like event, the recovery from the pandemic-like shock is slower if countries have adopted the localised policies. When economies are interconnected through GVCs the level of real GDP is higher in every year from 2014 to 2050 compared to those under policies supporting localised production.[8]

Higher GDP in Australia and better economic outcomes in 2020 and all future years under the interconnected GVCs policies stem from the more efficient allocation of scarce economic resources in the economy. While there is a greater negative shock because of a pandemic-like event, this affects a higher base. In other words, while Australian households suffer a larger percentage loss during a pandemic-like event in a globalised world, they are still better off under interconnected GVCs. The size and level of the differences suggest that this result is likely to be robust even if the frequency of a pandemic-like event was to increase beyond what has been modelled. However, as the frequency of such events increase, it is likely that the costs of not being in a globalised world will fall.

By shifting towards protectionist policies, Australian households are still relatively worse off, despite being marginally more insulated from global events. Under the localised policies, production costs are higher, leading to lower production in the economy and relatively poorer

[8] The reason for the different result in Brazil is that it becomes relatively more competitive in attracting global investment under the localised policy set than under the interconnected GVCs policies when the world chooses policies uniformly. This reflects the way that the scenarios in the modelling are designed: for Brazil, the "subsidisation" in the model is reducing relatively more market distortions in its economy than in other economies under the localised policies.

Australian households. These policies lessen the negative impact of a pandemic-like event by a small amount (0.02%; i.e., -12.22% vs -12.20% in Figure 2).

Despite the pandemic-like shock appearing to have a slightly greater impact under interconnected GVCs than localised policies, the level of GDP during the pandemic-like event in an interconnected world remains higher than under localised policies with no pandemic.

3.2.2 GDP and agricultural value-added are always lower for a localised economy when domestic and overseas shocks occur

Australian GDP and agricultural value-added are higher in the face of country-specific production disruptions if Australia remains connected to GVCs compared to a localised policy world. This also holds for other regions. However, the direct impact in the year of disruption (in this case 2030) for Australia and the world varies. For some regions the effect of a country-specific shock can be smaller in magnitude under the localised policies than under the interconnected GVCs or vice versa. This is the case for Australia's agricultural value-added, with the magnitude of the impact directly dependent on the specific country experiencing the shock.

The difference in the magnitude of impact on an individual economy results from the degree of bilateral trade between the specific economy and the economy experiencing the production disruption. It also depends on whether the economy facing the disruption is a competitor in exports. In general, localised policies could lead to a smaller impact on countries by making them less exposed to overseas shocks by being less reliant on global value chains.

In absolute terms, the localised policy settings do not provide any net gain by lessening the impact of the shock on the Australian economy. Australian households are always better off when Australia remains interconnected to GVCs.

Table 3 Being part of a globalised world makes Australia more resilient to country-specific production disruptions: GDP in 2030 relative to interconnected GVC results

Country/variable	Policy + shock	% deviation
Australia GDP	Localised + Australia shock **a**	-2.64%
	Localised + China shock **b**	-2.57%
	Localised + US shock **c**	-2.59%
World GDP	Localised + Australia shock **a**	-6.83%
	Localised + China shock **b**	-7.08%
	Localised + US shock **c**	-5.65%
Australia agricultural value-added	Localised + Australia shock **a**	-1.70%
	Localised + China shock **b**	-4.85%
	Localised + US shock **c**	-5.41%

Note: This table shows percentage deviations of GDP and Australian agricultural value-added under different policies from a comparable policy baseline. **a** 'Localised + AU shock' shows the percentage deviation of GDP or agricultural value-added under localised policies with the shock in Australia from the same indicator under interconnected GVCs with the shock in Australia. **b** 'Localised + CHN shock' shows the percentage deviation of GDP or agricultural value-added under localised policies with the shock in China from the same indicator under interconnected GVCs with the shock in China. **c** 'Localised + USA shock' shows the percentage deviation of GDP or agricultural value-added under localised policies with the shock in the United States from the same indicator under interconnected GVCs with the shock in the United States.

3.3 Choosing localised policies as insurance would cost $1 trillion

A key finding of this research is that the Australian economy and the Australian agricultural sector are better off in the long run by being interconnected with global value chains, even in the presence of pandemic-like and external shocks over time. The expected cost of turning inward and adopting localised policies can be calculated by the difference in the average net present value (NPV) of the simulation results under interconnected GVCs and localised policies.

Attempts to insulate the Australian economy from pandemic-like and external shocks through policies aimed at promoting local production across the economy through subsidies and trade restrictions (and encouraging reduced substitutability with imports) would cost the Australian economy around $1.0 trillion over the period from 2020 to 2050 in NPV terms, where the NPV of Australian GDP is about $34.7 trillion under the interconnected policies, compared to about $33.7 trillion under policies supporting localised economies, noting a discount rate of 4% is used in the calculations.[9] This represents a significant insurance premium which would make Australian households permanently worse off and arguably less resilient to other domestic-based uncertainties that have not been examined here. Similarly, for the Australian agricultural sector the modelling results indicate that there would be no advantage in choosing localised policies in an attempt to insulate the industry from external shocks. The size of the insurance cost, and the marginal gain from localised policies under a pandemic-like shock suggest this result is likely to be robust even if such events were to occur more frequently.

The results also highlight that local supply chains must be globally competitive to be welfare enhancing. Seeking to distort incentives to trade to encourage local production comes with real costs to the economy that do not outweigh the benefits in this example. This is not meant to imply that there is no reason to examine supply chain vulnerabilities or explore ways to enhance local industries. Policies aimed at promoting a globally competitive industry are desirable, such as those that reduce the costs of doing business, reduce trade costs and promote innovation. Further, exploring other means of ensuring supplies during global uncertainties could also be considered where it is found that private risk management dictates a higher risk appetite than is socially desirable. This could make the case for holding stocks of particular products, as is already done with the National Medical Stockpile.

[9] The 4% discount rate was chosen for illustrative purposes. The 4% figure represents longer run global GDP deflator values. The outcome of a positive NPV does not change under a range of different discount rates up to 10%.

Conclusion

Pandemic-like and other international production disruptions can be severe and come at a real cost to the Australian economy. However, GDP and agricultural value-added are higher under interconnected GVCs than localised economies despite the effects of shocks sometimes being more severe. While potentially attractive, attempts to shift the economy to be more reliant on local production systems are shown in the modelling results to provide minimal cover against these international events, at least for the scenarios covered. Furthermore, effects are generally of a similar magnitude to when open trade policies are chosen.

In a pandemic-like event in 2020, as well as in a country-specific disruption in a major market in 2030 (such as a natural disaster, regional disease outbreak or recession), the Australian economy is better off in an interconnected world than in an economy with more localised policies, as is demonstrated in the modelling results. The net present value of Australian GDP is around 3% higher under interconnected GVCs than under localised policies. Importantly, the insight gained here is valid for the scenarios modelled in this paper, as opposed to other scenarios, which may involve absolute blockages of imported inputs.

The results stem from the fact that in a localised world, the economy is hampered in its production ability by the tariffs placed on imported inputs. This increases costs of goods for final and intermediate consumers and diverts production activities away from the highest value activities. This means that even though the economy may seem to be less exposed to external shocks by the imposition of protectionist measures, the economy's productive capacity is actually lower since capital is invested in less productive industries. As a result, in the event of a shock, output remains higher under interconnected GVCs.

Choosing localised policies (higher tariffs, higher subsidies to local industries and reduced substitution of domestic products for imports) would cost the Australian economy around $1.0 trillion between 2020 and 2050. The Australian agricultural sector would also suffer. This $1.0 trillion cost can be interpreted as the price that would have to be paid to adopt localised policies as potential insurance against foreign shocks. That is, it would cost the Australian economy and ultimately Australian households $1 trillion over 30 years and it would result in essentially the same fall in GDP if a pandemic-like event were to occur (assuming Australia was also affected). Even if there were no pandemic under localised policies, those policies are still more costly in the long run than interconnected GVCs with a pandemic.

The modelling results also indicate that the Australian economy and the Australian agricultural sector would always be better off by choosing interconnected GVCs, whether in the case of a global pandemic-like shock or a regional shock, and even if other countries were to choose differently.

While a globalised world can transfer supply shocks to Australia, GVCs also create significant benefits and this is borne out in the results in this paper. Maintaining GVCs following the pandemic will help recovery and bring the greatest benefits to the Australian agricultural sector and the global economy. Where disruptions have affected sectors, other policies that help directly manage existing risks—such as the holding of stocks of key imported products—are likely to represent a better response than attempts to localise supply chains.

Appendix: Data aggregation in the model

An important consideration in the modelling is how countries are aggregated into regions. In computable general equilibrium modelling, countries are aggregated into regions to save computing time. However, including countries in the same region is equivalent to imposing free trade between those countries. This presents a modelling trade-off in this research, as outlined below:

- Computing time is important in this research given that it is a very large model, solved over a 35-year time span (although this model uses variable time steps for fast computing), for multiple baselines and multiple shocks.
- The more aggregation there is, the faster the computing time.
- The more aggregation there is, the less realistic the modelled effect from inward-looking economic policies.

Baselines 2 & 4 (and to some extent, Baseline 3) represent a pivot away from free trade. As a result, this paper must make a compromise between aggregation (to aid computing time) and realistic results for simulating localised economies. ABARES chose to use 14 international regions (Table 5) and 27 commodities (Table 6). This choice presents a reasonable trade-off with respect to the considerations above and covers Australia's major trading partners and export competitors for major tradable commodities.

Table 4 Mapping for aggregation of regions

Regions modelled	GTAP regions
1. AUS	Australia
2. CHINAHK	China, Hong Kong (SAR of China)
3. BRAZ	Brazil
4. EU-27	Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Bulgaria, Croatia, Romania
5. FSU	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Russian Federation, Ukraine, Rest of Former Soviet Union, Rest of Eastern Europe
6. GBR	United Kingdom
7. INDIA	India
8. INDON	Indonesia
9. JPNKOR	Japan, South Korea
10. NZL	New Zealand
11. USA	United States of America
12. ROASEAN	Brunei Darussalam, Cambodia, Laos, Malaysia, Philippines, Singapore, Thailand, Vietnam, Rest of Southeast Asia
13. RONAM	Canada, Rest of North America
14. ROW	All remaining regions in GTAP database

Table 5 Mapping for aggregation of commodities

Commodities modelled	GTAP commodities
1. RICE	Paddy rice, processed rice
2. WHEAT	Wheat
3. OCERL	Cereal grains not elsewhere classified
4. OSEED	Oilseeds
5. OCROP	Vegetables, fruit, nuts, sugar cane, sugar beet, plant-based fibres, crops not elsewhere classified
6. BOVSTK	Cattle, sheep and goats, horses
7. BOVMEAT	Bovine meat products
8. MLKDAY	Raw milk, dairy products
9. OLIVOP	Animal products not elsewhere classified, meat products not elsewhere classified
10. FISH	Fishing
11. FORST	Forestry
12. WOOL	Wool, silk-worm cocoons
13. EXTRACTN	Coal, oil, gas
14. OMING	Minerals not elsewhere classified
15. OPROCFOOD	Vegetable oils and fats, sugar, food products not elsewhere classified
16. BEVTOB	Beverages and tobacco products
17. PHARHLTH	Basic pharmaceutical products, human health and social work activities
18. CRPX	Chemical products
19. MANUFACTG	Textiles, wearing apparel, leather products, wood products, paper products, publishing, petroleum, coal products, rubber and plastic products, mineral products not elsewhere classified, ferrous metals, metals not elsewhere classified, metal products, Computer, electronic and optical products, electronic equipment, machinery and equipment not elsewhere classified, manufactures not elsewhere classified, motor vehicles and parts, transport equipment not elsewhere classified
20. UTILCONS	Electricity, gas manufacture and distribution, water, construction
21. ROADTP	Transport not elsewhere classified
22. AIRTP	Air transport
23. WATERTP	Water transport
24. OTHSVC	Trade, warehousing and support activities, communication, financial services not elsewhere classified, insurance, real estate activities, business services not elsewhere classified, dwellings
25. TOURISM	Accommodation, food and service activities, recreational and other services
26. ADMIN	Public Administration and defence
27. EDUC	Education

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