

Value-added Trade and the Australian Economy

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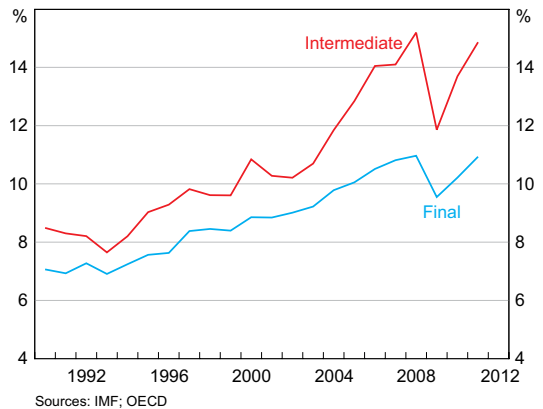
Australia's trade linkages have been affected by the expansion of global production networks, with Australia typically exporting commodities that are used to produce goods and services that are, in turn, exported to other markets. In this article, estimates of value-added trade are presented for Australia that complement conventional trade statistics. The value-added trade estimates suggest that the United States and Europe are more important for export demand than implied by conventional trade statistics, as some Australian content is exported to those locations indirectly via east Asia through global supply chains. The value-added trade estimates also highlight the importance of the services sector to Australian trade, as the services sector is integral to producing goods exports.

Introduction

The structure of international trade has changed dramatically in recent decades. A key feature of this structural change has been the emergence of global supply chains. Global supply chains are production networks that span multiple countries, with at least one country importing inputs and exporting output. The production of a single good, such as a mobile phone or television, typically now takes place across several countries, with each country specialising in a particular phase or component of the final product (Riad *et al* 2012).

The emergence of global supply chains has significantly affected both the level and composition of international trade. International merchandise trade has risen, as a share of world GDP, from around 15 per cent in the early 1990s to over 25 per cent more recently (Graph 1). The growth in trade has been dominated by trade in intermediate inputs – goods and services that are not consumed directly but are used to produce other goods and services. The rapid growth in trade and, in particular, intermediate goods and services trade, has been facilitated by

Graph 1
World – Merchandise Exports
Per cent of GDP, current prices



factors that have lowered the cost of trade, such as advances in transportation and communication technologies, the liberalisation of trade, the removal of foreign capital controls and the growing industrial capacity of emerging economies.

A related feature of this structural change in recent decades has been the growth in *intra*regional trade and the emergence of regional supply networks. This has been particularly apparent in east Asia. Between 1990 and 2011, east Asia's share of world intermediate

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goods trade rose from about 17 per cent to over 50 per cent. This occurred as the region became highly engaged in global supply chains, especially those involving components for computers and other electronic devices (Craig, Elias and Noone 2011). China has played a central role in the development of this supply network, following its accession to the World Trade Organization (WTO) in 2001, as the country experienced large inflows of foreign direct investment and became a major destination for the outsourcing and offshoring of global manufacturing. China is now a core market for intermediate inputs, such as resource commodities from Australia and complex manufactured components from Asian countries. These intermediate inputs are used to produce final goods, some of which are exported to advanced economies.

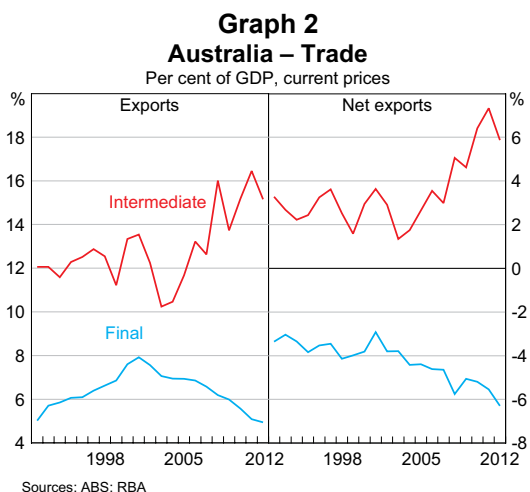
The emergence of global supply chains, and the related rise of trade in intermediate inputs, has a direct bearing on the structure of Australian trade. Australian exports of intermediate goods and services have consistently exceeded exports of final goods and services over the past two decades (Graph 2, left panel). Moreover, the gap between the two types of trade has widened over recent years. This reflects the resources boom, as a significant share of Australia’s resource commodities are exported to east Asia where they are used to produce goods and services that are either sold domestically in east Asia

or re-exported to other parts of the world. Australia’s growing integration into global supply networks is illustrated by the fact that Australia is increasingly a net exporter of intermediate goods and services, and a net importer of final goods and services (Graph 2, right panel).

Conventional measures of international trade based on gross flows of exports and imports do not fully capture the impact of global supply chains on Australian trade. In this article, new estimates of ‘value-added trade’ are constructed for Australia, which complement conventional measures, and illustrate how the fragmentation of production across international borders has affected Australian trade. Unlike conventional trade statistics, value-added trade statistics identify the contributions of each country and each industry to the final value of an exported good or service. While conventional trade statistics identify the initial destination of a country’s exports, value-added measures identify both the initial and effective final export destinations. A comparison of gross trade and value-added trade statistics provides a guide to the extent to which demand shocks stemming from final export destinations indirectly affect Australia. This will be increasingly important as countries become even more integrated into global production networks.

Measures of International Trade

Global supply chains challenge the conventional approach to measuring international trade based on gross flows of exports and imports. Conventional trade statistics typically measure the value of goods and services each time they cross a border. These estimates form the basis of international trade measured in the national accounts and balance of payments and are the most reliable and timely source of information on imports and exports. But gross trade flows do not necessarily identify the countries and industries that contribute to the production of the traded good or service; instead, the full value is attributed to the last country and industry that shipped the product. If a component



of an exported good crosses international borders multiple times in the process of becoming a finished good then the component is counted multiple times under conventional measures. This multiple counting can boost gross measures of trade flows relative to indicators of domestic output and can also overemphasise the importance of a country's bilateral trade flows.

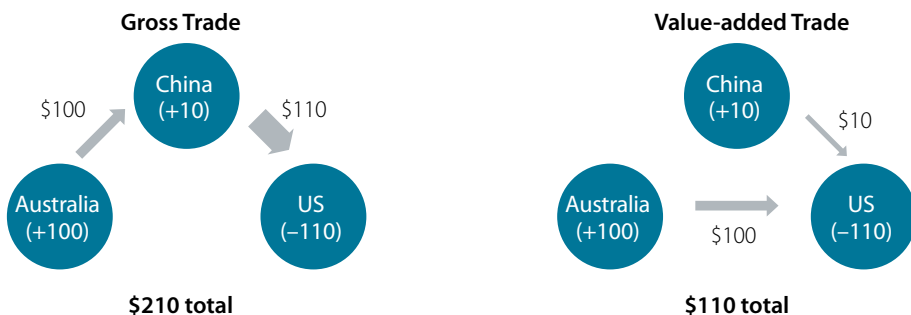
These issues reflect the different way in which economic activity is measured within and across national borders. Gross domestic product (GDP), the most commonly used indicator of a nation's domestic economic activity, records only expenditures on final goods and services (or 'final demand') and excludes expenditures on intermediate goods and services (or 'intermediate consumption'). GDP therefore measures the value added in the production process. For example, suppose a steel manufacturer produces steel worth \$100 (without any intermediate inputs) and sells it to another firm, which uses the steel as an intermediate input to produce a refrigerator, which is then sold domestically as a finished good for \$110. The 'gross output' of the economy is equal to \$210, while the 'value-added' (as measured by final expenditure) is equal to \$110. The national accounts will record the value-added of the finished good (\$110) as GDP, effectively avoiding counting the value of intermediate inputs multiple times.

In contrast, conventional measures of international trade do not make any distinction between trade in gross output and trade in intermediate inputs. To take a similar example, consider the trade flows

depicted in Figure 1. Suppose a steel manufacturer exports steel, produced entirely within Australia, worth \$100 to a firm in China. The firm in China then processes the steel (adding value of \$10) to create a refrigerator which is exported to the United States, where it is sold as a finished good (for a full value of \$110). The conventional measure of trade would record total global exports and imports of \$210, despite only \$110 of value-added being generated in production. The conventional measure would show that the United States has a trade deficit of \$110 with China, and no trade at all with Australia, despite Australia being the chief beneficiary of the final demand of the United States. If, instead, the trade flows were measured in value-added terms, total trade would equal \$110. Also, the trade deficit of the United States with China would be only \$10 and it would run a deficit of \$100 with Australia.

This example highlights the two main issues with the conventional measurement approach: gross trade relative to GDP provides an upper-bound estimate of the contribution of trade to economic activity, and the composition of each country's trade balance does not necessarily reflect value-added trade flows. However, while *bilateral* gross and value-added trade balances can differ, the aggregate level of each country's trade balance is the same when measured in either gross or value-added terms. In the example, Australia has an aggregate surplus of \$100, China has an aggregate surplus of \$10, and the United States has an aggregate deficit of \$110 under either approach to measuring international trade.

Figure 1: Comparison of Gross Trade and Value-added Trade



Source: RBA

The World Input-Output Database and Measures of Value-added Trade

The recognition of these issues has led to the development of an alternative measure of trade known as ‘value-added trade’ (Johnson and Noguera 2012). Rather than allocating the total value of a final good or service to the last country (or industry) that shipped the product, value-added trade estimates attempt to identify the contribution of each country (or industry) in the production process to the overall value of a final good or service.

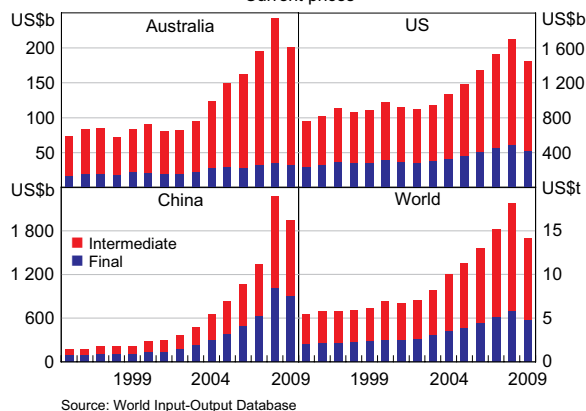
Gross trade can be measured relatively easily using customs data, but measuring value-added trade requires very detailed information on how exports and imports are used as intermediate inputs by various countries and industries. The European Commission recently published the World Input-Output Database (WIOD),¹ which combines information from national input-output tables with bilateral trade data to construct harmonised annual world input-output tables for 35 industries across 41 regions over the period 1995 to 2009. This database seeks to identify all the input-output linkages between countries and industries. The database can be used to construct measures of value-added trade. The WIOD can also be used to trace the path of a country’s intermediate exports through a global supply chain and to identify the effective final destination for the domestic content of a country’s exports.²

Value-added trade data provide information about where, and by whom, value is created in Australian trade. Value-added trade estimates complement, but do not replace, conventional trade statistics. Value-added trade statistics require detailed

information on inputs and outputs that are typically produced with a significant publication lag. For example, the latest WIOD data only cover the period up to 2009. Gross trade statistics for Australia, on the other hand, are produced on a monthly basis with a very short publication lag. Gross trade statistics therefore provide a more timely indicator of trends in Australian trade. Furthermore, the construction of value-added trade statistics requires a number of assumptions to be made (discussed in more detail in Kelly and La Cava (forthcoming)) which can make these statistics less reliable than estimates based on customs data.

Graph 3 presents the value of both final and intermediate exports measured on a gross output basis for Australia, the United States, China and the world as a whole.³ Exports of intermediate goods and services comprise a relatively high share of total exports for Australia. According to the WIOD, Australian intermediate exports have risen from around three-quarters of total exports in the mid 1990s to more than 80 per cent of exports more recently (Graph 3, top left panel). A similar pattern can be seen for both US and world exports (Graph 3, top and bottom right panels). In contrast,

Graph 3
Gross Exports
Current prices



1 More information about the World Input-Output Database can be found at <<http://www.wiod.org>>.

2 A joint OECD-WTO initiative has also recently developed a database of value-added trade indicators: see <<http://www.oecd.org/trade/valueadded>>. The OECD-WTO database has a similar coverage of countries and industries as the WIOD, but a much shorter sample period as it currently only covers the years 2005, 2008 and 2009. For these years, the estimates of value-added trade for Australia are very similar to those obtained from the WIOD.

3 Due to the aggregation of many countries into a ‘rest of the world’ region, the estimates for world exports understate the total level of world trade (as the estimate does not record trade between countries within this particular region).

final goods and services comprise a much higher share of Chinese exports, reflecting China's role as an assembly point in many global supply chains (Graph 3, bottom left panel).

To compare estimates of value-added trade with conventional estimates of gross trade, it is useful to construct a summary indicator known as the 'VAX ratio' (Johnson and Noguera 2012). The VAX ratio is the ratio of value-added exports to gross exports and is an approximate measure of the domestic value-added content of exports. The VAX ratio can be constructed for each bilateral trading partner, or each industry of a given country. The bilateral VAX ratio with a particular trading partner can be less than or greater than one. The bilateral VAX ratio is less than one when gross exports exceed value-added exports, which can occur either because some of the value of the exports is imported from another country or because the trading partner re-exports the content to another destination.⁴ The bilateral VAX ratio is greater than one when value-added exports exceed gross exports. This can occur when the country's exports reach the

trading partner directly (as measured by gross exports) *and* indirectly (when domestic value-added is embodied in a third country's exports to that partner). A similar logic applies to understanding variation in the measured VAX ratio across individual sectors of the economy. The VAX ratio for a sector can be less than one if intermediate inputs from other sectors, or from imports, contribute more to the value of the sector's exports than it contributes to the exports of other sectors. Conversely, the VAX ratio for a sector can be greater than one if the sector contributes more as an intermediate input to the value of exports of other sectors than those sectors contribute to the value of its own exports.

Australian Value-added Trade by Trading Partner and Sector

Table 1 compares Australia's exports to various trading partners on a gross and value-added basis. In terms of trading partners, the main difference between Australia's gross and value-added exports is the importance of emerging economies relative to the advanced economies. According to the WIOD,

Table 1: Australian Exports by Trading Partner
2000–2009 average

Trading partner	Share of value-added exports	Share of gross exports	Difference	VAX ratio
	Per cent	Per cent	Percentage points	
North America ^(a)	16.2	10.6	5.6	1.31
European Union	15.8	12.2	3.6	1.11
Japan	15.3	16.0	-0.6	0.82
China	12.9	15.9	-2.9	0.70
South Korea and Taiwan	7.6	11.1	-3.5	0.59
Other trading regions	32.1	34.3	-2.1	0.80
Total	100.0	100.0	0.0	0.86

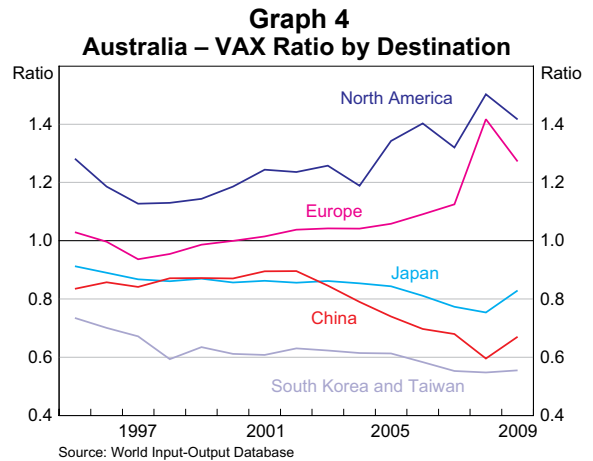
(a) Canada, Mexico and the United States
Source: World Input-Output Database

⁴ A country's total value-added trade cannot exceed its gross trade, which implies that the overall VAX ratio cannot be greater than one; only bilateral (or sectoral) value-added trade can exceed gross trade.

between 2000 and 2009, gross exports to China, Indonesia, Korea and Taiwan together accounted for about 30 per cent of Australia’s gross exports, but around 23 per cent of value-added exports. Conversely, North America and Europe accounted for about 23 per cent of Australia’s gross exports, but about 33 per cent of value-added exports. Australian value-added exports to the advanced economies are higher than gross exports because some Australian production is exported there indirectly via supply chains in Asia. Correspondingly, Australia’s value-added exports to Asia are less than gross exports because some of the exports are used as intermediate inputs in those regions to produce final goods and services for re-export to other countries.⁵

Graph 4 shows the ratio of value-added to gross exports by bilateral trading partners for Australia. Looking at how the bilateral VAX ratios have evolved over time, there has been a steady increase in the value-added content of Australia’s trade with North America and Europe but a gradual decline in the value-added content of Australia’s trade with east Asia. The volume of both gross and value-added exports to east Asia, and particularly China, has grown markedly, but an increasing share of Australian exports to the region are processed and re-exported rather than being consumed domestically, which has caused the VAX ratio to trend down. These trends mainly reflect the increasing integration of east Asia into global supply chains, with the effect being particularly pronounced during the 2000s.

The sectoral mix of Australia’s trade is also different when measured in value-added terms rather than gross terms (Table 2). The sectoral breakdown of Australian exports in value-added terms indicates which sectors ultimately benefit from trade. For this purpose, Australian exports are divided into broad



sectors based on the WIOD data: the resources, manufacturing, services, and construction and utilities sectors.⁶

Services exports account for a much higher share of Australia’s exports in value-added terms (42 per cent) than in gross terms (23 per cent) (Table 2). Australia’s exports therefore include a higher share of services than conventionally measured. Most services are non-tradable and so the services sector produces a small share of direct exports, which are captured by gross trade statistics. However, services are used extensively as inputs to produce manufactured and resource exports. For example, services, such as marketing and distribution, account for a relatively large share of the final value of manufactured goods. Furthermore, service industries tend to be labour intensive, requiring relatively few intermediate inputs in their own production.

Conversely, the manufacturing sector comprises a much smaller share of value-added trade (21 per cent) than of gross trade (40 per cent) (Table 2). These estimates indicate that about half of the

5 These estimates assume that, for each industry, the import content of production is the same for exported and non-exported products. But, due to China’s use of export-processing trade zones, Chinese exports tend to have higher imported content than goods and services produced for domestic consumption. This implies that the WIOD estimates may overstate China’s share of Australian value-added exports. This issue is discussed in more detail in Kelly and La Cava (forthcoming).

6 The WIOD classification of industries is very similar to the classification based on the 2-digit Australian and New Zealand Standard Industrial Classification (ANZSIC) system, which is used by the Australian Bureau of Statistics (ABS). Australian gross exports of resources and manufacturing goods are slightly higher, on average, based on the WIOD measure compared with the ABS measure, but these differences are unlikely to have a significant effect on the sectoral measures of the VAX ratios. Reclassifying industries into the manufacturing and resources sectors based on the split used by Rayner and Bishop (2013) has little effect on the measured VAX ratios.

Table 2: Australian Exports by Sector
2000–2009 average

Sector	Share of value-added exports	Share of gross exports	Difference	VAX ratio
	Per cent	Per cent	Percentage points	
Services ^(a)	42.3	22.9	19.4	1.58
Resources ^(b)	33.8	36.7	–3.0	0.79
Manufacturing	20.9	40.1	–19.3	0.44
Construction and utilities	3.1	0.2	2.9	12.37
Total	100.0	100.0	0.0	0.86

(a) Includes the transportation industry

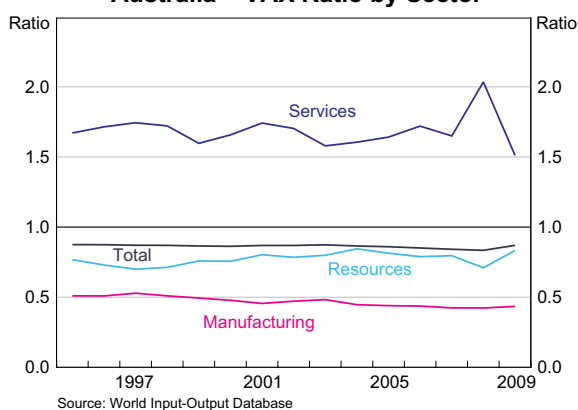
(b) Includes the agriculture, forestry and mining industries

Source: World Input-Output Database

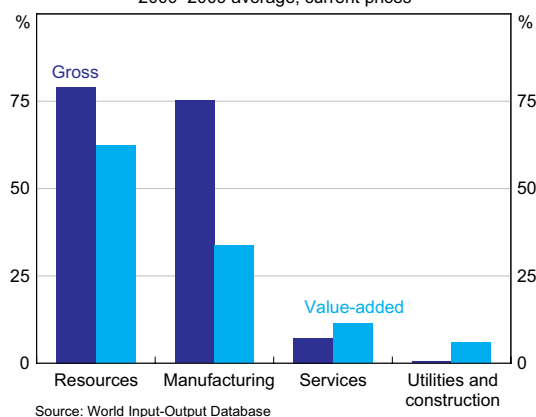
value-added in Australia's manufacturing exports comes from either imported inputs or the inputs of other domestic sectors. For the resources sector, the share of value-added trade (34 per cent) is similar to the share of gross trade (37 per cent). Production in the resources sector extensively uses intermediate inputs from other sectors, but the resources sector also produces a large share of the intermediate inputs used by other sectors, in the form of raw materials. These two effects largely offset each other. The sectoral VAX ratios have been fairly constant over time, although there has been a slight decline in the manufacturing VAX ratio over the past couple of decades (Graph 5).

The value-added trade estimates also affect measures of each sector's export dependence, such as the exports-to-GVA (gross value added) ratio. For instance, the share of manufacturing production that is exported is much lower on a value-added basis than on a gross basis (Graph 6). Conversely, the Australian services sector is more export dependent than implied by conventional estimates, although its overall level of exports is still low. The value-added trade estimates also indicate that sectors, such as utilities, are more exposed to trade than indicated by conventional estimates. For example, electricity is not exported directly as a product, but is used extensively to produce manufacturing and resource exports.

Graph 5
Australia – VAX Ratio by Sector



Graph 6
Australia – Exports-to-GVA Ratio by Sector
2000–2009 average, current prices



Aggregate Value-added Trade

The VAX ratio can also be constructed for Australia's aggregate trade by comparing total value-added exports to total gross exports. The aggregate VAX ratio implies that the share of value-added in Australian exports was about 87 per cent in 2009 (Graph 7).⁷ The value-added content of Australian exports is relatively high by international standards; the share of value-added in world exports was about 73 per cent in 2009. The high share of value-added content in Australia's trade reflects several factors, including its large endowment of natural resources and its geographic isolation, which contribute to the country's relatively low level of trade as a share of GDP (Guttman and Richards 2004). The high share of resources in Australia's export base implies a low dependence on imported inputs so most of the value-added of Australian exports is due to domestic production. Australia's geographic isolation also means that it is rarely involved in the intermediate processing stages of most global supply chains. In contrast, the value-added content of trade is typically

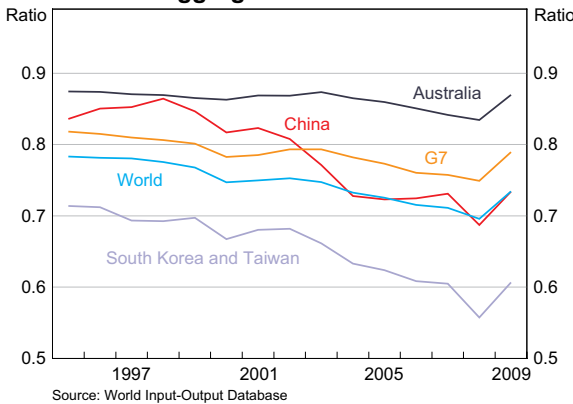
low for countries close to production hubs that are heavily involved in production sharing, such as those in Europe, east Asia and North America. These factors also largely explain why the value-added content of Australian trade has declined by much less than most other countries since the mid 1990s.⁸

Conclusion

The emergence of global supply chains has caused significant structural changes in Australian trade that are not fully reflected in conventional measures of gross trade flows. The WIOD allows the construction of value-added measures of trade that can identify Australia's underlying trade linkages. The estimates suggest that the United States and Europe comprise a larger share of Australia's value-added exports than gross exports, while China comprises a smaller share of value-added exports. The services sector also constitutes a higher share of Australia's value-added exports than gross exports because of its indirect exposure to trade, as services are extensively used as inputs to produce goods exports.

The value-added content of Australian trade is high by international standards, mainly due to Australia's large endowment of natural resources and its geographic isolation. These factors contribute to Australia exporting a relatively high share of resource commodities and a low share of manufactured goods. Globally, manufactured exports typically embody relatively little value-added as their production involves the extensive use of intermediate inputs, which are increasingly sourced from imports. These compositional differences also explain why the value-added content of Australian trade has been relatively stable while the value-added share of trade for most countries has fallen over the past two

Graph 7
Aggregate VAX Ratios



⁷ Total value-added exports are not simply the domestic content of total gross exports, but the amount of domestic content that is ultimately consumed as final demand outside the country. Value-added exports exclude 'reflected exports' – that is, the estimates exclude domestic content that is processed outside the country and then imported (e.g. Australia importing a Japanese car that contains Australian steel). But reflected exports represent only a small share of Australia's overall trade, so the VAX ratio provides a reasonable guide to the proportion of domestic content in overall exports.

⁸ The VAX ratio is measured in nominal terms and can therefore be affected by changes in the prices of intermediate inputs and gross outputs. For example, there is a clear downward spike in the aggregate VAX ratios of most countries over 2008 and 2009. This pattern is, at least in part, due to large fluctuations in commodity prices around that time. For instance, commodity prices rose sharply in 2008, which would have boosted the relative price of intermediate inputs, and hence reduced the value-added content of exports, for most countries and industries.

decades, as they increasingly source intermediate inputs from overseas.

Australia has increasingly become a net exporter of intermediate inputs and a net importer of final products over the past two decades. This reflects the growing fragmentation of production across borders, as the emerging economies in Asia become major importers of Australian resource commodities. ✎

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