CALCULATING IMPORT INTENSITY USING THE ABS INPUT-OUTPUT TABLES

This note estimates import penetration ratios (IPRs) for the different expenditure components of GDP using the ABS input-output tables. Business and public investment are the most import-intensive expenditure components while consumption, exports and public consumption are relatively less so. These estimates are used to construct an import-adjusted demand variable. Forthcoming work will use this variable to model imports and estimate IPRs at a more granular level.

Introduction

Measures of domestic economic activity subtract imports because they capture spending on goods and services that are produced outside of Australia. Import expenditure in the National Accounts is measured on a Balance of Payments basis, which means that it is not possible to attribute imports to the specific expenditure components such as consumption, public demand or exports. As a result, variation in the import intensity of the components of expenditure and sectors of the economy is overlooked.

Understanding the import-intensity (import penetration) of different types of expenditure can help to analyse and forecast the net effect of changes in spending on GDP, by more accurately accounting for the portion that is likely to have been imported. This is particularly useful as the economy continues to transition away from import-intensive mining investment towards growth in the non-mining economy.

This note outlines why the Balance of Payments measure of import expenditure does not reconcile with the National Accounts expenditure measures, and shows how the input-output framework is well-suited to dealing with this. Using the input-output tables, I estimate import penetration ratios (IPRs) across the GDP expenditure components, applying a method outlined in Bussière *et al* (2013). These IPRs are used to construct an updated import-adjusted demand (IAD) variable for Australia that accounts for the variance in import-intensity between different types of expenditure. This measure was used by Jääskelä and Mathews (2013) to explain the slowdown in global trade and will be used in future work for modelling imports.

Background – Imports and the National Accounts

To calculate GDP on the expenditure side of the National Accounts, each component of expenditure is added and then total imports (related to all expenditure) are subtracted because each type of expenditure contains implicitly a domestic and imported component.

$$GDP(E) = C + I + PubC + PubI + X - M + \Delta\, inv$$

Calculating the split between the domestic and imported component is complex. Imports in the National Accounts are produced on a Balance of Payments (BOP) basis, which means that they fall into either final or intermediate (import) categories. Final imports are goods and services imported for final expenditure purposes and are reasonably simple to map to the different components of expenditure; in the Balance of Payments these include capital, consumption and some service imports (Graph 1). Intermediate imports refer to goods and services imported for use as inputs into the production of other goods and services. These are much harder to attribute to particular components of final demand expenditure and account for an important share of total imports (Graph 1). On a BOP basis, intermediate imports and the remaining portion of service imports are considered indirect (or 'non-final') imports (ABS 2015, p286).

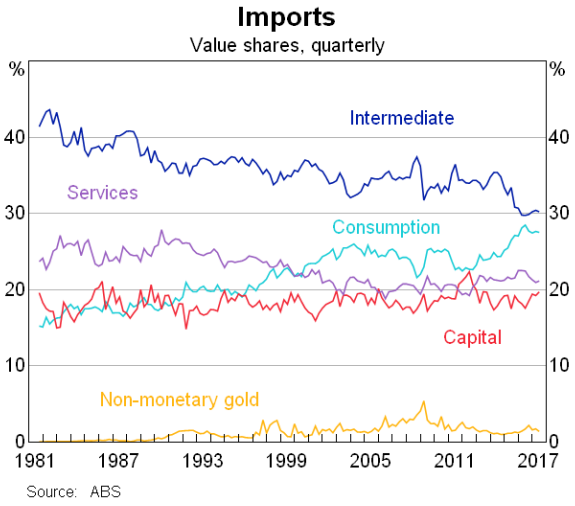
An import penetration ratio is the value of imports relative to the value of total final expenditure (Equation 1).[1]

$$IPR = \frac{Imported\ expenditure}{Total\ final\ expenditure} \qquad (1)$$

1 Total final expenditure is defined as domestic and imported spending for each component of GDP(E) (except imports). When it is summed across the expenditure components it will give gross national expenditure (GNE) plus exports, which is the denominator of the overall IPR.

Because it is complex to attribute imports in the BOP framework to their respective expenditure components, finding the numerator of this equation at a lower level than the aggregate is not a simple exercise and another approach to calculating IPRs is needed.

Graph 1



For example, comparing consumption imports with household final consumption expenditure would substantially understate the true consumption IPR. Consumption imports alone don't capture the intermediate imports that are used as inputs in the production of final consumption goods; neither will they capture any of the imported services related to consumption spending. Total consumption imports also include some categories that are not related to household consumption. For example, the purchase of passenger motor vehicles is considered a consumption import in the Balance of Payments, but would constitute consumption, investment and government spending in the National Accounts.

Using input-output tables to calculate import penetration ratios

The ABS input-output (I-O) tables provide information that is needed to allocate imports to different expenditure components and therefore calculate accurate import penetration ratios. This is because I-O tables represent the flow of resources supplied from an industry for use as inputs into production in all other industries (including itself), which is often why they are referred to as supply and use tables. When the relevant I-O tables are aggregated, they match the current price GDP expenditure estimates in the National Accounts.

Bussière *et al* (2013) estimate cross-country expenditure level IPRs (including for Australia) using the world input-output tables that are released every five years.[2] Using the ABS input-output tables, I am able to produce more frequent and timely estimates. The steps behind the calculation of the IPRs are detailed in a separate appendix, which also contains a description of the specific data required from the input-output tables. The ABS has input-output tables available digitally from 1998-99. Estimates prior to this are taken from Bussière *et al* (2013). Although the I-O release provides annual estimates, they are not released every year. Where data are missing for certain years, they are approximated by linear interpolation between the available data.

Expenditure-level import penetration ratios

This section presents estimates of IPRs based on different types of expenditure in the GDP(E) measure of the National Accounts. IPRs can only be estimated based on the broad expenditure classes: household consumption, private investment, public consumption, public investment and exports.[3] I-O tables do not provide functionality to disaggregate further than this within the GDP expenditure framework. As a simplifying assumption the IPR estimate for private investment is fully allocated to private business investment, because the imported content of residential building construction (the closest measure to dwelling investment in the I-O tables) is close to zero.[4] Forthcoming work will outline a work-around to this limitation by mapping the production-side ANZSIC industry classifications to a GDP expenditure framework and estimating some industry-level IPRs.

Graph 2 plots the total import penetration ratio for the Australian economy based on the quarterly National Accounts data. The import-intensity of expenditure has gradually increased over time, which is consistent

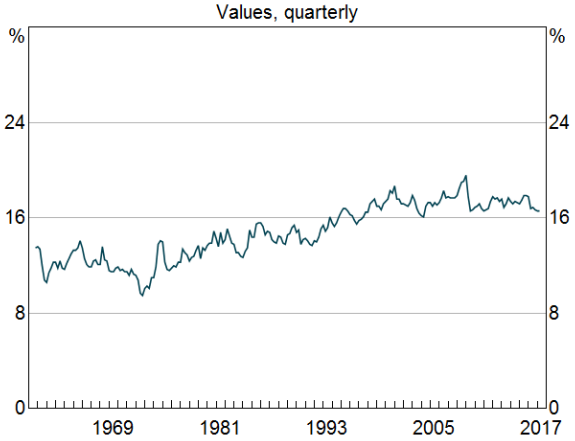
2 These estimates are only used as an input into the construction of the import adjusted demand variable, and are not discussed in the paper. They can be found in the online data appendices of the paper.

3 Public investment can be broken down into general government and public enterprise. I sum these two categories for the purpose of the note as public enterprise activity is small.

4 This implies that the estimates of the business investment IPR shown here may be a little understated because of this assumption.

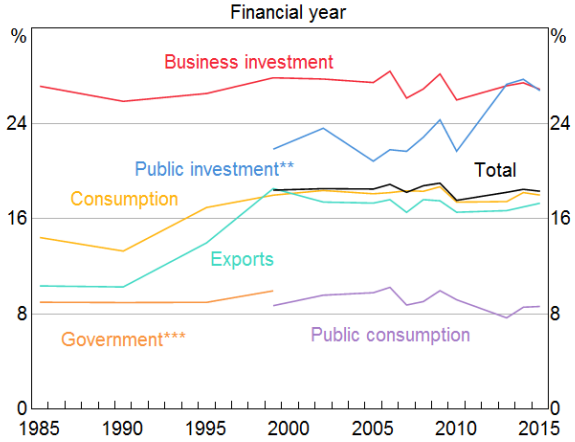
with the trade liberalisation that occurred over this period. However, the aggregate measure masks considerable variation in the import penetration across expenditure components; for example activities like resource exports or dwelling investment have very low import intensity, while other activities, like private business investment, have higher IPRs. Graph 3 shows estimated IPRs for the Australian economy by expenditure component.

Graph 2
Import Penetration Ratio*
Values, quarterly



* Import values divided by GNE + export values
Sources: ABS; RBA

Graph 3
Import Penetration Ratios*
Financial year



* Calculated from ABS input-output tables; prior to 1998/99, estimates from Bussiere et al. (2013) are used
** Includes public investment and public enterprise activity
*** Bussiere et. al (2013) estimates combine public consumption and public investment
Sources: ABS; Bussiere et al. (2013); RBA

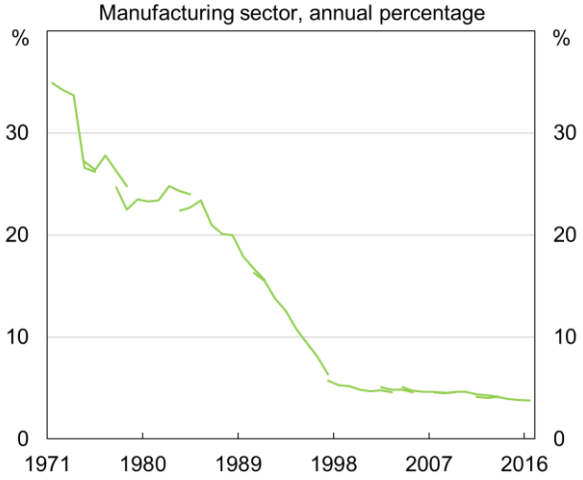
The total import penetration ratio derived from the I-O tables (Graph 3) broadly matches the equivalent measure from the quarterly National Accounts measure in Graph 2. Business investment is the most import-intensive component of the economy, followed closely by public investment, where the IPR has increased over the last decade. Household consumption and exports have similar import penetration rates to the aggregate and have gradually increased over time. The import intensity of public consumption spending is low; which is to be expected given that services like health care, education, defence and public administration that dominate this expenditure category are not easily imported.

A striking observation from Graph 3 is that import penetration hasn't increased as strongly as could be suggested by the large fall in the Productivity Commission's (2017) effective rate of protection (ERP) measure for the manufacturing sector (Graph 4). One potential explanation is the long-term shift in the composition of economic activity from goods toward services, which by nature tend to be less import-intensive. This may explain why the import-intensity of the high-level expenditure components has remained relatively stable over time. Heath (2017) discusses how services sectors, particularly business services, have become an increasingly important part of value-added at the expense of the goods production sector (Graph 5). As a result, increases in import penetration have probably been partially offset by shifts in the composition of spending away from import-intensive goods towards services.

Graph 4

Effective Rate of Protection*

Manufacturing sector, annual percentage

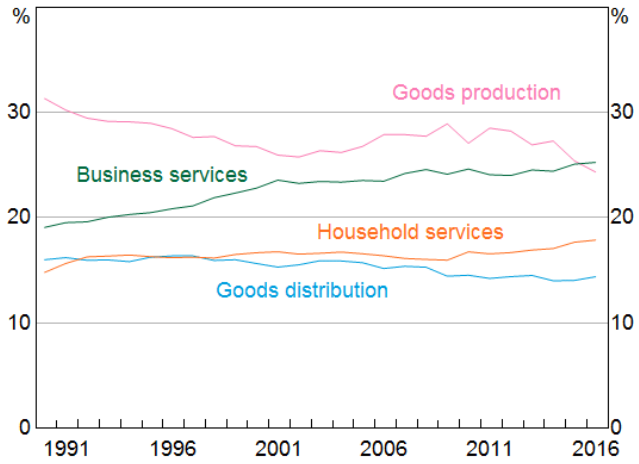


*Breaks or overlaps in the series result from methodological or data changes
Sources: Productivity Commission

Graph 5

Industry Gross Value Added*

Per cent of nominal GVA



* Excludes agriculture, forestry and fishing, public administration and safety, and ownership of dwellings
Sources: ABS; RBA

Using import penetration ratios: an import-adjusted demand variable

Import penetration ratios provide a framework to inform EA about the marginal contribution of different types of expenditure to aggregate economic activity. Bussière *et al* (2013) use the estimates of import penetration to produce a demand measure that adjusts the components of expenditure in a way that captures their differing import intensities.[5] This is in contrast to BAT's current modelling approach, which assumes all expenditure as having the same import-intensity. This import-adjusted demand (IAD) variable weights each component of demand by its import penetration and is constructed as follows:

$$IAD = C^{\omega_C} \times I^{\omega_I} \times PubC^{\omega_{PubC}} \times PubI^{\omega_{PubI}} \times X^{\omega_X}$$

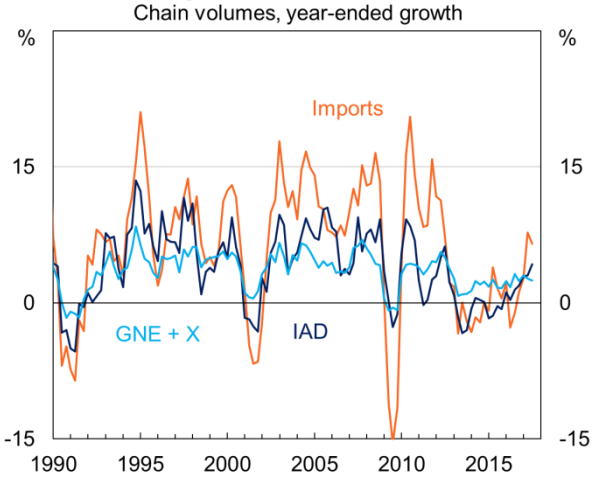
Where ω_i is the weight given to each component of final expenditure based on its import-intensity (where $i = C,\ I,\ PubC,\ PubI,\ X$ and $\sum \omega_i = 1$).

Graph 6 shows that growth in the IAD variable follows closely the growth rate in import volumes, but there are some differences that likely reflect the fact that the import-adjusted demand measure does not account for relative price changes (import prices relative to domestic prices), which have fallen since the mid-1980s alongside the effective rate of protection (Graph 4 and 7). Otherwise the IAD variable appears to track import expenditure better than aggregate demand does. Short term volatility in imports profile relative to the IAD variable will also capture changes in the exchange rate (Graph 6 and 8). Forthcoming work will test if the IAD variable can improve the performance of BAT's imports forecasting models.

Graph 6

Imports and Demand

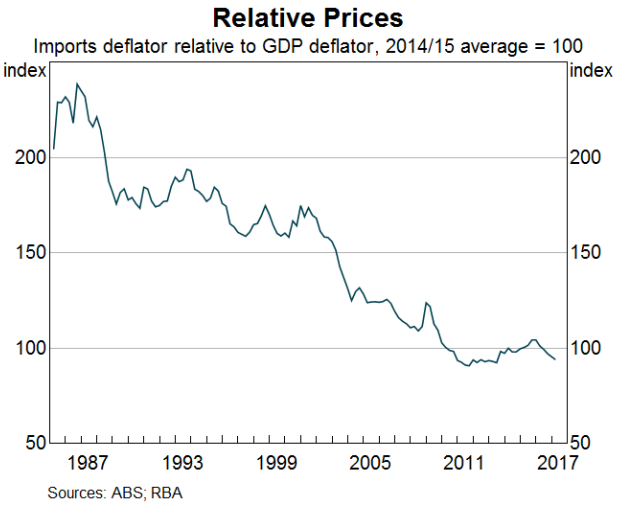
Chain volumes, year-ended growth



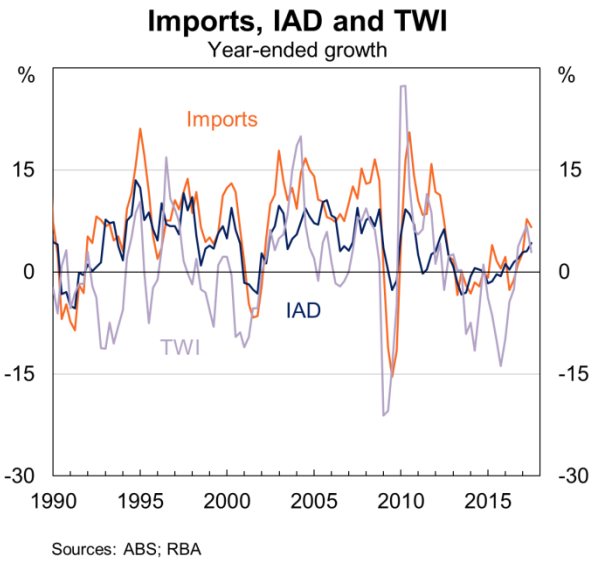
Sources: ABS; RBA

[5] Jääskelä and Mathews (2015) used this measure, among others, to explain the slowdown in global trade.

Graph 7



Graph 8



Conclusion

This note has introduced estimates of import-intensity across the broad components of GDP expenditure using the ABS input-output tables. Private business and public investment are the most import-intensive components of expenditure. Consumption and exports have lower import penetration and are similar to the aggregate measure, while the import-intensity of public consumption is low. IPRs are useful for forecasting the net effect of a change in expenditure on GDP, and will provide a good 'rule of thumb' style approach as a cross check against BAT's model forecasts. Having accurate estimates of import penetration has also helped EA to understand the reasons behind recent forecast errors on imports, highlighted in the 2017 Forecast Review. An added advantage of these estimates is that they can be used to construct an import-adjusted demand variable for Australia that is likely to be a useful modelling tool for forecasting imports. BAT will continue to update these estimates as new input-output tables become available to monitor trends in import-intensity in the economy.

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APPENDIX – CALCULATING IMPORT INTENSITY USING THE ABS INPUT-OUTPUT TABLES

Data:

To calculate import penetration ratios by expenditure component, four matrices are needed from the ABS input-output tables (catalogue **5209.0.55.001**).

Note that throughout the appendix direct imports are analogous to final imports and indirect imports are analogous to intermediate imports.

- **Table 3: Imports – supply by product group and inputs by industry and final use category.** Details imports by industry (intermediate) use and final use category. For each component of expenditure, the final use columns will give direct imports by industry (M_i^{dir}). This matrix is denoted M^{dir}.
- **Table 5: Industry by industry flow table.** Details inter-industry expenditure flows where imports are directly allocated to each expenditure component. From this table, can extract total domestic final expenditure by component for each industry, exclusive of imports. This is referred to as the F^d matrix.
- **Table 6: Direct requirement coefficients (direct allocation of imports).** Outlines the direct requirement coefficients (the amount of inputs from an industry that are directly required to produce a $100 worth of output in another industry). Imports are allocated directly to each industry, so that the requirement coefficients between industries do not include import requirements. Because imports are allocated directly, **Table 6** can also be thought of as the domestic direct requirements coefficients industry matrix. This is denoted as the A^d matrix.
- **Table 9: Direct requirement coefficients (indirect allocation of imports).** Also outlines the direct requirements coefficients, however here imports are allocated indirectly between industries. Imports from one industry used as inputs into production in another industry are included in the coefficients. **Table 9** can be thought of as the domestic direct requirements coefficients (**Table 6**) plus the indirect import requirements coefficients between industries. Differencing **Table 9** and **Table 6** isolates the indirect import requirements coefficients between industries, which will be denoted as the A^m matrix.
- **Table 7: Total requirement coefficients (direct allocation of imports).** Not strictly necessary, but transforms the A^d matrix (from **Table 6**) into what is known as the total requirements coefficients matrix (with direct allocation of imports). This specifies the total amount of domestic inputs from an industry required to produce $100 of output in another industry. This is known as the Leontief inverse matrix and is represented as $(I - A^d)^{-1}$.

Method:

Matrix notation copies Bussière et al. (2013). Assume there are S sectors and K final demand components in the economy. Imports that can be directly mapped to final demand expenditure activity in the economy is given by an S x K matrix of direct imports (Table 3):

$$M^{dir} = F^m$$

where F^m stands for imported final demand expenditure.

Assume also that domestic output from each sector is used both as an intermediate input into other sectors and as final expenditure. The domestic output from sector i required to satisfy final demand of expenditure component k is given by:

$$x_{i,k} = \sum_{j=1}^{S} a_{i,j}^d \, x_{j,k} + f_{i,k}^d$$

In words (because I found this very challenging), domestic output for expenditure component k in sector i is equal to:

- Its domestic [direct] requirement as an input into sector j (i.e. into itself and all other sectors) – denoted $a_{i,j}^d$ (comes from Table 6)

- Multiplied by domestic output in sector j
- Plus domestic output that satisfies final demand from sector i – denoted $f_{i,k}^{d}$

In matrix format across all sectors and components of expenditure this becomes:

$$X = A^{d}X + F^{d}$$

Where X is an S x K matrix of domestic output across S industries and K expenditure components, A^{d} is an S x S matrix of domestic [direct] requirements coefficients (Table 6) and F^{d} is the S x K matrix of domestic final demand for each industry by expenditure component (Table 5).

Domestic output over each expenditure component is then expressed as:

$$X = (I - A^{d})^{-1} F^{d}$$

$(I - A^{d})^{-1}$ is the S x S matrix of total requirements coefficients, or the Leontief inverse matrix (Table 7).

The X matrix is not directly observable from the I-O tables, but can be calculated and is important below in calculating indirect imports M^{ind}.

The imports of intermediate goods in sector i for use as an input into the production of domestic output in sector j (indirect imports) for each expenditure component k is given by:

$$m_{i,k}^{ind} = \sum_{j=1}^{S} a_{i,j}^{m} x_{j,k}$$

In words (because this is also challenging), indirect imports for expenditure component k in sector i are equal to:

- The imported direct requirement (from sector i) used as an intermediate input into sector j – denoted $a_{i,j}^{m}$ (comes from subtracting Table 9 – Table 6)
- Multiplied by domestic output in sector j

In matrix format this becomes:

$$M^{ind} = A^{m}X$$

Where M^{ind} is an S x K matrix of indirect imports attributable to each component of expenditure, A^{m} is an S x S matrix of imported [direct] requirement coefficients (table 9 – table 6), analogous to A^{d}, and X is as above.

Replacing X with the expression above:

$$M^{ind} = A^{m} (I - A^{d})^{-1} F^{d}$$

So that indirect imports can be expressed as a function of all the information accessible in the I-O tables.

This means total imports can be expressed as:

$$M = M^{dir} + M^{ind} = F^{m} + A^{m} (I - A^{d})^{-1} F^{d}$$

Where M is an S x Kmatrix, which presents total imports by sector and expenditure component. Summing along the rows of the matrix gives total imports for the economy by expenditure component. The total import content (import penetration ratio) of each final expenditure component k can then be computed as:

$$\omega_{k} = \frac{M^{dir} + M^{ind}}{F^{m} + F^{d}} = \frac{F^{m} + A^{m} (I - A^{d})^{-1} F^{d}}{F^{m} + F^{d}}$$