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LONG-RUN FORECASTS OF AUSTRALIA'S TERMS OF TRADE

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ABSTRACT

Australia's terms of trade rose significantly over the eight years to 2011-12 following a period of relative constancy over the preceding 40 years. Australian Government fiscal projections from the 2010-11 Budget to the 2013-14 Budget, assumed that beyond the near-term forecast period the terms of trade would fall by 20 per cent over the subsequent 15 years. This approach was silent on when the expected decline would end and the level at which the terms of trade would eventually settle. This paper details the projection methodology underlying the terms-of-trade projection assumption in the 2013-14 MYEFO. In contrast to the earlier approach it provides guidance on the timing of the end of the current expected decline and the associated long-run level of the terms of trade. The centrepiece of the new approach is detailed price and volume forecasting modules for Australia's major export categories, including global demand and supply models for the three major bulk commodities (iron ore, metallurgical coal and thermal coal). Based on this methodology, Australia's terms of trade are expected to fall at a more rapid rate than previously predicted in the 2013-14 Budget from 2012-13 to 2017-18 and remain reasonably constant thereafter at a level roughly equal to that recorded in 2006-07. As noted in the 2013-14 MYEFO, there are a number of downside risks to this outlook including uncertainty around the global economy, the nominal exchange rate and non-bulk commodity price forecasts. Applying prudent judgement to the model's outcome results in a long-run terms of trade that settles at the level observed in 2005-06 by 2019-20.

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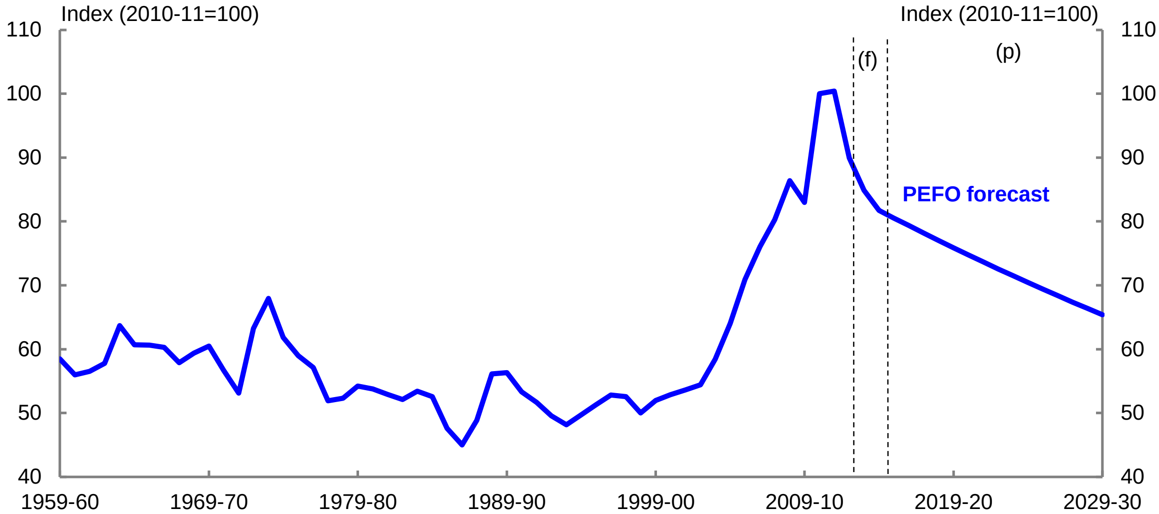
1. INTRODUCTION

Australia's terms of trade rose significantly over the 8 years to 2011-12 following a period of relative constancy over the preceding 40 years (Chart 1). Australian Government fiscal projections from the 2010-11 Budget to the 2013-14 Budget, assumed that beyond the near-term forecast period, the terms of trade would fall by 20 per cent over the subsequent 15 years.[3] This approach was silent on when the expected decline would end and the level at which the terms of trade would eventually settle. This paper details the projection methodology underlying the terms-of-trade projection assumption in the 2013-14 MYEFO. In contrast to the earlier approach it provides guidance on the timing of the end of the current decline and the associated long-run level of the terms of trade.

Chart 1: Terms of trade history, forecasts and projections



Source: Authors' calculations.

Note: In the 2013 PEFO, beyond the forecast period, the terms of trade were projected to fall by 20 per cent over the subsequent 15 years. This projection assumption had been used in Budget and MYEFO documents since the 2010-11 Budget.

Treasury divides its forecasting horizon into two distinct periods: the *forecast period* (f) which covers the first two years beyond the current fiscal year; and the *projection period* (p) which includes the last two years of the forward estimates and up to 36 years for intergenerational analysis. As documented in the recent review of Treasury's macroeconomic and revenue forecasting (Australian Treasury, 2012), forecasts over the forecast period are based on detailed short-run forecasting models, while forecasts over the projection period are based on long-run rules developed in large part through the intergenerational reporting process (see, Australian Government, 2010, for details). These rules, including the rule that governs medium- to long-run projection of the terms of trade, are refined in light of new information or improved modelling techniques.

3 This assumption was maintained in the 2010 and 2013 Pre-Election and Fiscal Outlook (PEFO) reported by the Treasury and Department of Finance and Deregulation.

Treasury's earlier terms of trade forecasting framework recognised two distinct phases of the mining boom: the initial *demand phase* over which there was a rapid rise in prices and a modest increase in supply; and the current *supply phase* during which the capital built over the demand phase is employed thereby rapidly increasing supply and lowering prices. In light of this, the earlier methodology assumed a two stage decline of the terms of trade over the supply phase, with an initial fall over the forecast period consistent with short-run models and market indicators, and a subsequent fall over the projection period based on a long-run rule-of-thumb of a 20 per cent decline over the following 15 years (Chart 1). This paper adds to this framework by allowing for a third phase of the mining boom, labelled the *balanced growth phase* (or long-run path), during which demand and supply move together, and the terms of trade display no secular trend.

The framework developed in this paper recognises that the terms of trade can be thought of as a weighted average of the prices of export categories relative to the aggregate import price level, with the weights equal to the volume of the export categories as a share of the total export volume. Following Treasury's short-run forecasting methodology, exports are divided into the following broad categories: rural goods; non-rural commodities, which are further divided into bulk and non-bulk commodities; non-commodity goods; and services. The approach for each export category uses detailed price and volume modules. These modules include extensions of existing short-run econometric forecasting models, expert advice or credible publicly available information, and new modelling designed to capture important aspects of the data not explained by the earlier framework.

The centrepiece of the framework is global demand and supply modelling of the three major bulk commodities (iron ore, metallurgical coal and thermal coal) which provides long-run export volume and price forecasts of the bulk commodities that extend beyond the forecast horizons of other publicly available forecasts. Considerable attention has been paid to non-rural bulk commodities because historical data suggest they are a fundamental determinant of Australia's long-run terms of trade. Each bulk commodity model uses detailed mine cost data from commercial providers to generate a supply curve, which is then intersected with a demand curve (based on a structural econometric model in the cases of iron ore and metallurgical coal, and International Energy Agency modelling in the case of thermal coal) to produce Australian export volume and unit export price forecasts over time.

The remainder of the paper is organised as follows: Section 2 outlines the projection methodology for aggregate import prices; Section 3 outlines the projection methodology for non-commodity goods and services export volumes and prices; Section 4 discusses the projection methodology for iron ore and metallurgical coal export volumes and prices; Section 5 discusses the projection methodology for thermal coal export volumes and prices; Section 6 outlines the projection methodology for rural export volumes and prices; Section 7 outlines the projection methodology for non-rural non-bulk commodity goods exports; Section 8 combines the forecasts of the various export volume and price modules to generate a medium- to long-run profile of the terms of trade; Appendix A reports the findings of various sensitivity analyses; and data sources are catalogued in Appendix B.

2. AGGREGATE IMPORT PRICES

The terms of trade can be thought of as a weighted average of the price of export categories relative to the aggregate import price level, with the weights (hereafter volume shares) equal to the respective volume of the export categories as a share of the total export volume:

$$\frac{PX_t}{PM_t} = \sum_{i=1}^{n} \frac{X_{it}}{X_t} \times \frac{PX_{it}}{PM_t}, \text{ where } X_t = \sum_{i=1}^{n} X_{it} \quad (1)$$

where at time t: PX_t is the implicit price deflator for aggregate goods and services exports; PM_t is the implicit price deflator for aggregate imported goods and services; n is the number of export categories, X_{it} is the volume of export category i; X_t is the volume of aggregate goods and services exports; and PX_{it} is the implicit price deflator for export category i.

Forecasts of the terms of trade therefore require estimates of the volume shares of all export categories and the price of each export category relative to the aggregate import price level (hereafter relative export price). With the exception of rural and non-bulk non-rural commodities, we forecast relative export prices directly. For rural and non-bulk commodities we forecast export price levels, which require a forecast of the aggregate import price level to generate relative export prices. This section outlines the projection methodology for aggregate import prices. Since import prices are modelled in aggregate, import volumes are not required for the analysis of the terms of trade.

Analytical framework

The theoretical framework underpinning the modelling of import prices is motivated by previous Australian research undertaken by Dwyer and Lam (1994), and updated work by Chung, Kohler and Lewis (2011) and Beames and Kouparitsas (2013), which suggests Australian households and producers are price takers facing an import price equal to the exchange rate adjusted foreign cost of a good or service (i.e. there is complete first-stage pass-through of foreign cost and exchange rates to import prices). Given that Australia is a significant importer of oil, and oil prices display different behaviour to the other goods import prices, aggregate import prices are modelled as a weighted average of oil prices and a trade-weighted aggregate of foreign consumption prices, with the relative weights determined by the model.

A deterministic time trend is also included in the model to account for the observed trend decline in the price of Australian goods relative to exchange rate adjusted foreign goods prices over the early part of the data sample. This trend decline reflects the composition of Australian imported goods which is weighted towards capital intensive goods. The price of capital goods has tended to grow at a slower rate than the broader consumption basket used to model foreign prices for various reasons, including the realisation of global economies of scale in the production of manufactured goods. More recent data suggest this trend decline has weakened significantly and is likely to be reversed in the medium-run as emerging market economies shift away from export-oriented production. In keeping with Treasury's broader projection methodology, which assumes domestic and foreign expenditure prices (converted to $A) grow at a constant annual rate of inflation of 2.5 per cent, all deterministic trends are held constant over the projection period.

The resulting imports price equation is as follows:

$$\ln\left(PM_t\right) = \alpha_0 + \beta_1 \ln\left(PCONF_t / ETWI_t\right) + (1-\beta_1)\ln\left(POILF_t / ETWI_t\right) + \beta_2 TREND_t \qquad (2)$$

where at time t: $PCONF_t$ is the trade-weighted foreign consumption price index; $ETWI_t$ is the trade-weighted exchange rate index; $POILF_t$ is the foreign currency denominated price of oil; β_1 is the share of non-oil goods in the import basket; and $TREND_t$ is a linear time trend.

Data

Historical annual (financial year basis) aggregate import price data are sourced from the Australian Bureau of Statistics (ABS) national accounts.

Detailed individual foreign country consumption prices are sourced from various national statistical agencies and other commercial data providers for the period to 2012-13. Forecasts of individual foreign country consumption prices from 2012-13 to 2014-15 are based on detailed bottom-up analysis. These forecasts are then weighted according to the respective countries' share of aggregate imports to form a trade-weighted foreign consumption price index forecast. This index is assumed to grow at 2.5 per cent, consistent with Treasury's projection period annual inflation rate assumption.

The historical trade-weighted nominal exchange rate index is sourced from the Reserve Bank of Australia (RBA), while the forecast assumes a constant nominal exchange rate. This implies complete pass-through of nominal exchange rate movements to all export and import prices. The sensitivity of the forecasts to this assumption is explored in Appendix A.

Oil import price forecasts are consistent with the oil export price forecasts derived below (Section 7). Consistent with other non-rural non-bulk commodities exports, the oil export price forecast from 2014-15 to 2022-23 is the mean price prediction of Consensus Economics (2013). From 2022-23 real oil prices are held constant (i.e., oil prices grow at an annual inflation rate of 2.5 per cent).

Parameter estimation and calibration

The long-run price equations are estimated using standard econometric techniques. The resulting estimates reported in Table 1 suggest that roughly 90 per cent of the import basket is non-oil goods (β_1). It was necessary to introduce an additional trend post 1999-00 to take account of an otherwise unexplained deceleration in the trend decline of Australian imports goods prices relative to exchange rate adjusted foreign goods prices (β_3) and a similarly otherwise unexplained level shift over the same time period (α_1). According to these estimates the trend decline in import prices relative to foreign consumption prices was 2.4 per cent up to 1999-00 and 1.4 per cent thereafter. Chart 2 shows that the full sample and post 1999-00 trends render the model's residuals stationary.

Table 1: Import price equation parameters

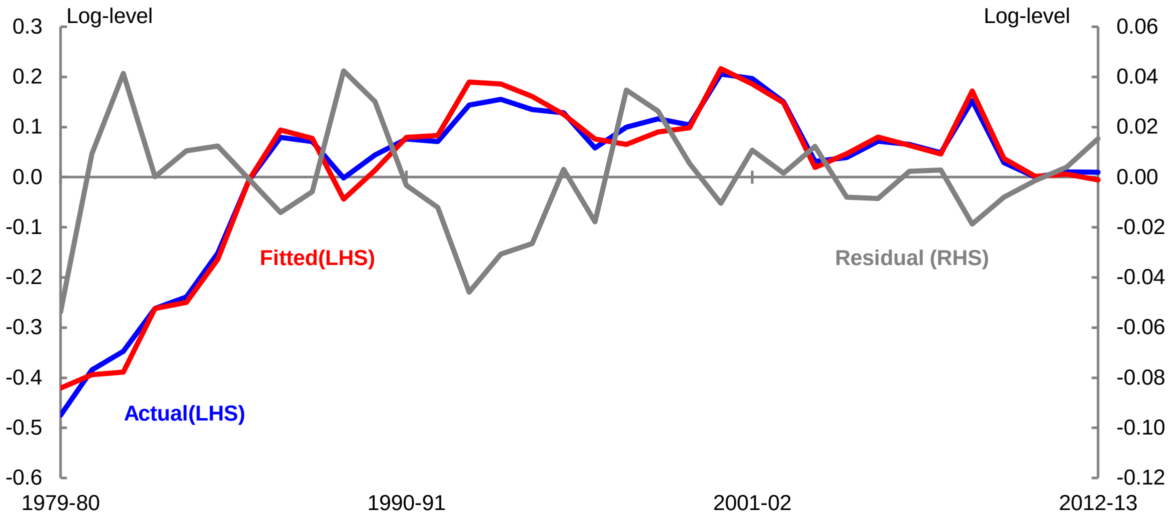
Method: Least Squares
Sample: 1979-80 2012-13

	Coefficient	Std. Error	t-Statistic	Prob.
$\alpha 0$	4.812444	0.227857	21.12047	0.0000
$\beta 1$	0.894277	0.021328	41.93038	0.0000
$\beta 2$	-0.023627	0.001855	-12.73638	0.0000
$\beta 3$	0.009407	0.003977	2.365152	0.0249
$\alpha 1$	-0.054515	0.022308	-2.443766	0.0209

R-squared	0.983422	Mean dependent var	0.012617
Adjusted R-squared	0.981135	S.D. dependent var	0.167044
S.E. of regression	0.022943	Akaike info criterion	-4.576523
Sum squared resid	0.015266	Schwarz criterion	-4.352058
Log likelihood	82.80089	Hannan-Quinn criter.	-4.499974
F-statistic	430.0723	Durbin-Watson stat	1.252388
Prob (F-statistic)	0.000000		

Source: Authors' calculations.

Chart 2: Import price equation fitted values and residuals



Source: Authors' calculations.

3. Exports of non-commodity goods and services

This section outlines the projection methodology for non-commodity goods and services export volumes and prices.

Analytical framework

Export volumes

Non-commodity goods and services exports are modelled by viewing them as imports of Australian goods by foreigners. Kouparitsas and Luo (2013) demonstrate that this approach leads to the following export demand equation:

$$\ln\left(X_{it}\right) = \alpha_{0i} + \ln\left(GNEF_t\right) + \beta_{1i}\ln(PX_{it} \times ETWI_t / PGNEF_t) + \beta_{2i}TREND_t \tag{3}$$

where at time t: X_{it} is the volume of Australian goods and services exports of category i; $GNEF_t$ is the trade-weighted index of foreign gross national expenditure (GNE) volumes; β_{1i} is the elasticity of substitution between Australian and foreign produced varieties of goods and services category i; PX_{it} is the Australian dollar price of Australian goods and services exports of category i; $PGNEF_t$ is the trade-weighted index of foreign GNE deflators; and $TREND_t$ is a linear time trend that accounts for rising or falling foreign import penetration.

Export prices

We assume Australian firms have some power in the markets for Australia's non-commodity goods and services exports, so the supply of these exports is modelled via a log-linear price mark-up equation, where the price of the export is a mark-up over nominal unit labour costs (i.e., total labour cost per unit of output) and possibly intermediate goods costs per unit of input. We further simplify this framework by assuming that there is no substitution between value-adding and intermediate goods and that all intermediate goods are imported (this is the form typically used in aggregate Australian price studies, such as De Brouwer and Ericsson, 1998), which implies the following log-linear export price equation:

$$\ln\left(PX_{it}\right) = \alpha_{0i} + \beta_{1i}\ln\left(WNULC_t\right) + (1-\beta_{1i})\ln(PM_t) + \beta_{2i}TREND_t \tag{4}$$

where at time t: $WNULC_t$ is the nominal unit labour cost; β_{1i} is the share of total costs attributable to domestically sourced inputs; and TREND is a linear time trend.

This implies the following relative price relationship:

$$\ln\left(PX_{it} / PM_t\right) = \alpha_{0i} + \beta_{1i}\ln\left(WNULC_t / PM_t\right) + \beta_{2i}TREND_t \tag{5}$$

Again, it is necessary to include a deterministic time trend to account for otherwise unexplained trends in the data, in this case the observed trends in the price of Australian export categories relative to economy-wide nominal unit labour costs and import prices. It is assumed that these trends will not continue in the long-run so they are held constant in the projection period.

Data

Historical annual exports data are sourced from the ABS Balance of Payments publication.

It is not possible to source GNE forecasts for many of Australia's trading partners so more readily available foreign country GDP forecasts are used for all countries, in place of foreign country GNE. Detailed individual foreign country GDP historical data are sourced from various national statistical agencies and commercial data providers. Short-run forecasts of individual foreign country GDP from 2012-13 to 2014-15 are based on detailed bottom-up analysis consistent with the 2013 PEFO forecast, while forecasts from 2014-15 to end of the projection period are based on Au-Yeung, Kouparitsas, Luu and Sharma's (2013) long-term projection methodology. Individual country GDP forecasts are weighted according to the respective country's share of aggregate exports to form a trade-weighted foreign GDP forecast.

Forecasts of Australian nominal unit labour costs from 2013-14 to 2014-15 are based on Treasury's 2013 PEFO forecast. Beyond 2014-15 nominal unit labour costs are assumed to grow at Treasury's projection period expenditure price inflation assumption of 2.5 per cent.

Parameter estimation and calibration

The long-run export volumes and price equations are estimated using standard econometric techniques.

Non-commodity goods

It was necessary to introduce a level shift in 2008-09 (α_1) to account for an otherwise unexplained fall in the level of non-commodity exports and a change to the coefficient of the deterministic trend in both 2000-01 (β_3) and 2008-09 (β_4) to account for an otherwise unexplained deceleration in the growth of non-commodity exports from 2000-01 to 2008-09 and 2008-09 to the end of the sample. The 2008-09 level and trend shifts coincide with the Global Financial Crisis (GFC).

With an elasticity of substitution of 0.21 (β_1), Australia's non-commodity goods exports are gross complements, which implies the income effect associated with changes in the relative price of non-commodity exports dominates the substitution effect (Table 2). This is an important observation since it implies a modest response of exports volumes to changes in relative export prices. Chart 3 reveals the two slope shifts render the model's residuals stationary.

Table 2: Non-commodity goods exports volume equation parameters

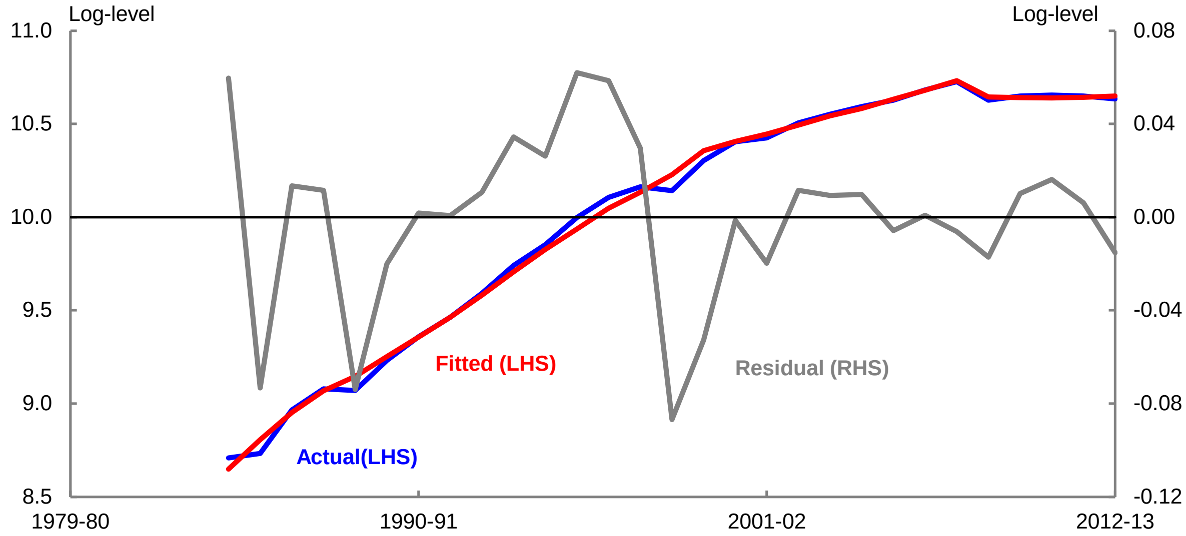
Method: Least Squares
Sample: 1984-85 2012-13

	Coefficient	Std. Error	t-Statistic	Prob.
$\alpha0$	7.865512	0.779031	10.09653	0.0000
$\beta1$	-0.206119	0.131440	-1.568154	0.1305
$\beta2$	0.065103	0.005486	11.86786	0.0000
$\beta3$	-0.053389	0.008146	-6.553876	0.0000
$\beta4$	-0.041533	0.013406	-3.098021	0.0051
$\alpha1$	-0.110325	0.042553	-2.592646	0.0163

R-squared	0.997009	Mean dependent var	10.00844
Adjusted R-squared	0.996358	S.D. dependent var	0.667083
S.E. of regression	0.040255	Akaike info criterion	-3.405166
Sum squared resid	0.037271	Schwarz criterion	-3.122278
Log likelihood	55.37491	Hannan-Quinn criter.	-3.316569
F-statistic	1533.219	Durbin-Watson stat	1.588499
Prob (F-statistic)	0.000000		

Source: Authors' calculations.

Chart 3: Non-commodity goods export volume equation fitted values and residuals



Source: Authors' calculations.

The estimated equation for non-commodity export prices is reported in Table 3. The coefficient on the imported intermediate goods variable (β_1) implies roughly equal weight for domestic labour costs and imported intermediate goods in the determination of non-commodity goods export prices. The slope of the time trend (β_2) is negative which suggests the non-commodity export sector displayed higher labour productivity growth than the aggregate economy over the estimation period. The residuals of this estimated equation are reported in Chart 4. They suggest the fitted equation captures the long-run trends of non-commodity export prices reasonably well as evidenced by the apparent stationarity of the residuals.

Table 3: Non-commodity goods export price equation parameters

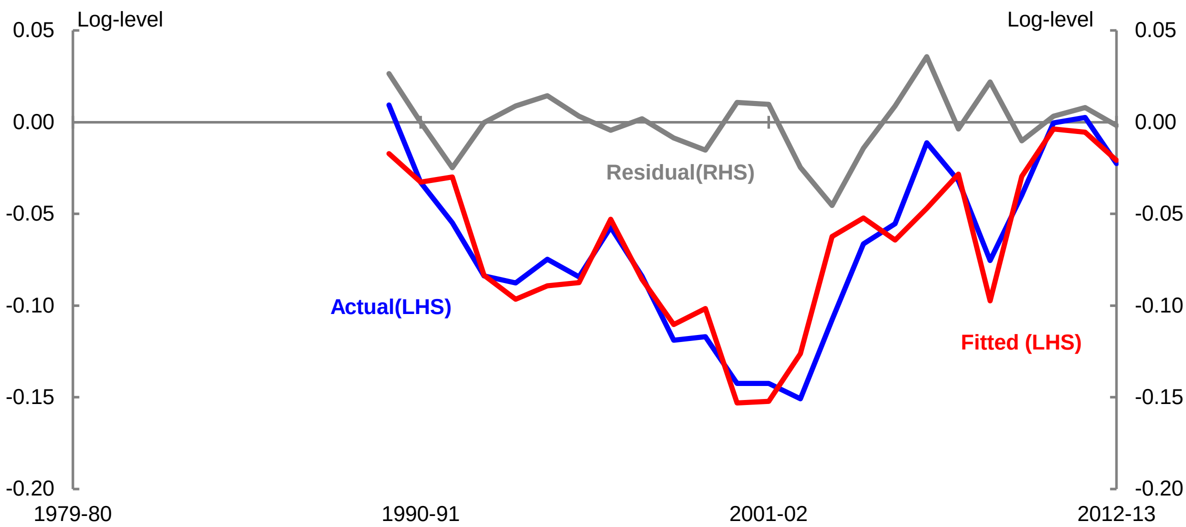
Method: Least Squares
Sample: 1989-90 2012-13

	Coefficient	Std. Error	t-Statistic	Prob.
$\alpha 0$	-0.571642	0.046171	-12.38104	0.0000
$\beta 1$	0.567991	0.051639	10.99937	0.0000
$\beta 2$	-0.014709	0.001569	-9.374137	0.0000

R-squared	0.859612	Mean dependent var	-0.067914
Adjusted R-squared	0.846242	S.D. dependent var	0.046793
S.E. of regression	0.018348	Akaike info criterion	-5.042071
Sum squared resid	0.007070	Schwarz criterion	-4.894814
Log likelihood	63.50485	Hannan-Quinn criter.	-5.003003
F-statistic	64.29270	Durbin-Watson stat	1.485904
Prob(F-statistic)	0.000000		

Source: Authors' calculations.

Chart 4: Non-commodity goods export price equation fitted values and residuals



Source: Authors' calculations.

Services

The estimated equations for services volumes and prices are reported in Tables 4 and 5. Again, it was necessary to introduce level and growth rate shift terms to account for otherwise unexplained variation in volumes and prices at the time of the GFC. The services export volume equation is similar to the non-commodity goods equation, albeit with a higher elasticity of substitution of 0.56. Services export prices also place higher weight on nominal unit labour costs than non-commodity goods (i.e. 68 versus 57 per cent). In contrast to non-commodity goods exports, the positive coefficient on the time trend in the services exports price equation implies lower labour productivity growth than the aggregate economy over the estimation period.

Table 4: Services export volume equation parameters

Method: Least Squares
Sample: 1980 2013

	Coefficient	Std. Error	t-Statistic	Prob.
$\alpha 0$	11.19148	0.471985	23.71152	0.0000
$\beta 1$	-0.559259	0.098158	-5.697537	0.0000
$\beta 2$	0.023799	0.001625	14.64382	0.0000
$\beta 3$	-0.064630	0.019857	-3.254730	0.0029
$\alpha 1$	-0.094221	0.053876	-1.748851	0.0909

R-squared	0.991868	Mean dependent var	10.19533
Adjusted R-squared	0.990746	S.D. dependent var	0.617073
S.E. of regression	0.059362	Akaike info criterion	-2.675285
Sum squared resid	0.102190	Schwarz criterion	-2.450820
Log likelihood	50.47984	Hannan-Quinn criter.	-2.598736
F-statistic	884.2379	Durbin-Watson stat	0.642257
Prob(F-statistic)	0.000000		

Source: Authors' calculations.

Table 5: Services export price equation parameters

Method: Least Squares
Sample: 1980–2013

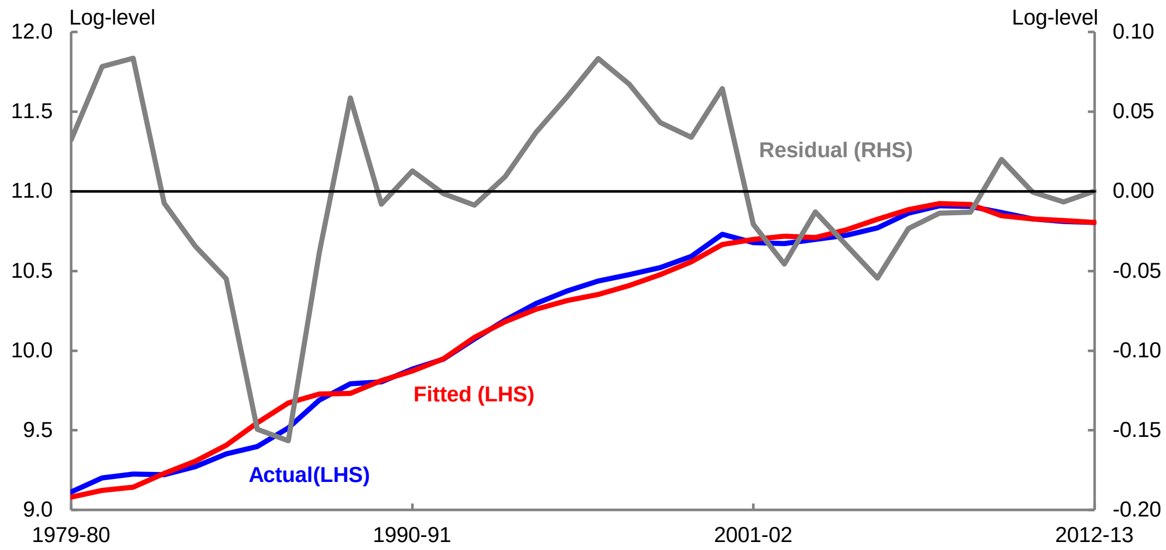
	Coefficient	Std. Error	t-Statistic	Prob.
$\alpha 0$	-1.781096	0.055852	-31.88936	0.0000
$\beta 1$	0.682936	0.048711	14.02029	0.0000
$\beta 2$	0.003659	0.001142	3.203714	0.0031

R-squared	0.982479	Mean dependent var	-0.370650
Adjusted R-squared	0.981348	S.D. dependent var	0.195022
S.E. of regression	0.026634	Akaike info criterion	-4.329123
Sum squared resid	0.021991	Schwarz criterion	-4.194445
Log likelihood	76.59510	Hannan-Quinn criter.	-4.283194
F-statistic	869.1304	Durbin-Watson stat	0.635951
Prob(F-statistic)	0.000000		

Source: Authors' calculations.

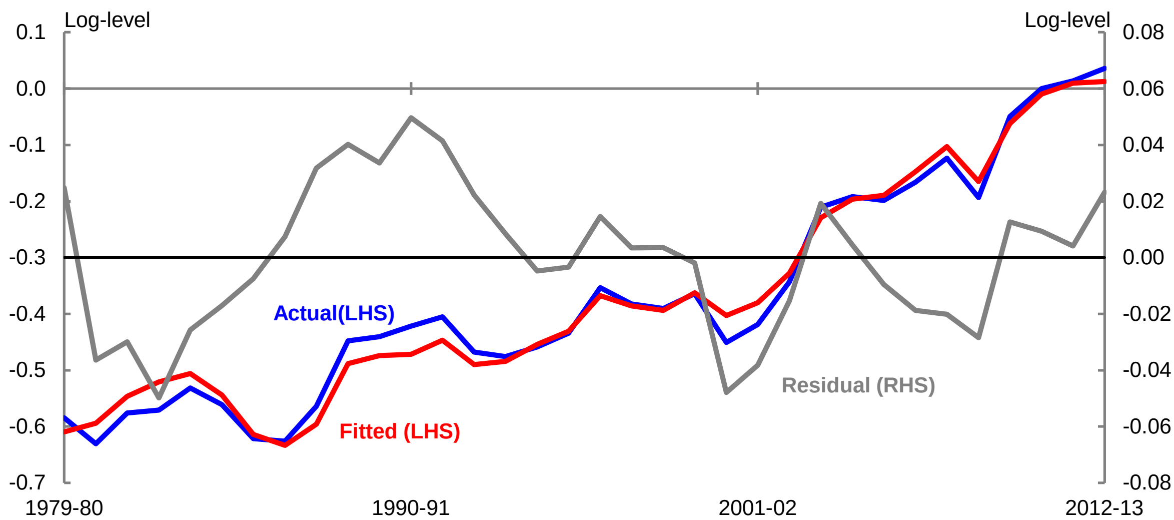
Plots of the services export volume and price equation residuals in Charts 5 and 6 suggest that the residuals are stationary.

Chart 5: Services export volume equation fitted values and residuals



Source: Authors' calculations.

Chart 6: Services export price equation fitted values and residuals



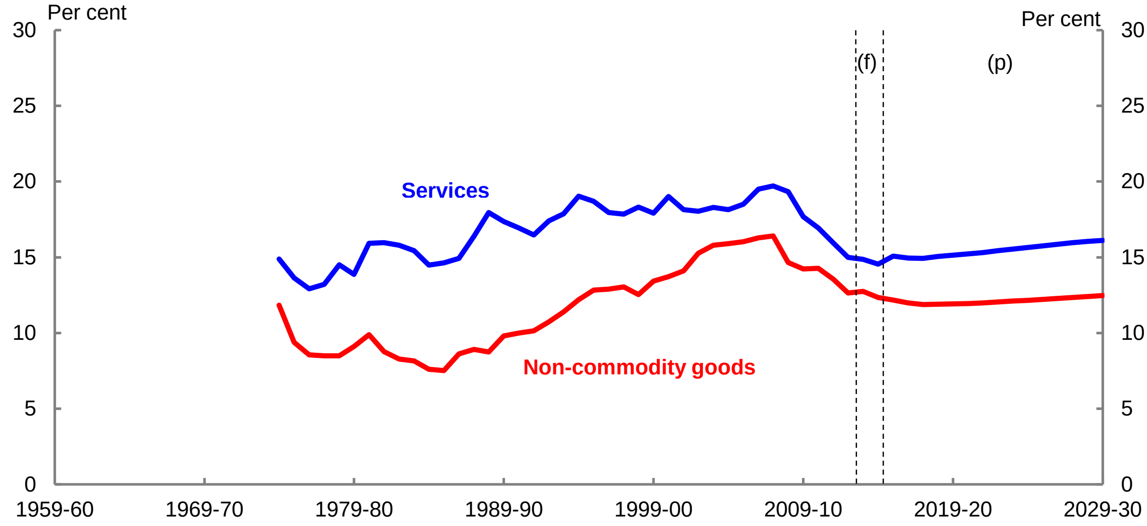
Source: Authors' calculations.

Forecasts

Chart 7 combines the short-run forecasts consistent with the 2013 PEFO and the long-run forecasts of the export volume models to generate a path for the volume shares of non-commodity goods and services over the projection period. The export volume shares of both non-commodity goods and services are expected to rise slightly over the projection period.

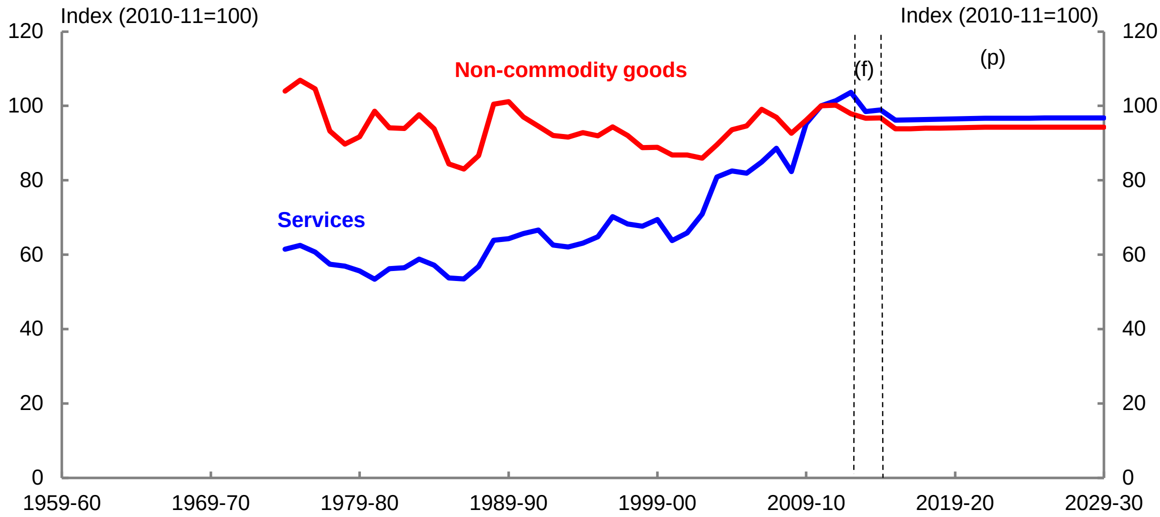
Similarly, Chart 8 combines the short-run forecasts consistent with the 2013 PEFO and the long-run forecasts of the export price models to generate a path for the relative prices of non-commodity goods and services over the projection period. Following a decline in non-commodity goods and services prices relative to imports over the forecast period, due in part to weak growth in nominal unit labour costs stemming from a weakening labour market, the long-run model implies constant relative prices over the projection period.

Chart 7: Export shares — non-commodity goods and services



Source: Authors' calculations.

Chart 8: Relative export prices — non-commodity goods and services



Source: Authors' calculations.

4. Exports of non-rural bulk commodities: iron ore and metallurgical coal

This section outlines the projection methodology for iron ore and metallurgical coal export volumes and prices.

Analytical framework

Iron ore and metallurgical coal are, to a large extent, fully consumed as intermediate inputs in the global production of steel. Iron ore and metallurgical coal exports have therefore been modelled based on estimated demand and supply curves for intermediate inputs to global steel production. The intersection of these curves generates a forecast of the quantity of global steel production and the marginal input costs associated with that level of production. This in turn implies the global level of iron ore and metallurgical coal production and their associated global prices.

Demand for intermediate inputs to steel production

The demand for steel is a by-product of an underlying production function which is assumed to have a nested structure. The first level takes the form of a constant elasticity of substitution, constant returns to scale, production function in value-added (i.e., labour and capital inputs) and intermediate inputs (i.e., iron ore and metallurgical coal). At the next level intermediate inputs are used in fixed proportions with one tonne of crude steel (based on the blast furnace and basic oxygen furnace) requiring the input of 1.4 tonnes of iron ore and 0.77 tonnes of metallurgical coal (see World Steel Association, 2011, for details).[4]

Assuming the costs of other factors of production (i.e., value-added) grow at a similar rate to US consumer prices, country i's demand for steel is as follows:

$$\ln CS_{i,t} = \beta_{0i} - \beta_1 \ln(PCS_t / PCPIUS_t) + \ln(IP_{i,t}) \tag{6}$$

$$PCS_t = (1.4 \times PFE_t + 0.77 \times PMC_t) \tag{7}$$

$$\begin{aligned} CFE_{i,t} &= 1.4 \times CS_{i,t} \\ CMC_{i,t} &= 0.77 \times CS_{i,t} \end{aligned} \tag{8}$$

where at time t: CS_{it} is country i's steel consumption; CFE_{it} is country i's iron ore consumption, CMC_{it} is country i's metallurgical coal consumption; β_{0i} is the country specific constant reflecting efficiency; β_1 is the common price elasticity of steel demand with respect to steel input costs; PCS_t is the US dollar global steel intermediate input cost; PFE_t is the US dollar global iron ore price; PMC_t is the US dollar global metallurgical coal price; $PCPIUS_t$ is the US consumer price index and IP_{it} is the country i's volume of industrial production.

The annual global steel demand curve is simply the sum of the individual country demand curves for a given intermediate input cost.[5] The resulting demand model is similar to that used by the International Monetary Fund (2006) in their closely related analysis of the possible duration of the commodity price boom.[6]

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4 Increasing trends in usage of other competing technologies/substitutes such as electric arc furnaces and scrap metal may affect the quantities of iron ore and metallurgical coal required in the overall production of crude steel in the future.

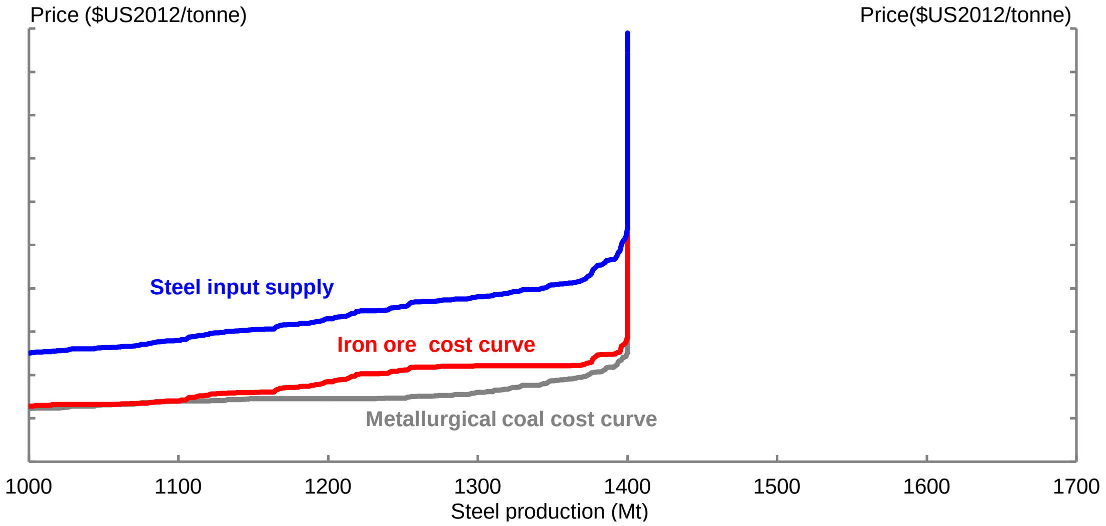
5 For simplicity, the analysis is conducted on the basis of global steel and iron ore values. Given the nature of indigenous supply of raw materials in the sector, there are certain geographies (e.g. Brazil, Russia) that would not be expected to form 'contestable' demand for Australian iron ore exports.

6 The demand for steel equation (6) is a simplified function. The equation fails to take into account the importance of the real estate and construction sector — another big user of steel. This may result in a negative bias in the forecast for steel demand, especially so for developing countries with rapid urbanisation and infrastructure development.

Supply of intermediate inputs to steel production

Estimates of the annual supply curves of steel intermediate inputs, iron ore and metallurgical coal, are based on private sector data. These data report the average variable cost of and maximum level of production for a large number of individual iron ore and metallurgical coal mines from around the world by calendar year. Mine-specific average variable cost and maximum production bundles are sorted by average cost to form global cost curves (global supply curves) for iron ore and metallurgical coal. The resulting supply curves can then be scaled according to their respective steel input requirements (i.e. multiply the average cost and divide maximum quantity of each mine by the input requirement) and summed vertically for a given steel production level to form a steel cost curve or supply curve (see Chart 9 for the indicative 2010 supply curves).

Chart 9: Indicative steel intermediate input supply (2010)



Source: Authors' calculations based in part on data from Wood Mackenzie and Analyst-B.

Market for intermediate inputs to steel production

Armed with the empirical global demand curves implied by equations 6 to 8 and the empirical supply curves sourced externally, global steel intermediate input prices and quantities are determined by the intersection of these curves (i.e. the steel intermediate input market equilibrium) for a given year (Chart 10). The equilibrium global steel volume for a given year corresponds to required volumes of both iron ore and metallurgical coal, which in turn imply global iron ore and metallurgical coal prices via the input specific cost curves for that year.

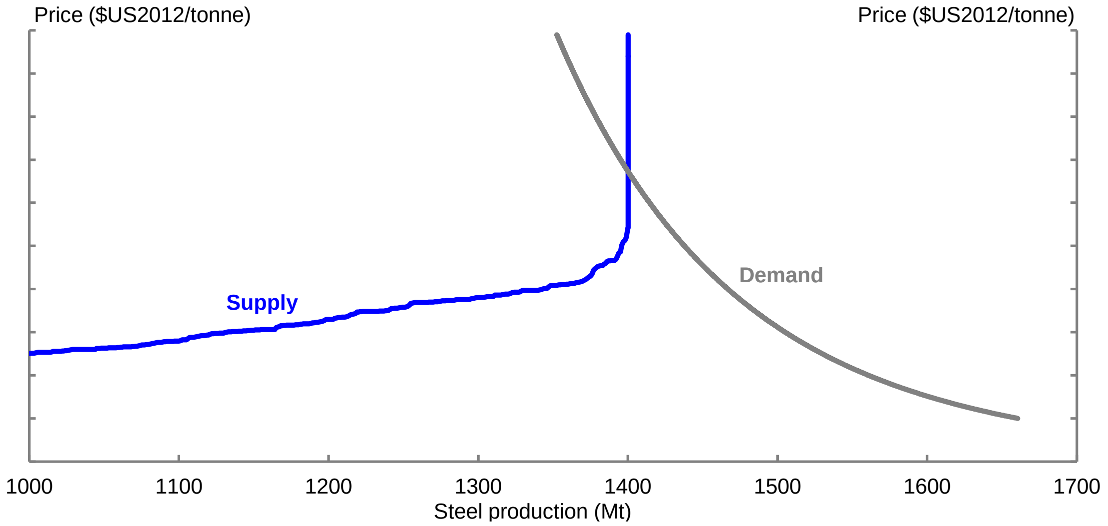
Australian production volume forecasts for iron ore and metallurgical coal for a given year are the sum of Australian mine output with lower production costs than the market clearing price.[7,8] This process is repeated each year which yields a price and volume path for the two commodities for all years of available cost curve data. Financial year forecasts are estimated as the average of the adjacent calendar year forecasts.

---

7 While the analysis has been conducted on a global basis, the location of steel production facilities and the location of supply will matter to the clearing price and hence Australia's production volumes.

8 Australia's foreign exchange rate is an important factor that will determine the location of Australian production along the cost curves. While the market clearing price and volume remains unaffected, this may have a significant impact on the volumes of Australian exports.

Chart 10: Indicative steel intermediate input demand and supply (2010)



Source: Authors' calculations based in part on data from Wood Mackenzie and Analyst-B.

Data

Steel consumption

Historical steel consumption data (i.e., apparent steel use) are sourced from the World Steel Association (2013) for 19 countries, covering approximately 77 per cent of world steel consumption in 2012, and total world consumption from 1990 to 2012. To ensure the broadest coverage of data, a residual rest of the world is calculated using the sum of the individual countries and the world total.

Industrial production

Historical industrial production data are sourced from the World Bank (2012) for the 19 countries with steel consumption data and the world total. Forecasts of industrial production over the projection years are generated by Treasury's version of ABARES Global Trade and Environment Model (GTEM), conditional on the long-run international GDP projections generated by the methodology proposed by Au-Yeung, Kouparitsas, Luu and Sharma (2013). Industrial production for the residual rest of the world is assumed to grow at the same rate as the 19 country aggregate over the forecast period.

Metallurgical coal and iron ore cost curves

Metallurgical coal cost curves are sourced from Wood Mackenzie, while iron ore cost curves are sourced from another confidential commercial provider (hereafter referred to as Analyst-B).

Wood Mackenzie's data provide detailed cash cost of production estimates that cover approximately 70 per cent of global metallurgical coal supply (444 mines). Analyst-B's data provide detailed analysis of direct cash production costs for a broad range of iron ore mines globally. Analyst-B estimates that its database captures over 90 per cent of global iron ore supply (437 mines). No data sourced directly from Analyst-B are reported in this paper due to commercial-in-confidence.

Production costs are estimated on a real US dollar per tonne basis. The total cash cost is a combination of a mine's operating cash costs plus royalties and levies. Capital costs (either expansionary or sustaining) are not included in the cash cost estimate. Examples of the cost components taken into account include the cost of mining, processing, maintenance, royalties, transportation and loading, but not shipping costs, with total costs estimated as Free on Board (FOB).

There are three main categories of metallurgical coal: (i) hard coking coal that forms high-strength coke; (ii) semi-soft coking coal that produces coke of lesser quality; and (iii) PCI (pulverized coal injection) coal. Wood Mackenzie uses the price of premium hard coking coal exported from Australia as the benchmark for its metallurgical coal cost curves. Prices for other metallurgical coals are assessed in relation to the hard coking coal base reference price and then assigned as a percentage discount or premium on that basis.

Parameter estimation and calibration

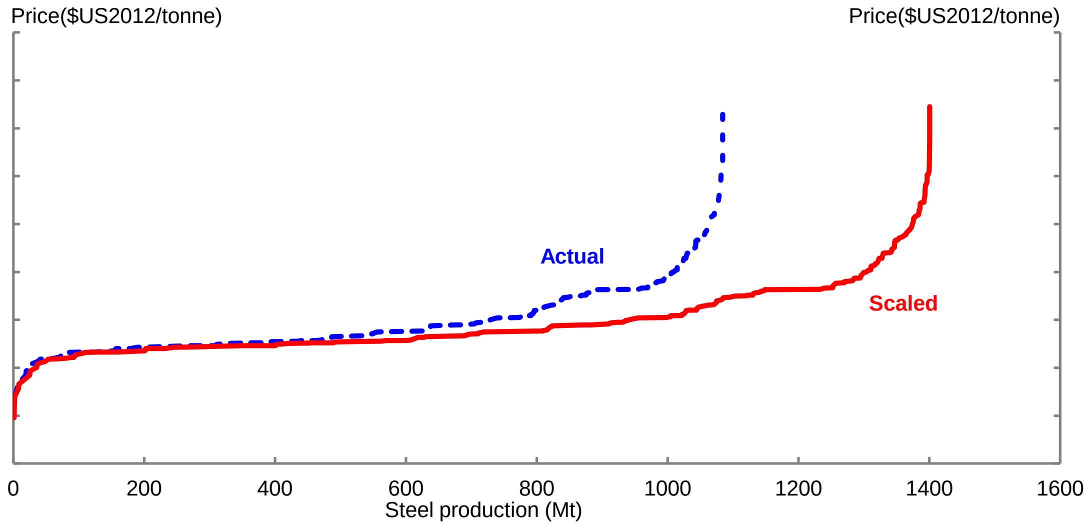
Steel intermediate input demand

The individual country steel demand equations (i.e., equation 6) are estimated jointly using ordinarily least squares. This approach yields a statistically significant estimate of the price elasticity of steel demand with respect to steel input costs of 0.09, which suggests the demand for steel and its intermediate inputs is relatively price inelastic.

Steel intermediate input supply

Historical metallurgical coal cost curve data from Wood Mackenzie and iron ore cost curve data from Analyst-B are scaled to ensure the historical intermediate input supply curves are consistent with actual levels of steel production (see indicative metallurgical coal supply in Chart 11) and observed market prices for metallurgical coal and iron ore. The scaling factors are the inverse of the coverage percentage of their respective datasets (i.e., around 1.1 for iron ore and 1.4 for metallurgical coal).

Chart 11: Indicative metallurgical coal steel input cost curve (2010)

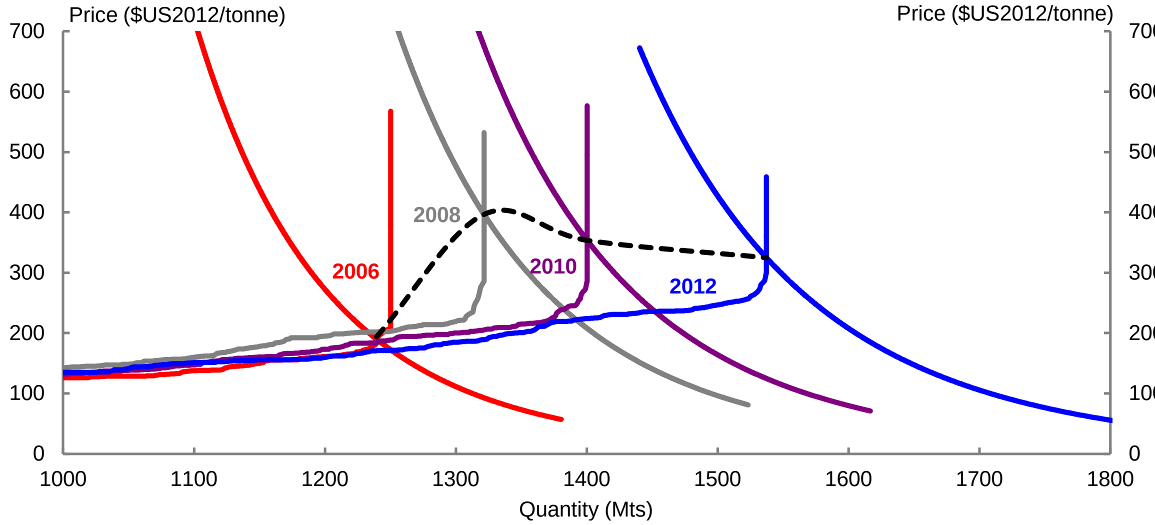


Source: Authors' calculations based on data from Wood Mackenzie.

Steel intermediate input market

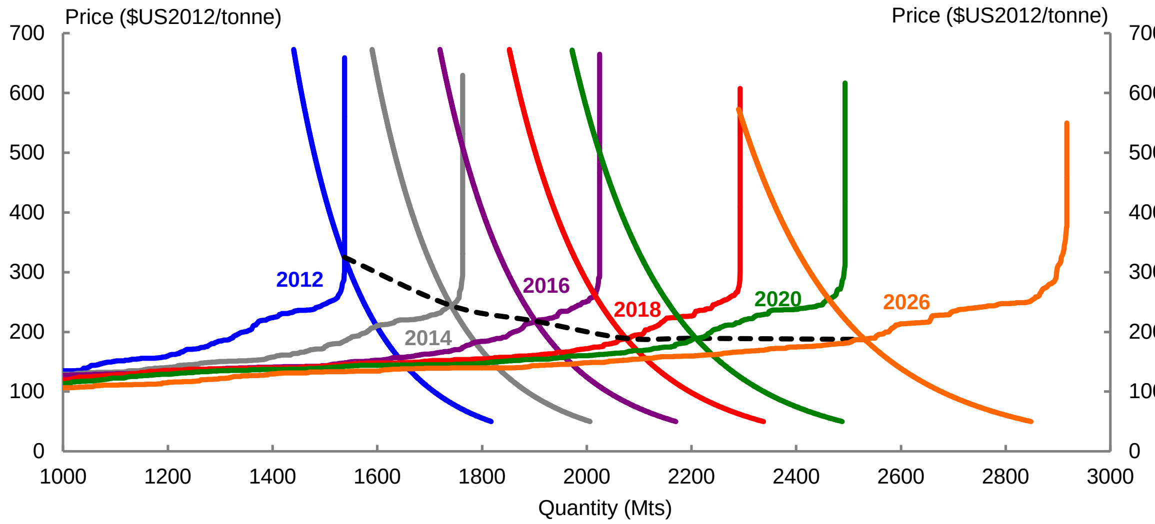
When combined, the estimated demand and calibrated supply curves provide an estimate of the goodness-of-fit of the overall framework. With the exception of 2009, the framework produces price and volume estimates that are close to their historical values. In 2009, the framework produces iron-ore price forecasts that are higher than the actual values, which reflects the fact that this is a medium- to long-run framework which is unlikely to capture large cyclical fluctuations such as those experienced during the GFC. The paths of the available historical demand and supply curves are plotted in Chart 12. This chart demonstrates that for most of the historical period, demand was sufficiently high to force supply to move along the vertical portion of the curve (i.e., prices have been above the marginal cost of production for even the highest cost producer).

Chart 12: Steel intermediate input demand and supply (history)



Source: Authors' calculations based in part on data from Wood Mackenzie and Analyst-B.

Chart 13: Steel intermediate input demand and supply (forecasts)



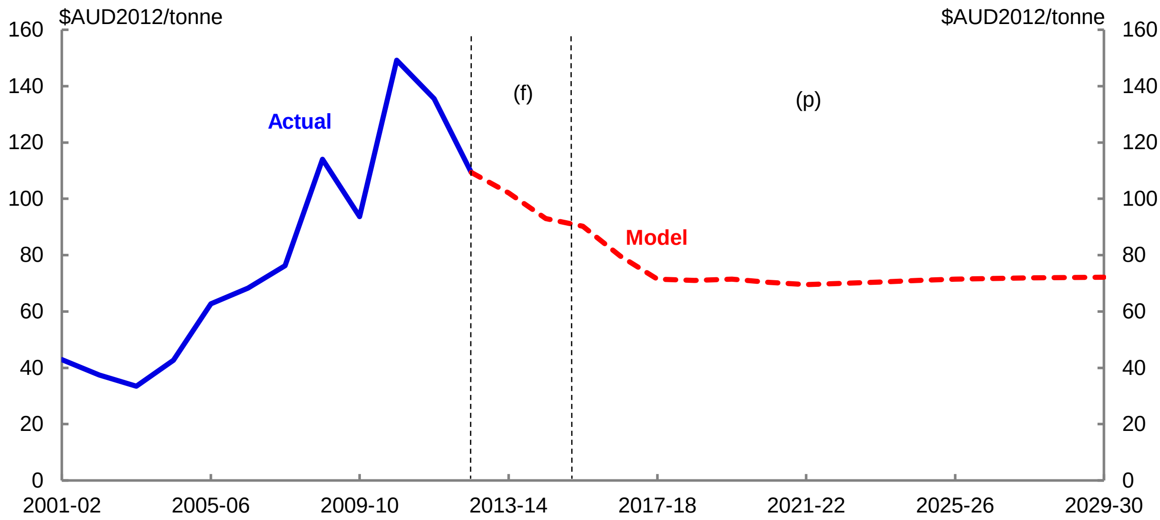
Source: Authors' calculations based in part on data from Wood Mackenzie and Analyst-B.

Forecasts

Chart 13 plots the steel intermediate input demand and supply curves over the end of the historical period (2012) and the forecast and projection period (2013 to 2026). The intersection of these curves provides global volume and price (expressed as a real price in 2012 US dollars) forecasts, which are then used to estimate Australian export volumes (i.e., equal to the sum of seaborne Australian production with cost below the global price) and Australian dollar unit export values for iron ore (Charts 14 and 15) and metallurgical coal (Charts 16 and 17). Note that the forecasts reported in the forecast period are generated by the global steel model and are not necessarily the same as the short-run forecasts underlying the 2013 PEFO.

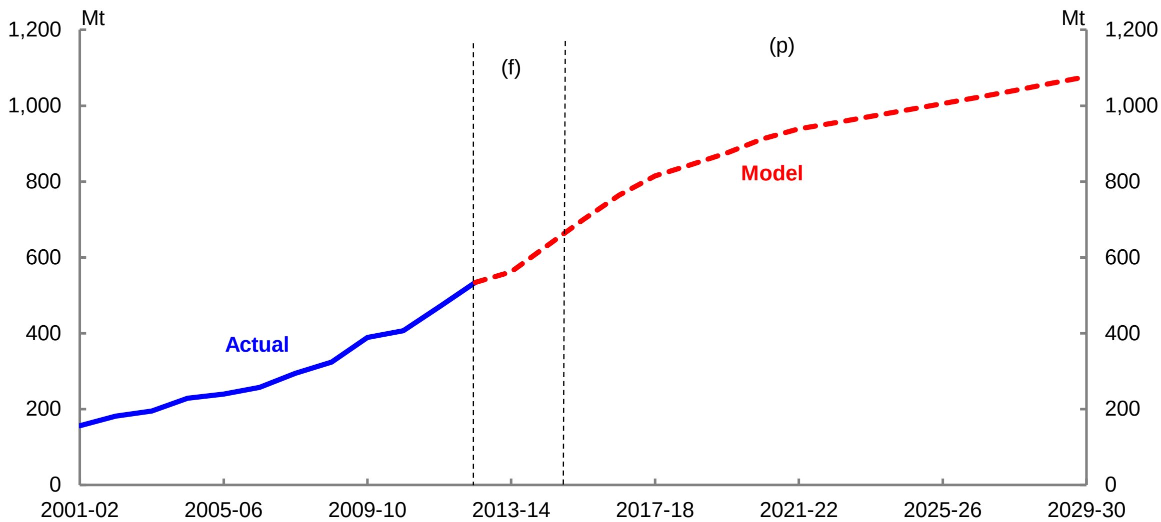
These forecasts suggest supply will increase at a much faster rate than demand over the projection period. In particular, demand is expected to intersect the interior of the supply curve in the current calendar year, ending the recent period over which demand intersected the vertical section of the supply curve. The shift of production to the flatter section of the supply curve is expected to cause a rapid fall in the real price of both iron ore and metallurgical coal. This pattern is expected to end around 2017-18, with real prices remaining roughly constant for the balance of the projection period. At the same time the increased Australian potential supply and on-going increases in demand are expected to double the volume of Australian exports of iron ore and metallurgical coal over the projection period.

Chart 14: Australian iron ore real unit export price forecast



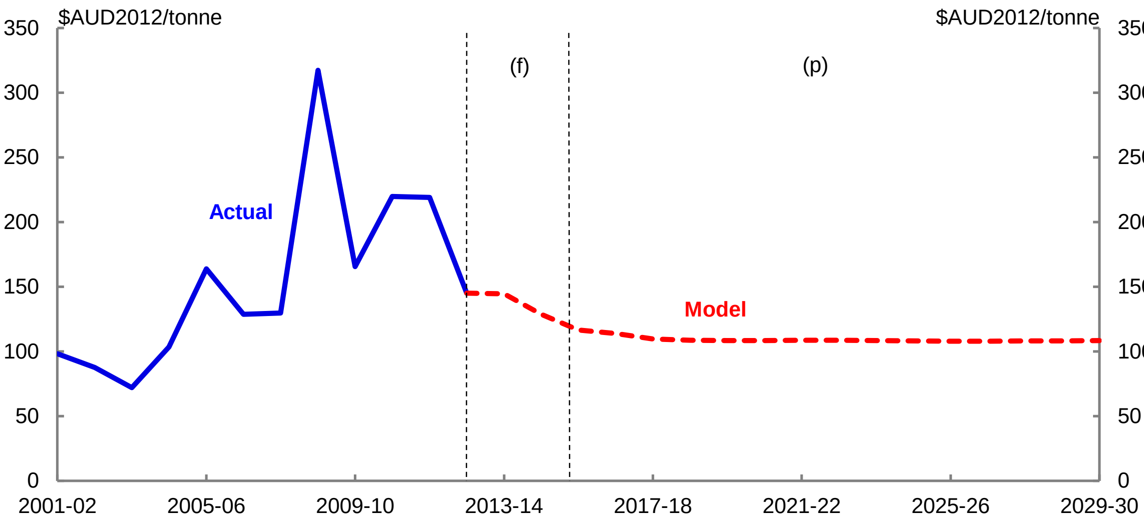
Source: Authors' calculations.

Chart 15: Australian iron ore export volume forecast



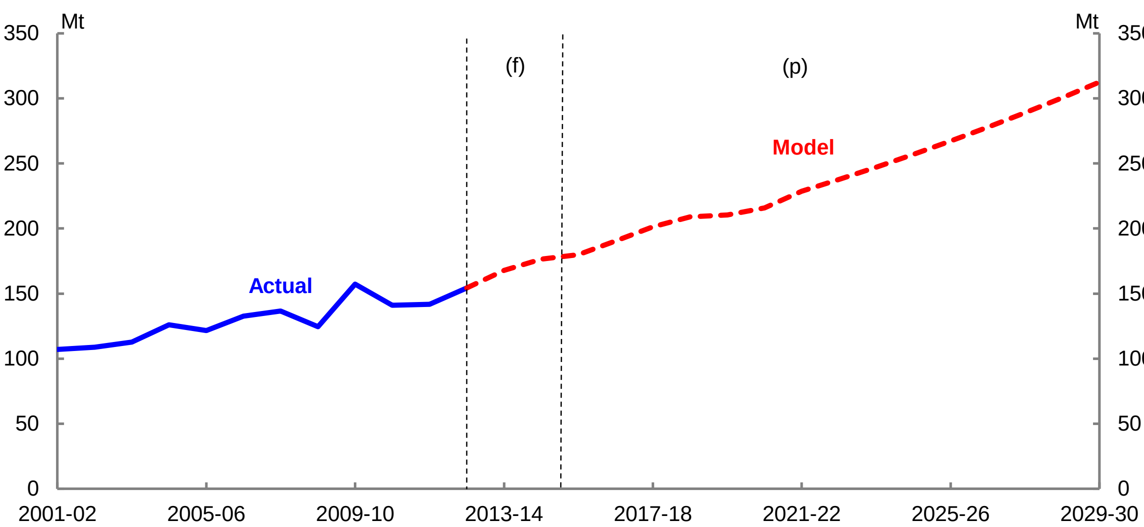
Source: Authors' calculations.

Chart 16: Australian metallurgical coal real unit export price forecast



Source: Authors' calculations.

Chart 17: Australian metallurgical coal export volume forecast



Source: Authors' calculations.

5. EXPORTS OF NON-RURAL BULK COMMODITIES: THERMAL COAL

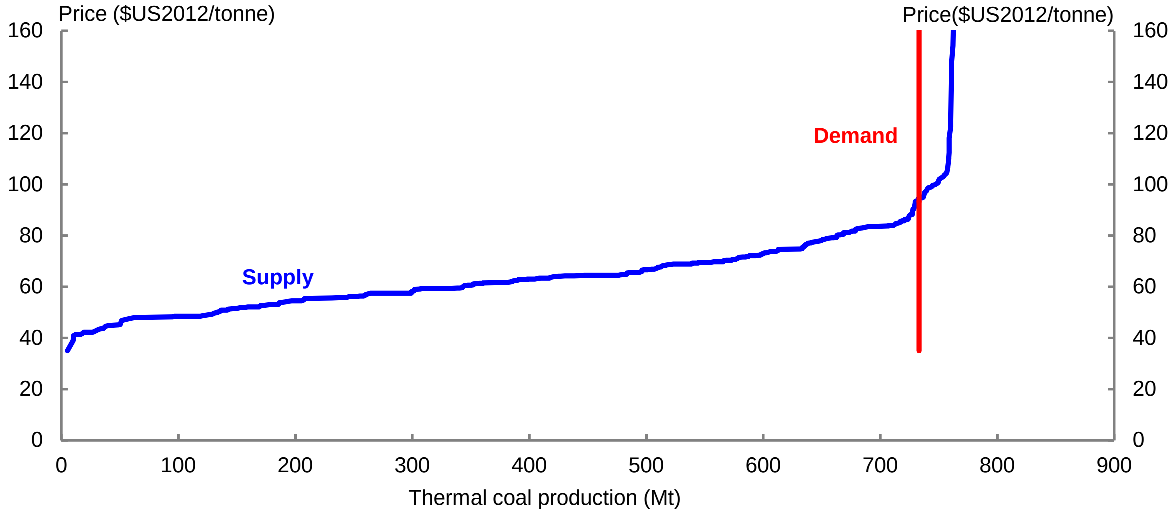
This section outlines the projection methodology for thermal coal export volumes and prices.

Analytical framework

Thermal coal volumes and prices are estimated using a global supply and demand approach similar to that used for iron ore and metallurgical coal. In the case of thermal coal it is assumed that the demand curve is perfectly inelastic with the level of demand based on seaborne trade forecasts reported by the International Energy Agency (IEA) (2012). Annual (calendar year) global trade forecasts are derived by the intersection of the vertical demand curve and an externally sourced empirical global trade cost curve (Chart 18). The Australian export volume forecast for thermal coal for a given year is the sum of Australian mine output with lower seaborne production costs than the forecast market clearing price.

This process is repeated each year which yields an export price and volume path for thermal coal for all years of available cost curve data.

Chart 18: Thermal coal demand and supply (2013)



Source: Authors' calculations based on data from Wood Mackenzie and International Energy Agency.

Data

Thermal coal supply

Thermal coal cost curves are sourced from Wood Mackenzie. The thermal coal cost curves are on an energy adjusted basis to simulate the costs of producing a standard Australian Newcastle type export thermal coal with a specific energy of 6322 kcal/kg. The total cash cost is a combination of a mine's operating cash costs plus royalties and levies. For seaborne exports, the total cash costs are estimated on a free-on-board (FOB) basis. Capital costs (either expansionary or sustaining) are not included in the cash cost estimate. To account for take-or-pay contracts, a declining percentage (linearly declining from 100 per cent to 0 over an eight year period starting from 2012) of existing Australian thermal coal producers are assumed to continue exporting thermal coal at negative cash cost if the market price is greater than their cash cost less transport costs.

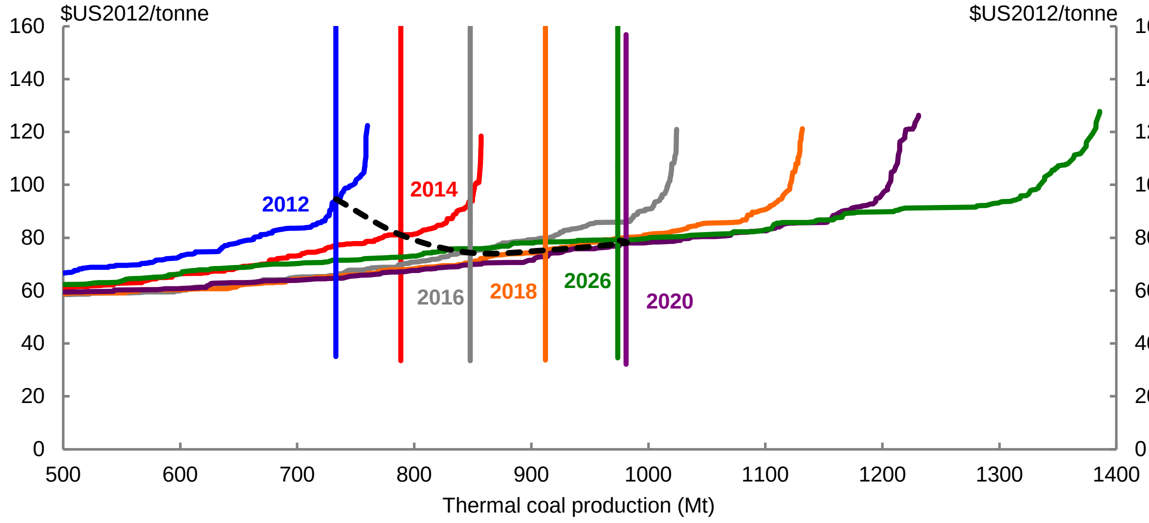
Thermal coal demand

Historical levels of global demand are calibrated to ensure they are consistent with actual price and export volume data and the global supply curve. These values are grown over the forecast period using forecasts of global seaborne thermal coal volumes reported in IEA (2012, Table 5.5). These data contain forecasts of international trade in thermal coal in 2010, 2020 and 2030 under three policy scenarios, with the *New Policy Scenario* assumed for the current analysis. Under this scenario, the volume of global thermal coal trade is expected to grow at an average annual rate of 3.7 per cent to 2020 and then decline slightly from 2020 to 2030 as recently introduced and planned policies to curb use take effect. Estimates of the implied thermal coal demand for years in between these published dates are constructed by growing demand for each of the intermediate years by the average annual growth rate over the interval.

Forecast

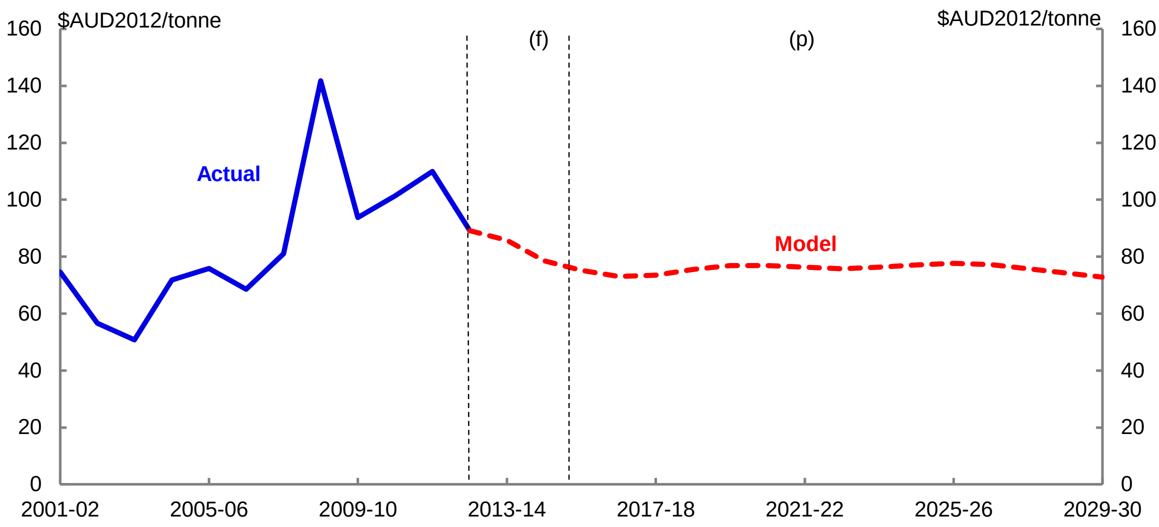
Chart 19 plots the thermal coal market demand and supply curves over the recent history (2012) and forecast and projection periods (2013 to 2026). The intersection of these curves provides global trade volume and price (expressed as a real price in 2012 US dollars) forecasts for thermal coal, which are then converted to Australian dollar unit export values (Charts 20 and 21). Note that the forecasts reported in the forecast period are generated by the global thermal coal model and are not necessarily the short-run forecasts underlying the 2013 PEFO.

Chart 19: Thermal coal demand and supply curves (forecast)



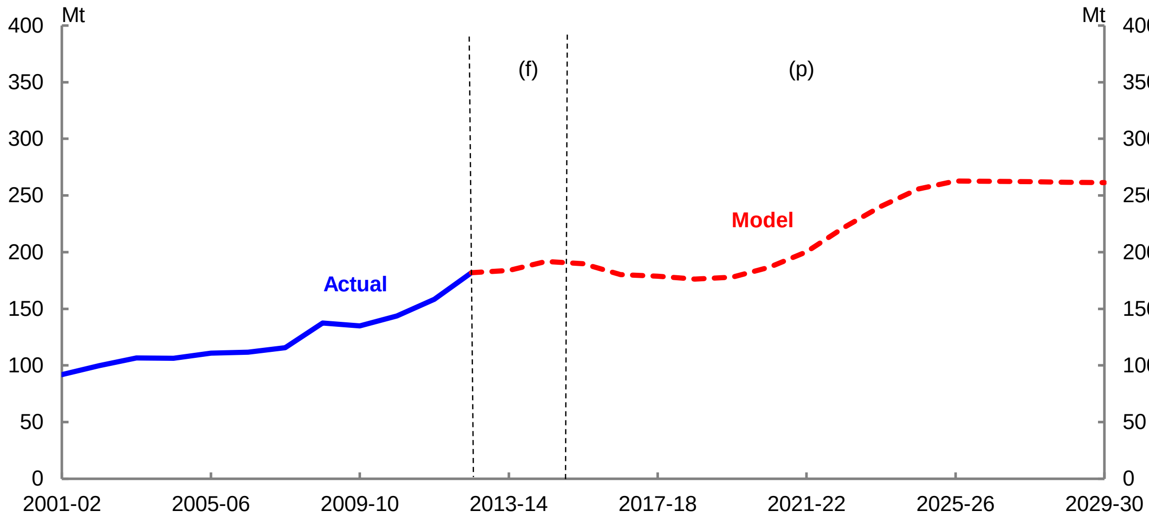
Source: Authors' calculations based on data from Wood Mackenzie and International Energy Agency

Chart 20: Australian thermal coal real unit export price forecast



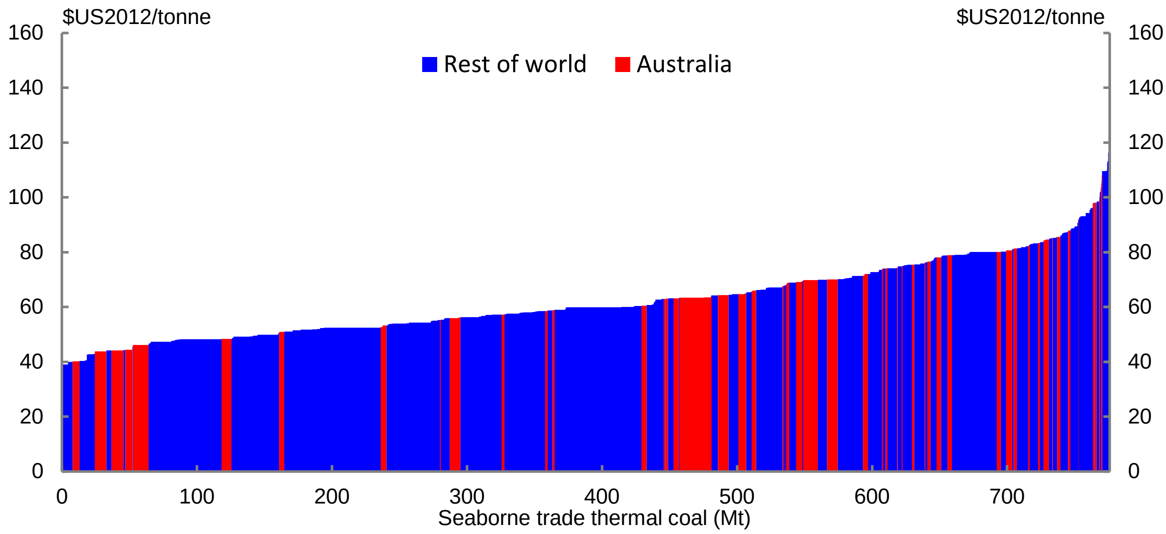
Source: Authors' calculations.

Chart 21: Australian thermal coal export volume forecast



Source: Authors' calculations.

Chart 22: Thermal coal cost curve (2013)



Source: Wood Mackenzie.

In a similar vein to the steel analysis, the thermal coal framework suggests supply will increase at a much faster rate than demand over the projection period. As with iron ore, demand is expected to intersect the interior of the supply curve by 2014 ending the recent period over which demand intersected the near-vertical section of the supply curve. The shift of production to the flatter section of the supply curve is expected to cause the real price of thermal coal to fall to around 2016-17, with real prices remaining roughly constant for the balance of the projection period. In contrast to iron ore and metallurgical coal, the thermal coal model forecasts relatively weak Australian exports volumes over the medium-run from 2015-16 to 2020-21. This reflects the non-trivial share of Australian production situated in the right tail of the thermal coal cost curve (Chart 22). Since global thermal coal demand is expected to grow at a slower rate than supply over the projection period, this suggests that Australian thermal coal export volumes may decrease at a time when Australian production capacity is increasing.

6. Exports of rural goods

Analytical framework and data

Following Treasury's short-run forecasting framework, rural goods are forecast using bottom-up volume and price analysis for each of the commodities within the four major ABS rural goods export categories: meat and meat preparations; cereal grains and cereal preparations; wool and sheepskins and other rural. For rural goods this involves forecasting 14 individual commodities, which are then aggregated using a weighted average of the growth in the individual commodities to forecast the relevant major ABS rural goods exports category (Table 6).

Prices and volumes for each of the 14 commodities rely heavily on published forecasts from the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES). Similar to Treasury's short-term rural goods exports forecasts, long-run projections of rural goods exports rely on the latest medium-run forecasts generated by ABARES. Rural goods exports volumes forecasts from 2015-16 to 2017-18 are drawn from ABARES (2013). Beyond this, forecasts are based on long-term modelling reported in ABARES (2011), with exceptions and assumed long-run growth rates reported in Table 7. Export price forecasts for the period from 2015-16 to 2016-17 are also sourced from ABARES (2013). Beyond 2017-18 rural export prices forecasts are not available, so prices are assumed to grow consistent with Treasury's projection period inflation assumption of 2.5 per cent. Given the aggregate import price forecast assumption, this implies constant relative rural export prices from 2017-18.

Table 6: ABS rural goods export categories (ABS cat. 5302.0)

Category	Commodity
Meat and meat preparations	Beef and veal Live cattle Lamb Live sheep Mutton
Cereal grains and cereal preparations	Wheat Coarse grains Oilseeds
Wool and sheepskins	Wool
Other rural	Cotton Butter Cheese Skim milk powder Whole milk powder

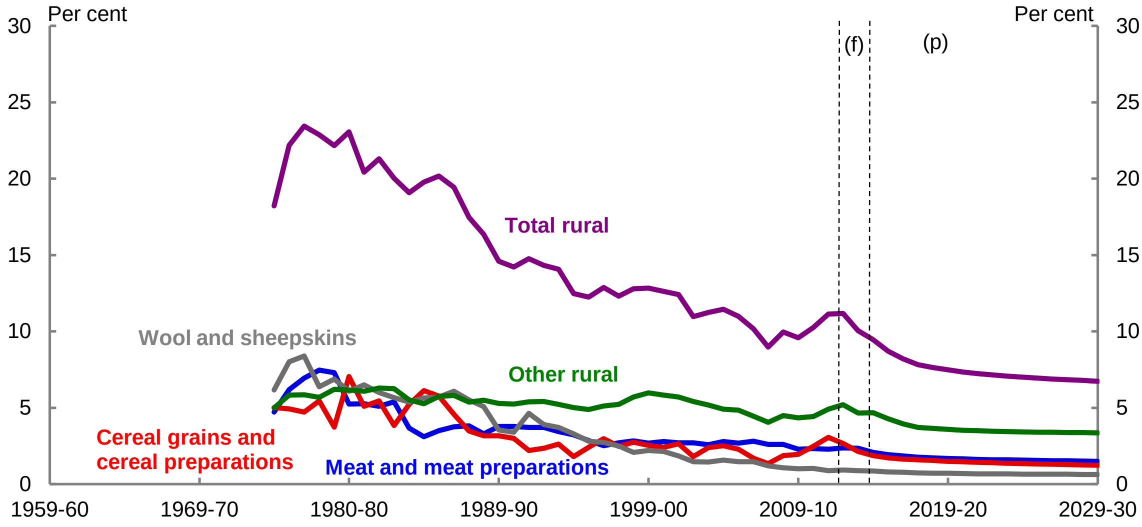
Table 7: Rural goods export volume forecast summary

Commodity	2015-16 to 2017-18	2018-19 to 2029-30	Long-run growth rate (per cent)
Beef and veal	ABARES (2013)	ABARES (2011)	1.5
Lamb and mutton	ABARES (2013)	ABARES (2011)	1.2
Pig meat	ABARES (2013)	ABARES (2011)	1.2
Poultry	ABARES (2013)	ABARES (2011)	1.0
Coarse Grains	ABARES (2013)	ABARES (2011)	0.8
Canola	ABARES (2013)	ABARES (2011)-Oil seed	0.7
Wheat	ABARES (2013)	ABARES (2011)	0.8
Wool	ABARES (2013)	ABARES (2011)	0.8
Cotton	ABARES (2013)	ABARES (2011)-Other crops	1.7
Sugar	ABARES (2013)	ABARES (2011)-Other crops	1.7
Wine	ABARES (2011)-Other crops	ABARES (2011)-Other crops	1.7
Butter	ABARES (2013)	20 year farm income growth rate	3.3
Cheese	ABARES (2013)	20 year farm income growth rate	3.3
Casein	20 year farm income growth rate	20 year farm income growth rate	3.3

Forecast

Expressed as a share of the total volume of exports, rural exports are expected to decline over the projection period from around 10 per cent to 7 per cent of total exports (Chart 23). This suggests rural goods prices will have a smaller influence on the overall terms of trade over the projection period. Turning to the major rural goods export categories, the framework suggests the composition of the rural export basket will remain roughly constant over the projection period, with exports of all major rural goods categories declining as a share of total exports.

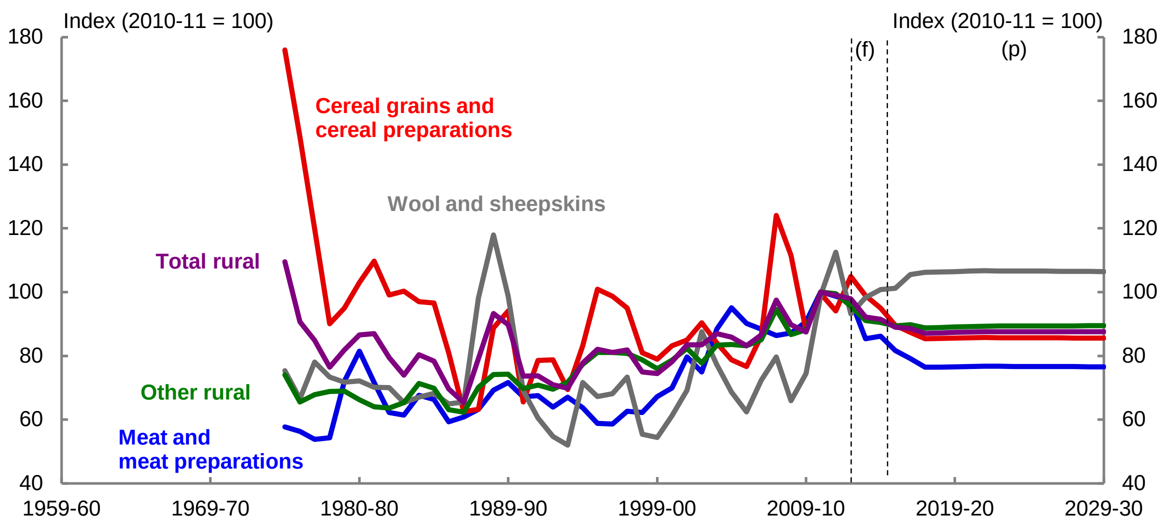
Chart 23: Export shares — rural goods



Source: Authors' calculations.

The relative price of total rural goods exports is expected to fall until 2017-18, when it is expected to settle above its historical average (Chart 24). This reflects a fall in the relative prices of meat, cereal and other rural exports and a less than offsetting rise in the relative export price of wool.

Chart 24: Relative export prices — rural goods



Source: Authors' calculations.

7. Exports of non-rural commodities

Analytical framework and data

Non-rural commodities are divided into bulk commodities (i.e., iron ore, metallurgical coal and thermal coal) discussed above and non-bulk commodities (i.e., metals, minerals, ores and fuels, excluding the bulk commodities). Following Treasury's short-term forecasting framework, each of the 16 non-bulk commodity prices and volumes are forecast using a bottom-up approach. Prices and volumes for each of these commodities rely heavily on publicly available forecasts from credible public and private forecasters who have expertise in forecasting the specific commodities. Where forecasts are not available a conservative assumption is applied.

Non-rural non-bulk exports volumes forecasts to 2017-18 are drawn from the Bureau of Resources and Energy Economics (BREE) outlook (BREE, 2013). There is no externally sourced forecast available for non-rural non-bulk commodities volumes beyond 2017-18. With the exception of liquefied natural gas (LNG), volumes are forecast to grow at their 10 year historical average annual growth rate (see Table 8 for a summary of the export volume forecast assumptions and sources). LNG volumes forecasts are based on BREE (2012).

With the exception of LNG, non-rural non-bulk export prices forecasts to 2022-23 are drawn from the mean forecasts reported in the most recent Consensus Economics (2013). Prices beyond 2022-23 are assumed to grow consistent with Treasury's projection period expenditure price inflation assumption of 2.5 per cent (see Table 9 for a summary of the export price forecast assumptions and sources). Given the aggregate import price forecast assumption, this implies constant relative non-rural non-bulk export prices from 2022-23. LNG price forecasts are based on IEA (2012, Table 1.4).

Table 8: Non-rural commodities export volume forecast summary

Commodity	2014-15 to 2017-18	2018-19 to 2029-30	Long-run growth rate (per cent)
Alumina	BREE (2013)	10 year average	2.2
Bauxite	BREE (2013)	10 year average	5.8
Copper ores and concentrates	BREE (2013)	10 year average	3.1
Iron ore and concentrates	See Section 4		
Lead ores and concentrates	BREE (2013)	10 year average	1.8
Nickel ores and concentrates	BREE (2013)	10 year average	7.7
Uranium ores and concentrates	BREE (2013)	10 year average	-3.3
Zinc ores and concentrates	BREE (2013)	10 year average	2.2
Metallurgical coal	See Section 4		
Thermal coal	See Section 5		
Crude oil	BREE (2013)	10 year average	-0.8
Liquefied natural gas (LNG)	BREE (2013)	BREE (2012)-low	2.8
Liquefied petroleum gas (LPG)	BREE (2013)	5 year average	-3.8
Aluminium	BREE (2013)	10 year average	0.8
Copper	BREE (2013)	10 year average	-2.3
Lead	10 year average	10 year average	-1.1
Nickel	BREE (2013)	10 year average	-11.4
Zinc	BREE (2013)	10 year average	-1.6
Iron and steel	BREE (2013)	10 year average	-8.6
Gold	BREE (2013)	10 year average	0.8

Finally, individual forecasts of bulk and non-bulk commodities are combined to generate volume and price forecasts for the five ABS non-rural commodity export categories: metal ores and minerals; coal, coke and briquettes; other mineral fuels; metals excluding non-monetary gold; and non-monetary gold (Table 10). Forecasts of these export categories are further aggregated to yield total non-rural commodity export volume and price forecasts.

Table 9: Non-rural commodities export price forecast summary

Commodity	2015-16 to 2022-23	2023-24 to 2029-2030
Alumina	Consensus	2.5 per cent
Bauxite	Alumina growth rate	Alumina growth rate
Copper ores and concentrates	Copper growth rate	Copper growth rate
Iron ore and concentrates	See Section 4	
Lead ores and concentrates	Lead growth rate	Lead growth rate
Nickel ores and concentrates	Nickel growth rate	Nickel growth rate
Uranium ores and concentrates	Consensus	2.5 per cent
Zinc ores and concentrates	Zinc growth rate	Zinc growth rate
Metallurgical coal	See Section 4	
Thermal coal	See Section 5	
Crude oil	Consensus	2.5 per cent
Liquefied natural gas (LNG)	IEA (2012)	IEA (2012)
Liquefied petroleum gas (LPG)	Crude oil growth rate	Crude oil growth rate
Aluminium	Consensus	2.5 per cent
Copper	Consensus	2.5 per cent
Lead	Consensus	2.5 per cent
Nickel	Consensus	2.5 per cent
Zinc	Consensus	2.5 per cent
Iron and steel	Consensus	Zinc growth rate
Gold	Consensus	2.5 per cent

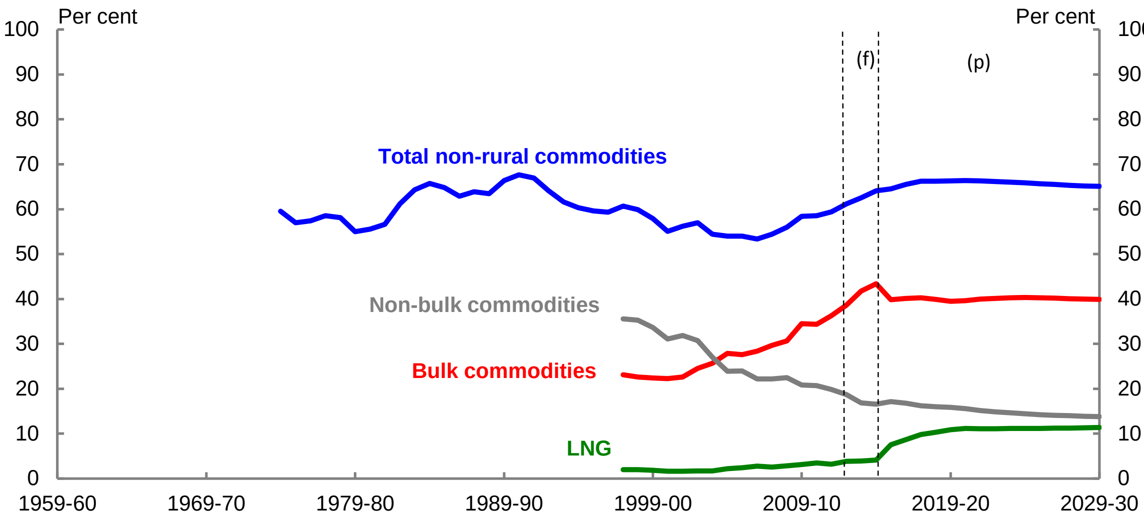
Table 10: ABS non-rural commodity export categories (ABS cat. 5302.0)

ABS Category	Commodity
Metal ores and minerals	Alumina Bauxite Copper ores and concentrates Iron ore and concentrates Lead ores and concentrates Zinc ores and concentrates Nickel ores and concentrates Uranium ores and concentrates
Coal, coke and briquettes	Metallurgical coal Thermal coal
Other mineral fuels	Crude oil and condensate Liquefied natural gas (LNG) Liquefied petroleum gas (LPG)
Metals (excl. non-monetary gold)	Aluminium Copper Iron and Steel Lead Zinc
Non-monetary gold	Gold

Forecasts

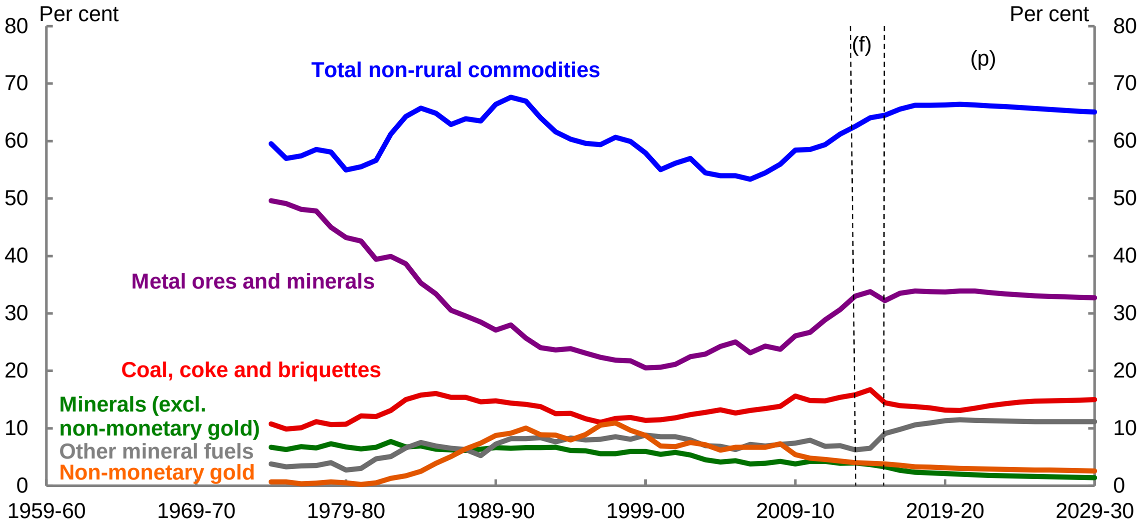
The volume of non-rural commodities as a share of total exports is expected to rise until 2017-18 and then remain roughly constant (Charts 25 and 26). Underlying this rising share are rapidly increasing volumes of LNG exports, increasing iron ore and metallurgical coal volumes and relatively flat thermal coal volumes. LNG's share of the total exports volume is expected to more than double from 5 per cent in 2014-15 to around 12 per cent in 2020-21.

Chart 25: Export shares — non-rural bulk and non-bulk commodities



Source: Authors' calculations.

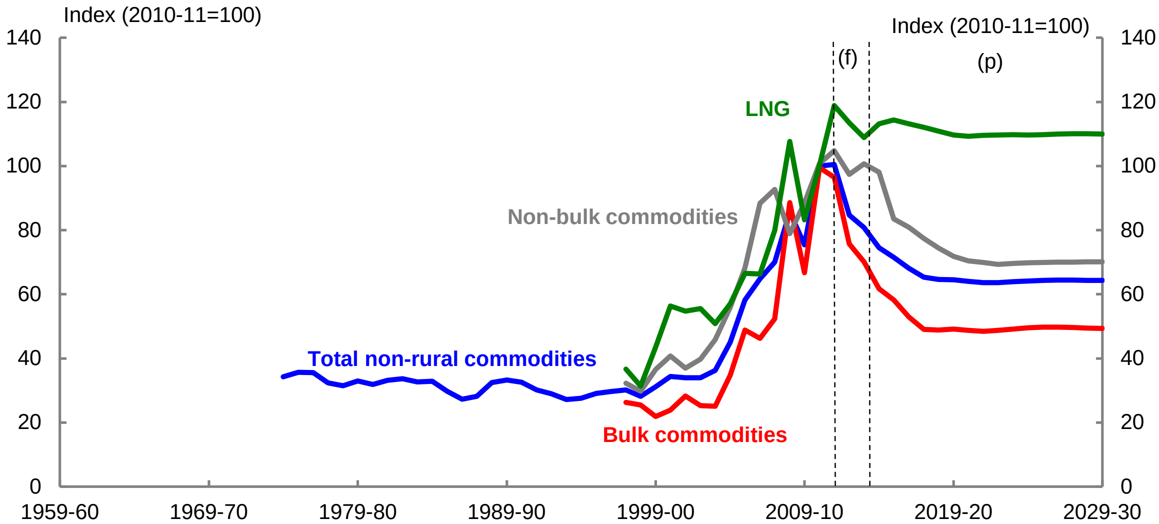
Chart 26: Export shares — ABS non-rural commodity categories



Source: Authors' calculations.

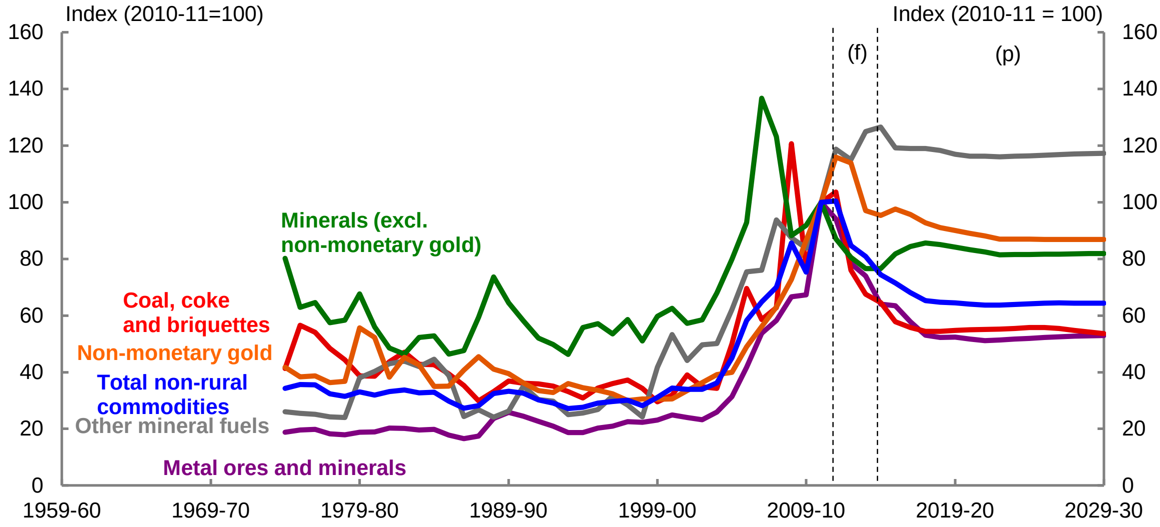
Charts 27 and 28 suggest that the decline in non-rural commodities export prices is primarily driven by the projected decline in bulk commodity prices until 2017-18. These relative prices are expected to settle at levels somewhat above the historical levels before the start of the resources boom (pre 2003-04). This change largely reflects rising real production costs for bulk commodities.

Chart 27: Relative export prices — non-rural bulk and non-bulk commodities



Source: Authors' calculations.

Chart 28: Relative export prices — ABS non-rural commodity categories

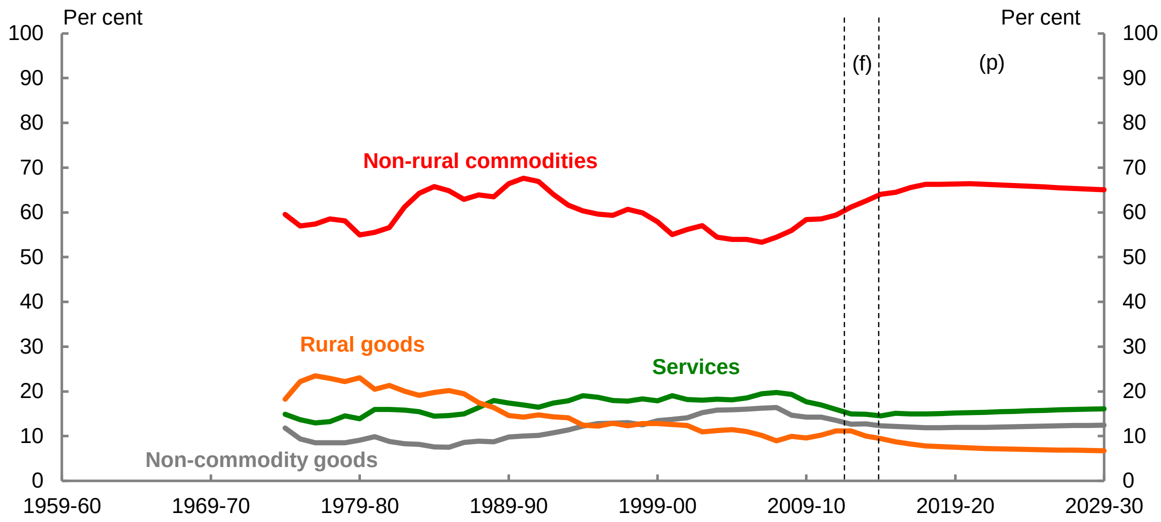


Source: Authors' calculations.

8. Terms of trade

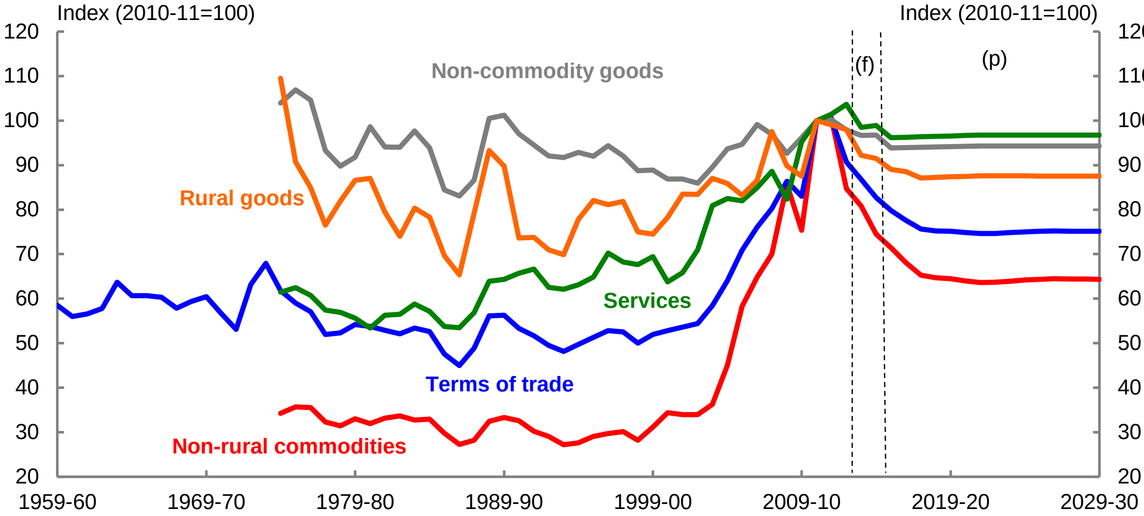
The terms of trade can be thought of as a weighted average of the price of export categories relative to the aggregate import price level, with weights equal to the export shares of the export categories. Combining the results of earlier sections, the export share of non-rural commodities is expected to rise over the forecast period and early part of the projection period, while the export share of rural goods is expected to decline over the forecast and projection period (Chart 29).

Chart 29: Export shares — broad export category



Source: Authors' calculations.

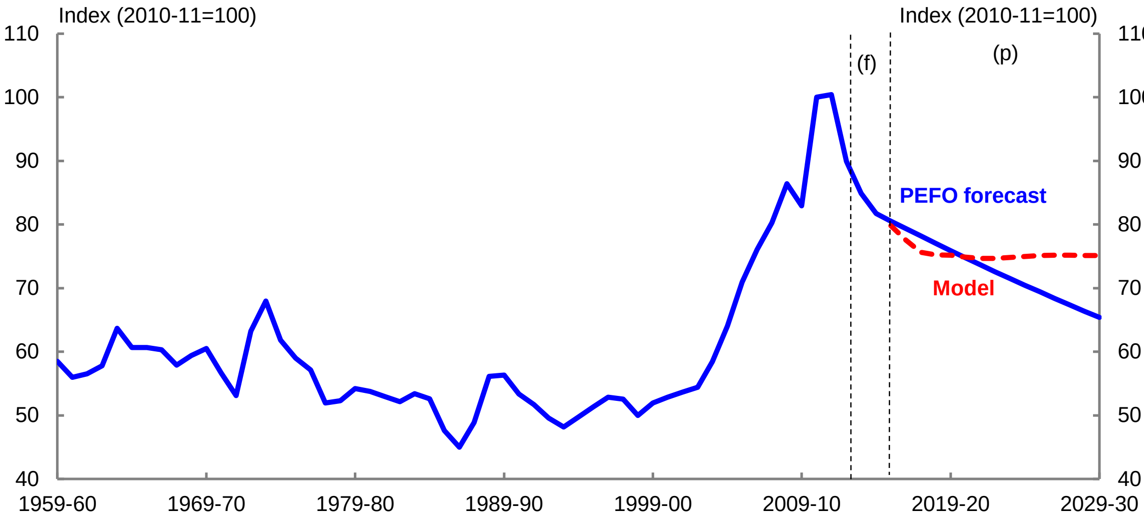
Chart 30: Relative export prices — broad export category



Source: Authors' calculations.

The relative export prices of all broad export categories are expected to decline until around 2017-18 and remain roughly constant over the balance of the projection period, with the relative price of non-rural commodity exports expected to have the largest fall (Chart 30). Overall, the terms of trade are expected to fall from 2012-13 to 2017-18 and then remain reasonably constant at a level roughly equal to that recorded in 2006-07. Given its export share of around 65 per cent and the size of the expected decline in its relative price, the main cause of the projected fall in Australia's terms of trade is the forecast decline in the relative price of non-rural commodity exports, which is largely driven by the fall in the relative prices of bulk commodities.

Chart 31: Long-run terms of trade forecast



Source: Authors' calculations.

Chart 31 reveals that the new framework predicts a more rapid decline in the terms of trade than predicted at the time of the 2013 PEFO. In particular, the model predicts a fall of around 16 per cent from 2012-13 to 2017-18, which compares with the 2013 PEFO terms of trade decline of 13 per cent over the same period.

Finally, as noted in the 2013-14 MYEFO, there are a number of downside risks to this outlook including uncertainty around the global economy, the nominal exchange rate and non-bulk commodity price forecasts (see Appendix A for details). Applying prudent judgement to the model's outcome results in a long–run terms of trade that settles at the level observed in 2005-06 by 2019-20.

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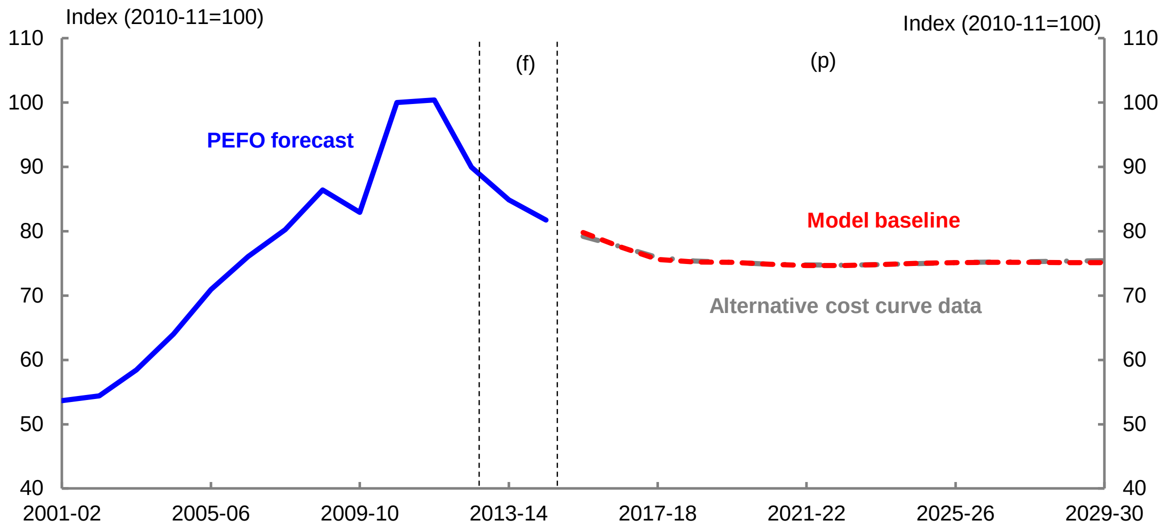
APPENDIX A: SENSITIVITY ANALYSIS

This appendix explores the sensitivity of the baseline model forecast of the terms of trade to alternative assumptions.

Alternative metallurgical and thermal coal cost curves

This sub-section explores the sensitivity of the terms of trade forecast to the use of alternative coal cost curve data sourced from Analyst-B, which have different coverage of both metallurgical and thermal coal seaborne production. These alternative coal cost curves were scaled using the methods described above, which produced virtually identical steel intermediate input and thermal coal supply curves. The resulting bulk commodity real unit value and export volume forecast based on these data are therefore very similar to those projected by the Wood Mackenzie data, which is reflected in the almost identical terms of trade forecast reported in Chart 32.

Chart 32: Terms of trade using alternative coal cost curve data



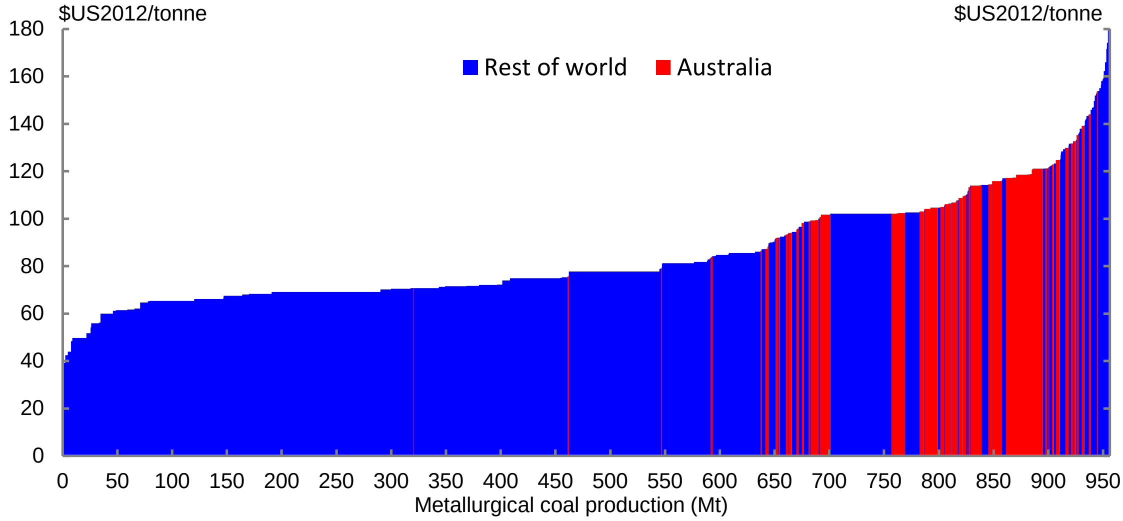
Source: Authors' calculations.

Variation in the global demand for steel

Cost curve data suggest Australian producers are situated around the middle of the iron ore cost curve and at the upper end of the metallurgical coal cost curve (Chart 33). Australian metallurgical coal export volumes are therefore expected to be sensitive to variations in the global demand for steel.

In this sub-section we explore the sensitivity of the terms of trade forecast to variation in industrial production (IP) which is the only exogenous input to steel demand. We test the sensitivity of the long-run terms of trade to variations in the global IP forecasts by varying the level of global IP over the projection period by a constant proportion ranging from -20 to +20 per cent.

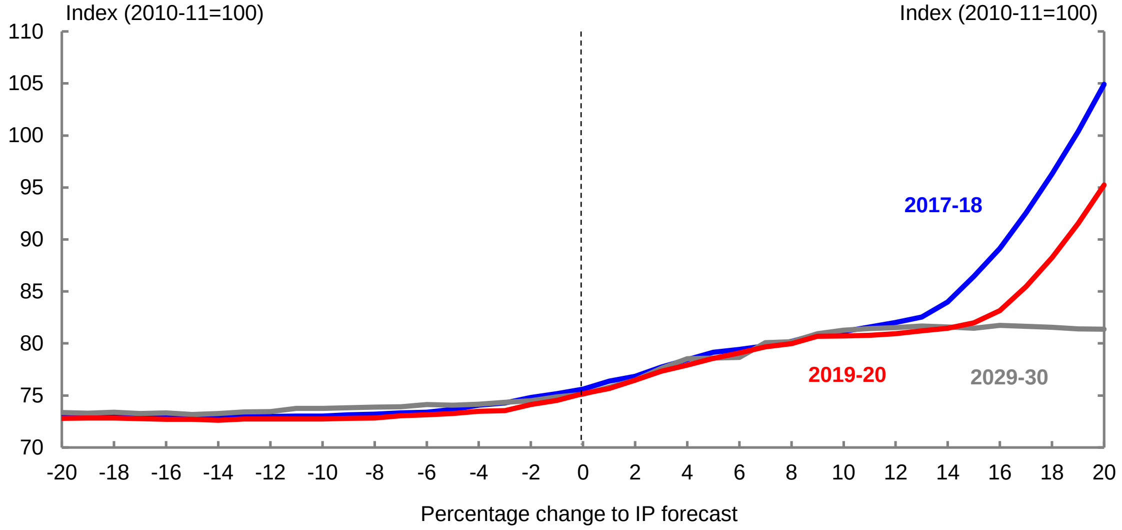
Chart 33: Metallurgical coal cost curve (2013)



Source: Wood Mackenzie.

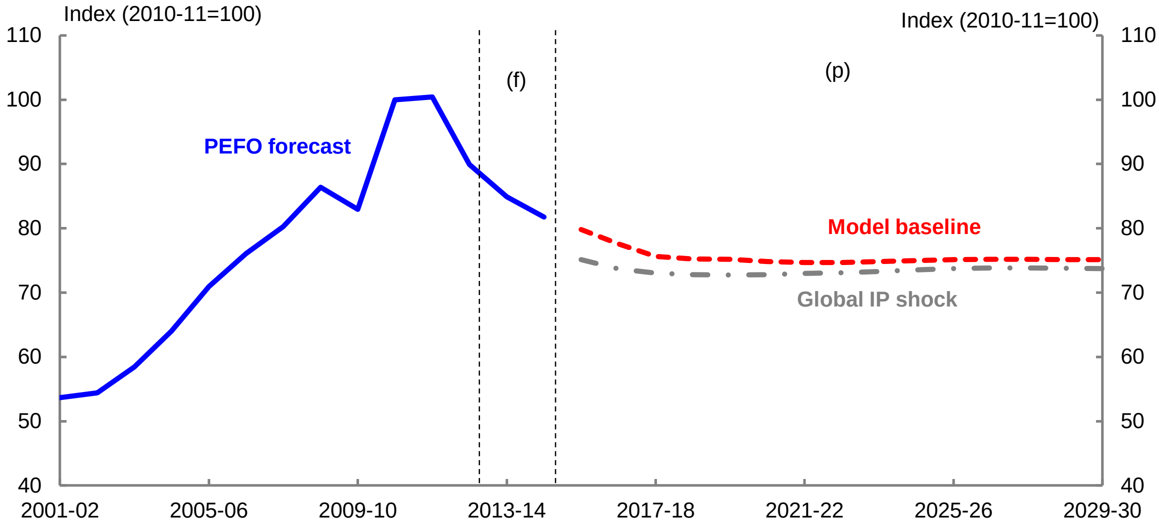
Chart 34 reveals that there are both price and volume effects associated with a change in steel demand. These effects are partially offsetting for both decreases and increases in IP. For example, a 10 per cent decrease in the forecast level of IP causes the projected iron ore price to be 25 per cent lower and the projected metallurgical coal price to be 11 per cent lower in 2019-20, while Australian exports volumes are projected to be 8 per cent lower for iron ore and 30 per cent lower for metallurgical coal. Since iron ore and metallurgical coal are the key commodities underlying the expected fall in the terms of trade and the prices of those commodities lie below all other relative prices, a decline in their export share partially offsets the fall in their relative price, leading to a terms of trade only 3 per cent lower in 2019-20 (Chart 35).

Chart 34: Sensitivity of long-run terms of trade forecasts to global IP forecast



Source: Authors' calculations.

Chart 35: Terms of trade assuming 10 per cent weaker global IP



Source: Authors' calculations.

Finally, it is important to emphasise that this analysis does not represent a comprehensive sensitivity analysis of the impact of a reduction in global IP on the terms of trade because a reduction in global IP would likely cause a decrease in the both the relative price and volume of all of the export categories, which would imply a greater fall in the terms of trade than reported here.

Comparison with other bulk commodity forecasters

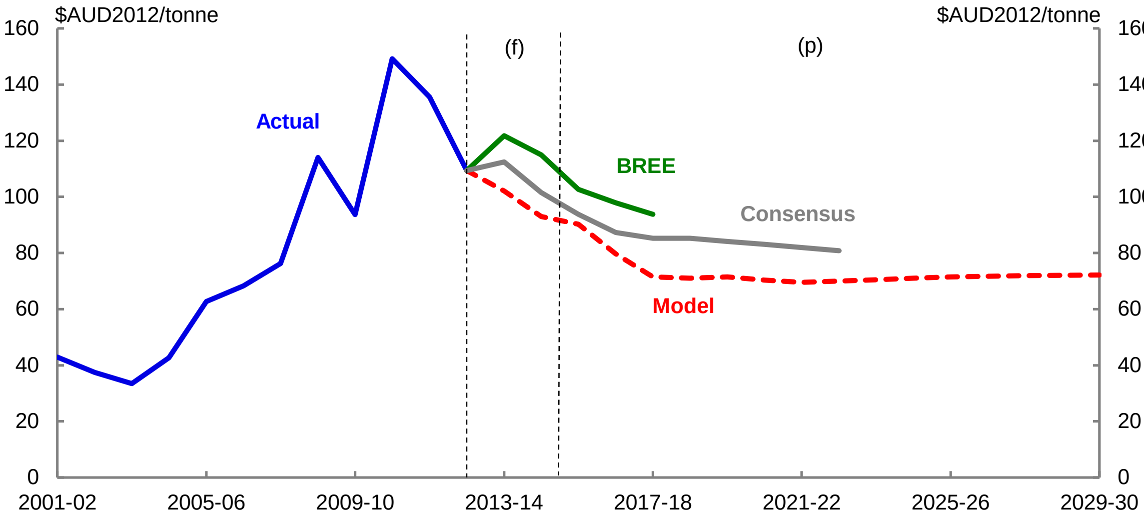
In this sub-section we explore the sensitivity of the terms of trade forecast to alternative bulk commodity price and volume forecasts from BREE (2012 and 2013) and Consensus Economics (2013).

The effect on the terms of trade from using BREE's price and volume forecasts of iron ore, metallurgical coal and thermal coal is shown in Charts 36 to 41. BREE (2013) provides price and volume forecasts until 2017-18. BREE volumes from 2018-19 are based on BREE (2013) 2017-18 forecasts and export growth rates implied by BREE (2012). In the case of iron ore and metallurgical coal we find that BREE's volume forecasts are roughly similar to those generated by the global demand and supply models, while its real unit export prices lie above those generated by the global supply and demand model. In the case of thermal coal, BREE predicts much higher export volumes, but similar real unit export prices over the projection period. The resulting terms of trade profile from the BREE bulk commodity forecasts lies above that generated by the Treasury model (Chart 42).

One possible explanation for the differences between BREE's and the Treasury's bulk commodity forecasts is that BREE's more detailed analysis incorporates freight costs, while the more stylised global demand and supply models employed here do not. Australian exporters are closer to Asian importing countries than many competitors, which suggests Australian exporters have a competitive advantage on freight costs. Preliminary analysis suggests that taking this geographic advantage into account would likely lead to slightly higher volumes and prices of Australian bulk exports than predicted by the global demand model.

Next we consider the effect on the terms of trade of using the Consensus price forecasts for iron ore, metallurgical coal and thermal coal to 2022-23, which is the end of the Consensus forecast horizon (Charts 36, 38 and 40). Consensus does not provide volume forecasts so this sensitivity analysis uses the same volume forecasts as those presented above using the supply and demand framework. Consensus forecasts of bulk commodity prices lie above those generated by the steel and thermal coal demand and supply models, so it follows that the terms of trade profile generated using Consensus price forecasts is higher than the model based forecast (Chart 42). It is also the case that the Consensus profile is very similar to that derived from BREE bulk-commodity inputs up to 2017-18. Unlike the model based forecast, the Consensus profile suggests the terms of trade will continue to fall after 2017-18.

Chart 36: Australian iron ore real unit export price forecasts



Source: Authors' calculations.

Chart 37: Australian iron ore export volume forecasts

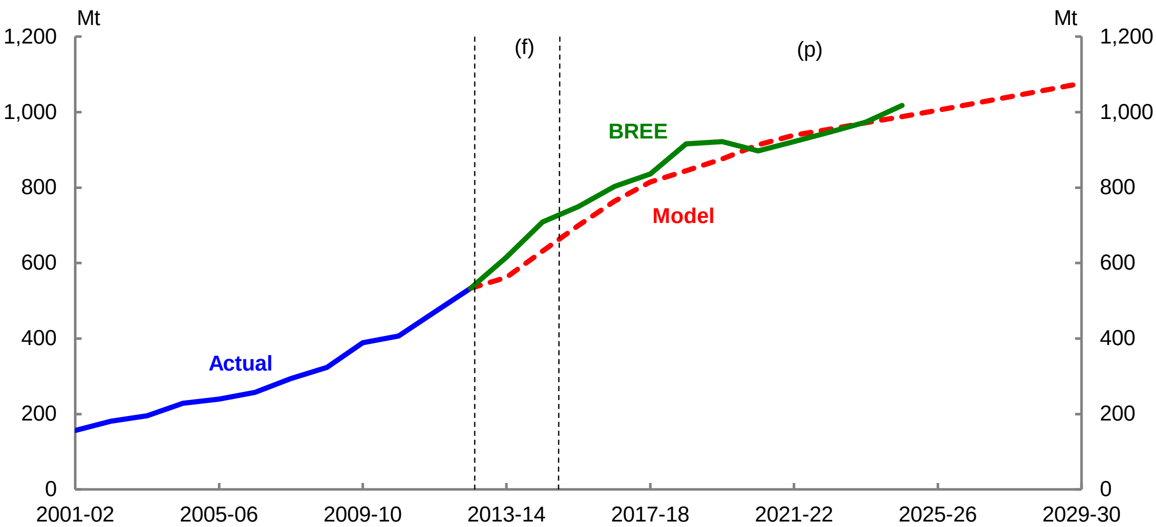


Chart 38: Australian metallurgical coal real unit export price forecasts

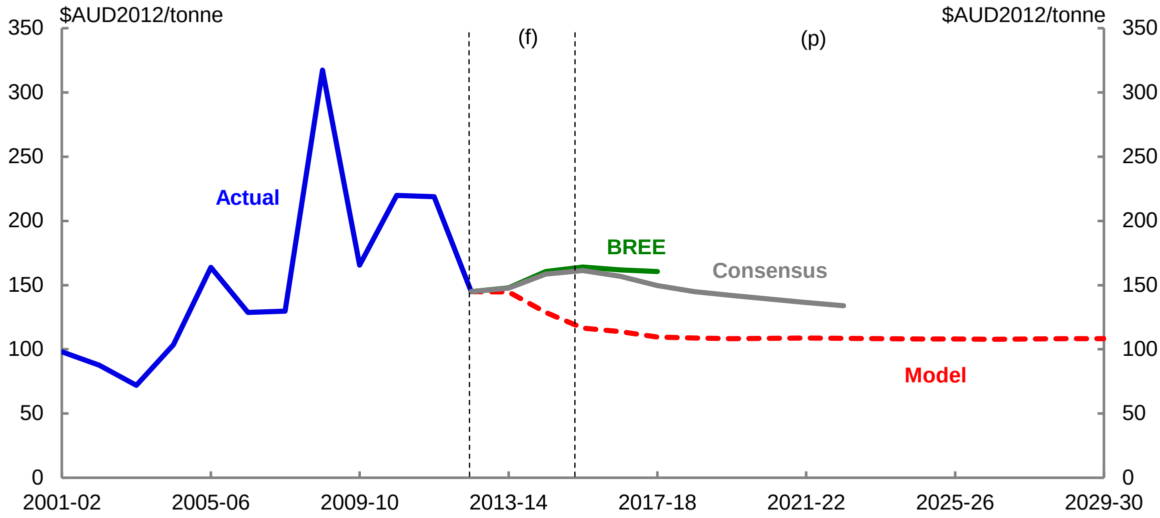
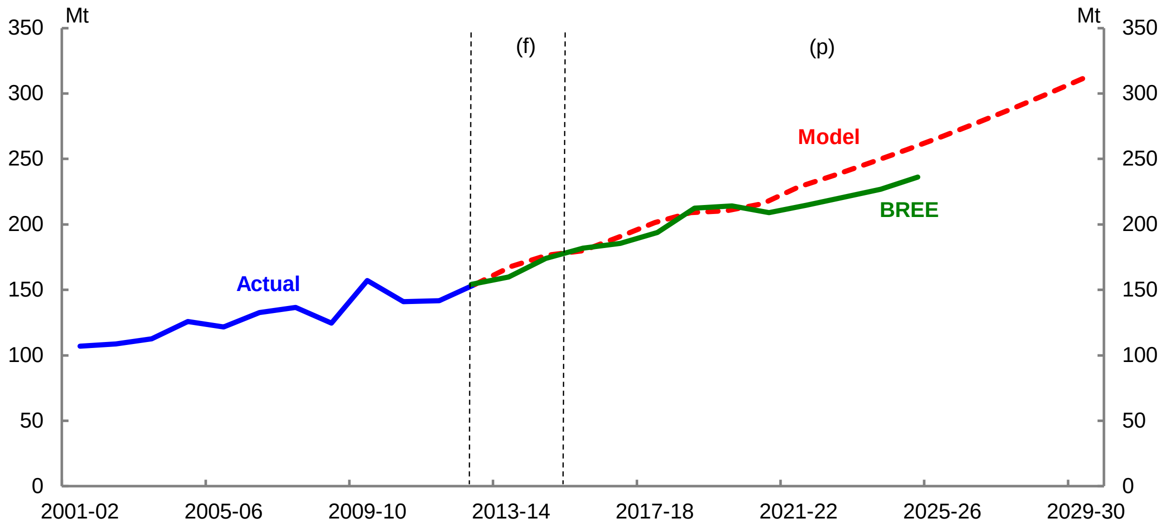


Chart 39: Australian metallurgical coal export volume forecasts



Source: Authors' calculations.

Chart 40: Australian thermal coal real unit export price forecasts

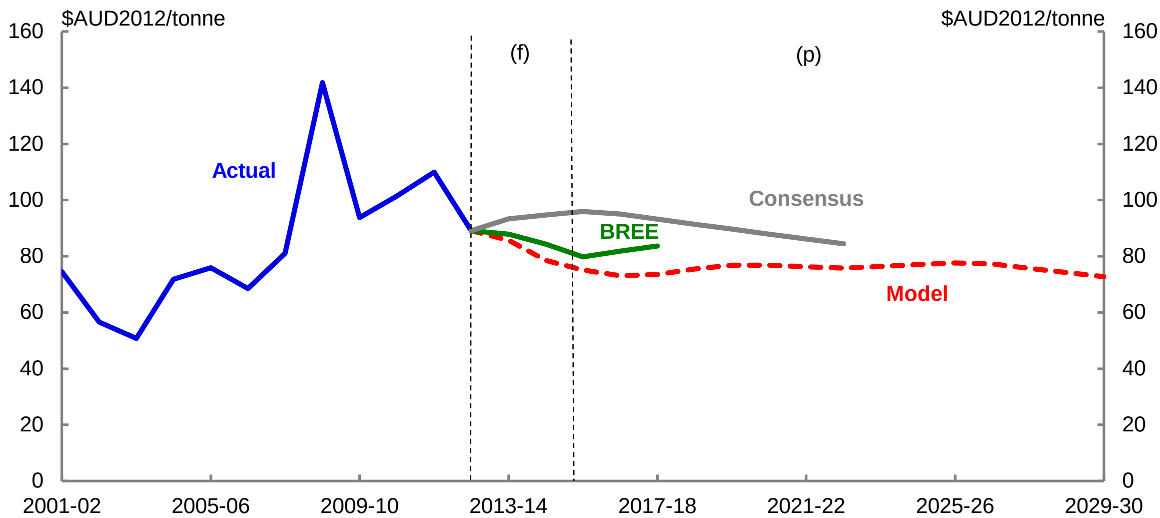


Chart 41: Australian thermal coal export volume forecasts

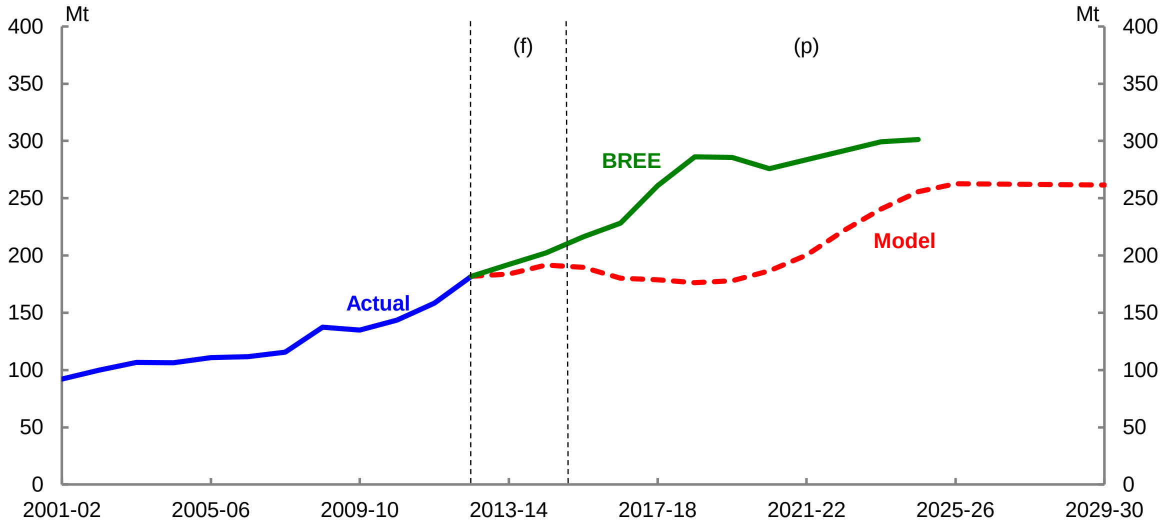
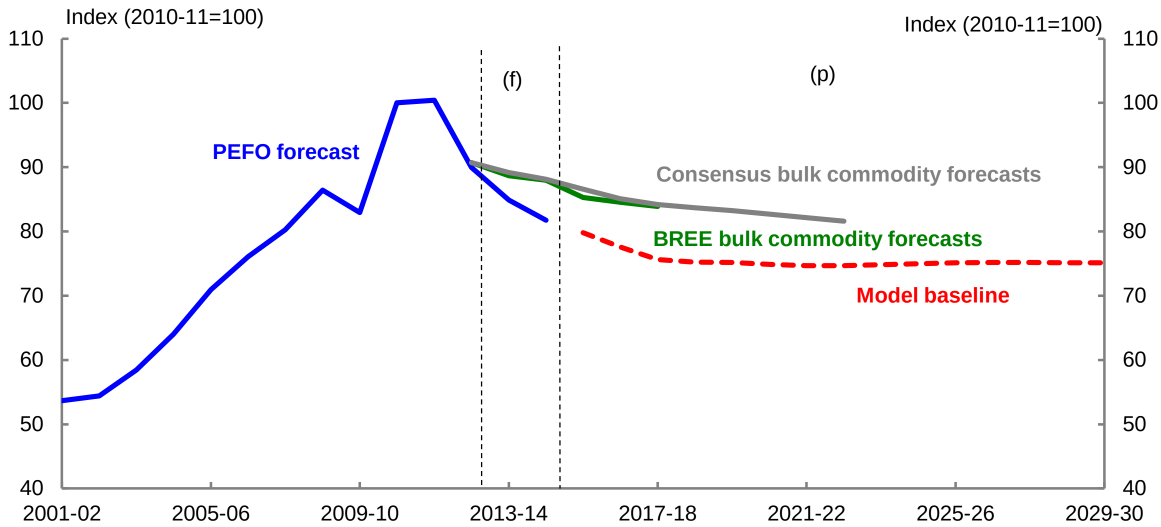


Chart 42: Terms of trade using external bulk commodity forecasts



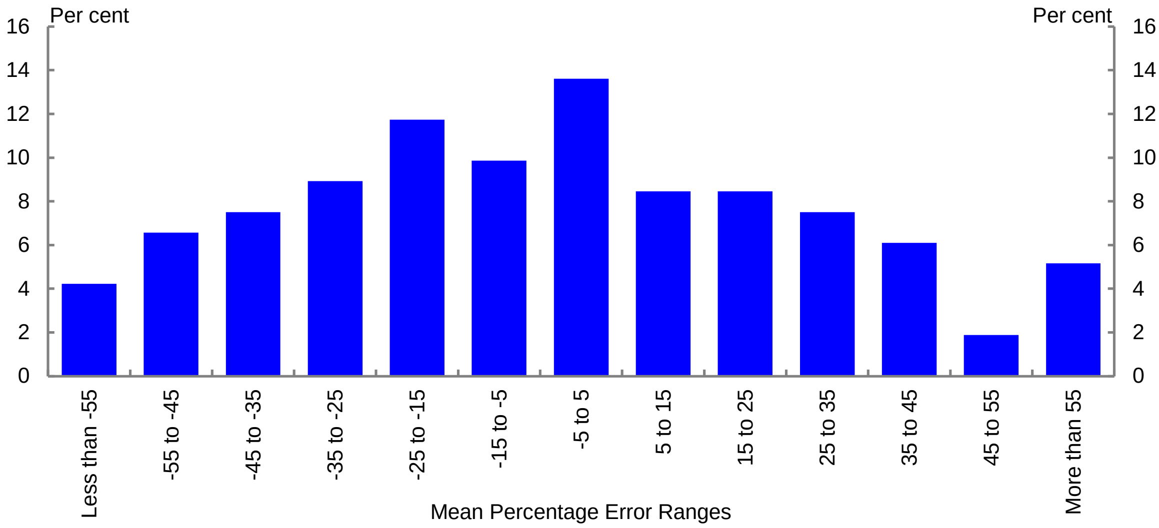
Source: Authors' calculations.

Non-rural non-bulk price forecasts

An analysis of the historical forecast accuracy of Consensus forecasts over the period from June 2005 to June 2013 finds a mean absolute percentage error of 28.9 per cent over a 10 quarter forecast horizon (there are not enough data to assess the accuracy of the Consensus long-run forecasts used for the terms of trade projection, but the accuracy of their 10 quarter ahead forecasts provides some guide to the accuracy of their longer-run forecasts). This high mean absolute percentage error reflects the difficulty in forecasting commodity prices, which are highly volatile.

While Consensus forecasts have a high absolute percentage error, there is limited evidence of systematic bias in the direction of its errors. Overall, the mean percentage error for its forecasts of non-rural non-bulk commodities is -2.6 per cent over a 10 quarter forecast horizon, suggesting a slight conservative bias over the historical time period. Over a 10 quarter time horizon, Consensus forecasts on average overestimated the price of 5 commodities and underestimated the price of 5 commodities. Therefore, while Consensus forecasts have a high mean absolute percentage error, positive forecast errors for some commodities have tended to be offset by negative forecast errors for other commodities. This is demonstrated in Chart 43, which shows the distribution of quarterly consensus forecasting errors over a 10 quarter forecast horizon for the 10 commodities over the 6 year sample period 2005-2011 (creating 213 observations).

Chart 43: Distribution of Consensus forecasts mean percentage errors

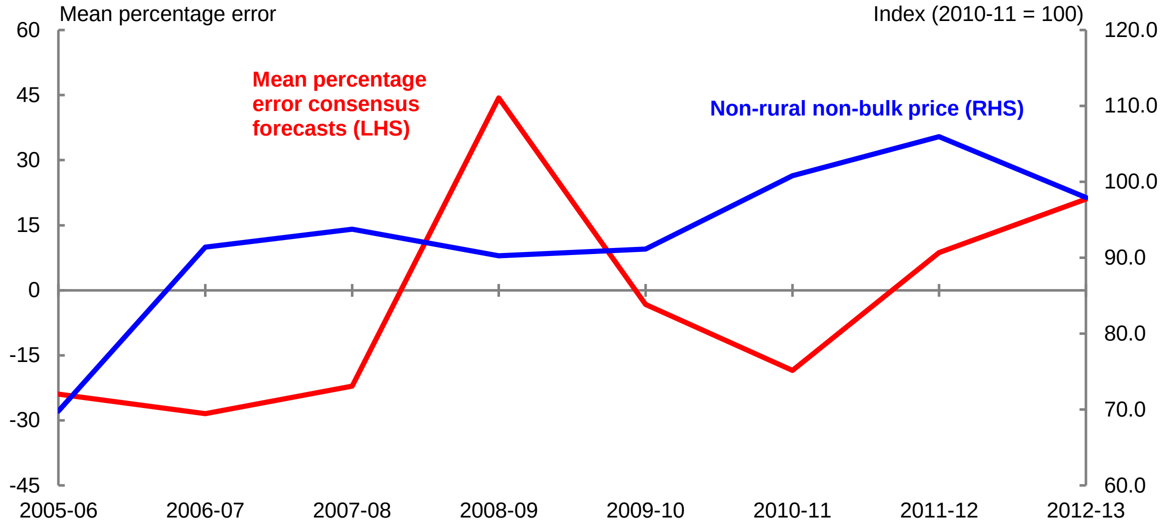


Source: Authors' calculations.

While there is little evidence of significant directional bias in Consensus forecasts over the entire sample period, since 2007-08 the Consensus forecasts have tended to overestimate prices over a period where prices have both risen and fallen, including over the last two years, when prices have been falling (Chart 44). This contrasts with the period from 2005-06 to 2007-08 over which Consensus forecasts tended to have a conservative bias over a period where prices were rising. It is likely that Consensus forecasts are slow to adapt to changes in prices, with Consensus forecasts remaining relatively high after a price fall and low after a price rise.

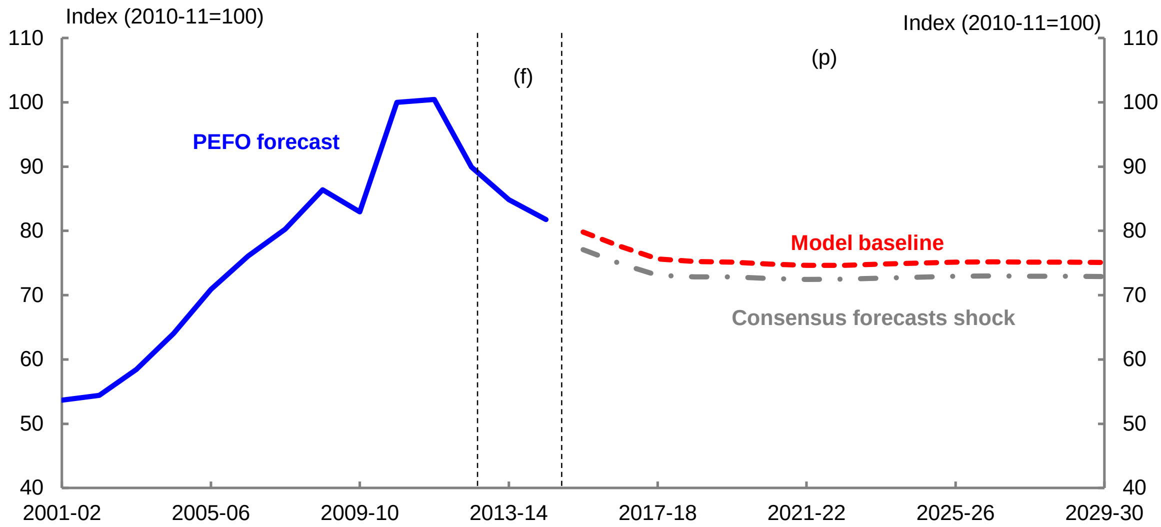
Based on the recent positive bias in Consensus price forecasts, we assess the effect on the terms of trade of Consensus forecasts for the non-rural non-bulk commodities that were systematically over-estimated by 20 per cent. Non-rural non-bulk commodities excluding LNG make up around 15 per cent of total export volumes. A 20 per cent reduction in the price of non-rural non-bulk commodities excluding LNG relative to import prices would therefore lead the terms of trade to be around 3 per cent lower (Chart 45).

Chart 44: Consensus mean percentage errors and non-rural non-bulk prices



Source: Authors' calculations.

Chart 45: Terms of trade assuming weaker Consensus price forecast



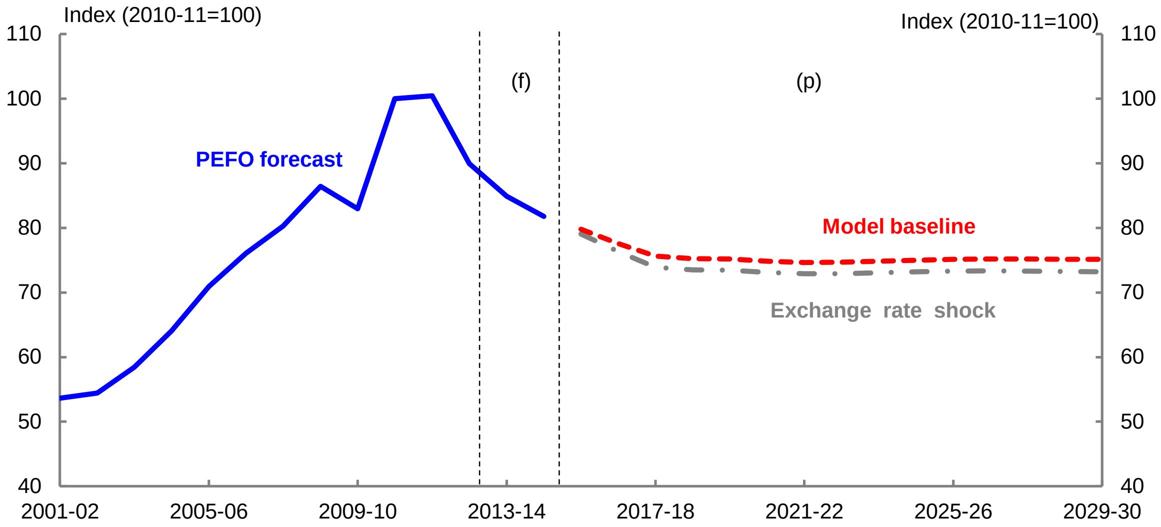
Source: Authors' calculations.

Exchange rate pass-through

The analysis to this point has assumed full pass-through of changes in the nominal exchange rate to import and export prices which implies no effect on the terms of trade from exchange rate fluctuations. While this assumption is true for rural goods export prices and non-rural commodities export prices, because they are almost entirely denominated in foreign currency terms, it need not be true for non-commodity goods and services because their prices depend on both domestic and foreign costs. In particular, domestic costs, especially labour costs, are typically nominally sticky downward, so falling foreign costs are not typically matched by falling domestic costs. However, the reverse is likely to be the case, with higher foreign costs typically leading to higher domestic labour costs, and non-commodity goods and services prices.

In light of Gruen and Wilkinson's (1994) analysis of real exchange rates, Australia's worsening terms of trade are expected to lead to a further depreciation of Australia's real exchange rate over the projection period (beyond that assumed in the short-run 2013 PEFO forecast), which implies rising foreign input costs (i.e., higher import prices). Therefore, we test the sensitivity of the terms of trade forecast to the complete pass-through assumption by considering an extreme case of no pass-through of rising foreign input costs to domestic labour costs following a depreciation of the nominal exchange rate. This experiment should provide an upper bound on the responsiveness of the terms of trade to a depreciation of the exchange rate.

Chart 46: Terms of trade assuming lower nominal exchange rate



Source: Authors' calculations.

The exchange rate is assumed to depreciate by 10 per cent relative to the level assumed in the baseline over the period from 2015-16 to 2017-18, which is consistent with the effect on the exchange rate of a 16 per cent fall in the terms of trade (i.e., the baseline model forecast) estimated by Gruen and Wilkinson. Under this scenario the long-run terms of trade are expected to be 2 per cent lower than the full pass-through model (Chart 46).

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