DISCUSSION PAPERS

POLICY ISSUES IN MINERAL SECTOR GROWTH: A KEYNESIAN MODEL

Edward W. Shann
Discussion Paper No. 60
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Policy Issues in mineral sector growth - a Keynesian model

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ABSTRACT

It has been widely argued that adjustment to growing mineral exports occurs via a real appreciation of the exchange rate, which rises until the trade account is brought back into equilibrium via higher imports and reduced exports. This paper suggests an alternative approach based on Harrod's foreign trade multiplier. Growth in exports stimulates a rise in GDP via the multiplier and accelerator process sufficient to induce the higher level of imports necessary to balance the trade account, with the real effective exchange rate constant. The realism of the two approaches is compared and some policy implications of the Keynesian model are considered.
Policy Issues in mineral sector growth - a Keynesian model

by

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Introduction

Gregory (1976) constructed a static equilibrium model for analysing mineral sector growth, which assumed full employment and a fixed supply of factors. In such a model adjustment to mineral sector growth will occur via a change in the real effective exchange rate (due in Gregory's model to a change in the real exchange rate or prices of non-tradeables ($P_{nt}$) relative to prices of tradeables ($P_t$), as he assumes externally produced tradeables are perfect substitutes for domestically produced tradeables).

The rise in export proceeds causes a current account surplus and an excess demand for non-tradeables. Adjustment must occur by raising the real exchange rate $P_{nt}/P_t$, which switches demand from non-tradeables to cheaper tradeables and resources from tradeables production to non-tradeables production. This is the only method in the model by which production of non-tradeables can be increased and the trade surplus eliminated - by a decrease in domestic tradeables production due to changes in $P_{nt}/P_t$. The result is a rise in the real effective exchange rate, or Australia's inflation rate (including both tradeables and non-tradeables) relative to our competitors' inflation rates adjusted by the nominal exchange rate.

* I would like to thank Fred Gruen, Tony Thirlwall and Ben Smith for helpful comments on an earlier draft. The views expressed are my own.
The model thus illustrates one method of adjustment to mineral sector growth. If we relax the full employment and fixed factor supply assumptions of the model, adjustment may also occur via other mechanisms - for instance by reducing unemployment, by drawing factors from overseas, or by demand stimulating productivity growth etc.\textsuperscript{1} The relative importance of the differing mechanisms can be tested by reference to the real world.

At the other extreme to the Gregory model would be models that assume relative prices do not change (or are unimportant) and that adjustment to a growth in exports occurs via changes in quantities rather than relative prices. Both Keynesian and classical theories are compatible with these alternative assumptions.

Thus a classical theory - which assumes that purchasing power parity holds in the long-term - would imply that the mechanism Gregory suggests of changes in $P_{nt}/P_t$ would be at best only a temporary short-term method of reaching balance of payments equilibrium as our general price level relative to overseas prices adjusted by the nominal exchange rate is fixed in the long-term.\textsuperscript{2}

Adjustment to an export boom can also be analysed in a Keynesian model based on Harrod's foreign trade multiplier. A Keynesian model assumes prices rigid in the short-term, due to the existence of unemployed factors, which can be drawn into use by increased demand. In the longer-term the model is compatible with a classical model which assumes relative prices are rigid i.e. purchasing power parity holds in the long-term. Of course the model is an extreme one - in fact there is ample evidence that real effective exchange rates do fluctuate in the short-term, although in the longer-term many economists would argue that purchasing power parity (or a fixed real effective exchange rate) is a reasonable working assumption.

\textsuperscript{1} See Shann (1981).

\textsuperscript{2} See Chipman (1980), Rivera-Batiz (1982), or Cassing and Warr (1982) where one factor is internationally mobile. More extreme versions of the classical model would assume no variations from purchasing power parity even in the short-run; see Samuelson (1980). For evidence on whether long-run purchasing power parity (or a constant real effective exchange rate) is reasonable see Officer (1980) or Shann (1982).
At the most simple level we can utilise traditional Keynesian trade equations to illustrate the implications of the two approaches. Such equations estimate an income elasticity of demand and a price elasticity of demand for imports in response to changes in the real effective exchange rate. For the purposes of this paper I will adopt the popular interpretation of the Gregory thesis, which is that what is implied by a growth in mineral exports is a deterioration in competitiveness measured by our general price level relative to that abroad. I will call this the real effective exchange rate, but I will measure it as is normally done in trade equations, by changes in price of tradeables produced in Australia \( (P_t) \) relative to prices of tradeables produced abroad adjusted by the nominal exchange rate \( (P_{e}) \). This is in fact what the applied work based on the Gregory thesis has done.\textsuperscript{3} The theoretical issues involved are discussed in the Appendix.

The rigid price model would assume that while the real effective exchange rate may fluctuate in the short-term, in the long-run purchasing power parity holds, so that the price elasticity of demand for imports becomes irrelevant as a means of adjustment since the real effective exchange rate can be assumed constant.\textsuperscript{4}

\textsuperscript{3} It may be objected that this conflicts with Gregory's formal model which assumes \( P_t = P_{e} \) because tradeables are perfect substitutes and that the trade account therefore reacts to changes in \( P_{nt}/P_{t} \). Empirical work shows that a change in \( P_{t}/P_{e} \) is the major relative price influencing trade flows and that changes in \( P_{nt}/P_{t} \) are unimportant for trade flows. The applied work by Gregory and others in fact uses price elasticities drawn from traditional trade equations based on variations in \( P_{t}/P_{e} \). Both approaches suggest a change in the general price level in Australia relative to overseas (adjusted by the nominal exchange rate) but suggest alternative mechanisms by which this occurs and can be viewed as alternative views of how exchange rate changes affect trade flows. As Gregory (1978) himself has pointed out the approach based on variations in \( P_{t}/P_{e} \) is consistent with the empirical data for Australia. The approach adopted in the text thus seems a reasonable interpretation of a model which implies variations in relative prices between Australia and overseas produce balance of payments equilibrium. See the Appendix and Shann (1982) for a more detailed discussion.

\textsuperscript{4} Because observed changes in \( P_{nt}/P_{t} \) primarily reflect productivity differentials between sectors, there is little difference between measures of real effective exchange rates based on indices including or excluding non-tradeables. In fact measures of competitiveness excluding non-tradeables give better econometric results in predicting trade flows.
If the income elasticity of demand for imports is stable we can simply calculate the rise in income necessary to induce a higher level of imports in response to an export shock. Thus

\[ \frac{df}{dx} = \frac{dx}{\text{income}} \]  

(1)

where \( dy \) is the rate of growth in income, \( dx \) the rate of growth in exports and \( \alpha \) is the income elasticity of demand for imports. The terms of trade are assumed constant. Thus the rise in total production becomes a multiple of the rise in exports, depending on the income elasticity of demand for imports. If total exports rise by 4.5% in volume terms per annum, with constant terms of trade and the income elasticity of demand for imports is 1.5, then GDP can grow at 3% per annum without a change in the current account balance. If mineral exports accelerated growth in total exports by 1.5 percentage points per annum above what they would otherwise have been, GDP could grow 1 percentage point per annum faster than otherwise, without a deterioration in the current account. If exports represent about 20% of GDP, this implies GDP ultimately rises by over 3 times the original increase in exports.

As discussed in Thirlwall (1980), this very simple theory in fact seems a reasonable approximation of real world events, because real effective exchange rates show large short-term term fluctuations, but little change over longer periods.6

Why is GDP likely to increase by a multiple of the original rise in exports? This can be analysed in the standard Keynesian rigid price model, which I will argue later can also be treated as a long-run model in which one set of relative prices (i.e. the real effective exchange rate)

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5. See Thirlwall (1980), Keizik (1968), Batchelor et al (1980) Chapter 7, or Kaldor (1979). I note Thirlwall's estimates make no allowance for variations in export prices relative to import prices or terms of trade changes. A change in the terms of trade due to a rise in the price of an exportable raises real incomes and can generate a multiplier/accelerator impact to bring the trade account back to equilibrium.

6. For evidence see Shank (1981), Officer (1980). The issue is discussed in the contributions on purchasing power parity in the JIE Vol. 8, May 1978. There is certainly not general agreement on the issue.
is assumed constant. This is of course compatible with various levels of
domestic price inflation, but in the long-term these are assumed to be
offset by appropriate nominal exchange rate changes, so that our inflation
rate equals that of our competitors' inflation rates adjusted by the
nominal exchange rate.

The Model

Following Caves and Jones (1981) we describe the model in its
conventional form as a short-run model, assuming a small open economy with
excess capacity. Changes in our import volumes do not affect world
expenditure on our exports and with (assumed) rigid prices and excess
capacity, foreign sales are not influenced by the level of our domestic
purchases of our exportables. Like domestic saving, spending on imports
is a leakage out of the domestic income circuit.

The equilibrium condition relating injections and leakages in the
income stream is the familiar Keynesian identity:

\[ I + X = S + M \]  
\[ \text{or } X - M = S - I \]  \( (2) \)

i.e. the surplus on the trade balance (a net injection from abroad) must
equal the excess of saving over domestic investment (a net domestic
leakage). Changes in injections to and leakages from the income stream
between the two positions of equilibrium, must also be equal:

\[ dI + dX = dS + dM \]  \( (4) \)

In addition to assuming prices rigid we assume for simplicity that
spending on imports varies only with the level of income (i.e. is not
linked to changes in the composition of expenditure). Where \( m \) equals the
marginal propensity to import and \( s \) the marginal propensity to save then:

\[ dI + dX = (s + m) \, df \]  \( (5) \)

The multiplier, with an exogenous change in exports and investment
constant is thus:

\[ \frac{df'}{dX} = \frac{1}{s + m} \]  \( (6) \)
We have omitted the government sector. We could add taxes as a leakage, or simply assume that any rise in taxes related to rising incomes is offset by an equal rise in Government expenditure. So long as additional domestic saving is induced (i.e. $s$ exceeds zero) imports will not rise by an amount equal to the rise in exports. The trade balance is improved by the percentage that the leakage into domestic saving constitutes of all domestic leakages.

We could achieve the further rise in imports necessary to produce equilibrium in the current account by a variety of methods. For instance, by assuming a net injection into the income stream from the government sector (this could represent lower taxes or higher government expenditure i.e. an increased government deficit). We could assume an expansion in domestic investment in response to higher domestic production via the accelerator. Alternatively, the external trade surplus could result in increased cash balances and lower domestic interest rates, which might also stimulate domestic investment. If financial capital is freely traded so that real interest rates are determined internationally, adjustment would occur by capital outflows offsetting the current account surplus, rather than by higher domestic investment raising domestic income until imports and exports are equal. The relative importance of these mechanisms will depend on the nature of particular economies and on government policies. 

Thus in summary an increase in exports in this model can give rise to an equal rise in imports based on a multiplier equal to $\frac{1}{\delta}$, which is called the open economy income multiplier. Expanded domestic investment, or a government injection to the income stream, means that the open economy income multiplier exceeds $\frac{1}{(\delta + \alpha)}$.

Relating this discussion to equation (1), the income elasticity of demand for imports, or the percentage change in imports divided by the initiating percentage change in income, is the marginal propensity to import divided by the average propensity to import:

$$\frac{dM}{dy} \cdot \frac{M}{Y} = \frac{dM}{dy} \cdot \frac{Y - M}{Y} = \frac{dM}{dy} \cdot \frac{M}{Y}$$

(7)

7. The above model is widely used in more complicated forms in Keynesian econometric models. See Caves and Jones (1981), p.314-318 for an example using the Data Resources model of Professor Eckstein applied to the USA.
AUSTRALIA

Graph 1: Imports/GNE and Exports/GDP

- Imports of goods and services/GNE
- Exports of goods and services/GDP

All in 1974/75 constant prices

Source: Lipp and Bailey (1982)
TABLE 1: A SURVEY OF ELASTICITIES OF DEMAND

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TABLE 2: Income and Price Elasticities of Demand

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</table>
Given the importance attached to the income elasticity of demand for imports in this model it is worth considering the empirical estimates of import equations more closely. The traditional import equation is in fact estimating the excess demand for imports:8

\[
M(Y) = D(Y) - S(Y)
\]
\[
e_{ny} = \left( \frac{D}{M} \right) e_{dy} - \left( \frac{S}{M} \right) e_{sy}
\]

where \( Y \) is income, \( D, S \) and \( M \) are demand, supply and imports respectively, \( e_{ny} \) the income elasticity of demand for imports, \( e_{dy} \) the domestic demand for importables and \( e_{sy} \) the income elasticity of domestic supply of importables.

To elaborate, a normal consumption demand equation estimates the demand response for a commodity resulting from a given change in income. An import demand equation on the other hand measures the difference between the demand and domestic supply response for that commodity for a given change in income. Thus the income elasticity of demand for imports is picking up both a demand and supply response. In theory one could also separate out the cyclical and secular income elasticities, by including a cyclical measure in the import equation, as the supply response is likely to vary greatly according to the position in the cycle.

A country encouraging import substitution could be expected to have a higher elasticity of supply of importables \( e_{sy} \) and this might push the income elasticity of demand for imports downwards. Graph 1 shows the historical trend of the imports/GNE ratio for Australia. This trend rise can be interpreted as the income elasticity of demand for imports. Many equations based on data from the mid-sixties to early seventies assumed Australia's income elasticity of demand for imports was about 1. However, if the decade of the seventies is taken, the income elasticity of demand for imports rises to around 1.6 to 1.8.9 Over a longer period the ratio would probably lie somewhere between these values. As shown in Table 1 the post-war average in international studies of OECD countries is around 1.4/1.8.

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8. See Jones (1980), Magee (1975) or Lawrence (1979) for a discussion. Much of the following is based on Magee.

Obviously the income elasticity of demand for imports may vary over time according to a variety of factors including the structural policies being followed (e.g. protection, foreign exchange constraints). Rapid growth in exports may in fact produce supply-side changes which raise the measured income elasticity of demand for imports.

It should be stressed that this Keynesian model is very different from a static neo-classical model in which growth is supply determined and prices are assumed to be perfectly flexible. Demand becomes an important constraint on growth, as well as resource availability. In particular autonomous demand increases can induce both increased factor supply (via higher participation rates, migration and importing capital goods) as well as more efficient use of existing factors. Productivity growth may be related to production growth as in the Verdoorn Law. This is the justification for suggesting that our short-term Keynesian, rigid-price model based on excess capacity, may also be applicable to the longer-term.

Equation 1 can therefore be viewed in two lights. As elaborated above the multiplier shows how a change in exports may generate further growth with relative prices constant. However, it should be stressed that the short-run working of the multiplier in response to a rise in exports may be short-circuited by a shift in the real effective exchange rate or offset by shifts in other autonomous demand factors which can also have a multiplier impact. As Australia illustrates at present a downturn in exports and investment can generate a negative multiplier depressing GDP. Equation 1 can also be viewed as the ultimate constraint on the economic growth rate. Growth in GDP will be limited by the need to finance by higher exports the rise in imports generated by any growth in income. Given a constant real effective exchange rate in the long-run equation 1 provides the formulae which indicates that constraint and the empirical evidence is shown in Tables 2 and 3. In the short-run other constraints on GDP growth may also operate e.g. skill shortages, savings shortages. In the long-run these can be overcome (e.g. skill shortages by training or migration, capital shortages by imports), so that the economy

10. For a discussion see Maizels (1968), Batchelor et al (1980), Keesing (1967), or Thirlwall (1980). Maizels for instance discusses the literature analysing the possible interaction of these constraints.
Note: These calculations do not allow for changes in the terms of trade (which particularly influence the figures for Japan and primary producers such as Australia). Countries whose balance of payments equilibrium growth rate exceeds the actual GDP growth rate (such as Japan) would be predicted to have external surpluses if the terms of trade were constant.

<table>
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<th>Country</th>
<th>% change of real GNP ((%))</th>
<th>% change in export volume ((%))</th>
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<th>% change in imports ((%))</th>
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<th>Balance-of-payments equilibrium growth rate from applying equation (1)</th>
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*1955-73.
f1954-73.
Source: Cornwall (1977, p. 163).

will tend to grow at the balance of payments equilibrium growth rate shown by equation 1. We have abstracted here from changes in the level of capital flows which may be important in the short-term in determining the sustainable growth rate, but do not appear on the evidence shown in Tables 2 and 3 to influence greatly the results of applying equation 1 to developed countries recent history.\textsuperscript{11}

In addition, the balance of payments constraint is in terms of a need to balance money imports and money exports. The formulae in equation 1 is based on real imports and real exports (the terms of trade being assumed constant). A deterioration in the terms of trade implies real imports (and real GNE) must grow more slowly than implied by the formulae if the balance of payments is to be in equilibrium in money terms.

The importance of the concept of a balance of payments constraint to growth perhaps needs some elaboration. If our imports consistently rise faster than our exports, when domestic and foreign incomes are rising at the same rate, we will be constrained to grow slower than the rest of the world in order to maintain trade equilibrium. This balance of payments equilibrium rate of growth may be below the rate of growth necessary for full employment. A faster rate of growth of exports thus raises potential GDP growth and reduces unemployment in the short-term. In the longer-term it may allow the growth rate to be expanded by encouraging higher factor inputs and greater productivity growth - as well as by removing the balance of payments constraint to achieving the full employment growth rate. Such export led growth models have been extensively discussed in the literature.\textsuperscript{12} I should add that this is not a mercantalist view of the world. Growth does not depend on net exports and in fact stress is placed on the benefits of rapid growth in imports in facilitating GDP

\textsuperscript{11} See Thirlwall (1980 and 1982) for a discussion of the theory and evidence. Where countries consistently run a current account deficit of the same proportionate size over time the formula will still operate. As Thirlwall shows if real capital imports grow at the same rate as export volumes the formula is still valid.

\textsuperscript{12} See Thirlwall (1980) Chapter 11 for a discussion and bibliography, or Batchelor et al Chapter 7.
growth. Both exports and imports grow and world GDP benefits from the gains from trade.13

If it is correct that the real effective exchange rate is fixed in the long-run, manipulating the real effective exchange rate is not an option for increasing our long-term growth rate. Our relative GDP growth rate therefore depends on the world income elasticity of demand for our exports and our income elasticity of demand for imports. Using the previous example, if the income elasticity of demand for our exports is lower than the income elasticity of demand for our imports then our GDP growth will have to be below the average of our trading partners if we are to maintain current account equilibrium.14

For instance if the income elasticity of demand for our exports is one then world GDP must grow at 4.5% for our total exports to rise by 4.5%. However, mining sector growth may stimulate an increase in our world export share. The discovery of new deposits, or a change in comparative advantage due to the rise in energy prices, may result in a rise in exports due to a change in Australia's ability to supply exports at a given real effective exchange rate, even though the income elasticity of demand for those exports may be low.

As has been argued by the IAC,15 Australia has in fact over the fifties and sixties had a comparative advantage in exports with lower income elasticity of demand than average (i.e. rural and mining products). Thus even if we had been able to maintain our share in world trade in these products, our share in total world trade would have fallen because the products in which we specialise have had slower than average growth in world trade. Unless we can consistently raise our share in world trade in the products in which we have a comparative advantage (or develop a comparative advantage in other products with faster growth in world trade) we will therefore on this theory grow at a slower rate than our trading partners, if we have the same income elasticity of demand for imports as they do.

This would suggest that Australia’s relatively poor growth performance post-war is in part due to the products in which we have had a comparative advantage. This is not of course to deny that our growth performance could have been improved by better use of existing resources and we have assumed that in the long-run price competitiveness is given (i.e. purchasing power parity holds). Some economists would dispute this last assumption, or suggest that even short-term improvements in price competitiveness can improve longer-term growth performance by stimulating productivity and factor inflows.  

The theory also suggests that it would be difficult for any country to continue to grow rapidly in a stagnating world. Low growth in demand overseas will limit the growth in exports and thus rapid domestic growth stimulating imports will quickly result in the balance of payments constraint operating. Of course for a period capital inflows, or a depreciating real effective exchange rate increasing our market share, or a change in comparative advantage raising exports, might allow growth to continue.

Empirical work

Given the expected rise in Australian mineral exports over the eighties, a number of recent studies have estimated the change in the real exchange rate necessary to produce an offsetting rise in imports. Thus these studies estimate the rise in imports due to the increased net income directly generated by the mining sector (after allowing for income payable abroad) and then use price elasticities drawn from conventional trade equations to estimate the change in the real effective exchange

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rate needed to produce a total rise in imports equal to the expected rise in mineral exports. Most assume we start from "equilibrium" and also allow for some contraction in traditional exports growth.

Some of these studies actually appear to believe that such changes in the real effective exchange rate are likely to occur. We must first determine the significance of the ceteris paribus assumptions of the model e.g. can we achieve equilibrium in the real world in other ways apart from a change in the real effective exchange rate if we relax the ceteris paribus assumptions of the model. If equilibrium can be achieved in other ways, how significant are the alternative mechanisms and in what circumstances will different mechanisms operate?

The analysis above suggests a very different approach to estimating the impact of mineral sector growth on the Australian economy. Instead of taking the price elasticity of import demand and calculating the necessary change in the real effective exchange rate needed to produce trade equilibrium, we would take the income elasticity of import demand and calculate the rise in GDP necessary to produce trade equilibrium (ceteris paribus). The result would be a prediction that GDP (and real incomes) would grow considerably faster (by a multiple of the original rise in exports) than in the Gregory type estimates and there would be no change in the real effective exchange rate. I would suggest such an approach would produce an estimate much closer to the actual observed outcome, than the "Gregory type" approach. For instance, a prediction of the change in the real effective exchange rate necessary to produce a rise in imports for the late sixties mining boom would have been difficult to reconcile with the real effective exchange rate of the late seventies which had returned to the same level as in the mid-sixties, including or excluding non-tradeables (see Graph 2 and Appendix).

18. A number of these studies claim to be calculating the change in the real exchange rate ($P_{tx}/P_{t}$), but as discussed earlier the actual calculations relate to the real effective exchange rate and it is concluded that to reach trade equilibrium Australia will require a real revaluation of 10% over the eighties. This implies that Australia inflates 10% faster than its competitors (in their view because $P_{tx}$ rises faster in Australia than abroad), or revalues the nominal exchange rate by 10%. See Appendix or Shann (1982) for a discussion.
Graph 2: Measures of competitiveness for Australia
Fall shows deterioration in competitiveness

Real effective exchange rates

--- Morgan Guaranty measure based on wholesale prices of non-Food Manufactures. Weights based on manufacturing trade in 1976 between 16 industrial countries.

----- AIDA measure based on CPI using TWI to measure nominal exchange rate and trade weights for 6 major trading partners for CPI.

Year (annual averages)
Australia’s recent experience also illustrates that export-led growth models need careful handling in interpreting real-world events. The recent growth in Australian GDP was primarily in response to an investment surge based on future exports. The multiplier/accelerator mechanism in response to a rise in autonomous investment demand stimulated general economic expansion and a rise in GDP. Exports in this investment stage actually fell in real terms due to the world recession, the drought and a rising real effective exchange rate. We do not observe a rise in exports followed by a rise in GDP, although it was certainly the prospect of future export which stimulated the higher investment. However, if exports fall subsequently to rise in line with the formulae in equation 1 the balance of payments constraint would eventually force a contraction in GDP. In the interim, capital inflows finance the current account deficit.

The treatment of mining exports as an addition to growth might also be justified at present by the heavy importing of factors (both capital and labour) and the limited calls on existing domestic resources which are in any case already underemployed. What the total growth in exports would be over the next decade is of course another matter. Calculations of total export growth over a decade need to be treated with considerable caution, as it is undoubtedly a gross oversimplification to assume, as done in some of these estimates, that the net increase in mineral exports estimated would occur on top of the trend rate of growth of GDP and exports. However, there is evidence to show our relative export and GDP performance improved in the late sixties as a result of the first mining boom. A similar prospect is likely from the early eighties (of course as the world performance is likely to be far worse, this may not make Australia’s performance particularly inspiring by historical standards).

There is no doubt that mineral sector growth does have the potential to boost our total growth rate, but the extent of this boost is open to debate. Certainly it seems reasonable to assume that our capital stock will end up being higher than it would otherwise have been. Table 4 shows that in the late sixties and at present, the rise in investment was accompanied by a rise in Australia’s current account deficit. Because of the current account deficit, the higher level of mining investment was possible without a rise in domestic saving, or a fall in other investment i.e., the total capital stock expanded faster than it would otherwise have done. In both cases it was not only mineral investment that expanded, but
Table 4: Saving, investment and the current account

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Domestic Saving (% GDP)</th>
<th>Current Account Deficit (% GDP)</th>
<th>Gross fixed capital expenditure (% GDP)</th>
<th>Mining new fixed capital expenditure (% GDP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962-63</td>
<td>23.0</td>
<td>2.9</td>
<td>24.9</td>
<td>0.4</td>
</tr>
<tr>
<td>1963-64</td>
<td>24.9</td>
<td>0.3</td>
<td>25.2</td>
<td>0.4</td>
</tr>
<tr>
<td>1964-65</td>
<td>25.5</td>
<td>4.0</td>
<td>26.7</td>
<td>0.5</td>
</tr>
<tr>
<td>1965-66</td>
<td>23.1</td>
<td>4.3</td>
<td>27.6</td>
<td>1.0</td>
</tr>
<tr>
<td>1966-67</td>
<td>24.2</td>
<td>2.9</td>
<td>26.3</td>
<td>1.1</td>
</tr>
<tr>
<td>1967-68</td>
<td>21.1</td>
<td>4.7</td>
<td>26.8</td>
<td>1.3</td>
</tr>
<tr>
<td>1968-69</td>
<td>24.8</td>
<td>3.7</td>
<td>26.4</td>
<td>1.6</td>
</tr>
<tr>
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<td>1.7</td>
</tr>
<tr>
<td>1970-71</td>
<td>24.9</td>
<td>2.4</td>
<td>26.0</td>
<td>2.3</td>
</tr>
<tr>
<td>1971-72</td>
<td>25.3</td>
<td>0.9</td>
<td>25.5</td>
<td>2.3</td>
</tr>
<tr>
<td>1972-73</td>
<td>25.9</td>
<td>-1.6</td>
<td>23.7</td>
<td>1.1</td>
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<tr>
<td>1973-74</td>
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</tr>
<tr>
<td>1975-76</td>
<td>22.1</td>
<td>2.0</td>
<td>23.4</td>
<td>0.9</td>
</tr>
<tr>
<td>1976-77</td>
<td>21.7</td>
<td>3.2</td>
<td>22.8</td>
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<tr>
<td>1977-78</td>
<td>19.6</td>
<td>3.4</td>
<td>22.9</td>
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<tr>
<td>1978-79</td>
<td>20.0</td>
<td>3.8</td>
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<tr>
<td>1979-80</td>
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<tr>
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<tr>
<td>1981-82</td>
<td>20.6</td>
<td>6.1</td>
<td>25.1</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Marked years indicate start and end of investment phases of mining booms. Domestic savings equals ANA gross accumulation less undistributed income payable abroad. The difference between columns 1 plus 2, and 3 is the change in total stocks plus the statistical discrepancy. Mining new fixed capital expenditure does not include base metals (i.e., processing) and the mushrooming of leasing in recent years means the proportion of mining investment to GDP is lower than would be the case if capital were allocated by industry of use, rather than by industry of ownership.


Table 4 needs to be interpreted with care - particularly because it is based on ratios. A rise in investment which has immediate multiplier effects on GDP would produce no change in the investment/GDP ratio because GDP would have grown faster.
as our multiplier/accelerator analysis suggests, investment generally. In brief, an expected rise in return on capital in energy related projects in Australia attracts capital to Australia and allows imports to finance investment in that (and other) sectors, as well as allowing higher consumption. The multiplier raises demand in other sectors (and returns on capital in them). The return to capital between sectors and internationally is equalised by attracting financial capital inflows. These inflows allow additional factors to be imported which raise our capital stock.

The Department of Trade and Resources estimate net mineral exports (after allowing for income payable abroad etc) will increase total export growth by about 2 percentage points per annum over the eighties. Suppose the income elasticity of demand for endogenous imports remains at about 1.5. The extra exports then have a potential to raise GDP by 1.3 percentage points per annum. If the income elasticity of demand for imports were say 1, the potential rise in GDP increases to 2 percentage points per annum.

To indicate orders of magnitude, these sums compare with GDP growth over the seventies of 3.3% per annum. Of course the actual potential growth rate in GDP in the eighties will depend on how other exports grow, the growth in exogenous imports, changes in the income elasticity of demand for endogenous imports, the terms of trade and the financing cost of net invisibles. The latter may be substantial given present historically high levels of capital inflow as a proportion of GDP and high real interest rates. The present stock of official external debt totals $5.5 billion and private external debt totals $25 billion, together equal to 20% of GDP, which is moderate by international standards. (See Budget Paper No. 8 and ABS catalogue No. 5306 and 5301.)

It is perhaps worth pointing out that exports of goods and services grew by 60% in real terms over the seventies, compared with a DTR estimate of 57% growth over nine years in the eighties, and an IAC estimate of 62% over the decade of eighties if real oil prices are stable, or 73% if real oil prices rise 2% per annum. The comparative change in export performance in volume terms on these estimates is hardly startling. Of course this does not tell us how we are performing relative to the rest of the world. Further the quite rapid growth in export volumes in the
seventies was unable to finance faster real import (and real GNE) growth because of a sharp deterioration in the terms of trade of 14% measured by implicit deflators. Total real imports grew by only 34% over the seventies - though this allowed the current account to improve as well. The above is not meant to imply much faith in such mechanical projections, or agreement with the particular estimates, but simply to illustrate a different approach to that taken by "Gregory type" calculations. The fundamental question is whether following a rise in exports equilibrium is achieved in the long run via a change in the real effective exchange rate, or via faster GDP growth (equivalent to faster GNE growth in equilibrium)? Gregory type estimates assume the change is via a move in the real effective exchange rate, while I would suggest that in the long run the evidence supports the view that adjustment occurs via a variation in GDP growth.

I note Johns considers\(^\text{19}\) whether a multiplier and accelerator effect should be included in his calculations of the impact of mineral sector growth. He argues that "such multipliers, however, cannot be large or sustained; if they were, real national income would increase without the need for a resources boom". He thus assumes no multiplier in his calculations. The implication is that an autonomous increase in demand has no multiplier impact on production even in a less than fully employed economy and that a lifting of the balance of payments constraint to growth is irrelevant. A rise in government expenditure can have multiplier effects, but will cause a deterioration in the trade account and may thus be unsustainable. A rise in exports on the other hand lifts the balance of payments constraint and by allowing importing of factors may also lift other constraints on growth. "Gregory type" calculations imply both large sustained changes in real effective exchange rates and a rapid rise in export and import ratios to GDP. Neither conclusion seem borne out as predictions about the real world. There seems no doubt users of the Gregory theory have assumed that their predictions will occur in the real world. Thus Gregory suggests\(^\text{20}\) "if relative prices do not change mineral exports will result in the accumulation of foreign resources in London and New York banks and the wealth of the community, in terms of the goods and

\(^{19}\) Johns (1982), p.85.

services it consumes, will not increase". This is true in his fully employed, fixed total factor supply model, but it is not true in the real world.

Stone insists\textsuperscript{21} that it is "logically undeniable" that it is relative prices that must change if imports are to rise to equal exports following a mining boom. It is logically undeniable in Gregory's model, but is highly debatable as a proposition about the real world. Forsyth and Kay\textsuperscript{22} state that the exchange rate is the market's mechanism for contracting manufacturing output and by increasing imports is the only means by which the economy as a whole can benefit. They suggest this means many sectors of industry and many individuals will be net losers. Again they appear to confuse their model with the real world.

O'Mara \textit{et al} suggest\textsuperscript{23} mineral sector growth implies a real appreciation of the Australian currency over the eighties if protection is not reduced. Johns makes specific estimates\textsuperscript{24} of the "prospective real revaluation" necessary to restore balance of payments equilibrium following a mining boom. Beenstock \textit{et al} state\textsuperscript{25} "we have suggested that the effects of North Sea oil on the real exchange rate are permanent. We accept the form of analysis set out by Forsyth and Kay which suggests that there will be a real exchange rate response to the extent that the increase in real income results in an increase in demand for non-traded goods". Again the model is assumed to apply directly in the real world. Such predictions about real world events can only be made if it is assumed alternative important methods of reaching equilibrium do not exist.

Considerable care needs to be exercised in transferring the conclusions of models directly into real world predictions. The key question in this case is how important are relative price changes compared with accelerated income/production growth in achieving equilibrium. I would suggest that relative price changes are important in the short-term,

\begin{enumerate}
\end{enumerate}
but that over time, as factor supplies can be augmented both domestically and by imports so that production capacity is expanded and productivity raised, our Keynesian model becomes increasingly relevant. The choice between theories seems to me to be basically an empirical matter, which can be analysed by reference to real world events i.e. do relative prices show trend shifts, or is there a high correlation between GDP and export growth? Do countries with faster export growth have faster GDP growth, or rising real effective exchange rates? The evidence seems clearly enough to support the Keynesian model.26

The Gregory thesis as applied by its exponents implies that growth of any high productivity tradeables sector is likely to lead to a rising real effective exchange rate. However, using Spearman rank order tests there is not the predicted relationship between the rate of growth in production, productivity or exports and changes in real effective exchange rates over the period 1973-79 between 15 industrial countries. As has been illustrated many times27 there is a relationship between export growth and growth in total production (significant at 5%).

In fact the relationship is the reverse of that predicted by supporters of the Gregory model. Countries whose real effective exchange rates have been on average over the period 1973-79 below the level in 1973 have had faster growth in exports and GDP (both significant at 5%). This is consistent with the many tests for individual countries showing that loss of competitiveness reduces export growth and raises imports. It suggests that faster growth in exports will not result in rising real effective exchange rates, but in faster GDP growth and that causality may

26. See Shann (1981) for the details of these tests. Extending the tests over 1970-80 confirm the results. There is no relationship between GDP growth and whether a country inflated faster or slower than its competitors. However, once allowance is made for nominal exchange rate changes, as well as relative inflation differentials, better competitiveness is correlated with higher growth. This suggests that what is significant for a country's relative growth performance in the short-run is not its relative inflation performance, but whether the nominal exchange rate moves so as to offset fully the differential inflation performance. Thus high inflation LDC can still maintain rapid growth as long as they devalue by enough to ensure competitiveness is not adversely affected. See Morgan Guaranty, World Financial Markets, October 1982 for a discussion concerning LDC.

27. See for instance Batchelor et al Chapter 7.
run from maintaining competitiveness to faster export and GDP growth. Comparing the level of the real effective exchange rate in 1979 with that in 1973, rather than the average level over 1973-79 with 1973, to test for trend shifts, shows no relationship between competitiveness and exports, but countries with the least deterioration in competitiveness have the largest rise in GDP (significant at 1%).

As one would expect, if purchasing power parity has some validity in the medium-term there is a strong inverse correlation between relative inflation rates and nominal exchange rates since 1973 (significant at 1%). The tendency for real effective exchange rates to fluctuate around purchasing power parity suggests that:

(i) the scope for manipulation of competitiveness may be limited except in the short-term; and

(ii) that the dominant determinant of growth rates in the longer term may be the income elasticity of demand of the tradeables a country produces. The impact of large deteriorations in competitiveness would, however, clearly be to depress growth rates of exports and GDP.

Some policy implications

The Gregory theory has concentrated attention on only one possible mechanism of adjustment to mineral sector growth - changes in the real effective exchange rate. I have suggested above that while the real effective exchange rate may be important (especially in the short-term), faster total GDP growth seems more important (especially in the long-term) in increasing import flows.

The policy debate in Australia has been focussed on:

(1) the structural conflicts inherent if one sector expands in an economy of given total size.

(2) the supposed relative price implications of adjustment to mineral sector growth i.e. whether the predicted change in relative prices is achieved by nominal exchange rate appreciation, or by faster domestic inflation. Some have suggested tariff cuts would
substitute - although the long-term net impact of tariff cuts on
the trade account is open to dispute.28

(3) methods of “maximising” the benefits to Australia of mineral
sector growth, which emphasise the tax take from the mineral
sector.

The previous analysis suggests that the structural conflicts from mining
sector growth may have been overemphasised, while the substantial
potential real income gains have been significantly underestimated. The
need to maximise the growth of the mineral sector, with its potential to
generate further general GDP growth via the multiplier/accelerator
mechanism, has tended to be buried in concern about predicted sectional
losses. In a growing economy, most structural losses are likely to be
relative rather than absolute.

While it may be true that the real effective exchange rate does not
show long-run trend changes, the stress in the Gregory theory on the real
effective exchange rate is clearly relevant in the short-term. For
instance, if a government decides to contract GDP (perhaps for anti-
inflationary reasons) in the presence of an expanding mineral sector, an
appreciating exchange rate can exacerbate structural conflicts. The UK
example is a clear enough warning of the implications.

However, application of the Gregory theory to estimating long-run
changes in the real effective exchange rate (a popular past-time in
Australia) seem rather pointless given the model’s restricted assumptions
and the lack of evidence that such long-run changes in real effective
exchange rates actually occur. Instead, policies to maximise mineral
sector growth, factor mobility and productivity growth are central if we
are to maximise the potential real GDP and real income gains from mineral
sector growth. Over-emphasis on the tax take on mining production as the
method by which Australia benefits, seems more likely to result in
restricting the original growth in the mining sector. The potential
multiplier benefits, along with the gains from a slackening in the balance
of payments constraint, will therefore be reduced.

28. IMPACT suggests tariff cuts eventually improve the trade account for
Concern about the capital-intensive nature of mining and the small number of jobs created in the mining sector itself seems misplaced. The multiplier mechanism elaborated above creates the potential to stimulate employment growth in other sectors - particularly in labour-intensive non-tradeables. The multiplier calculated above would be larger than the input/output multipliers which are based only on direct linkages to the mineral sector. The concern that mineral sector growth must result in unemployment thus seems misplaced. Extra employment can result from the multiplier mechanism, although the composition of the workforce may change considerably towards more white collar jobs requiring retraining and adjustment to the education and migration systems. The increased productivity of the tradeables sector is a positive benefit - it allows us to export more, with higher levels of real incomes and a smaller proportion of the workforce in tradeables production. Of course the economy may still operate at less than full employment due to world recession, a high real effective exchange rate, or restrictive government policies. A growing mineral sector does not guarantee full employment, but there is no necessary reason why it must create additional unemployment given the multiplier/accelerator mechanism.

The capital intensity of the export sector is certainly not a cause for concern and its financing by capital inflows allows Australia to finance higher levels of investment without cutting consumption, and drawing resources from other sectors. I note foreign financing may be by way of loans and need not involve greater foreign ownership.

For those interested in providing additional government services it should be noted that due to a mining boom the absolute size of the non-tradeables sector can be expanded without running into a balance of payments constraint. Thus rapid mineral sector growth allows more rapid growth in GDP and in the absolute (though not necessarily relative) size of the government sector. Thus if desired more resources can be applied to socially desirable ends. The tax base is expanded both directly from tax paid by the mineral sector and from the income generated by the multiplier/accelerator process.

Some economists might argue that it is desirable to minimise swings in the real effective exchange rate by spreading out resource growth to avoid production bottlenecks and by taking real income gains over a period in advance of exports coming on stream. This policy was adopted by
Norway, which as a result ran up a current account deficit equal to 14% of GDP in the late seventies. If the expected gains in productivity and exports are large enough and certain enough, this may well be a sensible policy. In Australia's case some of those gains have been delayed by world recession, emphasising that mechanical projections of export earnings on the assumption that export demand is infinite need cautious handling. Depending on one's view of likely developments in the world economy and the potential rebound in mining (and rural) exports over the next few years, Australia might still be justified in substantial official borrowing in the next two years, if necessary, to achieve short-term balance of payments equilibrium.

As in the early seventies, Australia has again revalued sharply (Graph 2) and had real wage growth in excess of productivity growth. Hopefully, however, the recovery period will not be as painful or prolonged. The sharp improvement in the current account in the early seventies was primarily the result of the commodity price boom, which raised prices of Australian exports sharply. The current account strengthened by an amount equal to 2.9% of GDP in 1972. From 1971-72 to 1972-73 rural exports rose by an amount equal to 2.1% of GDP. Despite the revaluation of the $A, export prices in $A still rose sharply by nearly 20% in each of 1972-73 and 1973-74. Thus Australia's terms of trade improved sharply. Despite revaluation, returns to Australian exporters (rural and mining) rose sharply, while the import competing manufacturing sector was squeezed by the revaluation - a revaluation which had very little to do with the gradual growth of the mining sector from the mid-sixties. The rapid strengthening in the current account in the early seventies was due to an external event - the sharp change in the terms of trade. When the world boom subsided, the terms of trade deteriorated and the exchange rate had to be devalued again and our real incomes lowered.

In the early eighties the current account deficit has been expanding to accommodate the investment stage of the mining boom and capital flows have forced revaluation. This has laid the basis for very rapid growth in export volumes and productivity when the world economy resumes growing. Australia over recent years has had rising real investment, while most industrial countries have had falling real investment. A recovery in world demand, continued increases in our capacity as projects are completed and a recovery from the rural drought, provide the potential for
rapid productivity growth which was not present in the mid-seventies. We are likely in fact to have improving terms of trade in a world upswing, rather than as in the mid-seventies be forced to lower real incomes to adjust to declining terms of trade. It may therefore be easier to overcome the present imbalance between real wages and productivity as demand and production increase as long as real wages are suitably restrained.

The danger in the present situation is that world recovery may be long delayed. This would make it increasingly difficult (and unwise) to finance the present current account deficit and real income levels in anticipation of the expected export and productivity growth.

I have not commented here on the structural implications of mineral sector growth if the real effective exchange rate remains constant in the long-term. I have discussed elsewhere how structural change may occur in the tradeables sector, even with a constant real effective exchange rate, if real wage rises are more equally distributed across tradeables industries than productivity growth, whilst tradeables prices are set internationally. Compared with Gregory's approach there are significant differences in the extent of structural change that is likely to result from mineral sector growth.

It should be noted other tradeables sectors may still be squeezed relatively because they will face higher real wages than they would have done in the absence of mineral sector growth, which raises aggregate national productivity and therefore the level of real wages across all industries. The mechanism by which this squeeze occurs is not in the long-run a change in the real effective exchange rate (a relative price), but a rise in real wages. In addition the total size of the economy expands, so these industries are a smaller part of a larger economy - export orientated tradeables industries which benefit least from an expanded home market would be most affected.

29. See Shann (1981). Minor changes in the real effective exchange rate may result due to differing productivity growth rates in different sectors.
This final section is designed only to illustrate some of the policy issues raised by a more Keynesian approach to analysing mineral sector growth. The limitations of the Gregory model and of the Keynesian model need to be kept in mind when we turn to analysing real world implications and policy issues.
Appendix 1 : Relative prices and competitiveness

Traditional trade equations are based on estimating the response of trade flows to changes in the general price level in Australia compared with abroad, adjusted by the nominal exchange rate.

The estimates are based on variations in the price of similar tradeables produced at home ($P_h$) and abroad ($P_w$) and adjusted by the nominal exchange rate ($e$). Wholesale price indices are thereforefavoured in measuring price competitiveness in aggregate measures as these are more limited to tradeables e.g. see Houthakker and Magee (1969), or Goldstein et al (1980).

Gregory (1976) assumed such variations in prices of tradeables are impossible because tradeables were assumed to be perfect substitutes. Thus variations in our general price level compared with abroad could only occur in his model via a change in prices of non-tradeables ($P_{nt}$) relative to prices of tradeables ($P_t$), as discussed in Lindner (1978) and O'Mara et al (1980). Prices of tradeables were assumed to be the same in $SA$ whether the good is produced at home or abroad i.e. $P_h = P_w$. Thus in this model $P_{nt}$ must rise in Australia to eliminate a trade surplus with the nominal exchange rate constant and by implication $P_{nt}$ in a two country model declines abroad as argued by Dornbusch (1975), or is constant on the small country assumption. In either case the rise in $P_{nt}$ in Australia raises Australia's aggregate inflation rate including tradeables and non-tradeables relative to that abroad (adjusted by the nominal exchange rate).

However, as shown in Graph 2 the major cause of changes in our general price level compared with abroad has been fluctuations in the $SA$ price of tradeables produced at home and abroad (measured by relative wholesale price indices). A measure using relative consumer price indices (which include more non-tradeables) shows little variation from the measure based on wholesale prices. Evidence for other countries is shown in OECD Main Economic Indicators on a monthly basis. The implication of Graph 2 is that prices of non-tradeables to tradeables varied by roughly the same amount in Australia as occurred abroad. In fact the evidence indicates that all countries have trend rises in $P_{nt}/P_t$, reflecting differing productivity growth rates in the two sectors (see Goldstein et al 1979). A change in $P_{nt}/P_t$ which simply reflects
underlying changes in real unit labour costs in the two sectors does not (necessarily) influence the relative profitability of the two sectors, or the relative profitability of our tradeables sector compared with our competitors' tradeables sectors e.g. see Argy pp 244-45. It therefore has limited implications for the trade account, as has been demonstrated by econometric work by for example Goldstein et al (1980), which shows variations in $P_t/P_{we}$ are more significant for trade flows than changes in $P_{nt}/P_t$ (which are generally insignificant in trade equations).

Gregory (1976) and others (see footnote 17) use price elasticities estimated from equations based on variations in $P_t/P_{we}$ to estimate the change in Australia's general price level relative to overseas necessary to achieve trade account equilibrium. Although they suggest (based on the Gregory model) that this variation in relative general price levels comes from a change in $P_{nt}/P_t$, this is clearly not what occurs in the real world, where the major variation in relative prices between countries is due to changes in $P_t/P_{we}$ and where the fluctuations that do occur in $P_{nt}/P_t$ appear to have little impact on trade flows.

In the text I have therefore assumed that what the Gregory thesis is meant to imply is that a change in our price level relative to overseas is the method by which trade equilibrium is reached. As empirical work indicates that the relative price which changes so that this occurs is $P_t/P_{we}$ and not $P_{nt}/P_t$ I have adopted the normal definition of the real effective exchange rate used in trade equations (of $P_t/P_{we}$) as representing the relative price Gregory claims changes.

It is possible to view these theories as alternative views of exchange rate adjustments, as Corden (1982) does on p 19 footnote 3. If tradeables are perfect substitutes a nominal exchange rate revaluation with money wages rigid changes $P_{nt}/P_t$, while if tradeables are imperfect substitutes and money wages are rigid, a nominal exchange rate revaluation changes $P_t/P_{we}$. It is argued by many economists that in the long-run the impact in either case is neutral because the money wage ultimately changes to offset the change in the nominal exchange rate (see Shann 1982).

A more detailed discussion of this issue, with references is provided in Shann (1982).
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