Mining Booms and the Exchange Rate

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1. Introduction

One of the important responses to a mining boom is the exchange rate. In turn, changes in the exchange rate drive some of the structural adjustment of the rest of the economy to a mining boom. The response of the exchange rate is likely to vary over different phases of the boom, with stages for the initial demand increase, the investment period in response to an increase in demand or a supply shift with new discoveries or new technology, the production stage, and an end of boom stage. Other characteristics of the particular mining boom will affect the time pattern and the magnitudes of the exchange rate changes, such as whether the boom is driven primarily by an increase in global demand or a shift in domestic supply, the mix of resident and non-resident ownership, the mix of domestic and overseas funds for investment, and the mix of source of home production and imported investment to expand production capacity. The distribution of the income windfall from the mining boom, and its expenditure, will affect the exchange rate and rest of economy adjustments. In turn, government policies on taxation and the use of the taxation revenue windfall, and private business and household expenditure decisions for their share of the income windfall, will have second round effects on the exchange rate response. This paper seeks to provide a general description of the time pattern of responses of a flexible exchange rate over the different stages of a mining boom, to indicate the effects of different characteristics of the boom on the exchange rate, and to illustrate the general description with the example of the Australian mining boom of the early 21st century.

A model employing the balance of payments identity is used to describe the time path of pressures for exchange rate adjustment to different stages of a mining boom under different industry and economy circumstances. The balance of payments identity links the current account, net foreign capital inflows, and net domestic investment and saving. A flexible exchange rate and a highly elastic supply of internationally mobile foreign capital are assumed.

For ease of exploration of alternative response paths driven by different mining booms with different industry characteristics a partial equilibrium model rather than a general equilibrium model is used. But, it is recognised that the issue is a general equilibrium issue and one that a more definitive analysis requires the use of a computable general equilibrium model. To a large extent the paper builds on and seeks to generalise Corden (1982). He considers a supply driven boom, focuses for the main on a fixed nominal exchange rate situation, and provides a comparative static assessment. Relative to the general equilibrium models provided by Snape (1976), Corden and Neary (1981), Corden (1984), Cook and Sieper (1984) and others, this paper pays more attention to the time path of exchange rate adjustments, and it explores the contrasting effects of the different characteristics of particular booms. As a less than general equilibrium model, the model used in this paper does not have the detail of a large computable general equilibrium model such as MONASH to incorporate, for example, different industries with different factor intensities, inter-industry intermediate input demand links and final demand functions. Rather, the purpose of the paper is to provide insights on the details of alternative specifications of such models, and then to assist in the interpretation of how these details and options influence the estimated time pattern of changes to the exchange rate in response to a mining boom.

The rest of the paper is organised as follows. Section 2 describes the balance of payments identity framework for assessing the time path of pressures for exchange rate adjustments to different stages of a mining boom under different industry characteristics. Details of the forces for exchange rate changes, and the effects of different boom source and industry characteristics, are provided in Sections 3, 4 and 5 for the demand boom, investment boom, and production boom stages. Section 6 focuses on the example of the current Australian mining with its specific characteristics as an illustrative application of the model. A final section makes some concluding observations.

2. Balance of Payments Model

The balance of payments identity provides a framework for thinking about the different ways a mining boom, and especially mining booms with different

characteristics, set in place forces to change a floating exchange rate over the different stages of the boom. In particular, the identity links the effects of changes in values of traded goods and services, and the different effects of resident verses non-resident funds for investment and investment equipment, and distribution of the income gains between government, residents and non-residents, and then differences in their expenditure decisions, on equilibrium exchange rates.

The balance of payments identity at the aggregate level equates the current account with the foreign capital account and in turn domestic saving and investment[1]. For the analysis a disaggregation of the aggregates is made, namely: exports and imports into mining and non-mining, with mining exports described by price times quantity; and, on the domestic savings and investment side, investment is disaggregated into mining and non-mining, and saving is disaggregated into private (household and business) and government. The disaggregated balance of payments identity is represented as

$$Qm*Pm + Xo - Mm - Mo - NYT = Sp + Sg - Im - Io \qquad (1)$$

where, Qm, Pm and Xm (= $Qm*Pm$) are mining export quantity, price and receipts, Xo other exports, Mm imports of mining capital, Mo other imports, NYT is net income plus transfers to non-residents, Sp is private saving, Sg is government saving (via normal fiscal surplus or a sovereign wealth fund), Im investment in mining, and Io is other investment. An increase (decrease) in either the current account on the left hand side of (1), or an increase (decrease) of net domestic saving which mirrors a fall in net foreign capital inflow on the right hand side of (1), provides a push for a currency appreciation (depreciation) to restore equilibrium.

In assessing the effects of a mining boom on the exchange rate, the Pm, Qm, Mm and Im variables in (1) are treated as exogenous mining boom variables with first round effects on the exchange rate. The income augmentation effects[2] and subsequent spending flow-on effects of a mining boom will be treated as second round effects of a mining boom on the exchange rate.

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[1] In practice, because of measurement errors the identity in practice includes a reconciliation term.
[2] Here it can be important to distinguish between the effects of a mining boom on GDP and GDI. As noted by Kearns and Lowe (2011) and explained in some detail by Hall (2011) and Gregory (2012), it is important to distinguish between the two when there are large changes in the terms of trade. As an approximation, Gregory links the real GDP, RGDP, and real gross domestic income, RGDI, as RGDI = RGDP + x (Px / Pm − 1), where x is the share of exports in RGDP, Px is the index of export prices, Pm is the index of import prices, and Px / Pm is the terms of trade.

The time path of effects of a mining boom on the exogenous and other variables in (1) is considered for four discrete time periods:

(i) Initial demand driven boom. In this phase most of the action is an increase of the prices received, Pm, for an unchanged quantity of exports, Qm, with an inelastic short run supply. The boom also provides a windfall increase in private sector and government incomes. This stage is not relevant for a boom driven by a new resource discovery or technology reducing costs on the supply side.

(ii) Investment period of several years and up to a decade (Topp et al., 2008, and Connolly and Orsmond, 2011) is initiated by the increase in expected returns to investment in response to either the demand increase of (i) above, or the supply shift following the discovery of new deposits or new technology reducing costs. Time is required to explore and evaluate new deposits, to seek approval from governments and others for access to land and to meet environmental, heritage and other requirements, to obtain finance, and then time to construct and bring into operation an extended production supply chain. Here the key exogenous change is an outward shift of the mining investment demand curve and an increase in investment, Im[3]. Some of this investment increase will go to additional imports, Mm. The flow through of higher incomes and how they are spent will have some second round exchange rate effects.

(iii) Production period. The production period extends for many decades for most mining booms. Because of the relative greater role of fixed costs relative to variable costs for established mines, the short run supply elasticity for established mines over the production stage usually is very small. Over the production period, relative to the earlier periods, there is an increase in quantity of mining exports, Qm, but a likely lower price, Pm, unless there are further increases in global demand. The price fall will be smaller for a supply driven mining boom than for a demand side driven mining boom, because the later stimulates investment and production throughout the world whereas the former affects a single (or just a few)

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[3] With mining being a relatively capital intensive industry, the mining investment shift will exceed any induced contraction of investment in the rest of economy.

producer countries. Further, with a demand side mining boom, it is possible that the price fall will exceed the quantity increase, at least in some years of the production stage, so that mining export revenue, Xm, falls in the production stage relative to the initial demand and investment stages of the boom. Similarly, whether the extra income of a mining boom during the production stage is greater or less than that of the preceding stages is ambiguous. Mining investment falls, with associated flow on effects on imports of mining equipment. Also, over the production period costs of depreciation and debt interest fund the return of investment funds to resident and non-resident savers.

(iv)   End of boom. While this stage might not be relevant in looking at the average medium to long term effects of the current mining boom for Australia[4], previous Australian mining booms and mining booms in other countries have moved from a production phase to an end of production phase. Also, almost certainly there will be short term or cyclical mining slumps from time to time as in the past. Here the driving forces on the exchange rate will be the reverse of (i) for a demand slump or fall in price of mining exports, or of (iii) for a fall in production with the exhaustion of key natural resource reserves. Taking a longer run perspective, the manner in which the cash income gains of the mining boom are spent, and in particular their effects on saving, consumption and investment flowing through to future income, become very important third round effects on the exchange rate.

For ease of explanation, the forces for changes in the exchange rate will be assessed in more detail below for each stage in isolation. It is likely that some degree of forward looking expectations by market participants, albeit under conditions of imperfect information, will smooth over time across the different stages the actual exchange rate

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[4] Australia has large known reserves of a diverse portfolio of different minerals, with many of the key ones with around one hundred years at current production levels (Geoscience Australia, 2011), and the prospects of finding more and of new technology further reducing costs of production are excellent. Petroleum is a notable exception, and here we have an example of a decline of boom stage. On the demand side, many see continued expansion of demand as developing countries catch-up on developed country living standards and lifestyles (e.g. Garnaut, 2012 and references therein, Dines, 2011) with Australia remaining a competitive supplier in a competitive global minerals and energy market.

changes.[5] But, the reality and extent of imperfect knowledge suggest a relatively high weight for naïve verses perfect knowledge rational expectations.

3. Demand Boom

A mining boom driven by an unanticipated increase of demand, together with a very inelastic short run supply curve, increases the world price, Pm[6]. Ceteris paribus, the increase in the value of mining export receipts, ΔXm, calls for an appreciation of the currency.

At the same time, ΔXm is a windfall increase of similar size in gross domestic product, and this increase has important second round effects on the exchange rate. Further, the improved terms of trade provides additional real income (Hall, 2011, and Gregory, 2012). In an extreme case, if all the windfall income were saved, increasing Sp and Sg in (1), or all the income increase was expatriated as an increase in net foreign income NYT in (1) in what might be termed a mining enclave model, the first round effect of higher mining export receipts on the balance of payment equation would be offset, with a negligible net change of the exchange rate. In the Australian context, and that of most mining countries, such a complete offset from second round effects is too extreme.

However, second round effects with the increase in national income resulting from a demand expansion mining boom will modify the magnitude of the required currency appreciation. First, a share of the income increase will go to additional government taxation revenue.[7] In turn, government will allocate the revenue windfall to a combination of (a) saving and a reduction in government debt or even the purchase of foreign assets, (b) additional spending, or (c) reduction in other taxes, such as personal income. An increase in Sg of (1) under (a) reduces the required net capital inflow and demand for the domestic currency, and works for a currency depreciation.

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[5] Cook and Sieper (1984) provide some ideas based on share market adjustments to new wealth and the permanent income and consumption model in their Section 6, and Krueger and Porter (1984) provide models of perfect foresight.

[6] An unexpected demand boost seems applicable to the recent boom (from about 2003 to 2012 and perhaps beyond) for iron ore and coal to support the rapid growth of the steel industry in China.

[7] In Australia, government taxation includes the special taxes on mining companies, including the state royalties and commonwealth PRRT and MRRT, and corporate income tax, plus additional personal income taxation on extra dividends and larger capital gains to residents, and withholding taxes on additional income distributed to non-residents.

In the case of government allocation options (b) and (c), some, but only a fraction, of the income gain will be spent on tradable goods and services, both imports and exports, resulting in an increase of Mo and a fall of Xo in (1), and to an increase in other investment Io in (1), to depreciate the currency.

Second, the after-tax share of the increase in mining company income will be distributed to shareholders, raising incomes of resident and non-resident shareholders.[8] For non-residents, this means increasing NYT, an increase in private saving Sp, or a combination. For residents, some of their share of the corporate income increase, and the real income gains flowing from the higher terms of trade, will find its way into higher purchases of tradeable goods and services, namely more imports Mo and less exports Xo. The ensuing increase of the current account deficit (or a smaller surplus) works for a currency depreciation.

Together, except for exceptional circumstances, these second round income effects of changes to Xm, Xo, Sg and Sp to depreciate the currency add to less than the first round increase in exports ΔXm to appreciate the currency. The net appreciation effect will be greater: the larger the mineral price increase and the more important mineral exports in total exports; the larger the share of the income gain from the extra mineral export revenue distributed to residents, including government, businesses and households, and the larger the share of this income gain that is spent on non-traded goods and services.

4. Investment Boom

The demand shift and/or a response to the discovery of new deposits or new technology which lowers costs of production represented as an outward shift in the long run supply curve justify additional investment to expand production[9]. Because of time lags it takes several years before production increases. The investment phase includes the increase in investment, and its effects on the exchange rate depend primarily on the source of funds and the source of the investment products.

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[8] Connolly and Orsmond (2011) report that as much as 80 per cent of the large mining companies are foreign owned.

[9] The current Australian mining investment boom partly represents a response to a demand shift in the case of iron ore and coal, and partly a mixture of supply shift and demand shift in the case of gas.

There is a large net increase in mining investment, Im in (1). Since mining is a relatively capital intensive industry, the increase in mining investment ΔIm will exceed any squeeze on other investment ΔIo. Most of the net increase in investment will be funded by international capital, both debt and equity provided by non-residents, with only small contributions of reallocated domestic saving or from a mining boom induced increase of domestic saving. This increase of net capital inflow and demand for the currency will induce an appreciation of the currency.

Additional imports of mining equipment, ΔMm, can be negligible to as large as ΔIm depending on circumstances. In the special case where almost all the equipment is imported and ΔMm $\approx$ ΔIm, the pressure for a further appreciation of the exchange rate change will be offset. For more likely cases where the domestic economy provides a significant share of the investment and ΔMm < ΔIm (and in the extreme case where all of the mining investment is sourced domestically) this import effect on the exchange rate will be smaller than the investment effect (and at the extreme zero).[10]

Also, for a scenario with some of the investment sourced in the domestic economy the investment phase will involve additional second round income effects. To the extent that under employed residents and new immigrants are drawn into the mining investment boom, and some labour and capital resources reallocate from other sectors of the economy to supply the mining investment to earn higher returns, the investment stage results in an additional increase of domestic income.[11] The magnitude of the net income gain will be less than the first round increased domestic investment in the mining boom, ΔIm - ΔMm.

Some of the net income gain for residents of the investments to expand mining output will be spent by governments, businesses and households as an increase in Mo and less Xo, or saved to increase Sp and Sg in (1). But, some of the income gain will be spent on non-traded goods and services. These second round income effects will

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[10] The RBA (2012, p. 33) estimates that at least a half of the mining investment in 2011 to have been imported. Anecdotal information indicates that the import share varies across mines, and is higher for oil and gas than for minerals (Connolly and Orsmonde, 2011).

[11] Krueger and Porter (1984) argue in addition that rational lifetime utility maximising shareholders will include the future expected income from a surprise discovery of additional mineral resource or an unexpected increase in demand for current deposits even before production begins in current period expected permanent income.

reduce the magnitude of the required first round currency appreciation. Because of leakages of any income gains to expenditure on non-traded goods and services these second round effects to depreciate the exchange rate will be relatively small in comparison to the first round currency appreciation effects of the mining boom investment.

In net, over the investment stage of the mining boom the balance of payments forces are for an appreciation of the currency. The magnitude of the appreciation will be larger: the more domestic intensive the investment; and the larger the share of any domestic income increase spent on non-traded goods and services. For a demand driven mining boom, the currency appreciation of the investment phase is an addition to the currency appreciation effect of the demand expansion phase.

5. Production Increase Boom

With a lag, the investment phase provides the capacity for transition into the production phase. This phase of the mining boom will last for many years, if not decades, and much longer than the investment phase. Relative to the investment phase, direct or first round effects of the production stage on the balance of payments equation (1) involve changes in export receipts Xm, and not necessarily an increase, and a fall of mining investment Im and of mining imports Mm. In addition, there will be second round income and expenditure effects on other variables in equation (1).

The quantity of mining exports Qm increase with the extra production, but price also is likely to fall. Given that most of the investment represents a sunk cost, the short run supply curve for mining production is very inelastic. In the case of a supply shift boom for a particular country with a highly elastic demand, the price fall will be relatively small, and so long as demand is elastic[12] mining export receipts Xm increase. By contrast, for a demand shift boom, with other countries also expanding mining investment and production, the demand curve facing Australia shifts down, causing a larger price fall than for a supply driven boom. It is possible that the price fall will exceed the quantity increase, with Xm falling relative to the demand boom and investment phases described above. Export mining receipts in the production

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[12] Computable general equilibrium models for Australia, such as MONASH, and the global GTAP model, in their base cases have elastic mineral export demand elasticites, and above -4.

stage on average exceeds pre-boom export receipts. Only in an extreme case of a "cob-web cycle" excessive investment effect and/or a short term global demand reversal would price fall so far that Xm falls below the pre-boom level; and this revenue loss scenario would not be sustainable over the longer run. Then, the first round effect of the increased production of minerals is for a further appreciation of the exchange rate in the case of a supply shift boom. In the case of a demand increase driven mining boom, in most cases there will be a further exchange rate appreciation, but there is the possibility of a depreciation in the event of a significant fall in the terms of trade.

With the end of the investment phase, Im and Mm in (1) fall back to pre-boom levels. These changes largely call for a partial currency depreciation to reverse the currency appreciation effects of the investment phase discussed in the previous section.

Given the capital intensive characteristic of mining, depreciation expenses and repayment of the cost of investment capital will be a large share of expenses.[13] The larger the share of non-resident funds used for the investment Im, the larger the return flow to non-residents and the magnitude of increase of NYT in (1).[14] These payments would put downward pressure on the exchange rate. Since the capital repayments over the entire production stage roughly equal the investment sum of the investment stage, the exchange rate appreciation effects per year of the capital inflow during the mining investment boom phase will be larger than the depreciation effects with the repayments per year over the production stage.

The production stage of most mining booms will increase national income and expenditure over and above the gains of the investment stage. Increased GDP always will be the case with a supply side boom, and for a demand side boom where export receipts increase. Exceptional cases of an income fall involve a large fall in the terms of trade for some demand increase caused booms.

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[13] Using ABS and ATO data, Connolly and Orsmonde (2011, Table 6) estimate for 2008-09 that of gross mining revenue of $177 billion, 10 per cent went to labour costs, 39.5 per cent to intermediate input costs for goods materials and services, and 50.3 per cent to gross operating surplus, and of the latter royalties represented 6.2 per cent of revenues and company tax 7.3 per cent.

[14] The RBA (2012, p. 57) indicates that mining companies in Australia for the current investment boom on average fund about a half of their investment with overseas source debt funds.

For booms with a net income gain, so long as government taxes some of the gains or there is significant resident supply of the debt and equity employed to fund the required investment, the GDP increase also increases aggregate income of residents. To the extent that some of the income windfall is saved, and over the long production period the proportion saved is likely to be small, and that some of the higher income is spent on other imports or other exports, rather than on non-traded goods and services, second round income and expenditure effects will partly offset the magnitude of the first round currency appreciation effect of the production stage of a mining boom.

An alternative expenditure option is to re-invest some of the gains from the mining boom. Such an investment option could be based on the Hartwick rule (Hartwick, 1977) to maintain or sustain living standards when a mining boom involves the exploitation of a non-renewable resource.[15] Such a strategy would increase Io in (1) (and with a smaller increase of Mo). In net, the investment stimulus will add to pressures for a currency appreciation.

There are a number of conflicting effects to be considered to assess the overall net effect of the production stage of the mining boom on the exchange rate relative to the investment phase. In the case of a supply generated boom, the direct effects of an increase in mining production and export receipts push for an increase of the exchange rate relative to the investment phase. However, with a demand boom export receipts may fall, or at least for some years of the production stage. The reductions of non-resident capital inflow and of mining investment import products in moving from the investment phase to the production phase, even if in part they are offset with the repayment of borrowings and increases in net income transfers to non-residents, will push for a depreciation of the currency. Second round effects of the additional income for governments and residents push for a depreciation of the currency, and more so the higher the proportion of the income gain spent on imports and export products. On the other hand, if the income gain stimulates other productive investments, this additional investment calls for an increase of capital inflow, and likely also more

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[15] Following the Hartwick rule (Hartwick, 1977), conversion of wealth in mineral deposits via mining into current income will not reduce future income if the economic rent earned by the mining is productively invested in physical and human capital.

imports, but at the same time increases GDP in its own right in addition to the mining boom. Aggregating, the net effect on the exchange rate of the production stage of the mining boom depends on many details, and it could be positive or negative. The net effect becomes an empirical question.

6. Current Australian Mining Boom[16] and Exchange Rate Movements

The current Australian mining boom has both demand side and supply side origins. From about 2003 unanticipated rapid increases in steel production in China, and to a lesser extent other developing countries, increased the global demand for iron ore and coking coal, and global economic growth, even with the global finance crash downturn of 2008-09, increased the demand for energy. These demand shifts contributed to most, but not all, of the trebling of the RBA index of commodity prices and the record high level of the terms of trade (RBA, 2012). Each year from 2003 to about 2010 most analysts failed to predict further increases in prices (Connolly and Orsmonde, 2011). A combination of new discoveries over the past three decades and advances in technology this century added to known profitable to exploit reserves of gas (Geoscience Australia, 2012).

Clearly, the mining boom is not the only force for changes to the Australian exchange rate. Other forces include developments in other industries and countries as they influence changes in comparative advantages and the terms of trade, trade policy, changes in global patterns of saving and investment, movements in interest rates, and it seems that sentiments, expectations and political statements are important, and especially to short movements of exchange rates. Granted these reservations, the magnitude of the current mining boom has been an important determinant of observed changes in the Australian exchange rate over recent years.

From 2003 mineral exports increased from about $50 billion a year, and 25 per cent of all exports, to $188 billion in 2011, and 60 per cent of exports, with increased prices accounting for most of the increase (data from RBA, 2012). Most of this increase was the demand increase phase of the boom. Over this 2003 to 2011 period the TWI rose from around 55 to 75, or a 36 per cent appreciation.

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[16] An extensive discussion of the boom is provided by Connolly and Orsmonde (2011).

The investment phase of the current mining boom starts from about 2005-06. Mining investment per year is still growing. Capital expenditure for minerals and energy has grown from below two per cent of GDP in the early 2000s, to about 4 per cent or $55.5 billion in 2010-11(ABARES, 2011), with further increases estimated to reach around 9 per cent of GDP in 2013-14 (Swan and Wong, 2012). Funds for the investment have come from retained company earnings and new debt borrowing, and then much from non-residents, and some new non-resident equity with new international company entrants in joint ventures.

Over the 2000s, net foreign capital inflow, or the gap between domestic investment and saving, has fluctuated between 2.5 and 6.5 per cent of GDP with an average of 4.6 per cent, and the ratio of the net international investment to GDP has been stable at around 0.5 (data from ABS, 2012). It is estimated that up to a half of the mining investment has been on imported equipment, but with wide variation across products and mines (Connolly and Orsmonde, 2011). To a large extent, the combination of retained mining company income as a form of increased domestic saving, the high import share of investment, and the increase of imports of non-mining goods and services supported by the higher income and exchange rate have contributed to a stable ratio of net foreign capital inflow to GDP. As a result, the investment phase of the mining boom to date appears to have had a small additional net effect on the exchange rate beyond the demand boom stage effect.

There has to be considerable uncertainty about the effects of the production stage of the mining boom on the exchange rate. As noted in section 5 above, there are several different sets of forces working in different directions. Also, there is imperfect information about many of the key empirical facts. In particular, while most argue that commodity prices over the longer run will not fall back to 1990s levels because the current investment projects are for higher per unit cost supplies, the price falls from current levels could still be large so that the export revenue flattens or even falls below current investment phase revenues.

7. **Some Concluding Observations**

A model based on the balance of payments identity linking the current account and net domestic investment and saving is used to assess the likely direction of effect, and then the order of magnitude of effects, of mining booms on the exchange rate. At a general level, it is argued that exchange rate responses vary with whether the boom primarily is driven by an increase in demand or by an increase in supply, the responses vary over different stages of the mining boom for the demand surge, the investment phase and the production phase. The magnitude of the exchange rate change, and sometimes its direction of change, varies with such characteristics as the share of resident verses non-resident ownership and investment funds supply, the proportion of investment imported verses domestic production, and the division of income gains between saving and spending, and the allocation of spending between tradable verses non-tradable products. In general, the exchange rate appreciates during the demand phase, with a further increase in the investment phase. But, in the production phase the different characteristics can mean further increases or a fall of the exchange rate.

An important finding is that the relationship between the terms of trade and the exchange rate is not a simple monotonic one, including possible reversals in the directions of change of the two variables. For a demand driven mining boom: an increase in the terms of trade is reflected in an appreciation of the exchange rate during the demand increase stage; there is a further appreciation during the investment stage, but with no necessary change in the terms of trade; and, for the production stage where the terms of trade falls, in some cases the exchange rate can depreciate, while in other cases the increase in production will be enough to offset the price fall and further appreciate the exchange rate. In the case of a mining boom where an increase in supply is the primary source of the boom, the exchange rate appreciates during both the investment and production stages, which coincide with no change in the terms of trade during the investment stage and a fall during the production stage.

The paper has shown that the time pattern of exchange rate responses to mining booms often involves a number of different directions of effect, as well as changes over time in magnitudes of effects. Then, estimation of the net effect on the exchange rate, and on other macroeconomic variables, becomes an empirical task. Further, a computable equilibrium model which captures the different stages of a mining boom

and different characteristics of the mining industry and boom becomes a desirable next stage.

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