The exchange rate, Dutch disease and manufacturing in South Africa: What do the data say

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Abstract

The Dutch disease argument suggests that in commodity exporting countries "overvaluation" of the currency due to increases in commodity prices harms manufacturing even though the economy as a whole benefits, led by the booming natural resources sector. The relationship between the real exchange rate and manufacturing is studied here with regard to South Africa as a minerals-rich export-led economy. Since manufacturing is co-determined within a system of inter-related variables, a Johansen VAR/VEC cointegration approach was used to estimate these relationships. Using quarterly data for the sample period 1980–2010, the main findings are: world growth is the single most important determinant of domestic manufacturing; while the real exchange rate has the predicted negative sign, there is no evidence of a Dutch disease specific effect on manufacturing; large increases in unit labour costs since the early 1980s have dragged down manufacturing in South Africa over the sample period.

JEL: E20, E31, F43, O55

1 Introduction

The Dutch disease argument suggests that in commodity exporting countries "overvaluation" of the currency due to increases in commodity prices harms manufacturing even though the economy as a whole may benefit, led by the booming natural resources sector. South Africa is a significant exporter of metals and other minerals and such "overvaluation" of the domestic currency is often flagged as a factor that has contributed to the relative decline of manufacturing in the country. The relative strength of the South African rand over the past few years has been associated with rising commodity prices following the recovery in economic growth from the effects of the global financial crisis. Recently, like other emerging market economies such as Brazil, various policy

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interventions have been debated with a view to reducing what is regarded by some economists as unwanted currency appreciation.

There are conflicting ideas and evidence about the links between commodity prices, the exchange rate and the extent to which different sectors of commodity exporting countries either benefit or are harmed by their resource endowments. Each such country has its own historically specific structural characteristics or factors which make generalizations in this regard tentative. This case study of South Africa tries to isolate these factors and show how they co-determine the commodity-exchange rate-manufacturing nexus. This may help domestic policy makers in evaluating findings based on studies of other countries or groups of countries that may or may not be applicable locally.

Due to the link between commodity prices and the exchange rate it is believed that upswings in the commodity price cycle, while directly benefiting the natural resources sector, indirectly harm manufacturing due to the relative price effect. Sustained real appreciations of the currency lower the price competitiveness of domestic versus foreign manufactured goods leading to lower exports and greater foreign import penetration. However, the commodity price cycle is largely driven by changes in world growth. Thus for an export-led economy like South Africa, when world growth is expanding there are likely to be two opposing forces acting on domestic manufacturing: a positive growth effect and a negative price effect due to the appreciation of the rand associated with rising commodity prices. A Dutch disease specific effect on domestic manufacturing thus only arises if the negative price effect is greater than the positive growth effect. An important part of this study is to try to indentify which of these two effects is dominant in the South African economy.

Besides changes in world growth and the real exchange rate, other variables selected here as possible co-determinants of domestic manufacturing include an international metals price index, the real money supply and manufacturing unit labour costs. Inclusion of an international metals price index helps to isolate any Dutch disease or commodity specific effect apart from the more general relationship between the real exchange rate and domestic manufacturing. Since manufacturing is co-determined within a system of inter-related variables, a Johansen VAR/VEC cointegration approach is used to estimate these relationships. The estimates on OECD growth (used as a proxy for world growth) and the real money supply are expected to be positive while the signs on unit labour costs, the real exchange rate and the metals price index are expected to be negative. A positive estimate on the metals price index contradicts the presence of a Dutch disease specific effect and implies that the positive growth effect outweighs the negative exchange rate effect on manufacturing. Using quarterly data for the sample period 1980–2010, the main findings are: OECD growth is the single most important determinant of domestic manufacturing; while the real exchange rate has the predicted negative sign, the positive estimate on the metals price index suggests that there is no evidence of a Dutch disease specific effect and; large increases in unit labour costs have dragged down manufacturing in South Africa over the sample period.

The rest of the paper is organized as follows. Section 2 summarizes the

findings of some of the main research on the relationships between the exchange rate, commodity prices and manufacturing. Section 3 motivates the selection of variables, their measurement and sources of data and includes a description of some basic time series trends and cross correlations in the data. Section 4 sets out the more formal Johansen VAR/VEC cointegration model and estimation results. Section 5 interprets and explains the main findings. Section 6 concludes.

2 Literature Review

The term Dutch disease refers to the effects of the discovery in the 1960s of natural gas in the Netherlands. Early studies of this phenomenon suggested that although the country benefitted from the booming natural resource sector, the appreciation of the Dutch currency and declining exports harmed their manufacturing base resulting in a contraction of the tradable goods sector of the economy (Corden 1981; Corden and Neary 1982; Corden 1984; van Wijnbergen 1984). These findings were specific to the effects of a natural resource discovery or windfall on a small, open economy with an established manufacturing sector reliant on exports. Later studies saw similarities between the Dutch experience and the effects of currency appreciation on developing, primary commodity exporting countries following commodity specific price booms [see, for example, Gelb 1988 (oil exporting countries); Lewis 1984, 1989; Wheeler 1984 (mining in sub-Saharan Africa)]. This was seen as a contributing factor helping to explain their relatively poor growth performance compared to the more industrialized economies of the developed countries.

However, some of these studies failed to find much evidence of a Dutch disease effect on domestic manufacturing (Auty and Evans 1994; Fardmanesh 1991) and recognized that additional assumptions or structural features of developing economies had to be included in the model to account for their low growth relative to developed countries. The Dutch disease argument was thus extended to (and sometimes confused with) a broader thesis labeled the 'resource curse' that, "not only may resource-rich countries fail to benefit from a favourable endowment, they may actually perform worse than less well-endowed countries" (Auty 1993: 1, 124 as quoted in Davis 1995: 1765). The resource curse thesis includes a much wider range of political and socio-economic factors that are argued to hinder the development and growth of natural resources-rich countries.

Some studies suggest that the stimulatory effects of a booming natural resource sector more than compensate for any contraction experienced in the manufacturing sector (see, for example, Magud and Sosa 2010; Davis 1995; Gelb 1988). Thus Davis finds little corroborating evidence for the resource curse thesis for a group of mineral-based economies (including South Africa) and concludes that "There is nothing inherently growth-inhibiting in mineral booms and any resulting Dutch disease phenomena. The Dutch disease is simply a description of the causes and structural effects of boom-induced growth. If there is an essential problem arising from the Dutch disease, it is resource

allocation and the burden of adjustment, at least from the point of the losing factor...and the political pressure this puts on governments to intervene..." (Davis 1995: 1768).

Not all episodes of real exchange rate increases or decreases in commodity exporting countries are necessarily linked to changes in commodity prices. Speculative changes in international capital flows associated with socio-economic and political uncertainty have often been important factors in this regard. Regardless of the causes, however, various studies suggest that sustained currency appreciations harm the growth performance of developing countries. Rodrik (2009) demonstrates this for a sample of developing countries and further shows that the effects are symmetrical for sustained under-valuations of a currency, which were found to stimulate economic growth via the industrial sector. Focusing on South Africa, Rodrik (2008) argues that the high unemployment and low growth experienced in the country since the early 1990s was mainly due to contraction in the manufacturing sector and lays part of the blame for this on an overvalued currency. Rodrik suggests that trade liberalization measures in the 1990s, such as the lowering and simplification of import tariffs, also played a role in lowering the competitiveness and profitability of manufacturing in South Africa (although contrary evidence for this is cited by Rodrik in the work of Aghion, Braun and Fedderke 2006).

3 Selection of Variables and Description of the Data

The main items of interest are the empirical relationships between manufacturing output and the real exchange rate in South Africa and whether or not a commodity specific exchange rate effect can be found in the data using an international metals price index. The other variables selected for inclusion in the model are OECD growth (as a proxy for world growth), real M3 money supply, and manufacturing unit labour costs. Each variable, its measurement and sources of data are explained below before estimating the formal Johansen VAR/VEC model in Section 4. Unless stated otherwise, the Time-Series Explorer software package was used to search and access the relevant data.

3.1 Manufacturing output (MAN)

Manufacturing output is measured in value added terms in constant 2005 prices (R millions) as presented in the National Income Accounts (Source: South African Reserve Bank (SARB) Quarterly Bulletins).

3.2 Real effective exchange rate (REER)

A real effective exchange rate index (2005=100) is the best indicator of the competitiveness of domestic manufacturing: an increase or real appreciation

indicating a decline in competitiveness and a decrease or real depreciation indicating greater competitiveness of manufactured goods. Changes in the nominal exchange rate only alter relative prices and thus the competitiveness of manufacturing if they are not offset by corresponding changes in inflation rates: thus nominal depreciation of the currency has no effect on the competitiveness of manufacturing if domestic prices rise (or foreign prices fall) by the same amount as the depreciation. Also, a multi-lateral trade weighted exchange rate is preferable to a single bilateral exchange rate (usually against the US dollar) used in some studies. The trade-weights are based on bilateral trade with the country's main trading partners in manufactured goods. (Source: SARB Quarterly Bulletins).

As shown in Figure 1, manufacturing (MAN) in South Africa has tended to decline steadily relative to the economy as a whole (measured as gross value added) since the early 1980s while the volatile real effective exchange rate (REER) has also declined (indicating depreciation), although much more erratically over the same period.

Figure 1 shows the long-term relative decline of manufacturing in South Africa, from just over 21 percent of gross value added in 1980 to around 17 percent in 2010. The real effective exchange rate of the rand has also declined slightly from an index value of about 118 to around 105 over the same period (note that by convention the REER is expressed indirectly as the foreign price of domestic currency such that decreases in the index indicate real depreciations and increases real appreciations of the domestic currency respectively). These longer-term trends do not on the face of it support the idea that a weaker currency helps manufacturing. If anything they suggest the opposite, with a lower exchange rate (depreciation) associated with a smaller manufacturing sector relative to the economy as a whole. However, both time series have fluctuated considerably, especially the notoriously volatile real exchange rate. Closer inspection of Figure 1 shows that the long-term trend declines in both MAN/GVA and REER have been interrupted by periodic increases. Thus certain sub-periods show that increases in MAN/GVA were associated on average with declines (depreciations) in REER (e.g. 1999-2001) and vice versa where decreases in MAN/GVA were associated with increases (appreciations) in REER (e.g. 2008-2010). Notwithstanding the long-term trend declines in both MAN/GVA and REER, these shorter-term trends lend some support to the idea that a weakening currency helps manufacturing while a stronger currency may harm it. Given the conflicting picture of the relationship between the real exchange rate and manufacturing in South Africa, a more formal model including the other co-determining variables and an appropriate lag structure is necessary to estimate the direction and extent to which changes in the real exchange rate of the rand have been responsible for the observed changes in manufacturing. Moreover, since the exchange rate is also influenced by factors other than commodity prices, to what extent, if any, can the changes in manufacturing be attributed to a Dutch disease specific effect?

3.3 OECD growth (OECD)

Perhaps the most enduring structural characteristic of the small, open South African economy is its dependence on commodity (primarily metals and minerals) export-led growth, a basic feature that has not changed for over a hundred years. As such, domestic growth is heavily dependent on world growth. When world growth increases, the foreign demand for exports (both primary commodities and manufactured goods) increases. Moreover, expansion in world growth often also leads to, or coincides with, an upswing in the commodity cycle (in both price and volume terms). Thus during expansionary phases in world growth, net exports increase sharply thereby directly injecting large inflows of spending into the domestic economy. The foreign trade multiplier further increases domestic demand, spending and income leading to increases in national income and output which are a multiple of the initial injection of net exports. Increases in world growth thus lead to increases in both foreign demand (directly) and domestic demand (indirectly) for manufactured goods.

Quarterly data on world growth is difficult to obtain as most sources (such as the IMF) only publish annual data. However, the OECD publishes quarterly data on member countries gross domestic product and growth. Since there is a very high correlation between OECD growth and global growth, it is a good proxy for the latter. Moreover nearly all of South Africa's trade in manufactured goods is with the OECD rather than non-OECD countries, which makes it consistent with the real effective exchange rate indicator used in the model. As explained in section 3.2, the trade-weights used to construct the REER are similarly based on multi-lateral trade in manufactured goods with OECD countries. The aggregate OECD series is measured as gross domestic product in US dollars with volume estimates using the expenditure approach, fixed purchasing power parities and the OECD reference year (Source: OECD StatExtracts, Quarterly National Accounts, on-line database).

3.4 International metals price index (METPI)

The Dutch disease argument is captured explicitly in the model by including a representative commodity price index. This variable helps to isolate the commodity specific exchange rate effect on manufacturing from other factors determining the exchange rate. In South Africa, speculative capital flows associated with political uncertainty have been an important factor in this regard, especially in the 1980s and leading up to the landmark election of the ANC government in 1994. Speculative capital flows resulting from the contagion effects of the emerging markets crisis in 1997-1998 and the domestic foreign exchange crisis in late 2001 also had major effects on the exchange rate. These episodes led to sharp depreciations in the rand, usually followed by appreciations as markets adjusted to initial over-reactions to these events. Thus not all appreciations of the rand and the effects thereof on domestic manufacturing can be attributed to a Dutch disease effect following rising commodity prices. Symmetrically, given Rodrik's (2009) argument about the stimulatory effects of under-valuations on

growth in developing countries, neither can depreciation of the rand always be attributed to declining commodity prices.

It is difficult to find or construct a representative commodity price index for South Africa. Unlike economies that are dominated by a single natural resource or commodity (e.g. the major oil exporting countries), South Africa produces and exports a diverse range of primary commodities (including gold, platinum, most base metals, coal and diamonds). Moreover, the contribution of these commodities to the country's exports has changed significantly over the sample period. For example, gold's contribution to merchandise exports declined from nearly half in 1980 to around ten percent in 2010 whereas other primary commodity exports such as platinum have grown substantially over the same period. However, despite the diverse and changing composition of South Africa's primary commodity exports, they have been mostly dominated in some shape or form by metals. With this in mind, the IMF non-fuel primary commodities metals price index (2005=100) was selected as a representative proxy thereof (Source: IMF, *International Financial Statistics*).

3.5 Real M3 money supply (M3REAL)

A broad measure of the real domestic money supply (M3) is included in the model to capture the effect of internal liquidity and demand conditions on manufacturing output. Without such a conditioning variable the effects of the other variables in the model are likely to be over-estimated. Changes in the real money supply show a strong positive correlation with changes in manufacturing output. However, unlike world growth and changes in international commodity prices which are unambiguously foreign exogenous factors influencing the domestic economy, arguments about the endogeneity of the money supply and direction of causation remain unresolved. According to the quantity theory of money $MV = PY$, where M is the money supply, V is the velocity of circulation of money, P is the price level and Y is real output or income. M is under the control of the central bank, V represents a stable demand for money function and Y is determined by real factors such as technology and leisure preference. Thus, according to the quantity theory, causation runs from changes in the money supply to proportionate changes in the price level and nominal income with real output and income remaining unchanged. Contrary to the orthodox monetarist interpretation of the quantity theory, however, causality may also run from changes in output to changes in the money supply. An advantage of the Johansen VAR/VEC approach used here is that there is no need to specify in advance which variables are exogenous and which are endogenous – the data will tell us that after the model has been estimated. Deflating M3 by the headline consumer price index (CPI) gives a broad measure of the real money supply which also captures wealth effects due to changes in financial asset prices such as bonds and shares (Source: M3, SARB Quarterly Bulletins; CPI, Statistics South Africa).

3.6 Manufacturing unit labour costs (MANULC)

Unit labour costs are an internal cost factor that is often used in international comparisons of manufacturing competitiveness. Increases in unit labour costs lower the competitiveness of the domestic manufacturing sector relative to foreign manufacturing. In this respect, increases in unit labour costs are similar to the effect of increases in the real exchange rate. While real wages could also be used as an indicator of changes in the labour cost of manufacturing, unit labour cost is a better measure since it adjusts earnings per worker for changes in productivity: changes in earnings per worker (wages) leave the competitiveness of manufacturing unaffected if they are matched by equivalent changes in labour productivity (output per worker). Unit labour costs in manufacturing rose more than seventeen-fold in South Africa between 1980 and 2010, from an index value of 10.4 to 179.1. Unit labour costs are likely to change counter-cyclically, with increases (decreases) in manufacturing leading to decreases (increases) in unit labour costs. This is because changes in wages and employment tend to lag changes in manufacturing output. Thus unit labour costs are most likely to be endogenous to the system. (Source: SARB Quarterly Bulletins).

Before estimating the Johansen cointegration model in section 4, it is helpful to get a rough idea of some of the main relationships between the variables using covariance analysis. After natural log and first difference transformations of the data to focus on growth or changes in the variables rather than their levels, the cross correlations between them are as set out in table 1 below:

In the first column (MAN) the significant positive correlations between the changes in manufacturing, OECD growth (OECD) and the real money supply (M3REAL) are as expected from the explanations given above. The significant negative correlation with unit labour costs (MANULC) is also as expected. However, the positive correlation with the real effective exchange rate (REER) is wrongly signed and insignificant. Moreover, the significant positive correlation with the metals price index (METPI) contradicts the Dutch disease argument: if the hypothesis holds for South Africa we would expect a negative correlation such that increases (decreases) in metals prices are associated with decreases (increases) in manufacturing output due to a stronger (weaker) currency.

A possible explanation for these contradictory findings is the significant positive correlation between OECD growth and METPI (column 2, row 3) and between METPI and REER (column 3, row 4). This suggests that expansions in OECD growth are associated with increases in metals prices while the latter is associated with increases (appreciation) in the real effective exchange rate (and vice versa for contractions in OECD growth). Thus when OECD growth expands there are potentially two opposing forces at work on the manufacturing sector: a direct positive growth effect (column 1, row 2) and an indirect negative exchange rate effect resulting from the appreciation of the currency due increases in the metals price index (column 3, row 4). However, the latter inference from commodity induced appreciation of the currency to lower manufacturing output is not supported by the cross correlation analysis here since, as noted above, the correlation between MAN and REER (column 1, row 3) is

insignificant. The absence of the expected negative correlation between these two variables may be due to the differencing operation. While differencing helps to avoid spurious correlations that arise purely due to coincidental trends in the time series data, it also removes any genuine long-run relationship that may underlie the data. The Johansen cointegration approach presented in the next section is a more efficient technique for estimating the variables in a model that avoids these problems.

4 Johansen Cointergration and Vector Error Correction Model

The list of variables from the motivation given in Section 3 is:

MAN - Manufacturing (constant 2005 prices)

OECD - OECD real GDP used as a proxy for world GDP (OECD reference year)

METPI - IMF non-fuel primary commodities metals price index (2005=100)

REER - Real effective exchange rate index (2005=100)

M3REAL - Nominal M3 money supply deflated by the headline consumer price index (2000=100)

MANULC - Manufacturing unit labour cost index (2000=100)

As is standard practice in models with time series data on South Africa, especially when they include an exchange rate variable, a dummy variable is often included to mark the structural break between the pre- and post-1994 democratic era. Here the dummy variable (D1) takes a value of 1 from 1980:Q1 to 1994:Q1 and a value of 0 from 1994:Q2 to 2010:Q4.

Given the strong theoretical expectations about the direction of causation between some of the variables it is tempting to use a single equation Engel-Granger cointegration approach to estimate the relationship between the variables, with domestic manufacturing set as the dependent variable on the left and all the others as independent variables on the right. After all, world growth and internationally determined metals prices are unambiguously foreign exogenous factors as regards their influence on the domestic economy. For a small, open economy like South Africa there is no reason to expect any significant feedback effect or reverse causation on these variables. Similarly for the real exchange rate of the South African rand which is determined in the international foreign exchange and other financial asset markets.

However, the money supply and manufacturing unit labour costs are likely to be endogenous variables, changes in which are caused by changes in the other variables in the system. The exogenous vs. endogenous debate regarding the

relationship between changes in the money supply and output remains inconclusive as explained in section 3.5. In the short-run, if wages and prices are sticky, changes in unit labour costs may respond to demand-led changes in manufacturing output (section 3.6). Moreover, there may be significant interactions and feedback effects between changes in world growth, commodity prices, the exchange rate and manufacturing. Unless the time paths of all the regressors are unambiguously exogenous, it is better to use a vector autoregression (VAR) approach. Thus in the present context where the variables are non-stationary in levels, the Johansen VAR/VEC cointegration approach was preferred to the single equation Engel-Granger approach. Where more than two variables are included in the system, there may be more than one cointegrating relationship. Even if only one of the cointegrating equations is of interest, there may be feedback effects between the equations that could alter the parameter estimates significantly. The Johansen approach provides a more efficient maximum likelihood test and estimates of the model parameters since it does not waste this information (Enders 2004: 347-348). The EViews 7 software package was used to follow the standard steps of the Johansen cointegration method in sections 4.1 – 4.5 below.

Log transformations of the variables were done to allow for an elasticity interpretation of the estimates. Plots of the variables suggest strong linear time trends for the data on manufacturing, world (OECD) GDP, real money supply and unit labour costs and less so for the metals price index and the real exchange rate:

4.1 Order of integration

After natural log transformations, all the variables were tested for unit roots using the Augmented Dickey-Fuller (ADF) test. All the variables were found to be I(1) and thus stationary in first differences (intercept and trend model) at the 1% level of significance:

The results of the ADF tests are supported by the results of both the Phillips-Perron (PP) and Kwiatowski-Phillips-Schmidt-Schin (KPSS) unit root tests which also suggest that the time series are I(1). The PP test statistics (Andrews automatic bandwidth selection using the Bartlett kernel) were smaller than the 1% critical value of -4.0350 (trend and intercept model) allowing the null hypothesis of a unit root to be rejected for all the variables. The KPSS test statistics (Newey-West automatic bandwidth selection using the Bartlett kernel) were smaller than the 1% asymptotic critical value of 0.4630 (intercept model) in this case allowing the null hypothesis that the variable is stationary to be accepted for all the variables.

4.2 VAR lag length

An initial lag length of 12 was used in the unrestricted VAR. The LR and standard information criteria tests suggested the following lag lengths (in parentheses): sequentially modified likelihood ratio, LR (7); final prediction error, FPE

(2); Akaike information criterion, AIC (2); Schwarz information criterion, SC (1); Hannan-Quinn information criterion, HQ (2). The LR indication of 7 lags was selected to give the best chance of obtaining stationary residuals.

4.3 VECM trend specification

The plots of the variables suggest the presence of linear time trends in the data for LN_MAN, LN_OECD, LN_M3REAL and LN_MANULC and less so for LN_METPI and LN_REER. Selecting the lag length as 7 (as determined above), the Johansen trace and maximum eigenvalue test suggest an intercept, no trend model for the cointegrating equations (compared to the no intercept, no trend model suggested by the SC test and the quadratic model suggested by the AIC test). Thus model 2 in the EViews 7 program (intercept, no trend in the cointegrating equation, no intercept in VAR) was used for the cointegration test.

4.4 Estimation and determination of rank

Selecting the above intercept, no trend model with a lag length of 1 to 7 suggested r=6 cointegrating equations under the Johansen trace test and r=2 equations using the maximum eigenvalue test at the 5% level of significance. Only the first cointegrating equation and associated loading matrix of adjustment coefficients is of interest in terms of its economic justification and for further testing of restrictions. Normalizing the equation with respect to manufacturing gave the following estimates of the long-run cointegrating relationship and the adjustment coefficients:

The EViews program estimates (rounded up to two decimal places) for the cointegrating relationship above can be restated in conventional regression equation form as:

$$\begin{aligned} LN\_MAN \quad = \quad & -1.15 + 0.76(LN\_OECD) + 0.08(LN\_METPI) - \\ & 0.17(LN\_REER) + 0.17(LN\_M3REAL) - \\ & 0.19(LN\_MANULC) + 0.03(D1) \end{aligned} \tag{1}$$

All the parameters in equation 1, with the important exception of LN_METPI, are as expected on the basis of theoretical considerations and findings of other studies. Note that the sign on LN_REER now has the expected negative sign, unlike the wrongly signed and insignificant correlation suggested by the preliminary cross correlation estimate in table 1 (see end of section 3). However, the positive estimate on LN_METPI contradicts the Dutch disease argument which suggests a negative sign. Testing for zero restrictions on the beta coefficients in Equation (1) is not applicable as there is no good economic justification for excluding any of the explanatory variables in this case. Also, as noted by Enders (2004: 361), for multiple cointegrating vectors the same number of variables must be removed from a single equation to constitute a testable exclusion. Removing r=6 variables would make little economic sense in this context.

4.5 Exogeneity tests

Tests of restrictions on the adjustment coefficients help to distinguish which of the variables are exogenous and which may be regarded as endogenous to the system. Restricting the adjustment coefficients to zero gives the associated LR statistics and probabilities for each variable in Table 2 below:

The null hypothesis of a zero adjustment coefficient is rejected for the real money supply (row 5) and for unit labour costs (row 6, where # indicates no convergence possible if the zero coefficient restriction is imposed) but cannot be rejected for manufacturing output (row 1), OECD growth (row 2), the metals price index (row 3) and the real exchange rate (row 4). Thus, the real money supply and unit labour costs are endogenous to the system and play a role in correcting deviations from the long run cointegrating relationship while manufacturing output, OECD growth, the metals price index and real exchange rate variables are weakly exogenous. The exogenous variables may thus be seen as causing changes in the other variables in the system rather than responding to deviations from the long run relationship itself. These results confirm our common sense reasons for believing world growth, the metals price index and the real exchange rate to be exogenous as explained in section 3. The finding that the real money supply is endogenous supports a Keynesian rather than an orthodox monetarist interpretation of the adjustment process, as explained in sections 3.5.

Since the (weakly) exogenous variables do not play a role in correcting deviations from the long-run cointegrating relationship, the parameters in equation 1 can be re-estimated taking this information into account. Restricting the adjustment coefficients on all the exogenous variables to zero, the signs on the estimates in equation 1 remain the same but the sizes of the estimates change as shown below:

The above results of the tests of the restrictions show that the null hypothesis cannot be rejected, showing that the new parameter estimates in the cointegrating equation are a valid representation of the relationship. Rewriting the equation in conventional regression form:

$$\begin{aligned} LN\_MAN \quad = \quad & -0.07 + 0.70(LN\_OECD) + 0.08(LN\_METPI) - \\ & 0.17(LN\_REER) + 0.18(LN\_M3REAL) - \\ & 0.17(LN\_MANULC) + 0.03(D1) \end{aligned} \tag{2}$$

The main change is the slightly smaller estimate on OECD growth, which decreases to 0.70 compared to the estimate of 0.76 in Equation 1. In absolute terms, there is a small increase in the estimate on the real money supply and a small decrease in the estimate on unit labour costs.

5 Intrepretation and Explanation of the Results

From Equation 2 it is clear that OECD growth has been the main driver of manufacturing in South Africa over the 1980-2010 sample period studied. The

positive estimate of 0.70 on LN_OECD is bigger than the absolute value of the estimates on the other four explanatory variables combined (or more than four times bigger in absolute terms than the estimated negative effect of the real exchange rate). This accords with the basic structural feature of South Africa as a small, open, export led economy. The elasticity estimate implies that a 1 percentage point increase (decrease) in world growth leads to a 0.70 percentage point increase (decrease) in domestic manufacturing.

The negative estimate of –0.17 on the real exchange rate (LN_REER) supports the findings of other studies (e.g. Rodrik 2009) that sustained episodes of real currency appreciation tend to be associated with lower growth in manufacturing and vice versa for depreciation or under-valuations of the currency. The presumed causal mechanism for this association is the relative price effect on the competitiveness of domestic manufactured goods. Thus sustained appreciation leads to an increase in the price of domestic manufactured goods relative to competing foreign goods which in turn leads to lower exports and greater import penetration of the domestic market (vice versa for depreciation). It may be the case that manufactured exports are more sensitive to changes in the real exchange rate than are such goods consumed domestically. This is likely to be the case the greater are any tariff and non-tariff barriers to imports. At a finer level of disaggregation, it may also be the case that certain industries are more sensitive to changes in the real exchange rate than others. For example, the clothing industry may be more sensitive than the steel industry. These more disaggregated effects are however outside the scope of this study.

The positive coefficient of 0.08 on the metals' price index (LN_METPI) is contrary to the negative sign one would expect if the Dutch disease argument were applicable to the South African economy. Although small, the positive estimate suggests that increases in the metals price index have been associated with higher rather than lower manufacturing growth in South Africa over the sample period studied here. The probable reason for this is that changes in the metals price index are also largely driven by changes in world growth as suggested in section 3 by the positive cross correlation in table 1 (column 2, row 3). When OECD growth expands there is a tendency for metals prices to increase and thus for the currency to appreciate in real terms (column 3, row 4). Moreover, the negative estimate on LN_REER in Equation 2 allows us to infer that the effect on domestic manufacturing is thus the net result of a contest between the positive effect of world growth and the negative relative price effect due to a stronger currency (see also the discussion at the end of section 3). Because the growth effect is so dominant, it more than compensates for the negative effect of currency appreciation associated with rising commodity prices. The impulse response functions in Figure 4 also help illustrate these effects.

5.1 Response to Cholesky One S.D. Innovations

The first panel shows the positive impulse response of the metals price index (over 10 successive quarters) to a unit standard deviation increase in OECD growth. Moving clockwise, the second panel shows the positive response of the

real exchange rate to an increase in the metals' price index while the third panel shows the negative response of manufacturing to an increase in the real exchange rate. The fourth panel shows the much stronger positive response of manufacturing to an increase in OECD growth.

As reviewed in section 2, some studies suggest that growth in mineral-rich exporting countries is not necessarily harmed by the effects of currency appreciation associated with upswings in commodity prices. Such studies find that although the manufacturing (lagging) sector contracts, this is more than offset by expansion in the resources (booming) sector of the economy such that growth as a whole increases. The results of this study, however, show that growth in the manufacturing sector in South Africa is positively correlated with commodity prices and thus upswings in the cycle are on average associated with expansion in manufacturing and downswings with contractions Thus whatever are the causes of the poor performance of manufacturing in South Africa, booming metals and minerals prices as such do not appear to be among them. Note, however, that a manufacturing sector that grows *more slowly* than the rest of the economy during upswings in the commodity price cycle is consistent with the declining contribution of manufacturing to national output portrayed in Figure 1.

The positively signed estimate of 0.18 on the real money supply (LN_M3REAL) is as expected, capturing the effects of changes in domestic demand due to liquidity and wealth conditions as explained in section 3.5. It should be noted here that if the monetary authority's reaction function favours an output rather than inflation target (either implicitly or explicitly), then there is a bias to finding a positive correlation between the money supply and output variables in such model estimations. However, the money supply variable is included here essentially as a conditioning variable to ensure that the effects of the other variables in the model are not over-estimated. In the system of variables and equations estimated here, the real money supply was found to be endogenous and thus to play a role in correcting deviations from the long-run cointegrating equation. In other words, shocks or impulses to the (weakly) exogenous variables tend to produce the deviations from long-run equilibrium while endogenous variables such as the real money supply do most of the work of correcting them in the model estimated here.

The negative coefficient of -0.17 on unit labour costs (LN_MANULC) suggests that increases in such costs drag down manufacturing significantly over the longer term. Increases in unit labour costs have a similar effect on manufacturing as do increases in the real exchange rate: if domestic unit labour costs increase at a faster rate than abroad, then over time the competitiveness of domestic relative to foreign manufacturing declines resulting in reduced exports and greater import penetration. The substantial rise in unit labour costs in South Africa since the early 1980s is the net result of earnings per worker (wages) increasing on average at a faster rate than output per worker (labour productivity) over the sample period. With reforms to apartheid labour legislation in the late 1970s and 1980s, trade unions were able to engage more effectively in strike action and to negotiate higher real wages for their members. The size and power of the unions grew further after the historic election of the

ANC government in 1994. While workers may have benefitted in this regard, the accompanying increases in real wages without matching increases in productivity have led to higher unit labour costs thereby contributing to the declining competitiveness of manufacturing in South Africa over the period.

The negatively signed unit labour cost variable was found to be endogenous to the system and thus to play a role in correcting deviations from the longrun cointegrating relationship. Since unit labour costs equal earnings per worker (wages) divided by output per worker (productivity), the negative sign on this variable is consistent with two alternative explanations of the adjustment process. The classical or supply-side view is that firms hire up to the point at which the marginal cost of labour equals its value of marginal product. Thus increases in wages not matched by increases in productivity result in higher unit labour costs, declines in employment and a fall in manufacturing output (and vice versa for increases in wages that are lower than increases in productivity) The classical assumption of highly flexible prices implies that the resulting increase in unemployment puts downward pressure on wages such that full employment is restored quickly. Keynesian or demand-side explanations see higher unit labour costs as the result of demandled decreases in manufacturing output which, due to sticky prices and wages, means that output per worker (productivity) falls faster than the adjustment in wages. The longrun relationship thus depends on the lagged response of wages and employment. The results of this study are consistent with either explanation depending on auxiliary assumptions about the degree of price and wage rigidity in the South African economy.

6 Conclusion

This paper examines the relationship between the exchange rate, commodity prices and manufacturing in South Africa. A Johansen cointegration approach was used to estimate the empirical relationships between selected variables in an economically defensible VAR/VEC model. Using quarterly data on manufacturing, an OECD proxy for world growth, real money supply, unit labour costs, an international metals price index and the real effective exchange rate for the sample period 1980-2010, the main findings and implications of this analysis are:

i) The OECD proxy for world growth is the single most important determinant of domestic manufacturing. Setting manufacturing as the dependent variable, the estimate on OECD growth in the structural cointegrating equation is bigger in absolute value terms than the sum of the estimates on all the other variables combined. The positive OECD growth effect is more than four times bigger in absolute terms than the negative estimate on the real exchange rate.

ii) There is no evidence of a Dutch disease specific effect on manufacturing in South Africa. The positive estimate on the metals' price index although small suggests that upswings in the commodity price cycle are associated with

increases, not decreases, in domestic manufacturing. The explanation for this relationship is that the commodity price cycle is positively correlated with both world growth and the real exchange rate. When world growth expands, commodity prices tend to rise and the currency appreciates. During these boom phases, the stimulatory effects of world growth and rising commodity prices on manufacturing more than compensate for the negative effect of currency appreciation. The opposite holds when world growth contracts, commodity prices fall and the currency depreciates. Currency depreciation helps to cushion the effects of declines in world growth and commodity prices on manufacturing but cannot reverse them.

iii) The negative estimate on unit labour costs suggests that the large increases in such costs experienced in South Africa (a seventeen-fold increase over the sample period) are a significant drag on manufacturing over the long run. If unit labour costs in foreign manufacturing increase at a slower rate than for domestic manufacturing, this erodes the competitiveness of local production Such increases in unit labour costs thus have a similar effect on domestic manufacturing as increases (appreciation) in the real exchange rate.

Disaggregating manufacturing into exports and domestic consumption or according to finer levels of industrial classification (for example, the clothing as compared to the steel industry) may reveal differential effects of changes in the real exchange rate at these levels. This may be a fruitful direction for further research in this area.

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Table 1: Cross correlations between manufacturing, OECD growth, international metals price index, real effective exchange rate, real M3 money supply and unit labour costs.

Covariance Analysis: Ordinary
Date: 03/12/12 Time: 22:36
Sample (adjusted): 1980Q2 2010Q4
Included observations: 123 after adjustments

Correlation Probability	MAN	OECD	METPI	REER	M3REAL	MANULC
MAN	1.000000 -----					
OECD	0.411052 0.0000	1.000000 -----				
METPI	0.288593 0.0012	0.427190 0.0000	1.000000 -----			
REER	0.017141 0.8507	-0.021340 0.8148	0.194478 0.0311	1.000000 -----		
M3REAL	0.239050 0.0077	0.112865 0.2139	0.067425 0.4587	-0.045174 0.6198	1.000000 -----	
MANULC	-0.578241 0.0000	-0.276949 0.0019	-0.254304 0.0045	0.035021 0.7006	-0.268370 0.0027	1.000000 -----

Table 2: ADF unit root tests on natural log transformations of the variables

VARIABLE	ADF stat	1% critical value	Prob.	H0: unit root
LN_MAN	-7.0069	-4.0350	0.0000	reject
LN_OECD	-6.0092	-4.0350	0.0000	reject
LN_METPI	-7.3068	-4.0350	0.0000	reject
LN_M3REAL	-8.4202	-4.0350	0.0000	reject
LN_MANULC	-10.0593	-4.0350	0.0000	reject
LN_REER	-6.0092	-4.0350	0.0000	reject

Table 3: Estimation results of cointegration tests, equations and adjustment coefficients for normalization on LN_MAN

Sample (adjusted): 1982Q1 2010Q4
Included observations: 116 after adjustments
Trend assumption: No deterministic trend (restricted constant)
Series: LN_MAN LN_OECD LN_METPI LN_REER LN_M3REAL LN_MANULC D1
Lags interval (in first differences): 1 to 7

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.483825	237.0384	134.6780	0.0000
At most 1 *	0.361058	160.3266	103.8473	0.0000
At most 2 *	0.254323	108.3655	76.97277	0.0000
At most 3 *	0.233434	74.32375	54.07904	0.0003
At most 4 *	0.152960	43.48697	35.19275	0.0051
At most 5 *	0.131031	24.23012	20.26184	0.0135
At most 6	0.066144	7.938217	9.164546	0.0850

Trace test indicates 6 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.483825	76.71179	47.07897	0.0000
At most 1 *	0.361058	51.96115	40.95680	0.0020
At most 2	0.254323	34.04174	34.80587	0.0615
At most 3 *	0.233434	30.83678	28.58808	0.0254
At most 4	0.152960	19.25685	22.29962	0.1261
At most 5 *	0.131031	16.29190	15.89210	0.0433
At most 6	0.066144	7.938217	9.164546	0.0850

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Restrictions:

B(1,1)=1

Tests of cointegration restrictions:

Hypothesized No. of CE(s)	Restricted Log-likehood	LR Statistic	Degrees of Freedom	Probability
1	2049.792	NA	NA	NA
2	2075.773	NA	NA	NA
3	2092.794	NA	NA	NA
4	2108.212	NA	NA	NA
5	2117.840	NA	NA	NA
6	2125.986	NA	NA	NA

NA indicates restriction not binding.

1 Cointegrating Equation(s): Convergence achieved after 1 iterations.

Restricted cointegrating coefficients (standard error in parentheses)

LN_MAN	LN_OECD	LN_METPI	LN_REER	LN_M3REAL	LN_MANULC	D1	C
1.000000	-0.764419	-0.079092	0.166267	-0.172356	0.185989	-0.032276	1.150288
(0.00000)	(0.15951)	(0.01012)	(0.02203)	(0.03192)	(0.03336)	(0.00763)	(2.41103)

Adjustment coefficients (standard error in parentheses)

D(LN_MAN)	-0.145494
	(0.13907)
D(LN_OECD)	0.017288
	(0.04274)
D(LN_METPI)	-0.347836
	(0.90973)
D(LN_REER)	-0.121560
	(0.74268)
D(LN_M3REAL)	0.437704
	(0.20407)
D(LN_MANULC)	-1.034371
	(0.21905)
D(D1)	2.295807
	(1.12186)

Table 4: Test results for restrictions on the adjustment coefficients

Variable	LR statistic	DoF	Probability
D(LN_MAN)	1.4730	1	0.2249
D(LN_OECD)	0.1574	1	0.6915
D(LN_METPI)	0.1831	1	0.6687
D(LN_REER)	0.0293	1	0.8640
D(LN_M3REAL)	5.9434	1	0.0148*
D(LN_MANULC)	#	#	#

Table 5: Estimates of cointegrating equation after imposing zero adjustment restrictions on the weakly exogenous variables

Restrictions:

B(1,1)=1
A(1,1)=0
A(2,1)=0
A(3,1)=0
A(4,1)=0

Tests of cointegration restrictions:

Hypothesized No. of CE(s)	Restricted Log-likehood	LR Statistic	Degrees of Freedom	Probability
1	2048.909	1.765507	4	0.778787
2	2074.628	*	*	*
3	2092.549	0.489854	2	0.782762
4	2108.091	0.242155	1	0.622654
5	2117.840	NA	NA	NA
6	2125.986	NA	NA	NA

* indicates convergence not achieved.
NA indicates restriction not binding.

1 Cointegrating Equation(s): Convergence achieved after 10 iterations.

Restricted cointegrating coefficients (standard error in parentheses)

LN_MAN	LN_OECD	LN_METPI	LN_REER	LN_M3REAL	LN_MANULC	D1	C
1.000000	-0.695094	-0.078605	0.173995	-0.182503	0.172088	-0.034278	0.074094
(0.00000)	(0.16344)	(0.01037)	(0.02258)	(0.03271)	(0.03418)	(0.00782)	(2.47042)

Adjustment coefficients (standard error in parentheses)

D(LN_MAN)	0.000000
	(0.00000)
D(LN_OECD)	0.000000
	(0.00000)
D(LN_METPI)	0.000000
	(0.00000)
D(LN_REER)	0.000000
	(0.00000)
D(LN_M3REAL)	0.505630
	(0.19072)
D(LN_MANULC)	-1.124720
	(0.17935)
D(D1)	2.426636
	(1.09964)

Figure 1: Manufacturing as a proportion of gross value added (MAN/GVA) and the real effective exchange rate of the rand (REER 2005=100), 1980: 1-2010: 4

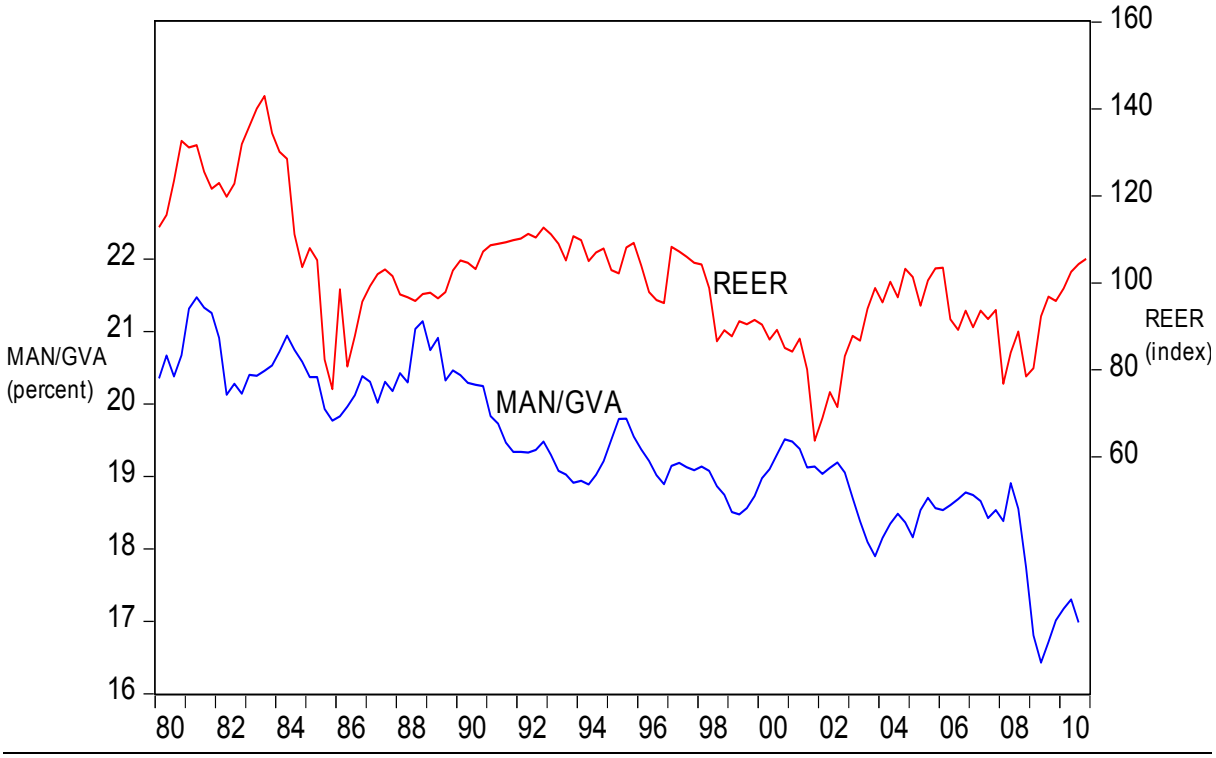

Figure 2: Plots of manufacturing, OECD gross domestic product, real M3 money supply, unit labour costs, international metals price index and the real effective exchange rate (natural logs), 1980: 1 – 2010: 4

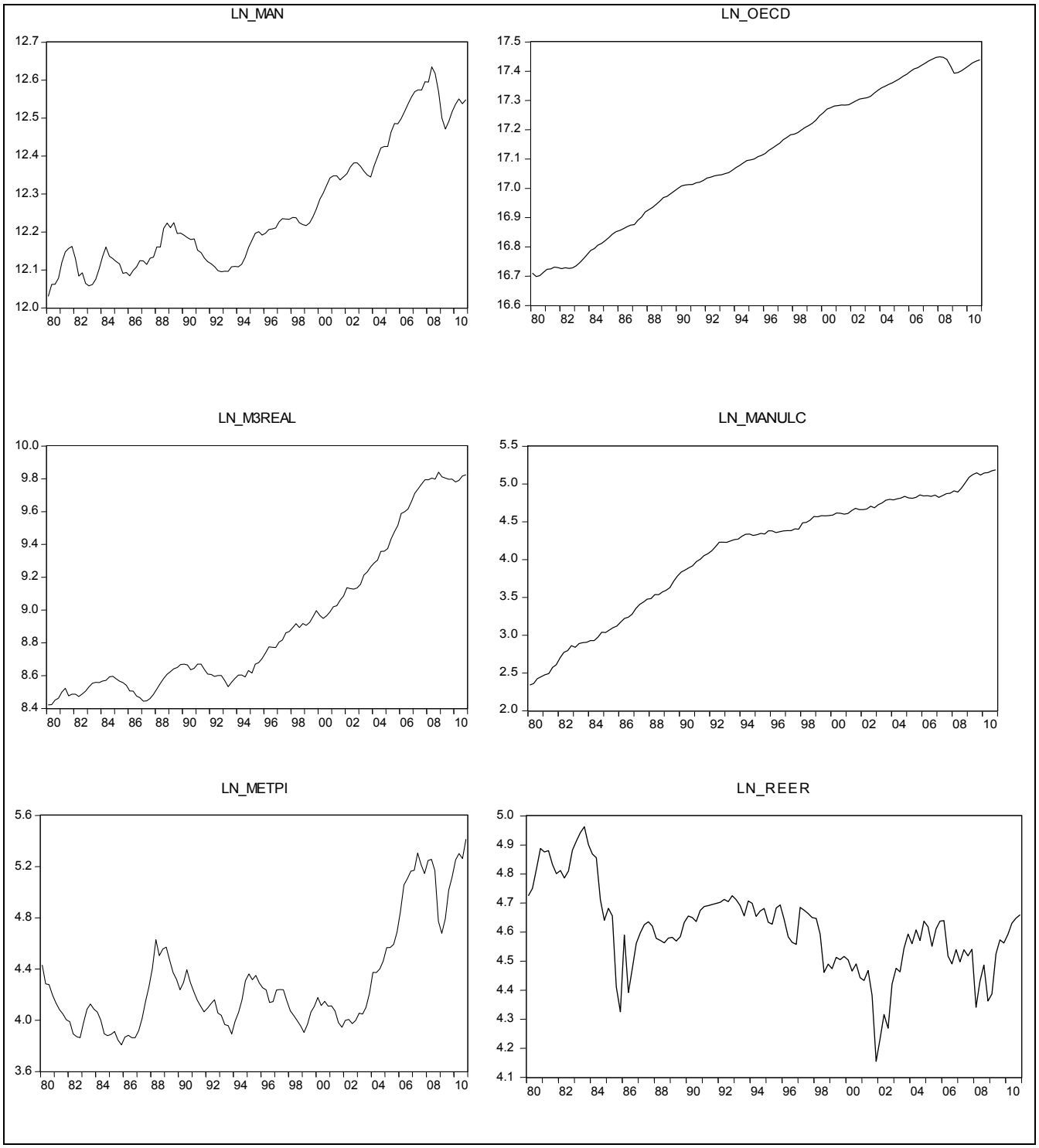

Figure 4: Impulse responses of metals prices, the real exchange rate and manufacturing