

# Monetary Policy Rules In Small Open Economies: A Keynesian Perspective

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## Abstract

Should central banks respond strongly to output gaps, asset prices and nominal exchange rate fluctuations? We answer these questions by using a Keynesian macroeconomic framework for a small open economy that features wage-price dynamics, disequilibrium in the goods and labour markets, and financial accelerators of the Dornbusch and Blanchard types to model financial dynamics. We compare our results with those found in new-Keynesian literature. The empirical version of our model is based on quarterly South African data for 1990:1-2005:2. We find that a policy rule that reacts directly to nominal exchange rate fluctuations is necessary for macroeconomic stability. This is contrary to the literature that emphasizes inflation targeting as a policy for macroeconomic stability.

**Keywords:** Macroeconomics, interest rate policy rule, exchange rate, stock prices, wage and price Phillips curves, business cycles.

JEL Classifications: C30; C32; E30; E50; E52

## 1. Introduction

Monetary policy analysis has in the last decade focused on the stabilizing powers of feedback policy rules. There is now broad consensus that central banks armed with such policy rules are in a better position to pursue their stabilization objectives. Yet, there is no consensus on the design of such policy rules (McCallum, 1999). Specifically there is no consensus on what the target variables in these rules should be. Discussions on this issue are mainly based on small-scale macro-models that are formulated in the New-Keynesian tradition, which overlooks a number of important feedback mechanisms that characterise modern economies. Because of this weakness these models are very limited in their approach, and the policy implications that are derived therefrom can only be tested against a more general framework that incorporates as far as possible these feedback mechanisms. This paper uses a Keynesian approach wherein these feedback mechanisms are explicitly modelled, following Flaschel, Gong and Semmler (2001), to evaluate monetary policy rules.

The questions dealt with in this paper continue to receive attention in the literature on policy rules. The first question is whether central banks should aggressively respond to output gaps. McCallum (2001) recommends against policies that react strongly to output gaps. The same conclusion is reached by Asada et.al. (2003:274) in what they call the corridor problem of monetary policy. For a closed economy modelled in the New-Keynesian tradition as in Svensson (1997), this recommendation essentially positions monetary policy to fight against destabilizing Mundell effects, which are just *one* feedback mechanism among others. It remains of practical policy interest to investigate, even in a closed-economy context and using a Keynesian macrodynamic framework, the conditions under which a policy rule whose primary objective is to fight Mundell effects is capable of achieving macroeconomic stability.

The second question that continues to draw most controversy in policy circles is the role of asset prices in the formulation of monetary policy. Bernanke and Gertler (1999, 2001) recommend against policies that respond to movements in asset prices, which includes exchange rate movements. They argue that such policies do

not improve macroeconomic performance, and instead lead to increased aggregate volatility including the volatility of the policy instrument. Yet Cecchetti et.al. (2000, 2002) argue that central banks should respond systematically to asset prices. This position is also advanced by Borio and Lowe (2002) on the grounds that a low inflationary environment can lead excess demand to appear in credit aggregates and asset prices, and may thus threaten macroeconomic stability.

For emerging market economies exchange rate stability is of special importance. Mohanty and Klau (2004) find that in most of these economies the short-term interest rate responds significantly to exchange rate fluctuations. This policy behaviour is endorsed by Mishkin (2000) who argues that monetary authorities should smooth exchange rates, especially for those economies that are vulnerable to volatile exchange rates. This is in line with Ball (1999, 2002) who also argues that the exchange rate should feature in the policy rule in the form of the monetary conditions index- which is a weighted average of the real interest rate and the real exchange rate. Yet Clarida, Gali and Gertler (2001) are of the view that central banks should target domestic inflation and allow the exchange rate to float freely. Bernanke and Gertler (1999) also argue that positive interest rate movements in response to exchange rate depreciation may worsen the balance sheet of firms and make economic contraction severe. Furthermore studies reviewed by Taylor (2001) find no significant improvement in macro-economic performance when the exchange rate is included in the policy rule.

Our main concern in this paper is to use a Keynesian framework, wherein a variety of feedback channels are modelled, to provide answers to the above questions namely: 1) should central banks respond directly to asset prices? 2) should central banks respond directly to exchange rate fluctuations? 3) should central banks respond strongly to output gaps? We also ask whether an inflation-targeting policy is necessary to stabilize a small open economy. We believe that because of its fairly general nature compared to its New-Keynesian counterpart, this Keynesian approach to modelling modern economies is likely to yield better insights to improve the conduct of monetary policy.

The paper is structured as follows: section 2 outlines the model used in this paper. We lay out the feedback channels that constitute the dynamics of our model, we then proceed to outline the wage-price module, aggregate demand determination which explicitly features income distribution, Metzlerian quantity adjustments in response to goods market disequilibria, asset price dynamics of the Dornbusch and Blanchard-type, and specification of a monetary policy function. Section 3 provides a feedback-guided and quantitative stability analysis of the model. Section 4 estimates the model using South African data. Section 5 performs simulation exercises in which we investigate the stability properties of the estimated model, and discusses model outcomes in relation to the three questions posed above. Section 6 is a conclusion.

## **2. A Keynesian framework for small open economies**

### **2.1 The structure of the model**

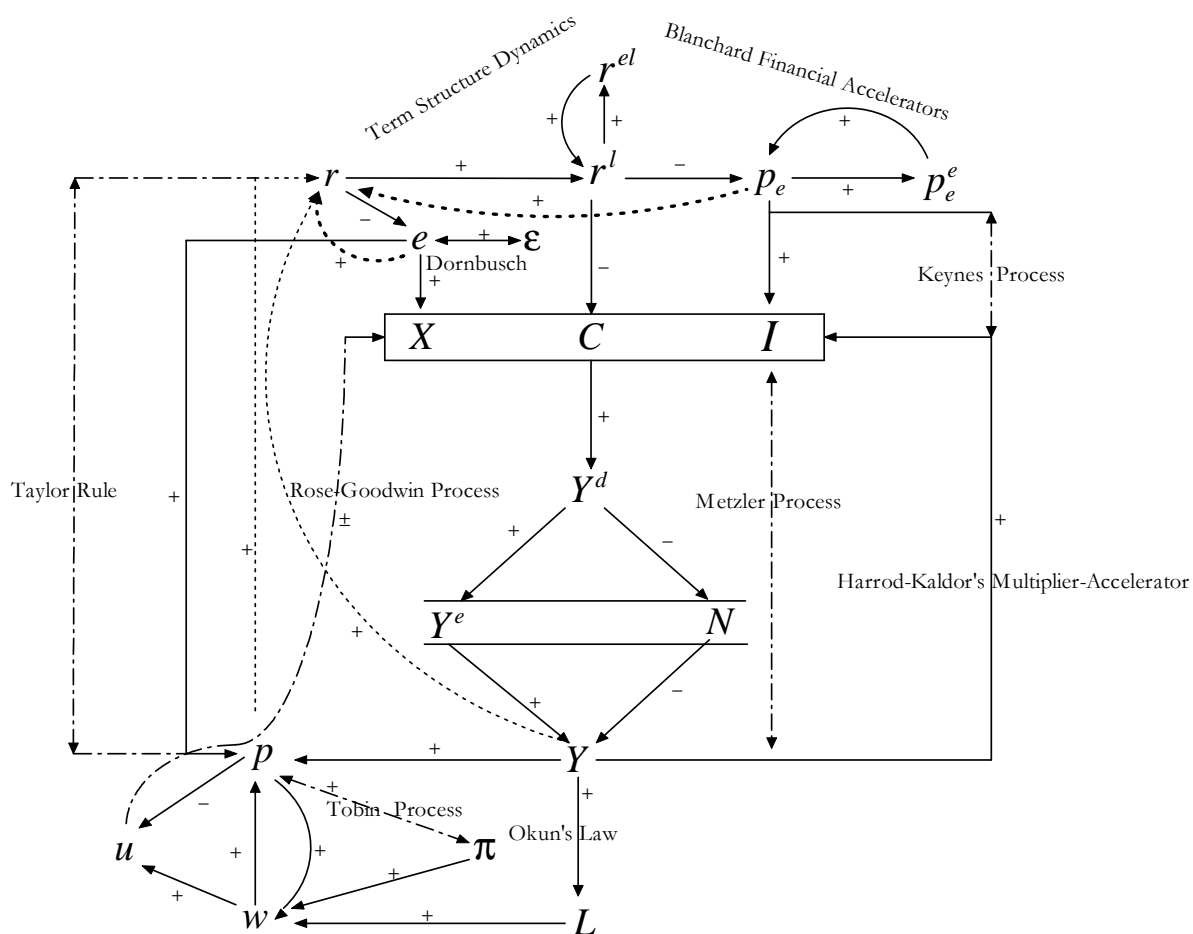
The framework presented in this paper draws insights from the Keynesian hierarchy in chapter 18 of the *General Theory*, where asset markets interact with the rate of profit to determine investment on the one hand, and consumption on the other hand. This hierarchy is enriched with other feedback channels in line with subsequent developments in Keynesian macro-dynamic theory. In presenting the feedback structure that characterises our model we also point to the potential stability properties of the various feedback channels.

Broadly speaking, the feedback structure exhibits asset markets having effects on aggregate demand. These aggregate demand effects create a gap between expected sales and actual demand, which leads firms to revise their sales expectations accordingly. Since production adjusts sluggishly, perhaps due to the gestation period in the capital goods sector in conjunction with caution from firms, inventories will vary and deviate from desired levels. Sales expectations in conjunction with movements in inventories then triggers firms to vary production levels, and thus also change the rates of capacity utilization and employment. The latter rates of resource utilization in turn affect wages and goods prices. Given the growth rate of labour productivity, the interaction between nominal wage and price inflation leads to variations in the

wage share. The wage share in turn enters aggregate demand via consumption and investment since it affects disposable income and the rate of profit. Price inflation further affects financial markets, since it directly impinges on the real rates of return across assets.

The schematic outline of these macro-interactions is presented below where at the top we have financial dynamics, feeding into the components of aggregate demand, influencing inventories and sales expectations, and so on.

Figure 1: The feedback structure of the Keynesian model for small open economies



The economy contains four assets: long-term bonds, short-term financial instruments, equities, and real capital. The short-term interest rate directly affects the long-rate in a positive fashion through some arbitrage relation between long-term bonds and short-term instruments. Movements in the long rate positively affect the sentiment in the bond market, which positively feeds back to the long-term interest rate. The destabilizing accelerator mechanism in the bond market and its interaction with the short-term interest rate constitute the term structure dynamics of our model.

An increase in the long rate in turn affects stock prices negatively, since the rate at which future dividends are discounted rises, or since the rate of return on bonds would exceed the rate of profit on capital. We then have expectational variables, which play the role of market sentiment. For example an increase in stock prices raises an expectation of a further increase, which feeds back to the actual stock price. The potentially destabilizing accelerator effects in both the bond and equity markets we call the Blanchard financial accelerators, following Blanchard (1981).

There is also the dynamics of the foreign exchange market that can be related to Dornbusch (1976). The negative effect of the short-term interest rate on the exchange rate leads to a further exchange rate appreciation via the accelerator effect in this market. These cumulative foreign exchange market effects also have real effects via net exports in aggregate demand, and also affect the imported component of price inflation. Exchange rate shocks can here be reversed by appropriate responses of the short-term interest rate.

We now proceed to the Keynes nexus between the real and financial sectors. We allow the long rate to negatively affect consumption, and the stock price to positively affect investment expenditure. Furthermore we also have the exchange rate channel, which moves in this instance from the short rate to the nominal exchange rate in a negative relation. The nominal exchange rate, all else equal, positively affects net exports. The increase in the short rate thus affects aggregate demand negatively via three channels. Relatively small changes in the short rate may therefore have dy-

namically large and cumulative effects when the accelerator mechanisms in financial markets are set in motion over time. This in short, is the transmission mechanism of monetary policy in our model.

The interaction between aggregate demand and output occurs via a Metzlerian adjustment process. Aggregate demand has a positive effect on sales expectations and a negative effect on inventories. A drop in aggregate demand leads to a downward revision of expected sales by firms, and a simultaneous accumulation of inventories. These two adjustment processes cascade down to the output decisions of firms which, via Okun's law, also affects the employment decisions of firms. Since firms keep inventories we would expect that fluctuations in capacity utilization would exhibit higher amplitude (and perhaps higher frequency) than employment fluctuations.

The employment and output decisions of firms partly drive the wage-price dynamics of the model. Demand pressure in the goods market cascades into capacity utilization and employment rates, which positively feed into prices and wages respectively. However there is a potentially destabilizing spiral between nominal wages and prices as emphasized in conflict theories of inflation. Given the level of labour productivity, the wage-price interaction affects income distribution measured by the wage share. If wages respond more to labour market pressures than prices respond to goods market pressures, and workers dominate in the wage-price interaction, then the wage share will rise<sup>1</sup>.

Changes in the wage share may positively or negatively affect aggregate demand via a Rose (1967) and Goodwin (1967) process. For example an increase in the wage share raises disposable income of workers, and since workers' marginal propensity to consume is higher than the capitalists', consumption would rise. If investment responds by a lesser amount to this profit-squeeze, the overall impact of a rise in the wage share is to raise aggregate demand. This aggregate demand effect, again cascades down through the Metzler process to output and employment decisions,

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<sup>1</sup>Also see Keynes (1936, Chapter 19).

which further feeds back positively into the wage-price dynamics. Thus the Rose-Goodwin process may be destabilizing.

Notice furthermore that there is a Tobin (1975) process in the model, which allows for the inflationary climate to influence in a destabilizing way the wage-price dynamics. In the context of destabilizing wage and price dynamics the adjustment of the inflationary climate plays a critical role in the stability properties of the economy. If the inflationary climate responds relatively fast to actual inflation, a cumulative inflationary process may be set in motion just as in financial markets. Such a process would give added momentum to the Rose-Goodwin process which is the direct link between the wage-price dynamics and aggregate demand.

There are of course other equally important roundabout channels which are set into operation by the Rose-Goodwin process. For example the rise in the wage share may raise output as just mentioned. But if the rise in the wage share more than offsets the increase in output, the rate of profit will fall. A falling rate of profit leads to a fall in stock prices, which reduces aggregate investment. The accelerator mechanism in the stock market would kick in, and filter through to depress investment further, whilst on the other hand the Rose-Goodwin process works in the opposite direction. If the stock market accelerator mechanism dominates the Rose-Goodwin effect on aggregate demand in the context of a falling rate of profit, then the economy would be stable.

There is also a link between output movements and aggregate demand, which occur via the rate of capacity utilization and investment on the one hand, and more conventional output effects in consumption and net export functions. In this connection we have the Harrod (1939) accelerator process together with the Kaldor (1940) dynamic multiplier process. The Harrodian process captures the response of fixed investment to production changes, and the Kaldorian multiplier process affects aggregate demand in general. Both these processes are potentially destabilizing since they are characterized by positive feedback loops.

We also want to note that in the framework presented here, it would appear that



the well-known Mundell-effect is absent. This is not the case. The price inflation rate enters the interaction between the rate of profit and the real rate of return on long-term bonds. All else equal, an increase in the inflation rate lowers the real rate of return on long-term bonds. The excess rate of profit drives stock prices up, which positively affects investment. The subsequent rise in aggregate demand cascades down via the Metzler process to capacity utilization, which further drives up the inflation rate. The Mundell-effect also sets in motion the accelerator mechanism in the stock market, which gives further momentum to the destabilizing process.

Developments in the economy feed back to the short term interest rate via a Taylor rule, which we here call the Taylor process. We first note that the nominal exchange rate positively affects prices through imported inflation. The simple policy rule in Taylor (1993) allows the short rate to respond to rate of capacity utilization and the price inflation rate. In our feedback structure, we also show the possibility that the short rate may also respond to the exchange rate and the stock price as well. By responding positively to the exchange rate the short rate affects aggregate demand through net exports, but it also indirectly affects prices by reducing imported inflation. By also responding to stock prices the short rate arrests the stock market accelerator process, and thus may stabilize the investment component of aggregate demand.

## 2.2 Wage-price dynamics

The wage-price dynamics presented here are a version of the general specification presented in Asada et.al. (2003, Chapter 8, module 7). Eq. (1) says nominal wage inflation responds to the employment rate in excess to the natural rate ( $V - V_0$ ), the weighted average of current inflation in the cost-of-living index  $\hat{p}$  and medium-term inflationary expectations  $\pi$ , and the growth rate of labour productivity  $n_x$ . In Eq. (2) inflation in the cost-of-living index is the weighted average of import price inflation and domestic price inflation  $\hat{p}_d$ , where  $\tau$  is the share of domestically produced goods in the consumer basket,  $e$  is the nominal exchange rate and  $p^*$  is index of the foreign price level. Domestic price inflation in (3) responds to the rate of

capacity utilization in excess to the natural rate ( $U - U_0$ ), and the weighted average of nominal wage inflation in excess of the growth rate in labour productivity and medium-term inflationary expectations. We thus assume that workers and firms hold the same inflationary expectations. Eq. (4) says medium-term inflationary expectations adjust adaptively to the gap between current inflation in the cost-of-living index and medium-term expectations. This allows agents to use developments in the exchange rate as part of the information in forming their expectations.

$$\hat{w} = \beta_w(V - V_0) + \kappa_w \hat{p} + (1 - \kappa_w)\pi + n_x \quad (1)$$

$$\hat{p} = \tau \hat{p}_d + (1 - \tau)(\hat{e} + \hat{p}^*) \quad (2)$$

$$\hat{p}_d = \beta_p(U - U_0) + \kappa_p(\hat{w} - n_x) + (1 - \kappa_p)\pi \quad (3)$$

$$\dot{\pi} = \beta_\pi(\hat{p} - \pi) \quad (4)$$

By simultaneous substitution of (1), (2) and (3) the following reduced form wage-price dynamics are obtained:

$$\hat{w} = \lambda \left[ \frac{\beta_w}{\tau}(V - V_0) + \kappa_w \beta_p(U - U_0) + \kappa_w \left( \frac{1 - \tau}{\tau} \right) (\hat{e} + \hat{p}^* - \pi) \right] + \pi + n_x \quad (5)$$

$$\hat{p} = \lambda \left[ \beta_p(U - U_0) + \kappa_p \beta_w(V - V_0) + (1 - \kappa_p \kappa_w) \pi + \left( \frac{1 - \tau}{\tau} \right) (\hat{e} + \hat{p}^*) \right] \quad (6)$$

$$\dot{\pi} = \beta_\pi \left\{ \lambda \left[ \beta_p(U - U_0) + \kappa_p \beta_w(V - V_0) + (1 - \kappa_p \kappa_w) \pi + \left( \frac{1 - \tau}{\tau} \right) (\hat{e} + \hat{p}^*) \right] - \pi \right\} \quad (7)$$

Where  $\lambda = \left[ \frac{\tau}{1 - \tau \kappa_p \kappa_w} \right]$ . Eqs. (5) and (6) give rise to yet another law of motion concerning income distribution. Letting  $\hat{u} = \hat{w} - \hat{p} - n_x$  denote the growth rate of the wage share, it follows that:

$$\widehat{u} = \lambda\beta_w\left(\frac{1}{\tau} - \kappa_p\right)(V - V_0) - \lambda\beta_p(1 - \kappa_w)(U - U_0) - \kappa_\pi\pi - \kappa_e(\widehat{e} + \widehat{p}^*) \quad (8)$$

Where  $\kappa_\pi = \lambda\left[\kappa_w\left(\frac{1-\tau}{\tau}\right) + (1 - \kappa_p\kappa_w)\right] - 1 \leq 0$  and  $\kappa_e = \lambda\left(\frac{1-\tau}{\tau}\right)(1 - \kappa_w) > 0$ . Notice again that  $\tau = 1 \implies \kappa_e = 0$  and  $\kappa_\pi = 0$ . The law governing the wage share would thus resemble the closed economy case.

### 2.3 Aggregate demand

The economy's aggregate demand features direct negative interest rate effects on workers's consumption. Workers are assumed to finance their consumption partly from their disposable incomes, and partly from credit. Capitalists earn, over and above profits earned by firms, interest income from workers and government. We then formulate simplifying tax rules as in Chiarella et.al.(2001). The intensive-form structure of aggregate demand is given by the following equations:

$$y^d = c + i + g + x \quad (9)$$

$$c_w = (1 - s_w)(uy + r^l b_w - t^w) - \psi r^l \quad (10)$$

$$c_c = (1 - s_c)[(1 - u)y - \delta + r^l b_c - t^c] \quad (11)$$

$$t^w = \sigma_w + r^l b_w \quad (12)$$

$$t^c = \sigma_c + r^l b_c - \delta \quad (13)$$

$$c = (s_c - s_w)uy + (1 - s_c)y - \psi r^l - \gamma_c \quad (14)$$

$$x = \theta_1 y^* - \theta_2 y + \theta_3 \left(\frac{ep^*}{p}\right) \quad (15)$$

$$i = i_1 p_e + i_2 (U - U_0) + n \quad (16)$$

$$g = \sigma \quad (17)$$

Eq. (9) is the aggregate demand identity. Eqs. (10) is workers' consumption. We

capture the credit-channel by allowing the interest rate to negatively affect workers consumption. Eq.(11) is capitalist consumption, which we assume for simplicity is not credit-constrained. Capitalist income is the sum of receipts from dividend payments, here identical to profit since firms are assumed not to retain earnings, and interest payments from government and workers.

Eqs. (12) and (13) are taxation rules, formulated conveniently to simplify the analytics of aggregate demand. When inserted in (10) and (11), positive interest rate effects from owning government bonds are removed for both classes. Notice that we have allowed, again for simplicity, full depreciation allowance in the taxation rule on capitalist income. Now aggregate consumption is given as the sum of workers' and capitalist consumption in eq. (14). The parameters are defined as follows:

$$\begin{aligned}\gamma_c &= (1 - s_w)\sigma_w + (1 - s_c)\sigma_c > 0 \\ \psi &= (1 - s_c)\psi_w > 0\end{aligned}$$

Various formulations of the real-financial interaction within the Keynesian macro-dynamic framework, the interest rate indirectly affects investment via Tobin's  $q$ , but here we have directly included the stock price as in Blanchard (1981). The third term represents the accelerator mechanism, sustained excess demand induces firms to invest. The last term is a trend term to capture a growing economy. Lastly government expenditure is formulated conveniently so as to be a constant proportion of the capital stock in (17).

## 2.4 Metzlerian adjustment in the goods market

The goods market adjustment process is similar to the one in Flaschel et al. (2001). Eq. (18a) postulates that expected sales are revised in an adaptive fashion in response to the gap between aggregate demand and current sales expectations.

The adjustment is augmented by a growth term to capture the context of a growing economy. Desired inventories  $N^d$  are a constant fraction of expected sales in (18b). Intended inventory investment  $\mathcal{I}$  moves on the basis of the gap between desired and actual inventories, again augmented by a growth term in (18c). Eq. (18d) says output is the sum of expected sales and intended inventory accumulation, the discrepancy between expected and actual demand leads to unplanned inventory accumulation. Eq. (18e) says inventory accumulation is given by the gap between expected and actual sales, plus intended inventory accumulation - which is just the gap between output and actual sales.

$$\dot{Y}^e = nY^e + \beta_{y^e}(Y^d - Y^e) \quad (18a)$$

$$N^d = \beta_{n,d}Y^e \quad (18b)$$

$$\mathcal{I} = nN^d + \beta_n(N^d - N) \quad (18c)$$

$$Y = Y^e + \mathcal{I} \quad (18d)$$

$$\dot{N} = Y - Y^d \quad (18e)$$

Let inventories in intensive form are  $v = \frac{N}{K}$ . Eq. (18a)-(18e) can be stated in intensive form, by substituting away intended inventory accumulation (18c), as follows:

$$\dot{y}^e = (n - i)y^e + \beta_{y^e}(y^d - y^e) \quad (19a)$$

$$y = b_1y^e - \beta_n v \quad (19b)$$

$$\dot{v} = y - y^d - iv \quad (19c)$$

Where  $b_1 = (1 + n\beta_{n,d} + \beta_n\beta_{n,d})$ . Aggregate demand for the economy is given by the following equation:

$$\begin{aligned}
y^d &= (s_c - s_w) uy + (1 - s_c)y - \psi r^l + i_1 p_e + i_2 (U - U_0) \\
&\quad + \theta_1 y^* - \theta_2 y + \theta_3 \left( \frac{ep^*}{p} \right) + \gamma
\end{aligned} \tag{20}$$

Where  $\gamma = n + \sigma - \gamma_c$ , plausibly greater than zero.

## 2.5 Production and employment

The production side of the economy is given by a simple Harrod-neutral technical progress production function:

$$Y^p = y^p K \tag{21}$$

Where  $y^p$  denotes the potential output-capital ratio, and  $Y^p$  is potential output. This function provides a simple way to define the rate of capacity utilization  $U$  by firms. The cointegration method of estimating potential output recently proposed by Shaikh and Moudud (2005) can be viewed as a version of this Harrod technology. Following Flaschel, Gong and Semmler (2001), we define the following:

$$U = \frac{y}{y^p} \tag{22}$$

Notice that the rate of capacity utilization  $U$  is used in the wage-price module of the model to proxy for excess demand pressures in the goods market. Tied to this measure is the rate of utilization of labour  $V$ . First we define the natural rate of employment (NARE) as that employment rate that is consistent with potential output. Let potential employment be  $E^p$ , which is given by the following relationship:

$$E^p = l^p Y^p \tag{23}$$

Again this allows us to define in a straightforward way the rate of utilisation of labour:

$$V = \frac{l}{l^p} \tag{24}$$

In order to close the real part of the economy, we assume an Okun-type relationship. We specify that the rate of labour utilisation is determined by developments in the goods market. We therefore assume the following relationship:

$$\dot{V} = \beta_V (U - U_0) \tag{25}$$

The rate of employment is therefore stationary at  $V_0$  when the rate of capacity utilisation is consistent with the natural rate.

## 2.6 Asset price dynamics

Our specification of asset price dynamics is such that for each law of motion of the asset price concerned, there is accompanying it a law that governs movements in financial market sentiment about that asset price. These sentiment terms are form through which we incorporate financial accelerator effects in our model. Eq. (26) posits stock price fluctuations to be determined partly by the discrepancy between the profit rate and the rate of return from holding government bonds (the fundamentals), and partly determined by the stock market sentiment. This formulation yields a dynamic equation related to Blanchard (1981) type stock price dynamics. Eq. (27) postulates an adaptive adjustment in stock market sentiment, denoted by  $\pi_e$ . This of course is a gross simplification, since such sentiment can switch in ways that are unpredictable.

Eq. (28) links the relative demands between foreign and domestic bonds along the lines of Ball (1999)- also justified along the lines of the portfolio balance approach. Note also that capital outflows are determined by expectations  $\varepsilon$  about the direction of the exchange rate. An expected depreciation will trigger a capital outflow. Eq. (29) specifies the revision of expected nominal depreciation as adaptive, which also still a simplification. Eq. (30) gives the growth rate of the long rate, which is just the negative of bond price inflation since we assume government issues perpetuities. The increase in the short rate above the rate of return on holding bonds leads to substitution away from bonds to short term instruments. Eq. (31) says expectations about the direction of the long rate are also formed adaptively.

$$\hat{p}_e = \beta_{p_e} [(1-u)y - (r^l - \xi - \hat{p})] + (1 - \beta_{p_e})\pi_e \quad (26)$$

$$\dot{\pi}_e = \beta_{\pi_e}(\hat{p}_e - \pi_e) \quad (27)$$

$$\hat{e} = \beta_e(r^* - r + \varepsilon) \quad (28)$$

$$\dot{\varepsilon} = \beta_\varepsilon(\hat{e} - \varepsilon) \quad (29)$$

$$\hat{r}^l = \beta_{r^l} [r - (r^l - \xi - \pi_{r^l})], \quad \left( p_b = \frac{1}{r^l} \right) \Rightarrow (\hat{p}_b = -\hat{r}^l) \quad (30)$$

$$\dot{\pi}_{r^l} = \beta_{\pi_{r^l}}(\hat{r}^l - \pi_{r^l}) \quad (31)$$

From these financial market dynamics it can be observed that there are potentially destabilising mechanisms across these three asset markets. The stock market sentiment drives actual stock prices which further drive up the sentiment. The same mechanism prevails in the bond and foreign exchange markets. Financial markets are thus intuitively potentially destabilising.

To close the financial side of the economy we postulate that the central bank implements the following fairly general policy rule:

$$\dot{r} = \beta_{r_1}(r_0 - r) + \beta_{r_2}(\hat{p} - \pi_0) + \beta_{r_3}(U - U_0) + \beta_{r_4}\hat{e} + \beta_{r_5}\hat{p}_e \quad (32)$$



In this rule, monetary authorities respond to both the inflation and capacity utilization gap. We add two more terms to the conventional rule. We include the rate of exchange rate depreciation and stock price inflation. Bernanke and Gertler (2001) use the log of Tobin's  $q$  in their policy rule. Given the controversy noted earlier surrounding the form of the policy rule to be followed by the central bank, we would not only like to test empirically the relevance of some target variables within the context of our Keynesian macrodynamic model in South Africa, but also we pose a normative question of *should* the central bank respond to target variables such as the exchange rate and stock price fluctuations.

### **3. The integrated dynamics of the model**

We have already alluded to the feedback structure of our model. The laws of motion governing key variables in our model are collected below. Our economy is driven by a core 12D dynamics. The specification of the monetary policy rule adds another law of motion, making the system 13D.

$$\hat{p} = \lambda \left[ \beta_p (U - U_0) + \kappa_p \beta_w (V - V_0) + (1 - \kappa_p \kappa_w) \pi + \left( \frac{1 - \tau}{\tau} \right) (\hat{e} + \hat{p}^*) \right] \quad (33a)$$

$$\dot{y}^e = (n - i)y^e + \beta_{y^e}(y^d - y^e) \quad (33b)$$

$$\dot{v} = y - y^d - iv \quad (33c)$$

$$\dot{\pi} = \beta_\pi \left\{ \lambda \left[ \beta_p (U - U_0) + \kappa_p \beta_w (V - V_0) + (1 - \kappa_p \kappa_w) \pi + \left( \frac{1 - \tau}{\tau} \right) (\hat{e} + \hat{p}^*) \right] - \pi \right\} \quad (33d)$$

$$\hat{u} = \lambda \beta_w \left( \frac{1}{\tau} - \kappa_p \right) (V - V_0) - \lambda \beta_p (1 - \kappa_w) (U - U_0) - \kappa_\pi \pi - \kappa_e (\hat{e} + \hat{p}^*) \quad (33e)$$

$$\dot{V} = \beta_V (U - U_0) \quad (33f)$$

$$\hat{p}_e = \beta_{p_e} [(1 - u)y - (r^l - \xi - \hat{p})] + (1 - \beta_{p_e})\pi_e \quad (33g)$$

$$\dot{\pi}_e = \beta_{\pi_e} (\hat{p}_e - \pi_e) \quad (33h)$$

$$\hat{e} = \beta_e (r^* - r + \varepsilon) \quad (33i)$$

$$\dot{\varepsilon} = \beta_\varepsilon (\hat{e} - \varepsilon) \quad (33j)$$

$$\hat{r}^l = \beta_{r^l} [r - (r^l - \xi - \pi_{r^l})] \quad (33k)$$

$$\dot{\pi}_{r^l} = \beta_{\pi_{r^l}} (\hat{r}^l - \pi_{r^l}) \quad (33l)$$

$$\dot{r} = \beta_{r_1} (r_0 - r) + \beta_{r_2} (\hat{p} - \pi_0) + \beta_{r_3} (U - U_0) + \beta_{r_4} \hat{e} + \beta_{r_5} \hat{p}_e \quad (33m)$$

The pertinent static equations of aggregate demand and output determination, to be inserted in the system (33), are:

$$\begin{aligned} y^d &= (s_c - s_w) uy + (1 - s_c)y - \psi r^l + i_1 p_e + i_2 (U - U_0) \\ &\quad + \theta_1 y^* - \theta_2 y + \theta_3 \left( \frac{ep^*}{p} \right) + \gamma \\ y &= b_1 y^e - \beta_n v \end{aligned}$$

The crucial partials of the real sector are as follows:

$$\begin{aligned}
y_{y^e}^d &= b_1 \left[ (s_c - s_w) u_0 + (1 - s_c) + \frac{i_2}{y^p} - \theta_2 \right] \\
y_v^d &= -\beta_n \left[ (s_c - s_w) u_0 + (1 - s_c) + \frac{i_2}{y^p} - \theta_2 \right] \\
i_{y^e} &= \frac{i_2 b_1}{y^p} > 0 \\
i_v &= -\frac{i_2 \beta_n}{y^p} < 0
\end{aligned}$$

A sufficiently strong response of imports to output can thus result in negative sales expectations impact on aggregate demand, and a positive impact on inventory accumulation on aggregate demand. We assume here that these perverse adjustments are non-existent, and that the economy adjusts normally. Therefore we assume that  $y_v^d < 0$  and  $y_{y^e}^d > 0$ . Furthermore we assume for simplicity that  $p^* = 1$ .

Consider the adjustment process in the light of a positive shock to expectations about capital losses in the bond market, i.e. a shock to (33l). The long rate will rise as a result and through the financial accelerator this would further lead to an increase expected capital losses. As this bond market accelerator process proceeds, the rise in the long rate depresses excess profitability and therefore leads to a fall in stock prices. This triggers another financial accelerator process, now in the stock market. The bond market accelerator depresses consumption expenditure, and the stock market accelerator depresses investment expenditure. The effects of these processes is a decline in aggregate demand.

The decline in aggregate demand leads to an accumulation of inventories and a downward revision of sales expectations. These two processes then lead to a reduction in output and thus a fall in the rate of capacity utilization. Via Okun's law this also leads to a reduction in the rate of employment. These output effects translate into a fall in both the nominal wage and price inflation rates, and therefore leads to a disinflationary climate. The fall in the price inflation rate gives further momentum

to the disinflation in stock prices and therefore adds to the financial accelerator in that market. Monetary policy can stabilize this situation by allowing the short term interest rate to fall with sufficient strength to reverse the bond market accelerator and hence the entire pattern of interactions that we have highlighted here. The power of the policy however depends on the extent to which it is capable of directly influencing the long rate and the exchange rate. The exchange rate itself has an accelerator process which works to amplify the effects of the short term interest rate on the macroeconomy.

## **4. Model estimation**

### **4.1 Data description and estimation strategy**

We estimate the parameters of the model using South African quarterly data (1990Q1-2005Q2). We would like to remark on some of the data series. The wage rate was derived by dividing compensation of employees by employment. The fixed capital stock is not available quarterly but gross fixed capital formation is available quarterly. So we constructed a quarterly series from 1990Q1-2005Q2 by using the reported capital stock in 1989 as a starting value, and then cumulatively adding gross fixed capital formation on this stock over the period to get quarterly gross fixed capital stock. As for gross fixed capital formation and consumption, we only used the total net of investment by general government. Gross investment is then simply defined as the change in fixed capital stock. For the long term interest rate we use the average yield on 3-5 year government bonds, and for the short term interest rate we use the lending rate. The wage share is estimated by dividing real compensation of employees by real GDP. Real GDP (at constant 2000 prices) is used to measure real output, and real compensation of employees is derived by deflating nominal compensation of employees with the GDP-deflator. The price-level proxy is the consumer price index.

Table 1: Data description

Variable	Description
$w$	nominal employee compensation divided by employment
$p$	consumer price index
$r$	term lending rate
$r^l$	yield on a 3-year government bond
$p_e$	all-share index at the Johannesburg Stock Exchange
$e$	South African rand-US dollar nominal exchange rate
$I$	gross private sector investment
$C$	final household consumption at 2000 prices
$Y$	real GDP at 2000 prices
$X$	net exports at 2000 prices
$K$	fixed capital stock at 2000 prices
$\hat{z}_t$	$\frac{z_t - z_{t-4}}{z_{t-4}}$ for some variable $z_t$
$U_t$	rate of capacity utilisation ( $= \ln Y - \ln Y^p$ )
$V_t$	rate of labour utilisation ( $= \ln l - \ln l^p$ )

It is important to also highlight issues related to employment data. The employment series is the most notorious in South African data. However, in the light of absence of alternative measures, we have used a series by Kingdon and Knight (2001) on which we applied interpolation to derive a quarterly series.

Next we explain how we derived our measures of capacity utilization. Here we refer to Shaikh and Moudud (2005), who define potential output as that component of output that is determined by the capital stock. As mentioned before this concept has strong resemblance to a Harrod-type production function. We nevertheless augment this formulation with a time trend function which is not necessarily linear as follows:

$$\ln Y_t^p = y_p \ln K_t + f(t) \tag{34}$$

Once (34) is estimated, we then derive  $U = \ln Y_t - \ln Y_t^p$ , which is the error terms of the estimation. The data shows that investment in South Africa was severely negatively affected by the global financial crisis of 1998. To control for this effect we included a dummy variable  $Dum99$ . The following is an estimation of (34):

$$\ln Y_t^p = -19.14 + 2.35 \ln K_t + f(t) \quad (34a)$$

(2.43)      (0.17)

To estimate the rate of utilisation of labour we only need to estimate the labour required to produce potential output, so that fluctuations in actual output over and above potential is linked to over and under-utilisation of labour. Our formulation follows (34), and the estimation yields:

$$\ln L_t^p = 8.30 - 0.62 \ln Y_t^p + g(t) \quad (34b)$$

(3.06)      (0.23)

The negative sign in front of potential output is in line with the developments over the 1990's, wherein the economy was shedding jobs whilst registering a positive though small growth rate. The estimation therefore indicates, in a fairly crude and simple way, that the NARE over the 1990's in particular was falling. The mechanisms of this phenomenon are however beyond the scope of this paper. The inflationary climate  $\pi$  is estimated by taking the unweighted 4-quarter moving average of price inflation. Climate terms for the stock and bond markets are also formulated as moving average inflation terms of the relevant asset prices.

As noted by Flaschel, Gong and Semmler (2001) since many of the model parameters appear non-linearly the estimations can be carried out by the use of non-linear least squares, and it is not necessary to estimate all of the parameters. Furthermore there is an unobserved component in the model, expected sales. Here we simplify our estimation strategy and assume that firms form their sales expectations

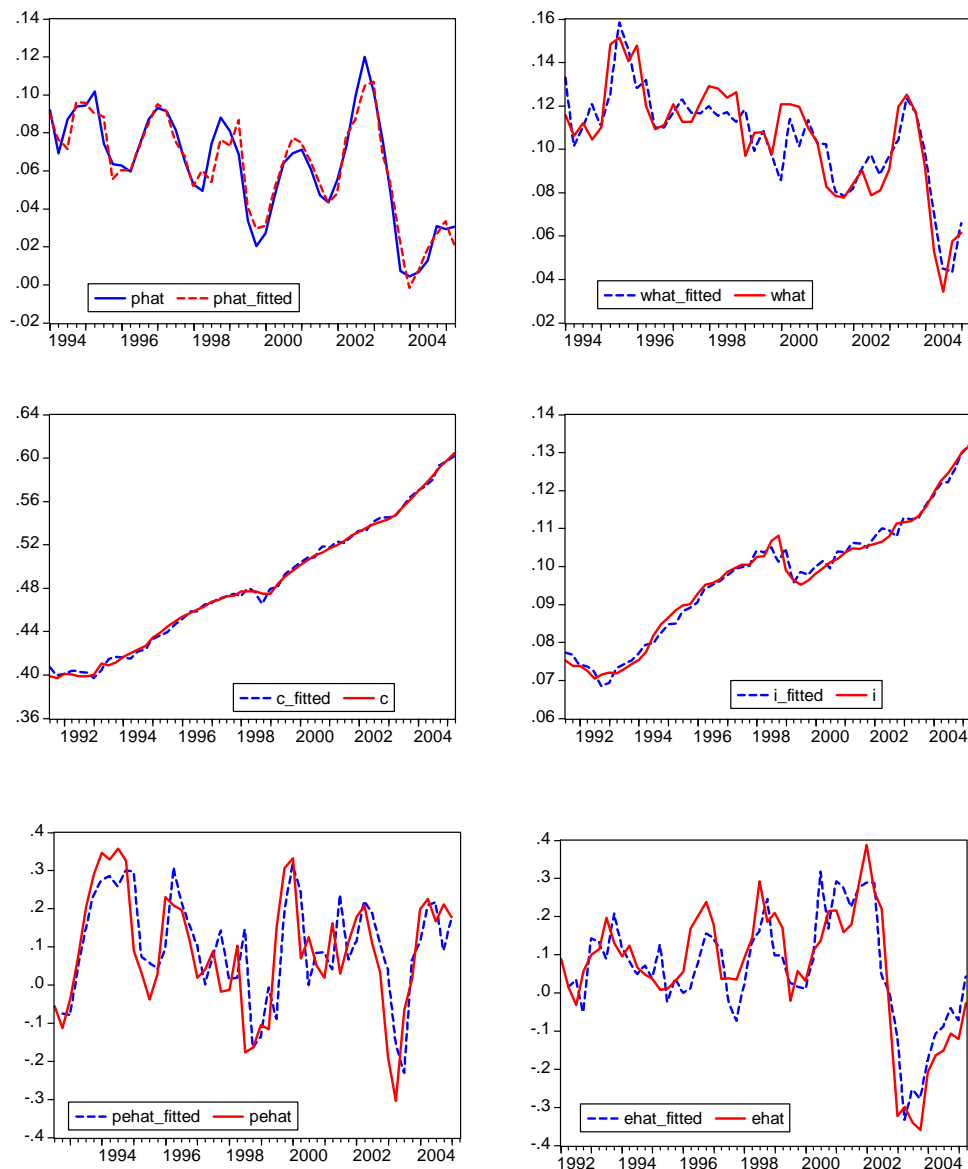
by looking at developments in aggregate demand. Specifically, we take the 4-quarter moving average of aggregate demand as a measure of firms' sales expectations. We estimate the model partly through 2-SLS and partly through single equations. Table 2 presents our estimated parameters.

Table 2: Estimated parameters

wage-price module	$\beta_w = 0.24(0.06)$	stock prices	$\beta_{p_e} = 0.1(0.07)$
	$\beta_p = 1.15(0.29)$		$\beta_{\pi_e} = 0.59(0.04)$
	$\beta_\pi = 0.56(0.03)$	exchange rate	$\beta_e = 0.94(0.07)$
	$\kappa_w = 0.35(0.08)$		$\beta_\varepsilon = 0.87(0.12)$
	$\kappa_p = 0.39(0.08)$	bond prices	$\beta_{r_i} = 1.05(0.11)$
	$\tau = 0.82(0.023)$		$\beta_{\pi_{r,i}} = 1.15(0.06)$
consumption	$s_c = 0.28(0.027)$	policy rule	$\beta_{r_1} = 0.17(0.05)$
	$s_w = 0.23(0.06)$		$\beta_{r_2} = 0.07(0.035)$
	$\psi = 0.21(0.04)$		$\beta_{r_3} = 0.32(0.14)$
	$\gamma_c = 0.06(0.02)$		$\beta_{r_4} = 0.018(0.006)$
investment	$i_1 = 0.016(0.004)$		$\beta_{r_5} = 0.00(0.00)$
	$i_2 = 0.078(0.05)$	other parameters	$n = 0.065(0.001)$
net exports	$\theta_2 = 0.18(0.024)$		$n_x = 0.039(0.004)$
	$\theta_3 = 0.81(0.12)$		$D98 = -0.01(0.002)$
	$\gamma_x = 0.096(0.014)$		
Okun's Law	$\beta_V = 0.45(0.29)$		
Metzler process	$\beta_{y_e} = 2.06(0.21)$		
	$\beta_n = 0.00(0.00)$		
	$\beta_{n,d} = 1.16(0.13)$		

The estimation of various equations that make up the model yield the fitted values illustrated in figure 2 below:

Figure 2: Fitted and actual values: wage-price dynamics



Our estimations closely track the data, especially the investment function estimation. Notice that the net exports estimation appears to give a relatively poor fit, though it nevertheless tracks the trend in the data.

## 5. Simulation of the structural model



## 5.1 Simulation strategy

In simulating the model, we calibrate the steady state as follows:

$$\begin{aligned}u_0 &= 0.5, y_0^e = 0.93, e_0 = p_0 = p_{e0} = 1, U_0 = V_0 = 1 \\r_0 &= 0.10, \xi = 0.02, r_0^l = 0.12, \pi_0 = 0.05\end{aligned}$$

We want to also mention that the estimated policy rule turned out to be incapable of stabilizing the economy. We then reformulated the policy rule by increasing the response of the central bank to the inflation and capacity utilization gaps, and the rate of exchange rate depreciation. The policy rule that we use to conduct the simulations is given below:

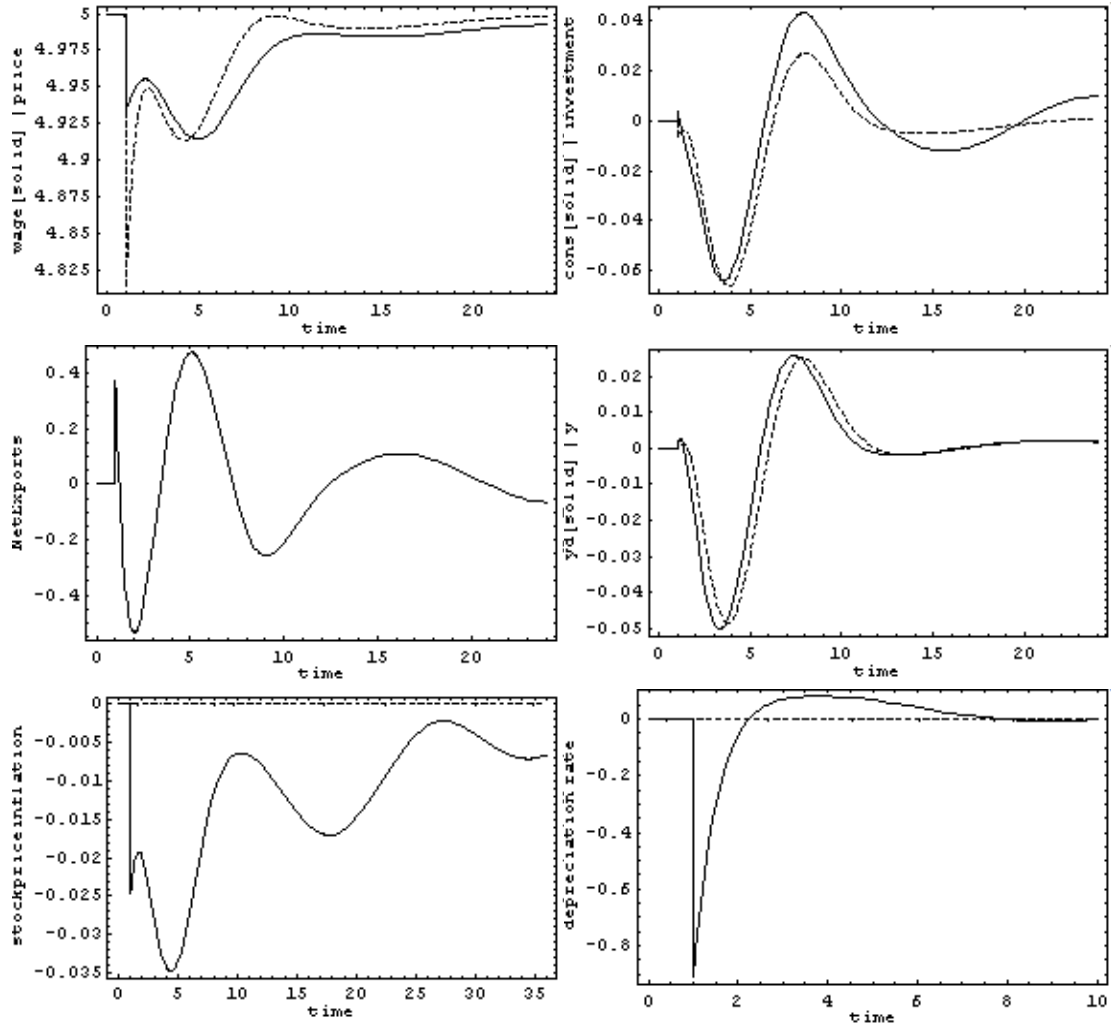
$$\dot{r} = 0.15(0.10 - r) + 1.5(\hat{p} - 0.05) + 0.5(U - U_0) + 2.5\hat{e} \quad (35)$$

Before evaluating the behaviour of the economy under rule (35), we test the behaviour of the economy under this rule when subjected to macro-shocks as in Christiano et.al. (1994) and Christiano and Gust (1999). Specifically we positively shock the nominal interest rate, by applying an impulsive force to it. We expect an increase in the short term interest rate to increase the long rate and therefore lower consumption and investment. Thus we expect positive interest rate shocks to negatively affect output and aggregate demand. Furthermore a positive interest rate shock should lead to exchange rate appreciation, which should adversely affect net exports. The impulse responses are illustrated below<sup>2</sup>:

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<sup>2</sup>All impulse responses are reported in terms of percentage deviations of variables from steady state values, except for the inflation rates. Nominal wage inflation was made comparable to price inflation by deducting from the former the assumed exogenous growth rate of labour productivity of 4%.

Figure 3: Impulse responses to a positive interest rate shock



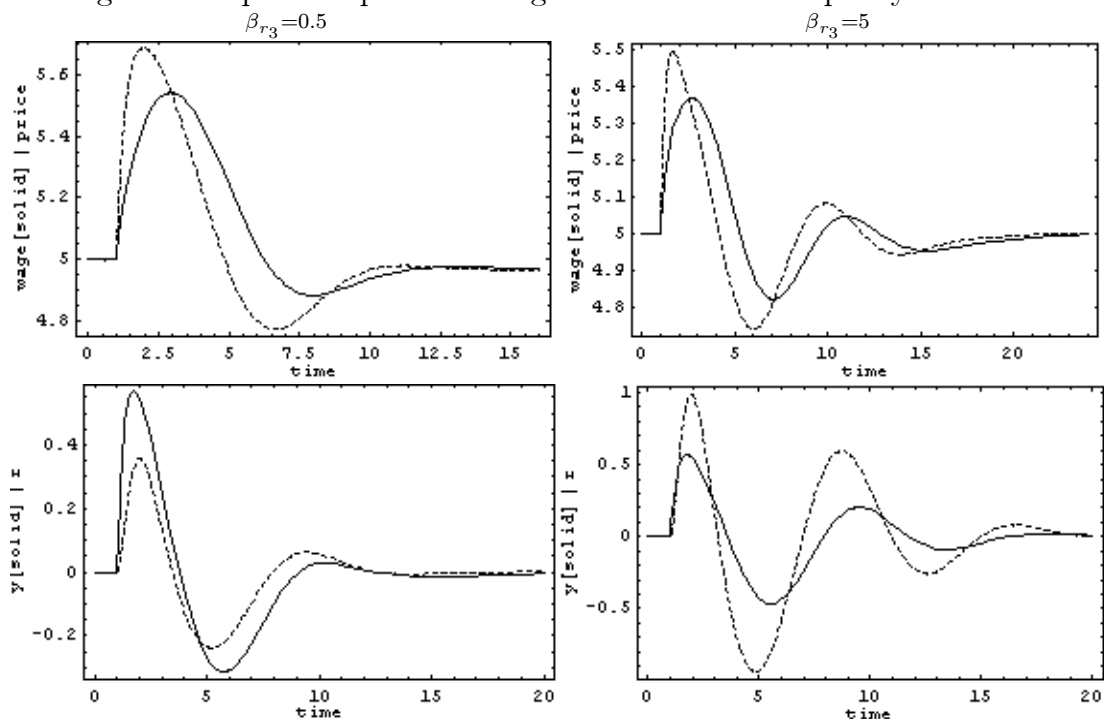
The impulse responses conform with economic intuition. A positive shock to the short term interest rate leads to an increase in the long rate, hence a reduction in consumption and investment, and hence a contraction in aggregate demand and output. Furthermore the exchange rate appreciates immediately because of the contemporaneous impact of the short term interest rate on the rate of exchange rate depreciation. As a result of the jump in the exchange rate, both the nominal wage and price inflation rate exhibit here an immediate jump, and a further reduction

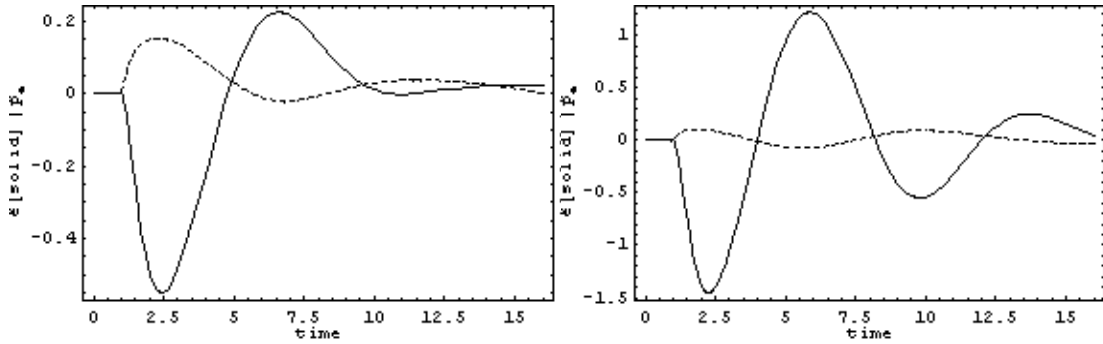
before the two rates return back to their equilibrium values. The inflation of the stock price here also exhibits an immediate jump, and thereafter gradually returns to its steady state value in a cyclical fashion. Our model also produces greater persistence of shocks to the inflation rates and the inflation of the stock price.

## 5.2 Monetary policy and stabilization

We recall here that McCallum (2001) argues that central banks should not respond strongly to output gaps. We now simulate the model, assuming that in one instance,  $\beta_{r_3} = 0.5$  and in another instance,  $\beta_{r_3} = 5$ , whilst retaining the other parameters fixed. For brevity we report impulse responses for the inflation rates, output (or capacity utilization) and the short rate, and the depreciation rate of the nominal exchange rate and stock price inflation. These impulse response function are derived by subjecting the model to a positive aggregate demand shock. Figure 4 illustrates the results:

Figure 4: Impulse responses with greater reaction to capacity utilization



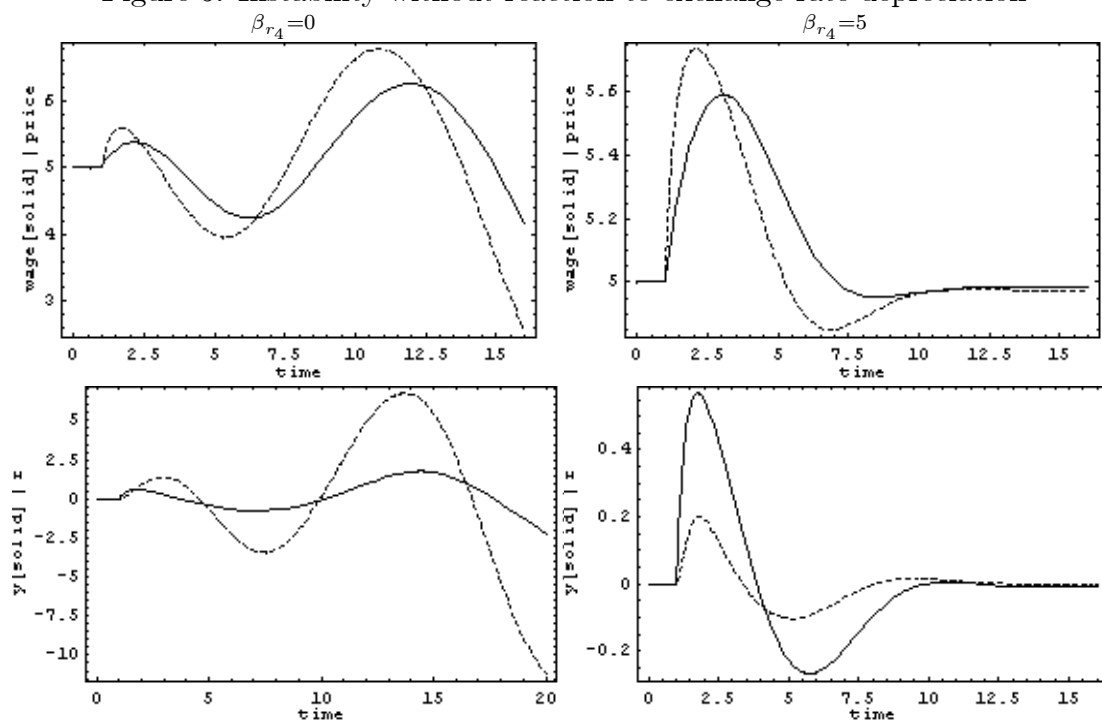


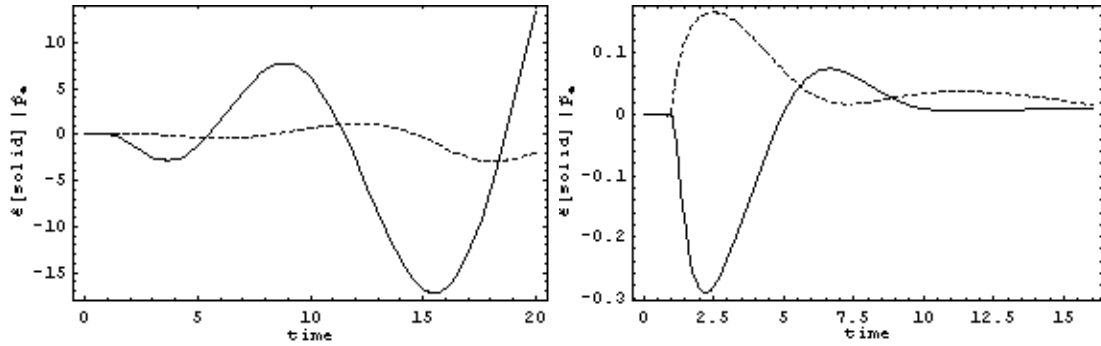
The figure suggests that increased aggression by the central bank against output fluctuations leads to greater volatility of the short term interest rate. The amplitude of the interest rate cycle is almost doubled, whilst there is very slight gain (almost 1 basis point) in taming the amplitude of the inflation cycle. Because of the increased volatility of the short rate, the cycle of the depreciation rate of nominal exchange rate exhibits a relatively large amplitude. Therefore increased aggression against output fluctuations by the central bank leads to increased volatility in financial markets. With sufficient aggression by the central bank so that  $\beta_{r_3} > 14$ , this financial market volatility ultimately leads the economy to switch from a stable to an unstable regime. Nevertheless such destabilizing policy reactions are implausible. We want to also add that even when setting  $\beta_{r_3} = 0$ , the economy remains stable.

The fact that our model remains stable even when the central bank does not respond to the capacity utilization gap, and becomes unstable at implausibly high reaction coefficients of the capacity utilization gap, may provide some rationale of why the output gap appears to be unimportant in the reaction functions of some central banks. Although they do not provide a macroeconomic model, Mohanty and Klau (2004) find that 7 of the 13 countries that they survey significantly respond to output gaps and the rest do not. Our model, which is stabilized by an open economy interest rate rule, thus does not lead to increased instability as the central bank becomes increasingly aggressive against the capacity utilization gap for a range of plausible reaction parameters on the capacity utilization gap.

We next test whether reacting directly to the exchange rate improves or worsens macro-performance. The following simulations thus test the recommendations of Clarida, Gali and Gertler (2001), and those of Ball (1999, 2001). Since in the above simulations we have assumed that the central bank responds to the rate of exchange rate depreciation, we here increase the reaction of the central to exchange rate fluctuations so that  $\beta_{r_4} = 5$  and compare this scenario with the one where  $\beta_{r_4} = 0$ . Figure 5 illustrates the impulse responses under both demand and exchange rate shocks:

Figure 5: Instability without reaction to exchange rate depreciation

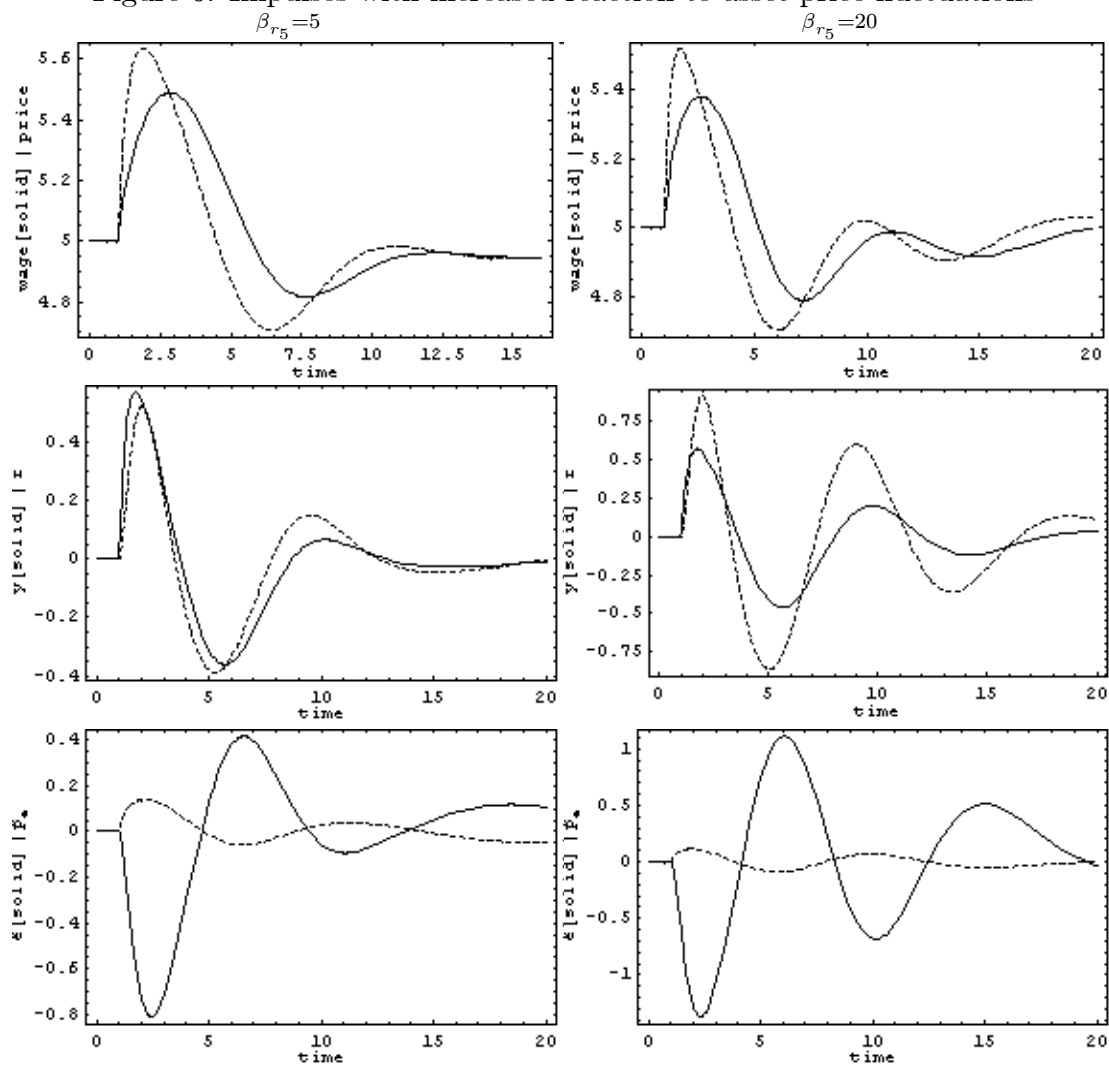




The results suggest that reacting to the depreciation of the nominal exchange rate leads to macro-stability. Our results therefore confirm Ball (1999, 2002). The recommendation by Clarida, Gali and Gertler (2001) thus worsens macroeconomic performance by inducing macroeconomic instability. Besides the "fear of floating" hypothesis advanced by Mohanty and Klau (2004), this result says that emerging market economies directly target nominal exchange rate fluctuations using the short term interest rate perhaps because such a policy delivers macro-economic stability.

Lastly we conduct simulations wherein policy reacts to asset price fluctuations. Since the simulations above are based on  $\beta_{r_5} = 0$ , we want to see how the economy behaves as the central bank increases its responses to asset price fluctuations. We therefore set  $\beta_{r_5} = 5$  and  $\beta_{r_5} = 20$ , whilst maintaining the other parameters of the policy rule fixed. The results for the simulations are presented in figure 6. Again we see that the business cycle tends to be amplified as the aggression of the central bank against asset price fluctuations rises. But this increase in volatility becomes significant and discernible at implausibly high degrees of central bank aggression.

Figure 6: Impulses with increased reaction to asset price fluctuations

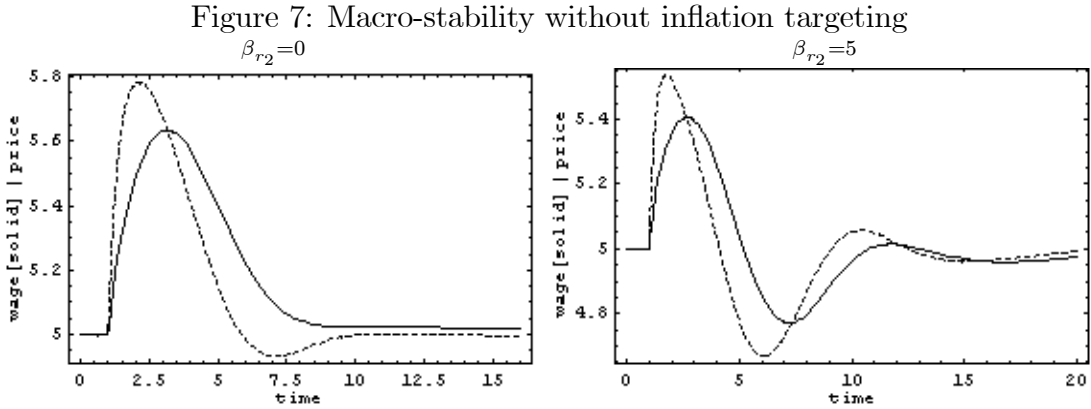


The results suggests that increased reaction to asset price inflation has no significant impact on the behaviour of the economy for a wide and plausible range of central bank aggression. It is only at implausibly high aggression levels that the results by Bernanke and Gertler (1999, 2001) are obtained, where increased macroeconomic volatility is significantly discernible. Our conclusion is that there are no significant gains that can be made by the central bank in responding systematically to asset prices, which are represented here by stock prices.

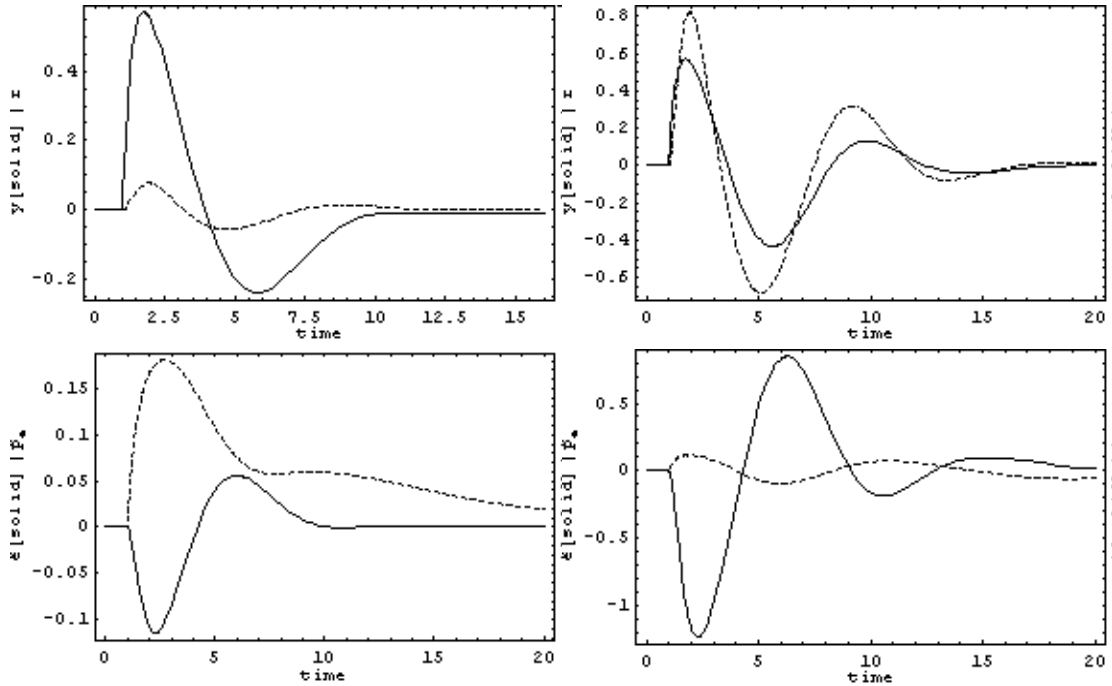
## 5.5 The exchange rate channel and the relevance of inflation-targeting

We now formulate a monetary policy rule that is capable of stabilizing the economy, but which apparently states that the central bank does not directly target the inflation rate. In dynamic control formulations such as the one in Svensson (1997), the policy rule that emerges features the inflation rate as one of the variables to which the central bank has to respond. This is the case precisely because the inflation gap is in the loss function of the central bank. Now we can interpret an interest rate rule that does not feature the inflation gap as suggesting a non-inflation targeting regime. Within the context of our Keynesian model, we want to ask whether inflation targeting is a necessary policy for macroeconomic stability. Furthermore we want to find out whether there are significant changes in the dynamic behaviour of the economy under this non-inflation targeting policy rule.

We now suppress the inflation rate in the Taylor rule, so that  $\beta_{r_2} = 0$  and also compare with a scenario where there is greater aggression against inflation such that  $\beta_{r_2} = 5$ . We produce impulse responses associated with these policy rules in figure 7.







These results show that in a model that is formulated to incorporate as many feedback channels and interactions between markets as possible, a feedback policy rule need not be an inflation-targeting rule in order to deliver macroeconomic stability. The results suggest that inflation deviations from target are benign here. The Mundell effect is thus not necessarily the only, and principal, potentially destabilizing effect in small open economies. Increased aggression by the central bank against inflation tends to generate cyclical convergence and greater volatility in output, interest rate and the exchange rate.

Our simulations show that given the estimated model, a policy rule that systematically responds to exchange rate fluctuations (without necessarily responding to the inflation rate) delivers better macroeconomic performance compared to an inflation-targeting policy rule that does not respond to exchange rate fluctuations. This finding of course throws some doubts on the relevance of inflation targeting when the nominal exchange rate plays an important role in shaping the dynamics of the economy. By responding to the rate of exchange rate depreciation and capacity

utilization, the central bank indirectly controls the inflation rate and is capable of achieving macro stability.

## 6. Conclusion

In this paper we deployed an open economy Keynesian framework to evaluate whether central banks should respond strongly to output gaps, exchange rate fluctuations and fluctuations in asset prices. We then compared our findings with those in the New-Keynesian tradition. Our macroeconomic framework extends the model in Flaschel, Gong and Semmler (2001), which is driven by 6D dynamics, in two ways. Firstly we have extended the model to the open economy context by considering exchange rate complications along the lines of Dornbusch (1976). Secondly we have presented a more elaborate treatment of financial markets by considering the dynamic relationships between the short and long-term interest rate, and further integrated into these financial dynamics stock price movements along the lines of Blanchard (1981). These extensions led to an integrated dynamic model in 13D. We then used South African data to estimate this model.

Our findings are as follows: Firstly, stronger reactions of the central bank to output gaps are destabilizing at implausibly high degrees of aggression. There thus exists a very wide range of parameter values that is such that central bank reaction to capacity utilization is stabilizing. Our empirical model further shows that even if the central bank does not react to the output gap, the economy remains stable. Secondly, a stronger policy reaction to nominal exchange rate fluctuations is stabilizing whereas a simple Taylor rule without the exchange rate depreciation term fails to stabilize the economy. Responding systematically to exchange rate fluctuations is, in our empirical model, a necessary condition for stability in our empirical model. Thirdly, we found that responding aggressively to asset price fluctuations tends to increase macroeconomic volatility, which is significantly discernible at implausibly high degrees of aggression by the central bank.

We have also explored the relevance of inflation targeting as a necessary policy for macroeconomic stability. Our results show that inflation-targeting is not necessary

for macroeconomic stability. A policy rule that responds with sufficient strength to exchange rate fluctuations is necessary for stability. This finding is of course not consistent with the literature review in Taylor (2001), but is consistent with the behaviour of a number of central banks in emerging market economies (Mohanty and Klau, 2004). Increased aggression by the central bank against the inflation gap tends to give way to macroeconomic volatility. Our paper thus argues for the inclusion of the nominal exchange rate in the policy rule for small open economies as a necessary condition for stability, whilst a policy that reacts to stock prices does not appear to yield any discernible gains.

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