ALTERNATIVE POLICY RULES FOR SOUTH AFRICAN MONTEARY POLICY

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Abstract

This paper simulates alternative policy rules within the context of a two-country New Keynesian DSGE model as estimated by Steinbach et al (2009). First, a loss function is postulated and used to determine optimal coefficients for a simple linear Taylor rule. Second, a number of alternative policy rules are tested including an open economy Taylor rule (i.e. including the exchange rate), a domestic inflation target policy rule and a foreign output-augmented policy rule. The optimal rules are compared to an estimated Taylor rule representing the current monetary policy stance, i.e. a flexible inflation targeting regime. Optimal policy is found to be related to higher weights on inflation and output in the Taylor rule; however caution should be placed on these weights as central banks face uncertainty. The performance of optimal policy also depends on the type and mix of shocks which affect the economy as demand and supply shocks affect optimal policy differently.

JEL classification: E1, E52, E58

Keywords: New Keynesian DSGE, Monetary Policy, Inflation Targeting, Policy Rules

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1. INTRODUCTION

New Keynesian models - although not without criticism - have found their way into many Central Banks across the world. This is especially true for inflation targeting countries where simple New Keynesian models have formed part of the suite of models used to debate and inform monetary policy (for a South African example see de Jager, 2007; and Steinbach et al, 2009). However, most of the analysis of these models have specifically focused on forecasting and structural relationships (Alpanda et al, 2011; Alpanda et al, 2010a; Alpanda et al, 2010b; Gupta and Steinbach, 2010; Steinbach et al; 2009; Lui et al, 2007; Lui and Gupta, 2007). This paper deviates from the current literature by recognising the New Keynesian model as a conduit to study more broad-based questions; in particular its ability to provide a simulated version of the South African (SA) economy for the study of alternative policy rules.

A similar concept is exposited in Alpanda et al (2010b) (henceforth AKW); however unlike AKW, other possible rules, such as domestic inflation targeting and a foreign output-augmented Taylor rule are studied. Also, given the differing responses of the economy to demand and supply shocks and consequently the likely differing responses of policy[2], optimal policy is studied under individual shocks (or innovations). This approach allows the policymaker to understand both the impact of varying policy responses to specific shocks and to the trade-off that exists between output and inflation (and more broadly the interest rate) under supply shocks (and in the aggregate). AKW was the first paper to address optimal monetary policy in the South African context; however robustness is needed when referring to the concept of optimality. Therefore, optimal policy needs to be invariant to the model and its assumptions. To partly address the issue of robustness, an alternative model and parameterisation is tested.

This paper is structured as follows: Section 2 describes the model. Section 3 discusses alternative policy rules focusing on an open economy Taylor rule, domestic inflation targeting and a foreign output-augmented Taylor rule. Section 4 discusses caveats and future work and Section 5 concludes.

2. MODEL

The estimated model adopted in this paper is the Steinbach *et al* (2009) New Keynesian Dynamic Stochastic General Equilibrium (DSGE) two-country model closely following Monacelli (2005). This section will only focus on the general properties of this model and its log-linear form. For details on the micro-foundations and parameterization refer to Steinbach *et al* (2009). Table 5 provides the estimated shocks used.

The model assumes a continuum of infinitely live households consuming aggregated domestic and imported goods. They are monopolistically competitive and supply differentiated labour to intermediate goods producers, who are also monopolistically competitive and produce differentiated goods for final goods producers. Households and intermediate firms set wages and prices in the labour and goods market subject to Calvo (1983) pricing. Final goods producers combine the differentiated intermediate goods to produce an aggregate domestic good in a perfectly competitive environment. Other features of the model include external habit formation[3], imperfect pass-through of exchange rate changes and the partial indexation of domestic prices and wages to past inflation.

The model can be represented in the following log-linear form:

$$y_t = (1-\gamma)c_t + \eta\gamma(2-\gamma)s_t + \gamma y_t^* + \eta\gamma\psi_{f,t} \quad (1)$$

[2] Inflation targeting under supply shocks lead to a trade-off between inflation and output while under demand shocks no such trade-off exists.

[3] Consumers maximising the change in consumption ($C_t - C_{t-1}$).

Equation (1) is the aggregate demand equation in the domestic economy with c_t representing domestic consumption, s_t the terms of trade, y_t^* foreign aggregate demand[4] and $\psi_{f,t}$ represents the law of one price (l.o.p.) gap.

The domestic Philips curve is given as:

$$\pi_{h,t} = \frac{\delta}{1+\delta\beta}\pi_{h,t-1} + \frac{\beta}{1+\delta\beta}\pi_{h,t+1} + \frac{(1-\theta_h)(1-\theta_h\beta)}{\theta_h(1+\delta\beta)}mc_t \qquad (2)$$

$\pi_{h,t}$ is domestic inflation and mc_t is real marginal cost. Overall inflation in the domestic economy is a function of both domestic and imported inflation such that $\pi_t = (1-\gamma)\pi_{h,t} + \gamma\pi_{f,t}$. $\pi_{f,t}$ is a function of its expectation and the l.o.p. gap.

The uncovered interest parity condition can be written as:

$$E_t\{\Delta q_{t+1}\} = (r_t - \pi_{t+1}) - (r_t^* - \pi_{t+1}^*) + \phi_t \qquad (3)$$

q_t is the real exchange rate, r_t is the policy rate and ϕ_t is the exchange rate risk premium.

The Central Bank is initially assumed to follow a basic Taylor rule of the form:

$$r_t = \rho_r r_{t-1} + (1-\rho_r)\left[\phi_\pi \pi_t + \phi_y(y_t - y_{t-1})\right] + \varepsilon_t^r \qquad (4)$$

Where r_t is the policy instrument, the repurchase rate in the case of SA, π_t is the quarter-on-quarter change in the consumer price index (CPI)[5], y_t is real Gross Domestic Product (GDP), ρ_r captures the inertia in the policy instrument, ϕ_π and ϕ_y are weights placed on inflation and output stabilisation by the Central Bank and ε_t^r is an i.i.d. shock to monetary policy. The policy rule assumes the Central Bank adjusts the policy instrument in response to changes in the level of inflation and to changes in output. Steinbach *et al* (2009) estimated $\phi_\pi = 1.389$ and $\phi_y = 0.625$.

3. CENTRAL BANK LOSS FUNCTION

Following AKW a loss function for policymakers is assumed to be a function of inflation, output and the policy rate. This function takes the following form:

$$L_t(\boldsymbol{\theta}) = \sum_{i=t}^{\infty}\beta^{i-t}\left[(\pi_t)^2 + \lambda_y(y_t)^2 + \lambda_r(r_t)^2\right] \qquad (5)$$

where $\lambda_y, \lambda_r > 0$ are weights on the variance of output and inflation, β is a time-discount factor and $\boldsymbol{\theta} = [\cdot]$ is a set of parameter coefficients of the specific Taylor rule; the loss function is a function of the coefficients in the proposed Taylor rules. Similar to AKW, the rest of the model parameters are assumed to be structural in nature and cannot be affected by monetary policy; i.e. are assumed to be constant. Parameter uncertainty is also abstracted from.

In the case of $\beta = 1$, the loss function can be simplified to:

$$L_t(\theta) = var(\pi) + \lambda_y var(y) + \lambda_r var(r) \qquad (6)$$

[4] $y_t^* = c_t^*$ since the foreign country is a closed economy.
[5] The inflation target was CPIX (excluding interest rates on mortgage bonds) up to 2008 and headline CPI onwards.

The choice of weights $\lambda_y, \lambda_r > 0$ is arbitrary and therefore a number of possible alternatives are chosen.

4. RESULTS

The model is estimated in Matlab using dynare 4.0. The initial optimal rule is the simple Taylor rule used in Steinbach *et al* (2009). Then other policy rules associated with a small open economy are implemented. First, the exchange rate is added, as in AKW, to test whether this variable plays a significant role in optimal monetary policy. Second, domestic inflation is used as the target instrument. Domestic inflation is targeted as it is more responsive to domestic monetary policy. Third, foreign output in included in the policy rule. In each case the same loss function is used to calculate an optimal policy rule to ensure comparability across rules. Finally, the individual shocks are studied to determine what is driving the gain in optimality in the aggregate case.

Similar to AKW, estimation of an optimal policy rule which includes ρ_r, the autoregressive term on inflation in the policy rule, results in a value of 0.99. This suggests that optimal monetary policy is equivalent to a random walk. Therefore, this value is set to 0.73 as estimated in Ortiz and Stuzenegger (2007) and adopted in Steinbach *et al* (2009).

4.1 An Optimal Simple Taylor Rule

Table 1 shows the optimal coefficient values for inflation and output in equation 4 given different weights for output and the interest rate in the loss function and the standard deviation of the variables of interest. The first column contains the estimated policy rule and implied volatility of inflation, output, interest rate and nominal exchange rate depreciation (N.E.R.D.). Subsequent columns indicate the percentage change between the optimal rule and the current stance.

Consensus across all weights ($\lambda_y, \lambda_r > 0$) suggest that optimal monetary policy is associated with much larger coefficient values on inflation and output compared to the estimated coefficients. The optimal coefficient on inflation deviates substantially with alternative weights in the loss function with a minimum of 4.06 and a maximum of 5.93. The optimal output coefficient displays a similar pattern to the inflation coefficient and is substantially larger than what is estimated (0.625), with a minimum coefficient value of 2.81 and a maximum of 8.36.

The impact of shifting from the current estimated stance to an optimal policy rule results in generally lower inflation, output and exchange rate volatility. Inflation volatility declines by a maximum of 25.6 per cent (average of 12,9 per cent). The maximum decline in inflation is associated with $\lambda_y = 0$ in the loss function. Under the simple optimal rule output volatility declines by a maximum 16,9 per cent (average of 8,1 per cent). Optimal policy also results in higher interest rate volatility as the Central Bank responds more aggressively to inflation and output. Interest rate volatility increases by a maximum of 23.4 per cent (average of 18,4 per cent).

4.2 An Optimal Open Economy Taylor Rule

Assume the Central Bank extended its policy rule to include the exchange rate such that:

$$r_t = \rho_r r_{t-1} + (1-\rho_r)\left[\phi_\pi \pi_t + \phi_y (y_t - y_{t-1}) + \phi_e (e_t - e_{t-1})\right] + \varepsilon_t^r \qquad (7)$$

Where e_t is the nominal exchange rate and ϕ_e is the coefficient defining the response of the Central Bank to changes in the exchange rate. The simple rule is the case where $\phi_e = 0$.

The results for the open economy Taylor rule are presented in table 2. The optimal coefficients on inflation and output are similar to those in table 1, however smaller throughout. On inflation, the maximum value is 5.45 and the minimum is 2.66. These values compare somewhat favourably to AKW who also find values for the coefficient to be significantly larger than the estimated value. However, the maximum optimal coefficient on inflation in AKW is only 3.76. On output the coefficient values vary from 0.06 to 8.18. AKW also find this value to be generally larger than their estimate (0.29).

The coefficient on the change in the nominal exchange rate (n.e.r.d.) is somewhat surprising in magnitude. AKW find in general that the optimal policy rule "requires little or no feedback from the currency depreciation rate" (2010b:26) and that the sign necessarily arbitrary given the magnitude of these coefficients. This is similar to Justiano and Preston (2010) who found that optimal policy in a small open economy places no weight on the exchange rate. However, table 2 suggests that the coefficient on n.e.r.d. is significant and positive, with a plausible optimal value in the domain of [0:0.73]. The results suggest that the Central Bank should take cognisance of exchange rate movements when setting policy.

4.3 Targeting Domestic Inflation and Optimal Policy

The current policy stance of the SARB targets CPI as this is an easily understood target for the public and is frequently used by the media to report on inflation developments. Targeting CPI may represent a greater challenge to policymakers as it is generally more volatile and includes components that are generally invariant to changes in the interest rate. Therefore, targeting domestic CPI may ensure that the SARB anchors the domestic economy more effectively and may be a more suitable nominal anchor for monetary policy.

This policy rule is defined as follows:

$$r_t = \rho_r r_{t-1} + (1-\rho_r)\left[\phi_\pi \pi_{h,t} + \phi_y(y_t - y_{t-1}) + \phi_e(e_t - e_{t-1})\right] + \varepsilon_t^r \qquad (8)$$

Where $\pi_{h,t}$ is the domestic part of overall inflation. Domestic Inflation Targeting assumes that the Central Bank only responds to domestic inflation outcomes and does not consider imported inflation, except for its indirect impact on domestic inflation.

Table 3 shows the optimal policy rule assuming the Central Bank responds to domestic inflation. The coefficient of domestic inflation tends to be smaller than the coefficient values on inflation in table 2, while the coefficient values on output and the exchange rate tend to be larger. This suggests that in order to stabilise overall inflation the Central Bank needs to be more responsive to the exchange rate and output. The standard deviations of inflation, output and the exchange rate and the subsequent loss function values suggest that it is not more optimal to target domestic inflation above overall inflation as these values are larger.

4.4 Targeting Foreign Output and Optimal Policy

Given the fact that South Africa is a small open economy which is significantly affected by foreign developments, it might be that reacting to foreign output may result in a better domestic economic outcome. As Borio and Filardo (2007) show, as world economies become more integrated, world factors are more likely to play a significant role in domestic inflation determination. Therefore, foreign output is added to the Taylor rule to establish whether reacting to world factors (in this case world output) could improve domestic monetary policy. This policy rule is specified as follows:

$$r_t = \rho_r r_{t-1} + (1-\rho_r)\left[\phi_\pi \pi_t + \phi_y (y_t - y_{t-1}) + \phi_{ys}(y_t^* - y_{t-1}^*)\right] + \varepsilon_t^r \quad (9)$$

Where y_t^* is rest of world output and ϕ_{ys} is the weight place on the change in foreign output.

Table 4 shows the results from the optimal estimation of this policy rule. It is clear from the table that foreign output does not play a significant role in optimal domestic monetary policy. The values of ϕ_{ys} tend around zero with a largest value of 0.06. This is most likely due to the fact that much of the impact of foreign output on the domestic economy is taken into account in a simple Taylor rule through output and inflation.

Figure 1 plots the standard deviation of inflation and output for all optimal policy rules against the current estimated stance of the Central Bank in the aggregate case; i.e. under all shocks. The current stance indicates that the standard deviation on output, or the deviation of output from potential, is 1.5 per cent while on inflation is 0.9 per cent. Optimal policy is associated with an inward shift for both inflation and output volatility, suggesting that the Central Bank can improve its loss function by increasing its responsiveness to inflation and output developments. However this shift is dependent on the weight a Central Bank places on output (λ_y). When $\lambda_y = 1$, output volatility is minimised at a cost to inflation volatility. This is shown through a downward shift from the current policy stance in figure 1. In this case, the shift to an optimal policy rule decreases output volatility by a maximum of 16.9 per cent or a decline in output by an annualised 1 percentage point. When $\lambda_y = 0$, optimal policy shifts leftward from the current stance in figure 1. This weight is associated with a maximum decline in inflation volatility of 30.4 per cent or 1.1 percentage points annualised. Figure 1 also indicates that a Central Bank is able to lower both inflation and output volatility if an intermediate weight (i.e. $0 < \lambda_y < 1$, specifically $\lambda_y = 0.5$) is chosen for output in the loss function. In this case optimal policy is associated with a 0.6 and 0.5 percentage point annualised drop in inflation and output respectively.

4.5 The Disaggregated Case

In the aggregate, optimal monetary policy results in a downward shift in both inflation and output volatility from the estimated stance (figure 1). However, given the economy's differing response to supply and demand shocks, it may be that gains from optimal policy only comes from a specific shock which improves the aggregate case. Figures 2 to 6 show the inflation-output trade-off for specific shocks modelled. The shocks chosen are domestic shocks to productivity, cost-push inflation, demand, wage mark-up and monetary policy.

One of the benefits of inflation targeting is the ability to stabilise both inflation and output when faced with a demand shock. Transmission of a positive demand shock results in consumption increasing, from an equilibrium stand point this suggests output above its potential rate, which would cause inflation to rise. Higher output leads to a contemporaneous appreciation of the real exchange rate. This appreciation will dampen the impact of imported inflation on overall CPI through a decrease in net exports and import prices. However, the rise in domestic inflation will outpace the decline in foreign inflation resulting in an increase in overall inflation. In this case, both output and inflation move in the same direction, allowing the Central Bank to respond adequately to both. This improvement is visible in figures 4 and 6. However, under a supply shock, this is not the case.

The alternative scenario is presented in figures 2, 3 and 5. For example, under a cost-push inflation shock such as an oil or food price shock, inflation initially increases. The supply shock negatively affects output which declines peaking after a few quarters. The cost-push inflation shock results in the depreciation of the real exchange rate, increasing imported inflation and placing further upward pressure on the overall inflation rate. As a result inflation and output move in opposite directions. Therefore, a monetary policy response to higher inflation results in a further depression in output. This trade-off therefore makes the choice between policy rules complex.

Figures 2-6 suggest that the improvement in the aggregate case is due to an improvement in responses to a demand and monetary policy shock rather than to supply shocks. Figures 2, 3 and 5 show optimal monetary policy is unable to sufficiently improve inflation and output volatility to result in a point closer to the origin than the current stance. These policy rules can be approximated using a second-order polynomial fitted line. This suggests that moving to optimal monetary policy will only shift a Central Bank along this line rather than improve on the current stance. If a Central Bank wishes to improve on its output (inflation) outcome, it will shift rightwards (leftwards) increasing inflation (output) volatility. A demand shock on the other hand results in points closer to the origin compared to the current stance.

Figure 7 shows the variance decomposition of the variables of the model. Of interest is whether inflation and output are driven predominantly by supply or demand shocks. Inflation is predominantly driven by supply shocks with close to 70 per cent of the variance due to cost-push inflation shocks (31.8 per cent), productivity shocks (35 per cent) and wage mark-up shocks (1.8 per cent). Only 0.25 per cent of overall inflation is due to foreign shocks supporting the insignificance of foreign output in the policy rule. Output is also predominantly driven by supply shocks with 82.9 per cent of the variation due to cost-push inflation, productivity and wage shocks. This indicates the importance of supply shocks to the macroeconomic stability in South Africa and the problem with attempting to shift to optimal policy.

5. CAVEATS AND FUTURE WORK

This paper relies exclusively on simulated data in order to compare alternative policy rules and therefore is subject to the assumptions and linearisation of the DSGE model. Although the model represents the South African economy sufficiently, real world outcomes could be significantly different. A number of assumptions of the model need to be taken into account. First, the model assumes a very specific linear policy rule for monetary policy which may not necessarily accurately represent the SARB's response function. Although linear Taylor rules are widely used in the literature and are a good approximation of a central banks response, recent developments indicate the importance of non- linearities in policy rules (see Naraidoo and Raputsoane 2010, 2011). Also, as de Jager (2007) points out, a Taylor rule, although optimal in the class of linear reaction functions, is not the most effective way to design monetary policy even though such a rule does offer a sensible description of policy responses. Second, the estimated model is a linear approximation of the micro-founded version and extending this to an n^{th}-order approximation may alter results. Third, the model does not include the financial sector and therefore asset prices and wealth effects. Fourth, AKW (2010a) suggest that the model adopted in this paper does not accurately model external shocks on the economy. Finally, the model does not take into account uncertainty that exists in reality which would necessarily make a Central Bank more conservative in its response to innovations.

Other caveats also remain. The estimated model takes account of the average response given all shocks that hit the economy which does not necessarily mean that the SARB does not respond more aggressively when faced with a demand (supply) shock.

Future work could include adding other policy rules to the analysis. Currently of interest are price level targeting and other core inflation measures as targets for monetary policy such as CPI less food and fuel and trimmed-mean inflation. Studying the current alternative policy rules in the context of other models might also allow for further robust results.

6. CONCLUSION

Several general results can be gleaned from this paper. First, optimal policy is only able to decrease inflation volatility by a maximum of 30.4 per cent compared to the current estimated stance. Second, optimal policy has a lesser impact on output, in contrast to AKW, decreasing output volatility by a maximum of 16.9 per cent. Third, similar to AKW, optimal policy will increase the volatility on the interest rate by a maximum of 24,7 per cent. This is expected as an optimal policy rule suggests that the central bank should be more responsive to changes in inflation and output. AKW state that part of the reason for a lower estimated value is due to model, policy and parameter uncertainty. Fourth, the exchange rate is part of an optimal Taylor rule in contrast to AKW and Justiano and Preston (2010). Fifth, targeting a less volatile inflation series, such as domestic inflation, does not improve on the optimal open economy Taylor rule. Sixth, Foreign output has little impact on optimal policy.

The results also suggest that responses to individual shocks matter. First, supply shocks (for example the cost-push, wage mark-up and productivity shocks) lead to a trade-off between inflation and output and demand shocks do not. Under supply shocks higher interest rate volatility is generally associated with higher output and lower inflation volatility. Under demand shocks (for example the Uncovered Interest Parity (UIP) risk premium shock) monetary policy can lower the volatility of inflation and output simultaneously but at a cost to greater interest rate volatility. Second, in the aggregate case, supply shocks and therefore the inflation-output trade-off dominates.

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Tables and figures

Table 1: Optimal Policy Rule Coefficients: Simple Taylor Rule

Coefficient	***Estimated***	***Wts.*** (λ_y, λ_r) *(0.5,1)*	*(1,1)*	*(0,1)*	*(0.5,0.5)*
Inflation (ϕ_π)	1.389	4.06	4.66	4.22	5.93
Output (ϕ_y)	0.625	4.84	8.36	2.81	7.44
Smoothing (ρ_r)	0.73	0.73	0.73	0.73	0.73
Loss Function	-	1.98	2.86	0.91	1.79
Standard Dev. (%)					
Inflation	0.9226	-12.1%	0.1%	-25.6%	-14.2%
Output	1.5211	-8.5%	-16.9%	1.5%	-8.7%
Interest Rate	0.5358	11.5%	19.8%	23.4%	18.7%
N.E.R.D.	1.9857	-31.9%	-36.7%	-21.5%	-35.8%

Table 2: Optimal Policy Rule Coefficients: Open Economy

Coefficient	***Estimated***	***Wts.*** (λ_y, λ_r) *(0.5,1)*	*(1,1)*	*(0,1)*	*(0.5,0.5)*
Inflation (ϕ_π)	1.389	3.64	4.51	2.66	5.45
Output (ϕ_y)	0.625	4.14	8.18	0.06	6.68
N.E.R.D. (ϕ_e)	n.a.	0.59	0.21	1.53	0.73
Smoothing (ρ_r)	0.73	0.73	0.73	0.73	0.73
Loss Function	-	1.97	2.86	0.83	1.79
Standard Dev. (%)					
Inflation	0.9226	-13.9%	-0.3%	-30.4%	-15.4%
Output	1.5211	-7.3%	-16.7%	8.2%	-7.9%
Interest Rate	0.5358	10.0%	19.7%	20.7%	17.4%
N.E.R.D.	1.9857	-40.2%	-39.1%	-37.8%	-43.8%

Table 3: Optimal Policy Rule Coefficients: Domestic Inflation

Coefficient	**Estimated**	**Wts.** (λ_y, λ_r) (0.5,1)	(1,1)	(0,1)	(0.5,0.5)
Dom. Inflation (ϕ_π)	1.389	3.27	4.04	2.4	4.99
Output (ϕ_y)	0.625	4.62	8.97	0.27	7.62
N.E.R.D.(ϕ_e)	n.a.	0.92	0.57	1.79	1.07
Smoothing (ρ_r)	0.73	0.73	0.73	0.73	0.73
Loss Function	-	2.01	2.9	0.86	1.81
Standard Dev. (%)					
Inflation	0.9226	-13.9%	-0.2%	-30.0%	-15.2%
Output	1.5211	-7.1%	-16.7%	8.5%	-7.9%
Interest Rate	0.5358	14.8%	24.7%	23.7%	22.0%
N.E.R.D.	1.9857	-44.1%	-42.7%	-40.2%	-46.3%

Table 4: Optimal Policy Rule Coefficients: Foreign Output

Coefficient	***Estimated***	***Wts.*** (λ_y, λ_r) *(0.5,1)*	*(1,1)*	*(0,1)*	*(0.5,0.5)*
Inflation (ϕ_π)	1.389	4.07	4.65	4.23	5.93
Output (ϕ_y)	0.625	4.85	8.36	2.82	7.43
For. Output (ϕ_{ys})	n.a.	0.02	-0.03	0.06	-0.05
Smoothing (ρ_r)	0.73	0.73	0.73	0.73	0.73
Loss Function	-	1.98	2.86	0.91	1.80
Standard Dev. (%)					
Inflation	0.9226	-12.1%	0.2%	-25.6%	-14.2%
Output	1.5211	-8.5%	-16.9%	1.5%	-8.6%
Interest Rate	0.5358	11.5%	19.9%	23.4%	18.7%
N.E.R.D.	1.9857	-31.9%	-36.7%	-21.5%	-35.8%

Table 5: Standard deviations of shocks

Parameter	*Prior*[+]	*Posterior mean*
Domestic		
σ_a : Productivity	I.G. (2,∞)	1.151
σ_d : Demand	I.G. (2,∞)	0.483
σ_w : Wages	I.G. (2,∞)	1.403
σ_p : Prices	I.G. (2,∞)	1.952
σ_r : MP	I.G. (2,∞)	0.366
Foreign		
σ^*_a : Productivity	I.G. (1,∞)	0.610
σ^*_d : Demand	I.G. (1,∞)	0.280
σ^*_p : Prices	I.G. (1,∞)	0.769
σ^*_r : MP	I.G. (1,∞)	0.211

[+] I.G. is inverse gamma

Figure 1: The Trade-off Between Inflation and Output: All shocks

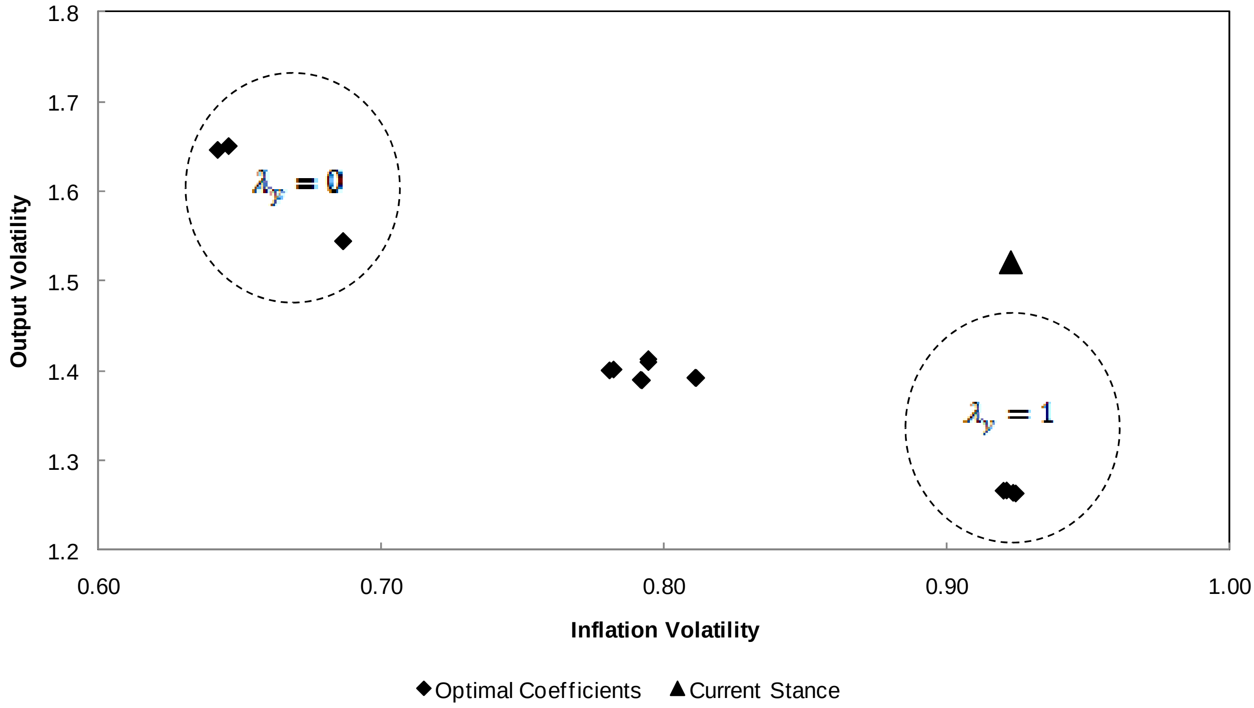

Figure 2: Domestic Cost-Push Inflation Shock

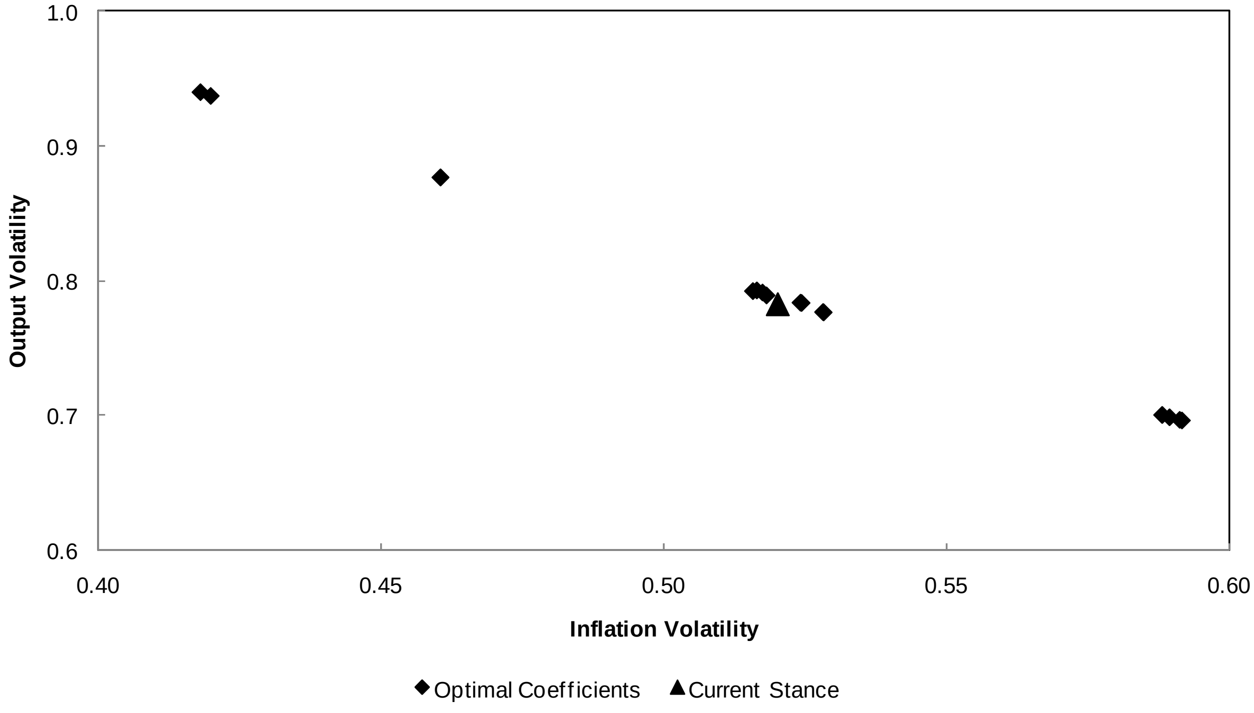

Figure 3: Domestic Wage Mark-Up Shock

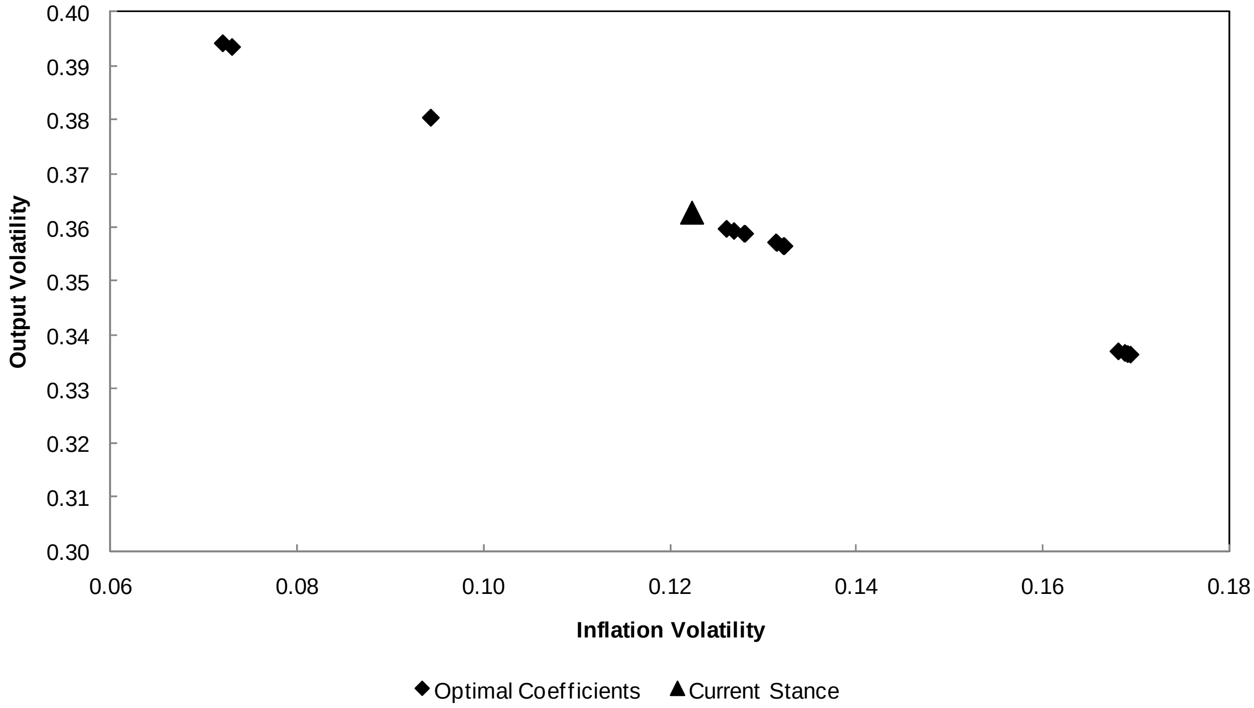

Figure 4: Domestic Demand (UIP Risk Premium) Shock

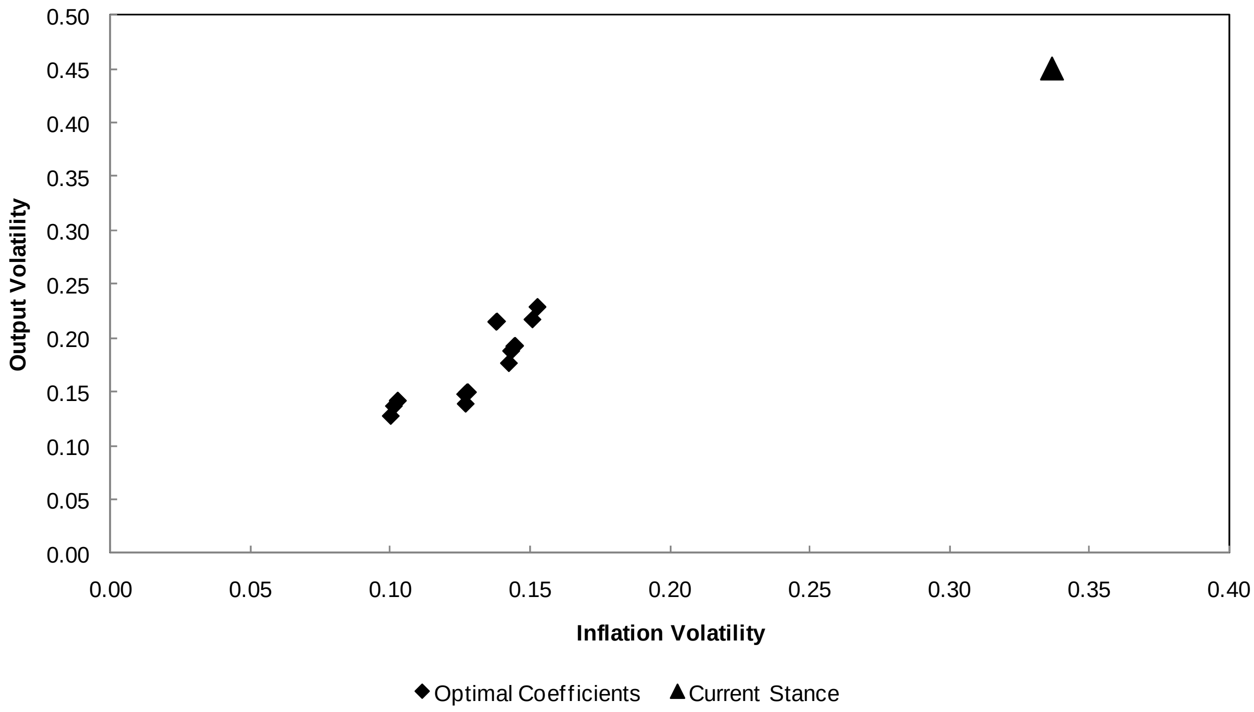

Figure 5: Domestic Productivity Shock

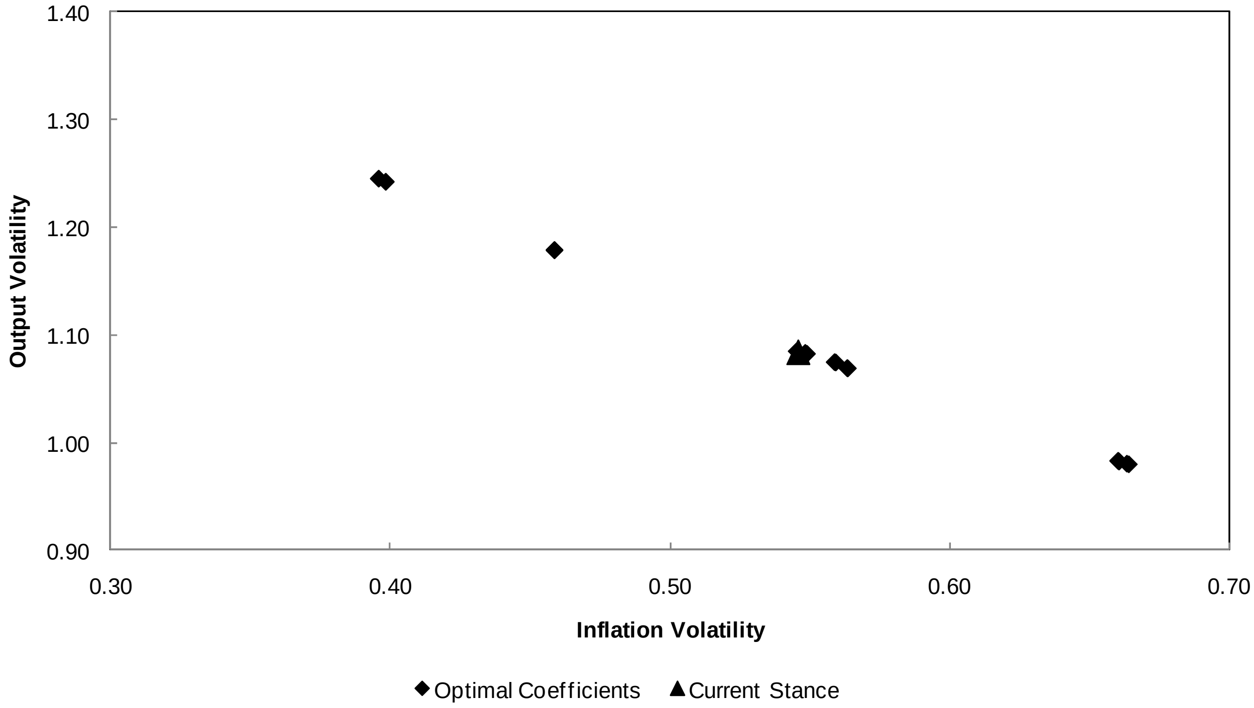

Figure 6: Domestic Monetary Policy Shock

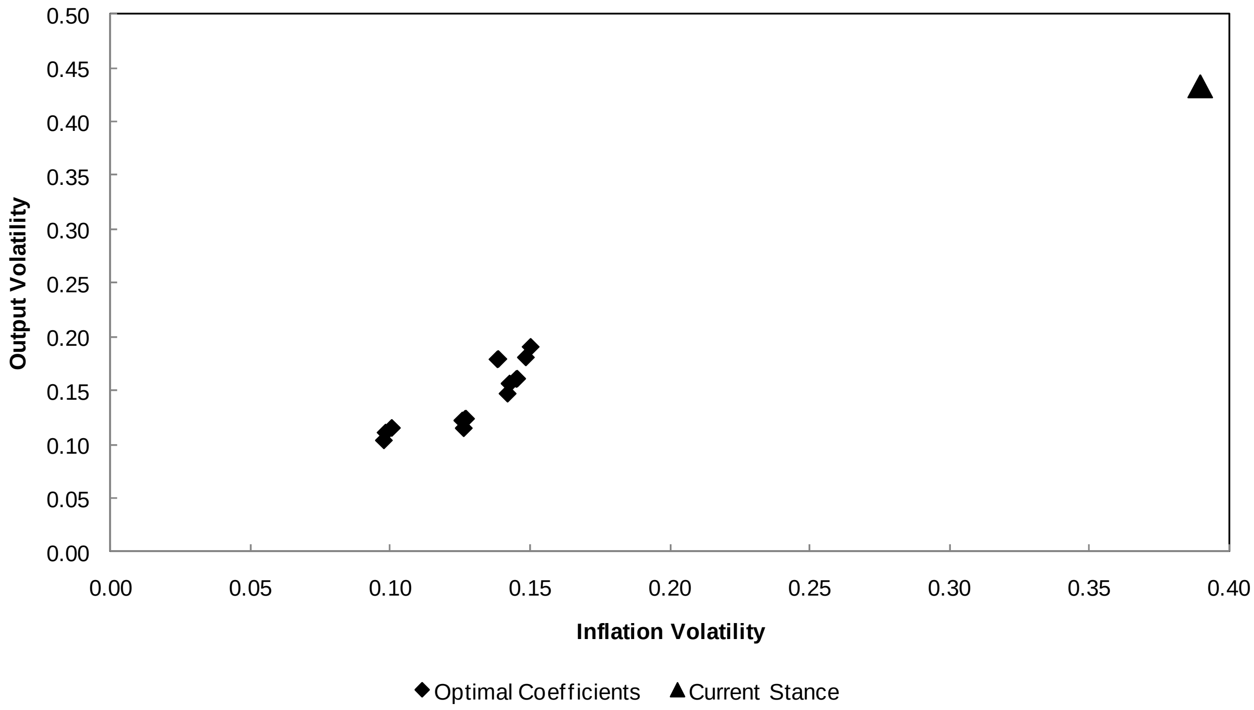

Figure 7: Variance Decomposition