Monetary Policy and Medium-Term Fiscal Planning

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– Abstract –

The medium-term fiscal plan is based on projections of fiscal revenues and expenditures, conditional on future economic and financial developments including the stance of the monetary policy. This paper investigates how a more aggressive monetary policy would influence medium-term fiscal planning objectives.

From a theoretical perspective, the effect of a more aggressive monetary policy on fiscal planning is ambiguous. A more aggressive monetary policy could have a stabilizing or destabilizing influence, depending on several factors. We investigate this issue from an empirical perspective using stochastic simulation methods.

Our stochastic simulation results indicate that a more aggressive monetary policy raises the variability of short-term interest rates, but can lower the variability of output, inflation and debt service costs. This stabilising influence means that the fiscal authority is more able to keep the debt-to-GDP ratio on a clear, downward profile without sacrificing its other objectives, namely “policy smoothing” and economic stabilisation. There is a limit, however, to the stabilising influence of monetary policy. The monetary authority can only reduce the variation in inflation to a certain point before it begins to have a destabilising influence on the “policy smoothing” and economic stabilisation objectives of fiscal policy.

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1. Introduction

The response of monetary policy to economic developments plays a potentially important role in medium-term fiscal planning. Projections of fiscal revenues and expenditures are conditional on economic developments, which are determined in part by the stance of monetary policy. For example, if inflationary pressures turn out to be significantly stronger than anticipated, the monetary authority would tighten monetary conditions by raising interest rates in order to reduce economic growth and thereby curtail the inflationary pressure. The effect of monetary policy on interest rates, output and inflation can have a major influence on debt service costs, tax revenues and fiscal expenditures.

This paper examines how a more aggressive monetary policy influences medium-term fiscal planning. One would expect that a more aggressive response by the monetary policy to economic developments would lead to higher variation in short-term interest rates and thereby raise the amount of uncertainty surrounding debt service costs. The influence of monetary policy on medium-term fiscal planning, however, extends beyond the linkage between short-term interest rates and debt service costs. One must also take into account the effect of monetary policy on other macroeconomic variables such as output, inflation and longer-term interest rates.

The influence of monetary policy on medium-term fiscal planning will also depend on the nature of the shocks impinging on the economy. To illustrate, consider the case where the monetary authority raises interest rates in response to stronger than expected growth in real output. The initial *aggregate demand* shock leads to higher tax revenues along with lower fiscal expenditures, which together raise the primary budget balance. The response of the monetary authority (in the form of higher short-term interest rates) raises debt service costs. This offsets the increase in the primary budget balance and thereby stabilizes the overall budget balance. A more aggressive monetary policy response to an *aggregate demand* shock could result in less variation in the overall budget balance and the debt-to-GDP ratio. This would imply lower uncertainty surrounding medium-term fiscal planning.

Monetary policy can have the opposite effect, however, in the case of an *aggregate supply* shock. Consider the case of an unanticipated increase in inflation that was not due to stronger economic activity. The monetary authority would respond by raising interest rates, leading to higher debt service costs (as in the case of an aggregate demand shock). The tighter monetary conditions would eventually constrain output growth and thereby reduce the primary budget balance. In this case, the higher debt service costs and the lower primary balance would act together to reduce the overall budget balance. A more aggressive monetary policy response to an *aggregate supply* shock could result in more variation in the overall budget balance and the debt-to-GDP ratio. This would imply higher uncertainty surrounding medium-term fiscal planning.

From a theoretical perspective, the influence of a more aggressive monetary policy on medium-term fiscal planning is ambiguous. A priori, it is unclear whether a more aggressive monetary policy would make medium-term fiscal planning more difficult, or easier. This paper investigates this empirical issue using stochastic simulation methods.

The plan of the paper is as follows. Section 2 describes how we model monetary and fiscal policy in a stochastic simulation framework. In section 3, we describe some of the key simulation properties of the model using a few illustrative shocks. Stochastic simulation results are then reported in Section 4. Section 5 discusses an extensive set of additional stochastic simulation experiments undertaken to examine the robustness of our results. Section 6 concludes by drawing policy implications.

2. Modelling Monetary and Fiscal Policy in a Simulation Framework

2.1 Monetary Policy

The monetary authority in our analysis seeks to keep inflation within a target range as much as possible in the presence of uncertainty about future economic developments. This is implemented in a stochastic simulation setting using a simple policy rule of the following form:

$$(r_t - r_t^*) = \gamma_1(E_t\pi_{t+1} - \pi^*) + \gamma_2(r_{t-1} - r_{t-1}^*) \quad (1)$$

where $(r_t - r_t^*)$ represents the deviation of the short-term real interest rate from its equilibrium level and $(E_t\pi_{t+1} - \pi^*)$ represents the expected deviation of the "core" inflation rate from the mid-point of the target range over the coming quarter.[1] The monetary authority's expectations are generated in a model-consistent manner so that $E_t\pi_{t+1}$ represents the model's forecast of *core* inflation in the coming quarter.

The autoregressive term $(r_{t-1} - r_{t-1}^*)$ is intended to capture the "interest-rate smoothing" aspect of monetary policy. High (positive) values of the autoregressive parameter γ_2 act to dampen quarterly movements in short-term interest rates, which delays the monetary policy response to shocks (as shown by Taylor 1999b). "Interest rate smoothing" was originally motivated by the contention that the monetary authority seeks to curb short-run volatility in interest rates in order to preserve orderly operation of financial markets (Goodfriend 1991). More recent research has shown that "interest rate smoothing" can be motivated by other aspects of the monetary policy process such as uncertainty about data and parameters (Sack and Wieland 1999).

The autoregressive parameter γ_2 is set to a value of 0.8, which is consistent with estimates obtained by Orphanides and Wieland (1998) for the U.S. The other policy parameter γ_1 represents the responsiveness of monetary policy to shocks. Higher values

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[1] "Core" inflation π_t is measured as the year-on-year change in the CPI excluding food, energy and indirect taxes.

of γ_2 imply that the monetary authority responds more aggressively, resulting in a higher degree of inflation control. Varying γ_1 across a range of values enables us to examine the implications of implementing monetary policy in a more aggressive manner in a stochastic simulation framework.

2.2 Fiscal Policy

The fiscal authority in our analysis seeks to keep the debt-to-GDP ratio within a target range that declines gradually over time. If debt reduction were the only objective, the fiscal authority could plan its budget by adjusting program spending and/or taxes to keep the projected debt-to-GDP ratio at the mid-point of the target range over the coming fiscal year. This would require large and frequent discretionary changes to program spending and/or taxes and also result in a *pro-cyclical* fiscal policy stance. Large and frequent discretionary changes run the risk of having to “backtrack” on announced program spending and tax measures. The fiscal authority also wants to provide economic stabilisation by introducing discretionary changes to taxes and program spending in a counter-cyclical manner. The fiscal authority, therefore, faces a fundamental conflict between its debt control objective and its “policy smoothing” and economic stabilisation objectives.[2]

The fiscal authority in our analysis balances the conflicting policy objectives using a simple policy rule of the form:

$$(b_t - b^*) = \tau(E_t d_{t+1} - d^*) \tag{2}$$

where $(b_t - b^*)$ represents the deviation of the budget balance from its target level (expressed as a proportion of GDP) and $(E_t d_{t+1} - d^*)$ represents the expected deviation of the debt-to-GDP ratio[3] from the mid-point of the target range.[4]

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[2] For a more detailed discussion of the fiscal policy trade-off, see Hostland and Matier (2001).

[3] The “debt-to-GDP ratio” refers to net federal debt as a proportion of GDP throughout the paper.

[4] More precisely, $E_t d_{t+1}$ represents the forecast of the net debt-to-GDP ratio over the coming fiscal year (the current quarter plus the coming three quarters).

The fiscal authority reacts to unanticipated economic and fiscal developments by making discretionary changes to program spending and/or taxes that are required to bring the debt-to-GDP ratio back to the mid-point of the target range in a gradual manner.[5] A higher value of the parameter τ implies that the debt-to-GDP ratio reverts to the mid-point of the target range more rapidly. This reduces the range of fluctuations in the debt-to-GDP ratio. The parameter τ is set to a value of 0.1 in the benchmark version of the model. This results in a 90 per cent confidence interval for the debt-to-GDP ratio of about three percentage points.

3. Dynamic Simulations

Due to space limitations, we will not present the structure of the stochastic simulation model used to generate our results.[6] Instead, we will illustrate the main properties of the model by showing dynamic responses of selected macro and fiscal variables to two shocks of interest: a transitory increase in output and inflation.

3.1 An Output Shock

Figures 1a and 1b show dynamic responses of selected macro and fiscal variables to a one percentage-point transitory increase in real output. The simulations are conducted using two alternative values of the parameter γ in the monetary policy rule (1). The solid lines are generated using a low value of γ_1 (0.5); the dashed lines are generated using a high value (1.5). The implications of a more aggressive policy response can be inferred by comparing the solid and dashed lines.[7]

Let us first consider the monetary policy response for the low value of γ_1 shown by the solid lines in Figure 1a. The monetary authority reacts to the inflationary impact of the aggregate demand shock by raising the short-term interest rate by about 50 basis

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[5] Hostland and Matier (2001) refer to this as a *flexible debt rule*.

[6] Specification of the stochastic simulation model is documented in Hostland (2001).

[7] The two settings of $\gamma = 0.5$ and 1.5 result in a standard deviation for *core* inflation of 1.9 and 1.0 percentage points, respectively.

points. This results in a 20 basis point increase in long-term interest rates on impact (through the term structure of interest rates), along with a one percentage point appreciation in the real exchange rate[8] (through uncovered interest rate parity). The tighter monetary conditions act to curtail the economic expansion, such that output reverts back to its potential level and the inflationary pressure subsides. The transitory increase in inflation implies a permanent rise in the price level, which is reflected in the permanent increase of nominal GDP.

Now consider the effect of raising the monetary policy parameter γ (represented by the dashed lines in Figure 1a). The short-term interest rate response increases from 50 to 100 basis points. This brings about a larger appreciation in the real exchange rate. The tighter monetary conditions act to bring output back to its potential level more rapidly. This curbs the inflationary pressure sooner, leading to a smaller rise in the price level component of nominal output.

Note that a higher value of γ_1 reduces the response of the long-term nominal interest rate. The intuition for this result is as follows. The long-term interest rate is determined as an average of expected short-term interest rates over the future (according to the expectations hypothesis of the term structure). A higher value of γ_1 causes the short-term nominal interest rate to rise by more in the first year following the shock and then decline more rapidly thereafter. The average of expected short-term interest rates is lower for higher values of γ_1. A more aggressive monetary policy response therefore leads to higher short-term interest rates along with lower long-term rates. There is little impact on the implicit interest rate on public debt because it is a weighted-average of short- and long-term interest rates, which move in opposite directions.

To sum up, a more aggressive monetary policy response to an output shock acts to stabilise output and inflation, with little effect on the implicit interest rate on public debt.

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[8] The exchange rate is defined as the price of foreign exchange so that a decrease represents an appreciation.

Figure 1b illustrates the impact of the output shock on selected fiscal variables in the model. Once again, let us first examine the case where the monetary policy parameter γ_1 is set to the low value (represented by the solid lines in Figure 1b). The output shock leads to a decline in the debt-to-GDP ratio. This reflects in part the permanent rise in the price level component of nominal GDP (the denominator of the debt-to-GDP ratio). In addition, the automatic stabilisation properties of the model imply that non-discretionary spending declines (as a proportion of GDP) along with output.[9] This raises the overall budget balance and thereby, reduces the level of net debt. Although the debt burden declines, debt service costs rise initially because the implicit interest rate on public debt is slightly higher. The fiscal authority in the model responds to the projected decline in the debt-to-GDP ratio by increasing discretionary spending to bring the debt-to-GDP ratio back to the mid-point of the target range in a gradual manner.

Now consider the response of the fiscal variables when the monetary policy parameter γ_1 is increased (represented by the dashed lines in Figure 1b). A higher value of γ_1 curbs the decline in the debt-to-GDP ratio and the overall budget balance (as a proportion of GDP). This reflects the fact that a more aggressive monetary policy response curbs the increase in inflation and output (shown in Figure 1a). The dampened inflation response implies a smaller permanent increase in the price level component of nominal GDP. The dampened output response implies a slightly smaller decline in non-discretionary spending coming through automatic stabilisation. Debt service costs rise slightly in the first year following the shock, but then decline thereafter. The fiscal policy response entails a smaller increase in discretionary spending. This is desirable for the "policy smoothing" objective of fiscal policy. Furthermore, the smaller primary budget deficit means that the fiscal policy is less pro-cyclical, which is desirable for economic stabilisation purposes. In sum, a more aggressive monetary policy response to an output shock improves the fiscal policy trade-off.

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[9] The economic expansion also raises tax revenues as a proportion of GDP in the model (not shown in Figure 1b), which reduces net debt even further.

3.2 An Inflation Shock

Figures 2a and 2b show dynamic responses to a one percentage-point transitory increase in inflation As before, the simulations are conducted using high and low values of the parameter γ_1 in the monetary policy rule (1).

In the case of the low value of γ_1 (represented by the solid lines in Figures 2a and 2b), the monetary authority reacts to the unanticipated increase in inflation by raising short-term interest rates by about 85 basis points on impact. This leads to a 30 basis point increase in the long-term interest rate, along with a 0.15 percentage point appreciation in the real exchange rate. The tighter monetary conditions reduce output below its potential level, which curtails the inflationary pressure. Note, once again, that the transitory increase in inflation implies a permanent increase in the price level component of nominal output.

Now consider the effect of raising the monetary policy parameter γ (represented by the dashed lines in Figure 2a). The short-term interest rate response increases from 85 to 125 basis points, but this has virtually no effect on long-term interest rates (for the reasons outlined above). The implicit interest on public debt is slightly higher in the first few quarters following the shock, but declines thereafter. The tighter monetary conditions cause output to decline by more, bringing inflation back to its target level sooner. The tighter monetary policy stance has a relatively small effect on inflation because the shock is transitory and monetary policy is forward-looking.[10] The dampened inflation response implies a smaller permanent increase in the price level component of nominal output.

Two points are worth highlighting here. First, note that a more aggressive monetary policy has a stabilising influence on nominal income in the case of inflation shocks and output shocks. A higher value of γ_1 acts to dampen the response of nominal income in both cases. Second, also note that the maturity structure of public debt has a

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[10] The stance of monetary policy has a larger effect on inflation when inflation exhibits higher persistence. We examine this later in the paper using sensitivity analysis. The degree of inflation persistence in the model can be increased by putting more weight on the backward-looking component of expectations and by reducing the weight on the inflation target in the formation of long-run expectations.

stabilising influence on debt service costs in the presence of inflation shocks. This is because an unanticipated increase in inflation lowers the *ex post* real yield on outstanding long-term government bonds. This relationship is symmetric so that it has no effect on average debt service costs. There is, however, a stabilisation benefit due to the timing factor – the *ex post* real yield on outstanding long-term bonds declines when the *ex ante* real yield on new bond issues rises.

The responses of the fiscal variables are illustrated in Figure 2b. A higher value of γ_1 curbs the response of the overall budget balance (as a proportion of GDP) and the debt-to-GDP ratio. This is desirable for the debt control objective of fiscal policy. However, a higher value of γ_1 amplifies the reduction in discretionary spending, which is undesirable for the "policy smoothing" objective. Moreover, it also amplifies the increase in the primary budget balance, which is counter to the economic stabilisation objective. In short, a higher value of γ_1 is desirable for the debt control objective of fiscal policy, but not for the "policy smoothing" and economic stabilisation objectives.

To summarize, a more aggressive monetary policy stance improves the fiscal policy trade-off in the case of an output shock. In contrast, a more aggressive monetary policy stance alters the fiscal policy trade-off in the case of an inflation shock – a more aggressive monetary policy improves the debt control objective, at the cost of the "policy smoothing" and economic stabilisation objectives.

Dynamic simulations are useful for developing our understanding of the transmission mechanism linking monetary and fiscal policy, but they do not allow us to draw any overall policy conclusions. The simulations reveal that the influence of monetary policy on medium-term fiscal planning depends on the nature of the shocks encountered. This raises the question of what the overall effect would be for a wide range of shocks that policy makers can expect to face in the future. We investigate this empirical question in the following section of the paper using stochastic simulation methods.

4. Stochastic Simulation Experiments

Policy makers are continuously faced complex decisions about how to react to numerous shocks of different magnitudes that vary from period to period. Stochastic simulation methods enable us to examine policy making under these conditions. We use a stochastic simulation setting that includes several stochastic shocks drawn from a random number generator. The relative magnitudes of the shocks vary stochastically from period to period. [11] The monetary authority in the model reacts to the shocks each quarter, whereas the fiscal authority reacts only once every four quarters to emulate an annual fiscal planning process. Repeated stochastic simulations are conducted to calculate a probability distribution for the outcomes.

4.1 Calibration Methodology

Results obtained from stochastic simulation experiments generally depend on the calibration of the model used. In this paper, the standard deviations of the random error terms in the stochastic simulation model could have a major influence on the results. For example, the dynamic simulations outlined above showed that monetary policy has a stabilising influence on fiscal planning in the case of an output shock. One might expect this result to carry through to the stochastic simulation experiments if output shocks played a dominant role. Before turning to the stochastic simulation results, we will first discuss the methodology used to calibrate the relative magnitudes of the shocks in model.

The model is calibrated using the *Method of Simulated Moments*. Conceptually, this entails setting standard deviations for each of the error terms in the model such that the variation in variables simulated by the model matches the variation in the data observed over the historical period.[12] To illustrate, consider the case of inflation. The standard deviation of core inflation averaged about 2.75 percentage points over the post-

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[11] The stochastic simulation model has a total of 16 additive random error terms – five in the foreign section and eleven in the domestic sector (see Hostland 2001).

[12] For a more detailed discussion of the calibration methodology see Hostland (2001)

war period.[13] The variation in inflation declined dramatically, however, in the early 1990s following the introduction of inflation targets in Canada.[14] Since the end of 1992, the standard deviation of core inflation calculated relative to the mid-point of the target range is about 0.75 of a percentage point.[15] The model is calibrated such that the standard deviation of core inflation varies across a wide range of outcomes. We consider a standard deviation of core inflation in the range of about 0.4 to 1.25 percentage points.

The amount of variation in real output, real interest rates and the real exchange rate simulated by the model is calibrated to match the historical period. More specifically, the amount of variation in real interest rates and the real exchange rate matches that observed over the flexible exchange rate period 1970Q3-2000Q2. In the case of real output, we abstract from the effects of disinflationary monetary policy, which contributed to the depth and duration of the recessions in the early 1980s and early 1990s. The average amount of output variation observed during the 1980s and 1990s is judged to be too high for the purpose of calibrating the model in an inflation-targeting environment. This is because the monetary policy rule in the model is specified with reference to an inflation target and hence, episodes of disinflation do not occur in stochastic simulation experiments. We calibrate the amount of variation in output to match the historical data prior to the 1981 recession.[16]

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[13] The standard deviation of quarterly changes (expressed at an annual rate) in the CPI excluding food, energy and indirect prices is 2.74 percentage points on average over the period 1953Q1 to 2000Q2.

[14] The *Inflation Reduction Guidelines*, announced in February 1991, specified a gradual reduction in inflation from the end of 1992 to the end of 1995. This was followed by a 1% to 3% target range, introduced in February 1993.

[15] The standard deviation of quarterly changes (expressed at an annual rate) in the CPI excluding food, energy and indirect prices relative to the mid-point of the target range is 0.74 of a percentage point over the period 1992Q4 to 2000Q2.

[16] The standard deviation of our measure of the output gap has a standard deviation of 1.5 percentage points over the period 1953Q1-1980Q4.

4.2 Stochastic Simulation Results

The stochastic simulation experiments are designed to examine how a more aggressive monetary policy influences fiscal policy. This is implemented by varying the parameter γ_1 in the monetary policy rule (1). A series of stochastic simulation experiments are conducting using a range of values for γ_1. Higher values of γ_1 result in lower variation in inflation. We interpret this as a more aggressive monetary policy stance. Figure 3 illustrates how reducing the variability of inflation (moving along the horizontal axis toward the origin) influences the variability of the short-term nominal interest rate and the implicit interest rate on public debt (measured on the vertical axis). The top line in Figure 3 shows that reducing the standard deviation of *core* inflation to about 1.5 percentage points lowers the standard deviation of the short-term nominal interest rate slightly. Reducing the variability of core inflation further raises the variability of the short-term nominal interest rate substantially. For example, reducing the standard deviation of *core* inflation from 1.5 to 0.5 percentage points raises the standard deviation of the short-term nominal interest rate from about 2.3 to 4.0 percentage points.

Figure 3 illustrates that the non-linear nature of the relationship between the volatility of inflation and short-term interest rates. Reducing the variability of inflation reduces the variability of expected inflation but requires higher variability of the real interest rate. The relationship between the variability of inflation, expected inflation and real interest rates in non-linear. When the standard deviation of core inflation is reduced to 1.5 percentage points, the decline in the variability of expected inflation is greater than the increase in real interest rate variability so that the nominal interest rate variability declines. However, the opposite occurs when the standard deviation of core inflation is reduced below 1.5 percentage points – the decline in the variability of expected inflation is less than the increase in real interest rate variability so that the nominal interest rate variability increases.

The bottom line in Figure 3 shows that reducing the amount of variation in inflation has relatively minor implications for the amount of variation in the implicit interest rate on public debt. The standard deviation of the implicit interest rate on public debt varies by less than 10 basis points when the standard deviation of *core* inflation is reduced from 1.8 to 0.75 of a percentage point. However, the non-linear nature of the relationship becomes more prominent when the variability of inflation is reduced further. Reducing the standard deviation of *core* inflation from 0.75 to 0.45 of a percentage point raises the standard deviation of the implicit interest rate on public debt by 30 basis points.

The results shown in Figure 3 suggest that reducing the variability of inflation beyond a certain point would raise the variability of debt service costs. Figure 5 shows that this is indeed the case. The solid line in Figure 5 corresponds to stochastic simulation results obtained using the benchmark version of the model with includes a monetary policy rule ‘with interest rate smoothing’. The thin line corresponds to results obtained ‘without interest rate smoothing’. We will focus on the results obtained using the benchmark model for now and come back to the results obtained using the alternative specification of the monetary policy rule later in the paper when we discuss sensitivity analysis. The solid line in Figure 5 shows that reducing the standard deviation of core inflation from 1.8 to 1.5 percentage points lowers the standard deviation of debt service costs (as a proportion of GDP) slightly.[17] The non-linear nature of the relationship becomes more prominent as the variability of inflation declines further. Reducing the standard deviation of *core* inflation from 1.5 to 0.5 of a percentage point raises the standard deviation of debt services costs (as a percentage of GDP) by 0.18 of a percentage point.

Figure 4 shows that reducing the variability of inflation results in lower variation in net debt and the overall budget balance (measured as percentages of GDP). This implies that a more aggressive monetary policy facilitates the debt control objective of fiscal policy.

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[17] Debt service costs are expressed as a percentage of potential GDP to take into account the effect of economic growth over the simulation period. We analyse the variability of variables that are stationary around steady-state levels throughout the paper because they have well-defined probability distributions that can be interpreted as confidence intervals. Adjusting for cyclical component of GDP makes the results easier to interpret but has minor implications for our main findings.

Figure 6 shows how reducing the variability of inflation influences the variability of discretionary spending. Once again, we will focus on the results obtained using the benchmark version of the model that includes a monetary policy rule “with interest rate smoothing”. The thick line in Figure 6 shows that reducing the standard deviation of core inflation from 1.8 to 0.7 of a percentage point lowers the standard deviation of discretionary spending by about 0.85 of a percentage point. Reducing the standard deviation of core inflation further to 0.45 of a percentage point raises the standard deviation of discretionary spending by about 0.15 of a percentage point. This implies that a more aggressive monetary policy facilitates the “policy smoothing” objective to a certain point before becoming counter-productive.

Assessing the impact of monetary policy on the economic stabilisation objective of fiscal policy is complicated by the fact that the variability of output is affected by monetary and fiscal policy simultaneously. This makes it difficult to disentangle the separate influence of fiscal policy. We use the correlation between the primary budget balance (as a proportion of GDP) and the output gap to gauge the cyclical influence of fiscal policy on output.[18] The thick line is Figure 6 (corresponding to results obtained using the benchmark version of the model) shows that reducing the standard deviation of core inflation from 1.8 to 0.75 of a percentage point raises this correlation from –0.07 to 0.33. Reducing the standard deviation of core inflation further to 0.45 of a percentage point lowers the correlation to zero. This implies that a more aggressive monetary policy facilitates the economic stabilisation objective of fiscal policy to a certain point before becoming counter-productive (as in the case of the “policy smoothing” objective).

To sum up, the stochastic simulation results indicate a more aggressive monetary policy enhances the debt control objective of fiscal policy. Reducing the variability of inflation leads to a lower amount of variation in the budget balance and net debt (as percentages of GDP). The stabilising influence of monetary policy on fiscal planning is

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[18] This correlation serves to proxy the extent to which increases (decreases) in the primary balance reduce (raise) output in the model. This linkage is intended to capture the effect of changes in disposable income on consumption-savings behaviour of agents that are liquidity constrained.

partly due to its effect on the correlation between the primary budget balance and debt service costs. This is illustrated by Figure 8, which plots the primary balance-debt service correlation against the variability of inflation. The upward slope of this line implies that reducing the variability of inflation raises the correlation between the primary balance and debt service costs. A higher correlation means that the primary budget balance increases (decreases) when debt service costs rise (decline). This acts to stabilize the overall budget balance.

Figure 8 implies that monetary policy has a strong influence on the correlation between the primary budget balance and debt service costs. The calculations reported in the appendix show that there is no apparent systematic relationship between changes in the primary balance and debt service payments over the historical period. This might be because of the different policy regimes in place over the past few decades.

The implications of a more aggressive monetary policy for the “policy smoothing” and economic stabilisation objectives of fiscal policy are more complex because of the non-linear nature of the relationship. Reducing the variability in inflation can improve the fiscal policy trade-off, but only up to a certain point. Our simulation results indicate that reducing the standard deviation of core inflation below about 0.75 of a percentage point would make it more difficult for the fiscal authority to attain its “policy smoothing” and economic stabilisation objectives.

5. Sensitivity Analysis

An important element of our research strategy is to determine whether the main findings outlined above hinge on the particular model that was used. This section of the paper conducts sensitivity analysis to examine the robustness of our results with respect to alternative specifications of the model. For presentation purposes, the alternative specifications are grouped under the following four categories: monetary policy rules, the fiscal policy framework, expectations formation and calibration issues.

5.1 Monetary Policy Rules

We examined whether our results are sensitive to the particular form of the monetary policy rule used in the benchmark version of the model. This entailed conducting stochastic simulations using different specifications of the monetary policy rule. The specifications are encompassed by a monetary policy rule of the general form:

$$(r_t - r_t^*) = \gamma_1(E_t\pi_{t+i} - \pi^*) + \gamma_2(r_{t-1} - r_{t-1}^*) + \gamma_3(y_t - y_t^*) \tag{3}$$

where $E_t\pi_{t+i}$ represents the model-consistent forecast of *core* inflation "i" periods in the future and $(y_t - y_t^*)$ represents the deviation of output from its potential level. The monetary policy rule used in the "benchmark" version of the model corresponds to the case where γ_2 is set to 0.8, γ_3 is zero and γ_1 is varied to reduce the variability of inflation.

Interest rate smoothing

First we investigated the importance of the "interest rate smoothing" term. Stochastic simulations were conducted without "interest rate smoothing" in the monetary policy rule (γ_2 was set to zero). Figures 5 to 8 compare results obtained with and without interest rate smoothing. Figure 5 shows that reducing the standard deviation of core inflation below one percentage point has a much smaller effect on the variability of debt service costs when monetary policy is set without "interest rate smoothing". Figure 6 shows that interest rate smoothing results in higher variation in discretionary spending, which is counter to the "policy smoothing" objective of fiscal policy. Moreover, Figure 6 also shows that when monetary policy is set without "interest rate smoothing", the variability of inflation can be reduced to about 0.5 of a percentage point before becoming counterproductive for "policy smoothing" purposes. Figure 7 shows that a similar result holds for the economic stabilisation objective of fiscal policy.

The inflation forecast horizon and "Taylor rules"

We next investigated whether our results depend on the forecast horizon used in setting monetary policy.[19] Recall that in the "benchmark" version of the model, monetary policy is set using the model-consistent forecast of *core* inflation over the coming quarter. This corresponds to setting the index "i" to 1 in the monetary policy rule (3) above. We consider the implications of varying i from a value of -1 to 3.[20] In the case of i = -1, monetary policy is set on the basis of the lagged *core* inflation rate. In the case i = 3, it is set using the model-consistent forecast of *core* inflation over the coming year. We also investigated the implications of setting monetary policy using a "Taylor rule". In its general form, this entails putting a weight γ_3 on the output gap with the inflation forecast horizon set to the current quarter (i = 0).[21]

The stochastic simulation results obtained from the alternative specifications of the monetary policy rule were found to be quite similar to those reported above, for the most part. Technical complications emerged, however, when the variability of inflation was reduced beyond a certain point.[22] The stochastic simulation experiments were conducted without the "interest rate smoothing" in the monetary policy rule to overcome these technical complications. The results were found to be quite similar to those obtained using the benchmark version of the model without interest rate smoothing.

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[19] The "optimal" forecast horizon for monetary policy generally depends on the properties of the model and the objective function. Batini and Haldane (1999) and Levin et al. (1999a) compare the performance of monetary policy rules with different forecast horizons and draw conflicting conclusions.

[20] In other words, we examine the implications of setting monetary policy using "backward-looking" versus "more forward-looking" rules. Or alternatively "inflation forecast rules" using the terminology of Svensson (1999) and Rudebusch and Svensson (1999) versus "outcome-based" rules.

[21] Levin et al. (1999b) find that "Taylor rules" perform quite well in stochastic simulation experiments (in terms of minimizing the variability of output and inflation) and are robust across alternative models.

[22] Dynamic simulations revealed that the model responses displayed an oscillatory pattern when monetary policy was set using current and lagged inflation together with a high degree of interest rate smoothing. In these specifications, a very aggressive monetary policy (implemented using very high values of γ_1) magnified the oscillations to the point where the variability of inflation could not be reduced beyond a certain level.

These simulations indicate that our results are quite robust with respect to the specification of the monetary policy rule.

5.2 The Fiscal Policy Framework

Fiscal policy rules

The fiscal authority in our analysis seeks to keep the debt-to-GDP ratio within a target range by reacting to fiscal developments over time using a forward-looking policy rule. We investigated the importance of this particular reaction function by considering alternative policy rules that entail different responses to fiscal developments. Under one alternative policy rule, the fiscal authority does not respond to unanticipated changes to the debt-to-GDP ratio. The fiscal plan is set to attain a projected budget balance of $3 billion over the coming fiscal year, regardless of fiscal developments.[23] Under another alternative policy rule, the fiscal authority responds more aggressively to unanticipated changes to the debt-to-GDP ratio. This entails making discretionary changes to bring the projected debt-to-GDP ratio back to the target range at a faster pace than in the fiscal policy rule used in the benchmark version of the model. The more aggressive policy response leads to a higher degree of debt control and consequently, the debt-to-GDP ratio fluctuates within a narrower range.

Stochastic simulations were conducted using the two alternative fiscal policy rules outlined above and the results were much the save as those obtained using the benchmark version of the model. On this basis, we conclude that our findings are robust to the specification of the fiscal policy rule.

The maturity structure of public debt

We also investigated the importance of the maturity structure of public debt in the model. The fiscal authority in our analysis issues bonds of varying maturity, ranging from

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[23] We also considered the case where the fiscal plan is set to attain a projected budget balance as a proportion of GDP and obtained similar results.

one quarter (90-day treasury bills) to 80 quarters (20-year government bonds).[24] Financing public debt with long-term bonds acts to stabilize the implicit interest rate on public debt in two ways. First, long-term interest rates are less volatile than short-term rates. This is implied by the expectations hypothesis of the term structure used in the model. Second, in analysing debt service costs it is important to recognize that current interest rate movements affect only the bonds that mature in the current period. The effect of fluctuations in short-term interest rates on the average yield of outstanding long-term bonds is mitigated by the fact that long-term bonds mature infrequently.[25] In other words, long-term bonds have lower "roll-over risk".

We examined the importance of the maturity structure of public debt by considering the case where the fiscal authority only issues bonds with maturities of three years and less.[26] Stochastic simulations reveal that shortening the maturity structure of public debt raises the volatility of debt service costs significantly. This affects the point at which a more aggressive monetary policy begins to be counterproductive for fiscal policy objectives. For example, in the case where the maturity structure is limited to three years, we find that reducing the standard deviation of core inflation below one percentage point is counter to the "policy smoothing" and economic stabilisation objectives of fiscal policy. We conclude that the maturity structure of public debt plays an important role in our analysis.

Linkages between monetary and fiscal policy

We also investigated the importance of feedback between fiscal policy and monetary policy. Changes in primary balance affect the level of economic activity in the model. A decrease in the primary budget balance leads to an expansion in aggregate demand, which raises inflationary pressure and thereby elicits a monetary policy

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[24] The maturity structure of federal debt is calibrated to be broadly consistent with the federal government's debt management objective of having 35 per cent of its outstanding debt maturing within the coming year.

[25] In other words, long-term bonds have lower "roll-over risk".

[26] The fiscal authority issues five-, ten- and twenty-year bonds in the benchmark version of the model.

response. The stronger the output response to a change in the primary budget balance, the more vigorous monetary policy response. This element of the model enables us to vary the degree of feedback between fiscal policy and monetary policy.

Stochastic simulations were conducted using calibrations of the model having stronger and weaker degrees of feedback between fiscal policy and monetary policy. The results were found to be quite similar those obtained using the benchmark version of the model. We conclude that our findings are robust with respect to this linkage.

5.3 Expectations formation

Forward- versus backward-looking expectations

We investigated whether expectations play an important role in our analysis. Expectations of inflation, interest rates and the exchange rate are formed using a combination of forward- and backward-looking components in the “benchmark” version of the model. We examined the implications of making expectations more backward-looking and more forward-looking manner.

Stochastic simulations were conducted using calibrations of the model with different weights on the backward- and forward-looking components of expectations. In one case, all expectations were formed in a fully forward-looking model-consistent (“rational”) manner. In another case, expectations were formed largely in an adaptive manner. The results indicate that the formation of expectations influences the point at which a more aggressive monetary policy becomes counterproductive for fiscal policy. For example, under adaptive expectations the standard deviation of core inflation can be reduced to 0.8 of a percentage point before it raises the variability of discretionary spending, whereas under fully forward-looking expectations, it can be reduced to 0.525 of a percentage point. These results demonstrate the extent to which the formation of expectations influences our quantitative estimates.

Credibility of monetary policy

We also investigated the credibility aspect of monetary policy in the model. Long-run inflation expectations in the model are “anchored” by the inflation target. A higher weight on the inflation target implies that changes in inflation are perceived as being transitory and hence, have little effect on long-run expectations. This can be interpreted as a situation where monetary policy has high credibility such that inflation is expected to revert quickly to the mid-point of the target range, regardless of current economic conditions. Varying the weight on the inflation target has an important influence on inflation expectations in the model, but has relatively minor implications for our main findings. We conclude that our results are robust with respect to this aspect of the model.

5.4 Calibration Issues

Conditional covariances

Most of the error terms are mutually independent in the benchmark version of the model. We examined whether "orthogonality assumptions" of this nature play an important role in our analysis. This entailed conducting stochastic simulations in cases where some of the error terms are correlated. For example, we considered a case where the output shock and the inflation shock have a correlation of –0.33 (rather than zero as in the benchmark model).[27] One could interpret this as a period that is dominated by supply shocks (which raise inflation and lower potential output simultaneously). This was found to have little effect on our results. More generally, our findings were found to be quite robust to alternative specifications of the covariance matrix for the error terms.

Calibration of the Shocks

We investigated whether our results depend on the relative magnitudes of the stochastic shocks drawn in the stochastic simulation experiments. This entailed conducting stochastic simulations using different values for the standard deviations of the various shocks. To illustrate, consider the case where the standard deviation of the inflation shock is increased by a factor of two. Because the shocks are larger, monetary policy has to respond more aggressively in order to confine fluctuations in inflation. The standard deviation of core inflation can be reduced to 0.78 percentage points before the variability of discretionary spending begins to rise (instead of 0.7 percentage points in the

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[27] This is based on empirical estimates reported by Hostland (2001).

benchmark version of the model). We conclude that our results are fairly robust with respect to alternative calibrations of the shocks in the model.

The Term Structure of Interest Rates

We investigated the importance of the term structure of interest rates. The term structure is modelled using the expectations hypothesis, which is often rejected by empirical tests.[28] Empirical studies typically indicate that long-term interest rates exhibit significantly more variation than what is implied by the expectations hypothesis. We take this into account in the benchmark version of the model by adding a random error term to longer-term interest rates. This enables us to match the amount of variation in long-term interest rates to that observed in the data.

In order to examine the robustness of this aspect of the model, we took an alternative approach to explain the “excess variation” in long-term interest rates. This entailed constraining the forecast horizon for calculating the return on long-term bonds. We set the expected yield on a ten-year bond equal to the expected average return on a one-period bond over the coming three years (instead of over ten years as implied by the expectations hypothesis of the term structure). This makes expected return on longer-term bonds much more sensitive to movements in short-term interest rates and hence, more volatile. More importantly, this specification of the term structure gives monetary policy a much greater impact on long-term interest rates.

Stochastic simulations conducted using this alternative specification for the term structure of interest rates generated results that were quite similar to those obtained using the benchmark version of the model. In particular, the two different approaches to modeling the “excessive volatility” of long-term interest rates result in about the same amount of variation in debt service costs. We conclude that our results are robust with respect to this aspect of the model.

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[28] See Bekaert and Hodrick (2000) and references therein.

6. Conclusions

To summarize, our analysis demonstrates that the effect of monetary policy on the variability of short-term interest rates is only one element of the transmission mechanism linkage monetary and fiscal policy. Our stochastic simulation results reveal that monetary policy has a stabilising influence on output, inflation and the implicit interest rate on public debt. A more aggressive monetary policy can improve the fiscal policy trade-off – the fiscal authority is more able to keep the debt-to-GDP ratio on a “clear, downward profile” without sacrificing its other objectives, namely “policy smoothing” and economic stabilisation. There are limits to the stabilising influence of monetary policy, however. Reducing the variation in inflation beyond a certain point requires higher variation in discretionary spending, which is counter to the “policy smoothing” objective of fiscal policy, and results in a less counter-cyclical fiscal policy stance, which is counter to the economic stabilisation objective.

Sensitivity analysis of the simulation results indicates that the estimates depend on several factors, to some extent, but the qualitative finding is very robust. A few factors in particular were found play an important role. For instance, we found that setting monetary policy with “interest rate smoothing” impairs the stabilising influence of monetary policy on medium-term fiscal planning. A similar result arises when the maturity structure of public debt is shortened and when expectations are formed in a more backward-looking (adaptive) manner. This signifies that the monetary policy reaction function, the debt management strategy and the formation of expectations are important elements of the transmission mechanism linking monetary and fiscal policy. Taking all these factors into account, our estimates indicate that it would become increasingly difficult to attain the “policy smoothing” and economic stabilisation objectives of fiscal policy if the standard deviation of core inflation was reduced below 0.5 to 0.8 of a percentage point.

To put this range of estimates into a historical perspective, *core* inflation exhibited a standard deviation of 2.8 percentage points over the period 1971 to 1991.[29] The variation in inflation has been substantially lower since the introduction of inflation targets in the early 1990s. Since 1992, the standard deviation of *core* inflation, calculated relative to the mid-point of the inflation target range, is about 0.75 of a percentage point on average. Our results therefore imply that the marked decline in inflation variability since 1992 has had a substantial stabilising influence on medium-term fiscal planning. This might not be the case, however, if inflation variability were to be reduced too far.

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[29] This calculation is based on the quarterly percentage change in the CPI excluding food and energy prior to 1984, and the CPI excluding food, energy and indirect taxes thereafter.

Figure 1a: Response of Macro Variables to Output Shock

(One percentage point transitory increase in output)

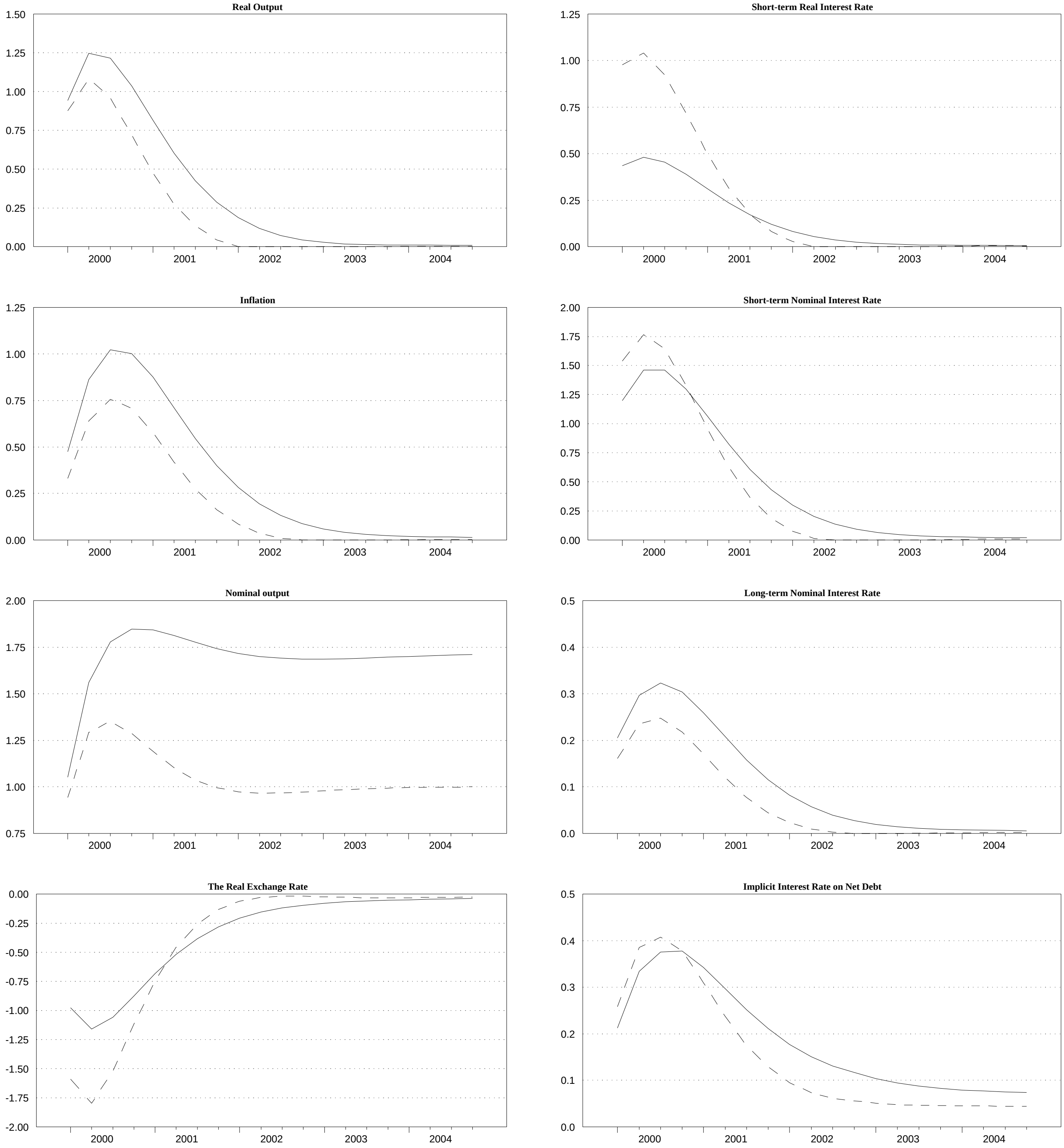


Figure 1b: Response of Fiscal Variables to Transitory Output Shock

(Expressed as a percentage of GDP)

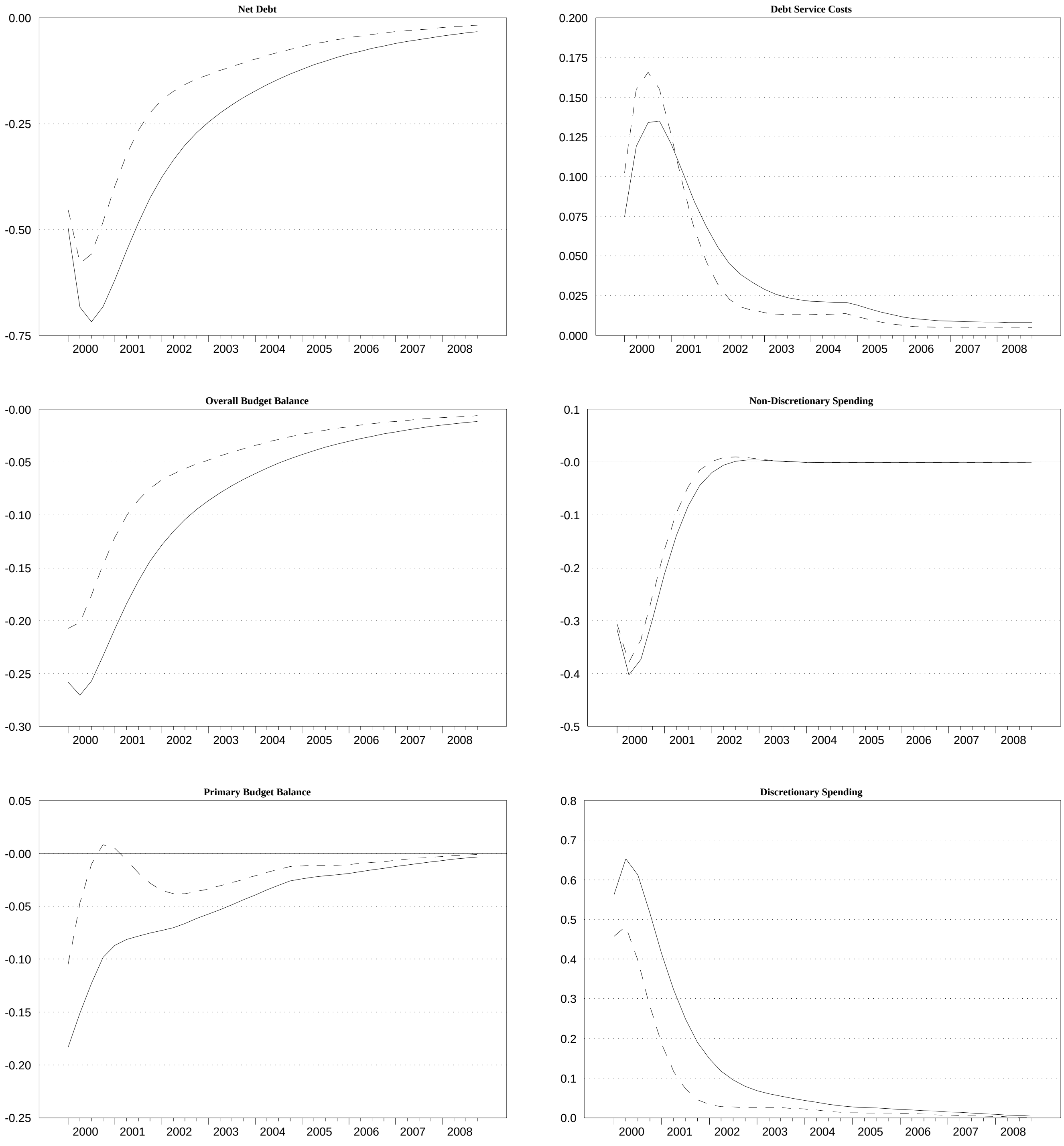


Figure 2a: Response of Macro Variables to Inflation Shock

(One percentage point transitory increase in inflation)

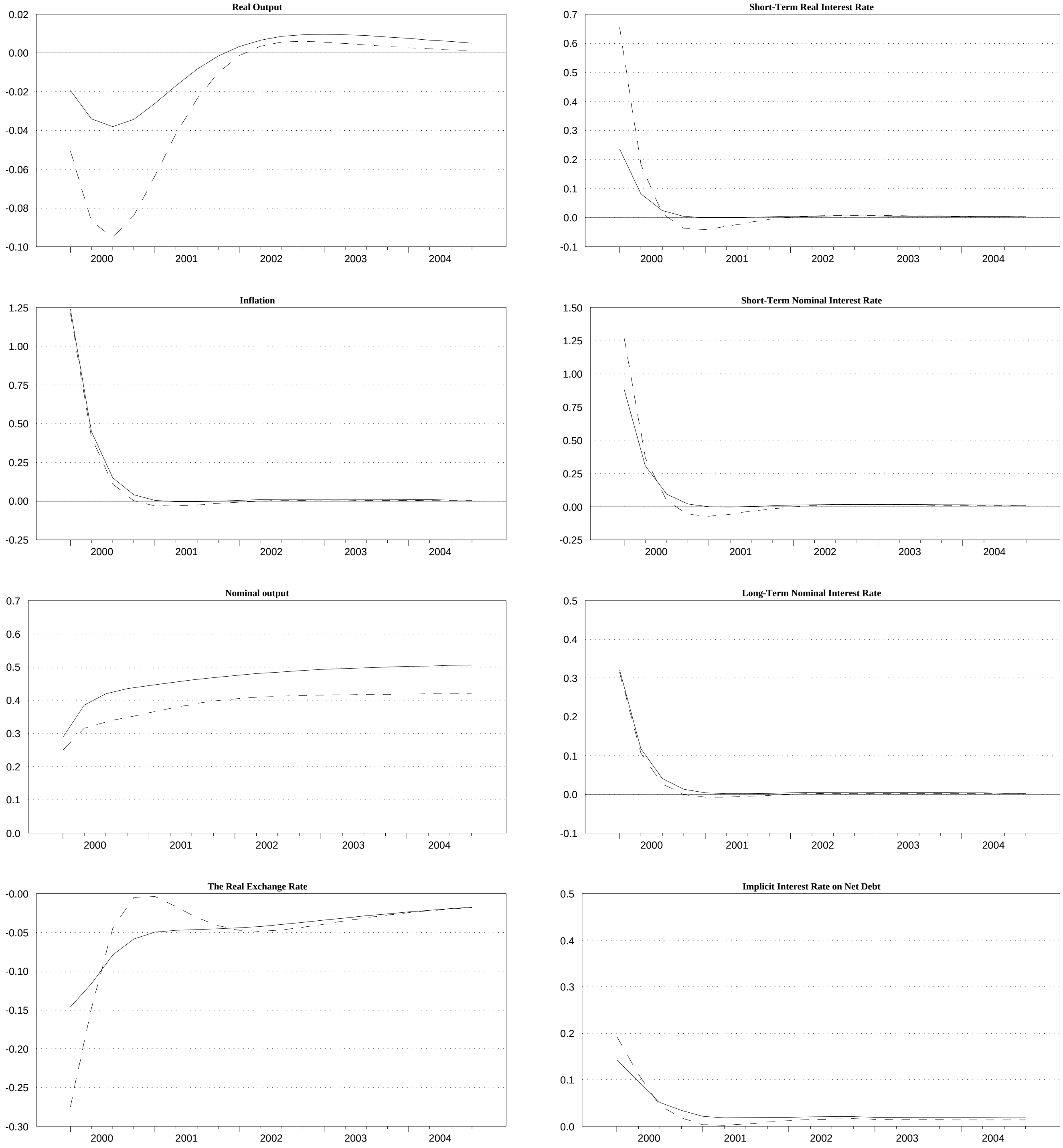


Figure 2b: Response of Fiscal Variables to Transitory Inflation Shock

(Expressed as a percentage of GDP)

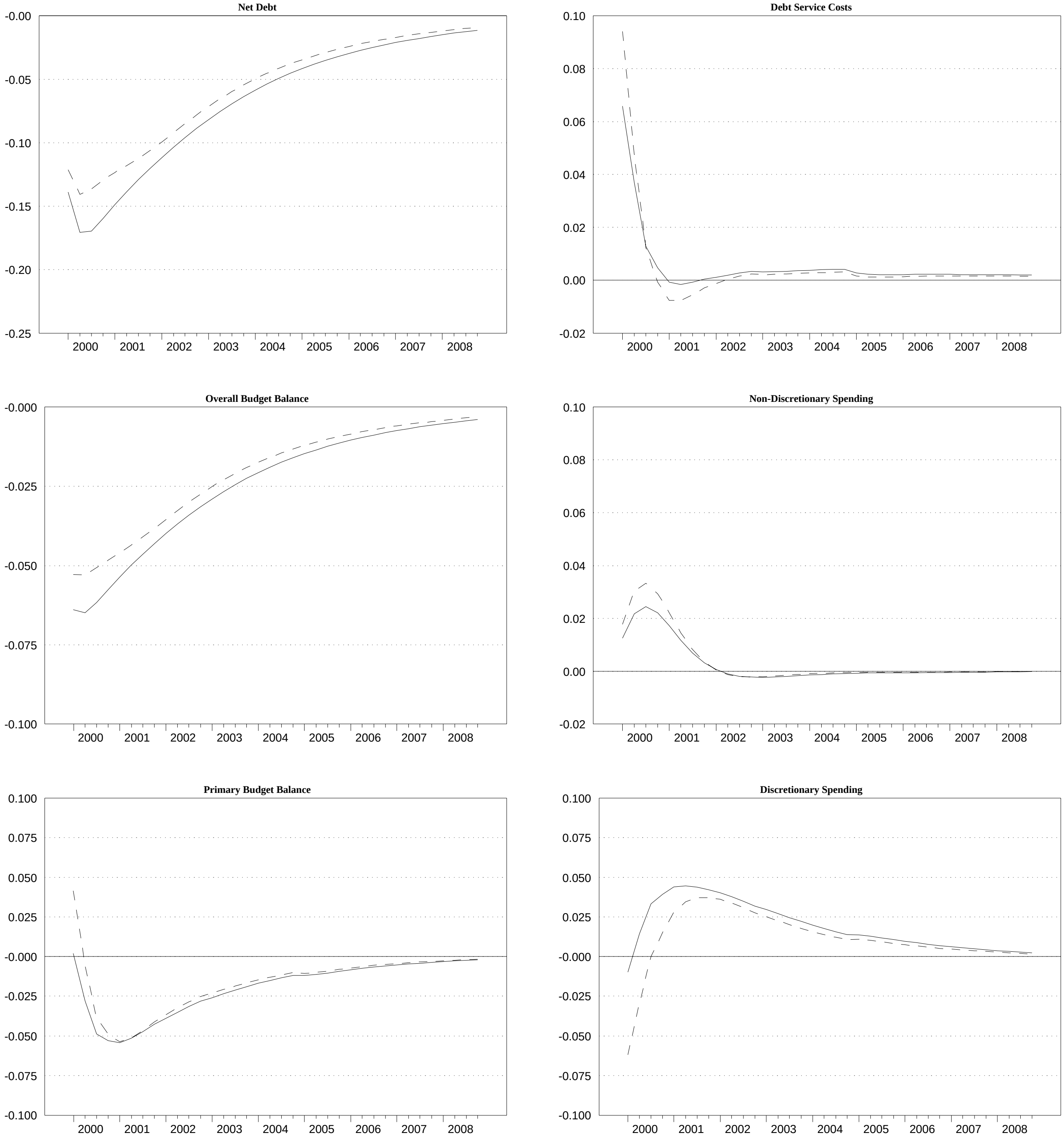


Figure 3: Inflation-Interest Rate Variability Trade-off

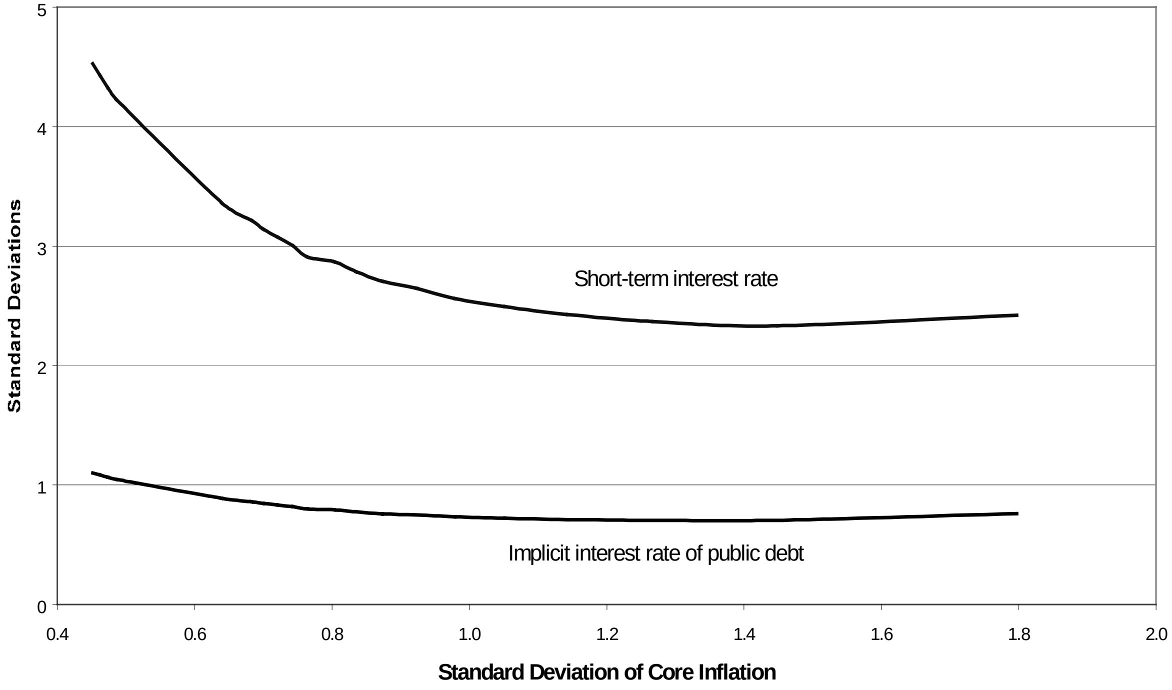


Figure 4: Variability of Inflation versus Public Debt and Budget Balance
(As proportions of GDP.)

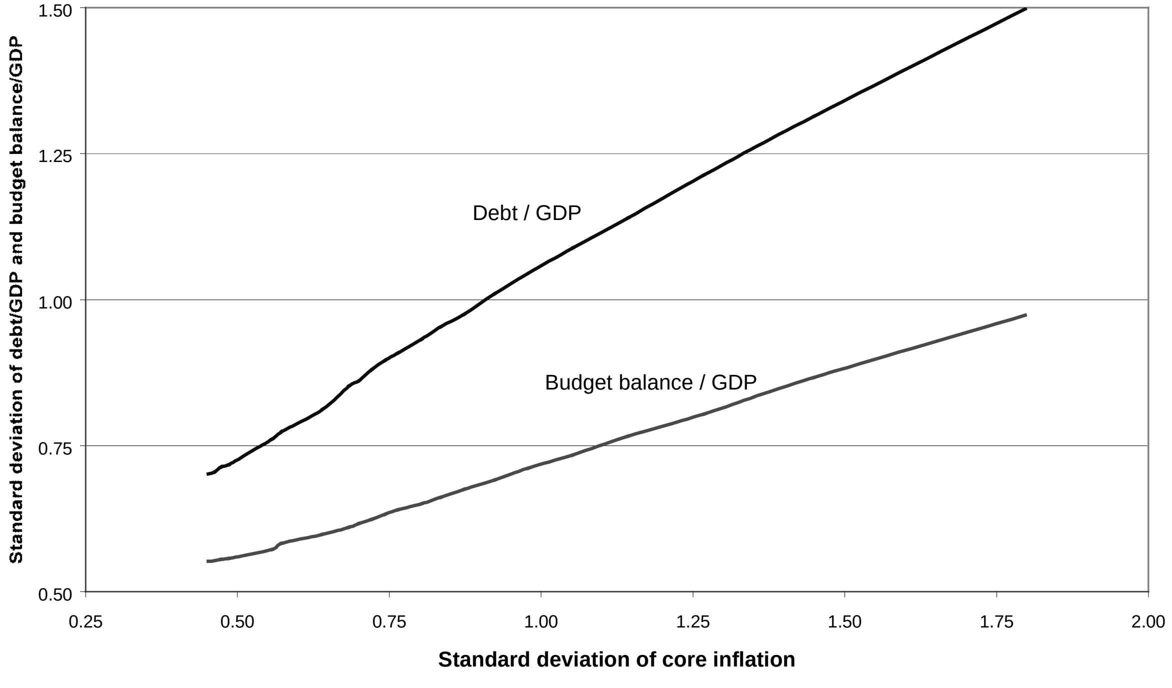


Figure 5: Variability of inflation versus debt service costs

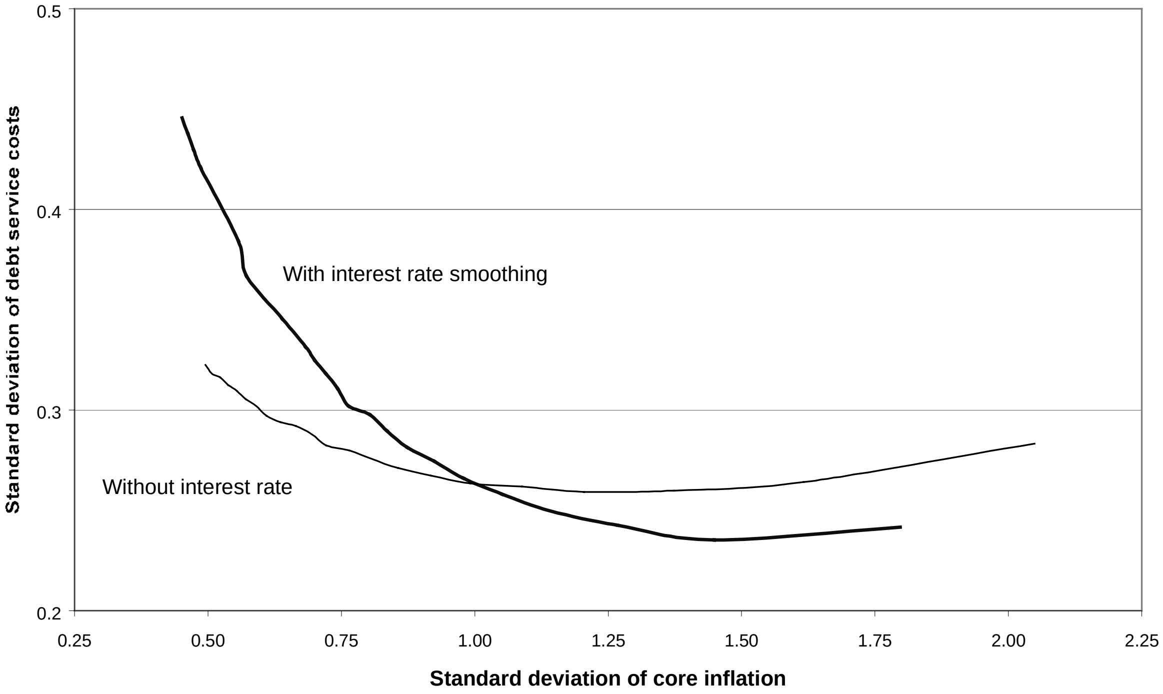


Figure 6: Inflation variability versus policy smoothing objective

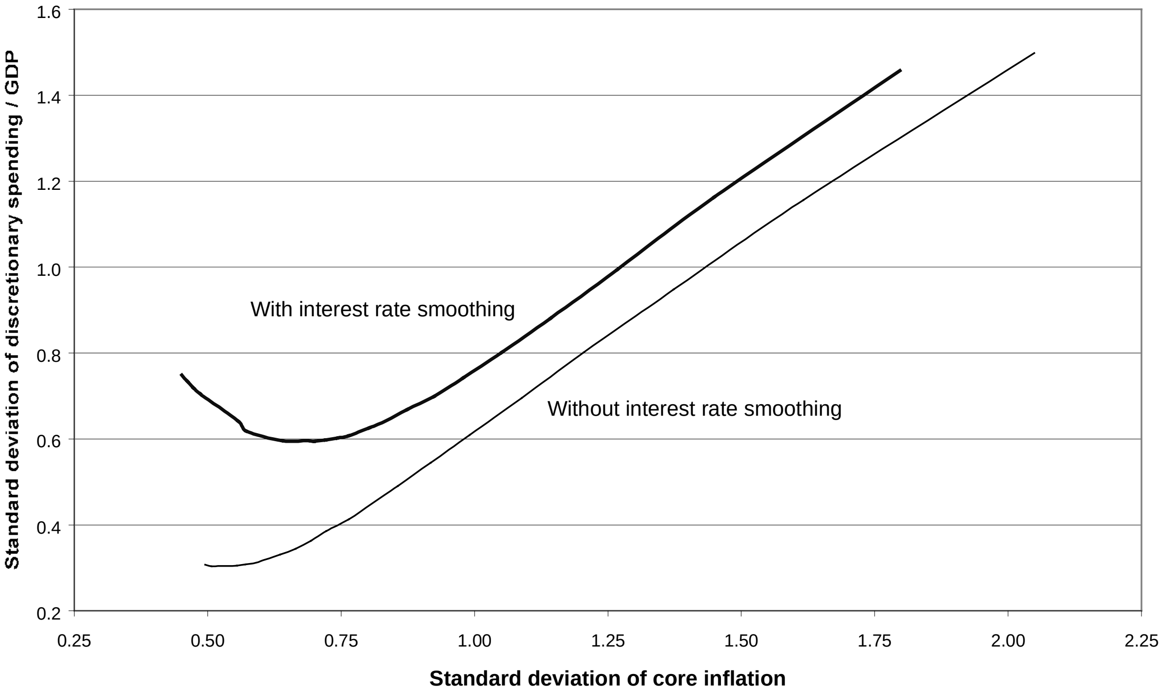


Figure 7: Inflation variability versus economic stabilisation objective

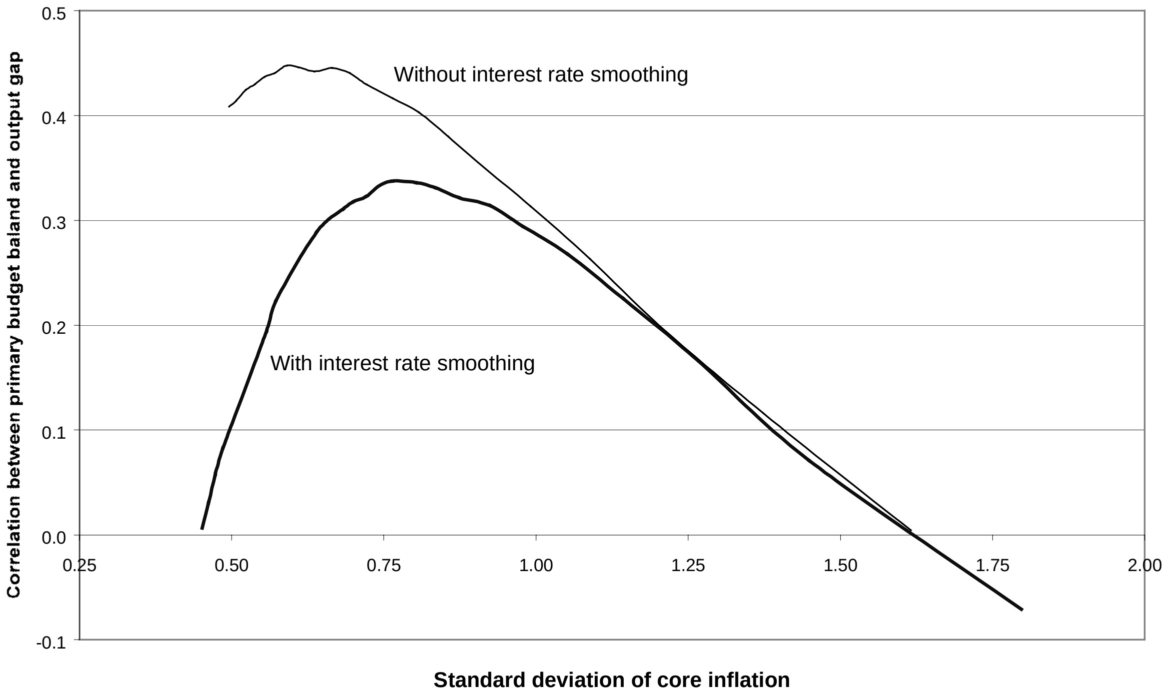
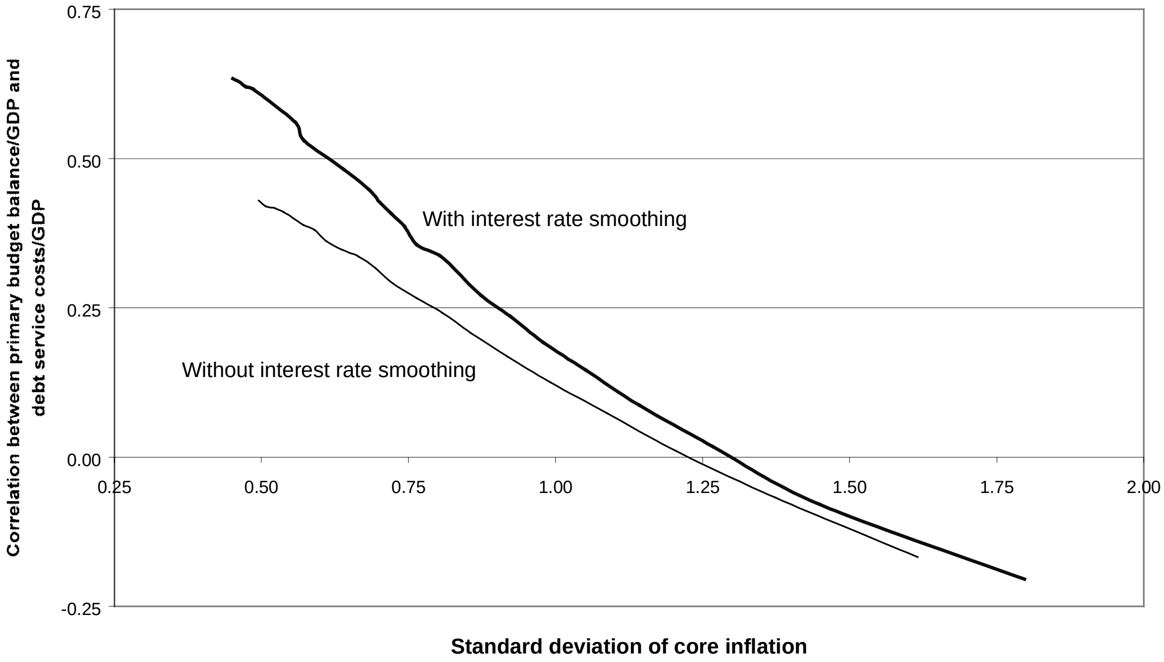


Figure 8: Inflation variability versus correlation between primary budget balance and debt service costs (as proportions of GDP)

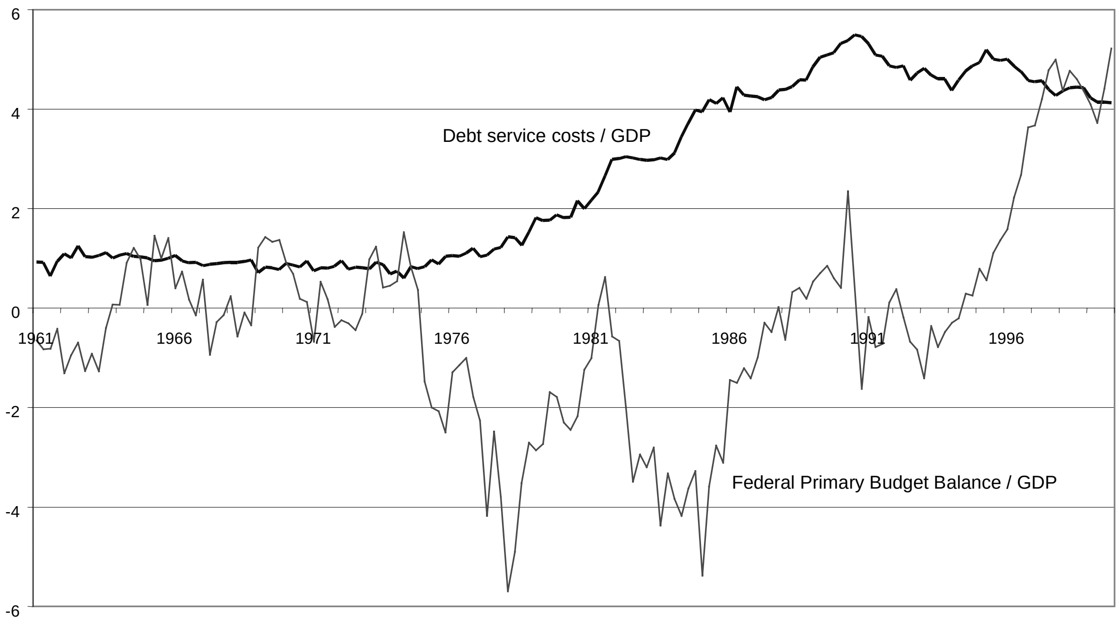


Appendix

Debt service payments and the primary budget balance over the historical period

This appendix investigates whether debt service payments and the primary budget balance have exhibited a systematic correlation over the historical period. Figure A1 illustrates federal debt service costs and the federal primary budget balance measured as percentages of GDP over the period 1961-1999.[30] Both series are scaled by nominal GDP adjusted for cyclical fluctuations in order to control for inflation and the trend rate of economic growth.[31] This allows us to abstract from cyclical movements in the scaling factor (GDP) in order to focus on the question of whether there has been co-movement between debt service costs and the primary budget balance over the business cycle.

Figure A1: Debt Service Costs versus the Primary Budget Balance
(As percentages of GDP.)



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[30] All fiscal variables examined in this paper are measured on a *national accounts* basis.

[31] Adjusting GDP for cyclical fluctuations entails using *potential* GDP in place of *actual* GDP. Potential GDP is measured using the Hodrick-Prescott filter with the smoothing parameter set to the conventional value of 1600 at the quarterly frequency.

It is difficult to detect a systematic correlation between the two series shown in Figure A1 on the basis of casual observation. Both series appear to be mean-stationary from the early 1960s until the mid-1970s when debt service payments begin a gradual ascent and the primary budget balance moved sharply into a deficit position. Federal debt service payments peaked at over five per cent of GDP in the late 1980s, before declining to four percent in the late 1990s. At about the same time, the primary budget balance increased to a surplus position at over four per cent of GDP.

Our objective is not to explain the long-term trends in these series, but rather to compare their short-term movements. We use two alternative methods to decompose the long-term trends from the short-term cycles in each of the series. The Hodrick-Prescott (H-P) filter is applied to each series. We also take first differences. Table 1 reports simple correlation coefficients obtained using levels of the series along with detrended measures obtained using the H-P filter and by differencing the data.

Table A1

Correlation between debt service costs and the primary budget balance.[32]

	Sample period			
De-trending method	*1961-99*	*1961-75*	*1976-94*	*1995-99*
Levels	0.22	-0.34	0.62	-0.93
H-P filter	0.24	-0.34	0.33	-0.68
First difference	-0.05	-0.57	0.16	-0.19

The level of federal debt service costs and the federal primary budget balance exhibit a positive correlation of 0.22 on average over the period 1961-1999. The correlation increases slightly (to 0.24) when the series are detrended using the H-P filter

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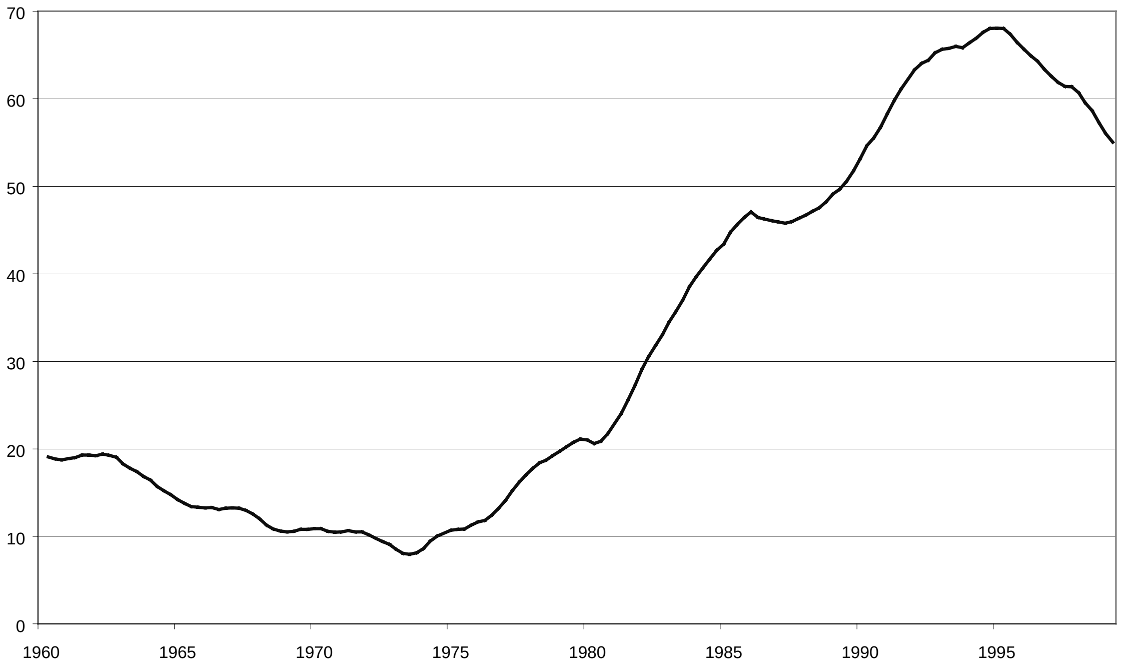
[32] Annual debt service costs and the primary budget balance at the federal level measured as proportions of potential GDP.

but becomes negative (-0.05) when calculated using differences of the series. Moreover, the correlation varies considerably across three sub-periods of interest. The three sub-periods roughly correspond to changes in long-term trends in net federal debt as a proportion of GDP illustrated in Figure A2. The debt burden declined gradually from the early 1960s to the mid-1970s when it rose sharply and continued to increase until the mid-1990s. The correlation between the primary budget balance and debt service costs was negative during the sub-periods when the debt-to-GDP ratio declined and positive when the debt-to-GDP ratio increased.

Figure 2: Net Federal Debt as a Proportion of GDP



In order to control for the effect of changes in the debt-to-GDP ratio on debt service costs, we calculate the correlation between the primary budget balance and the implicit interest rate on net public debt.[33] This correlation is reported below in Table 2. Once again, the correlation varies substantially with the detrending method used and across sub-periods.

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[33] The implicit interest rate on public debt is calculated as debt service payments less investment earnings as a proportion of net debt at the federal level.

Table A2

Correlation between implicit interest rate on public debt and primary budget balance. [34]

	Sample period			
De-trending method	*1961-99*	*1961-75*	*1976-94*	*1995-99*
Levels	-0.41	0.08	-0.02	-0.94
H-P filter	0.49	0.08	0.61	0.18
First difference	0.26	-0.06	0.50	-0.43

These simple calculations indicate that it is difficult to broadly characterize the correlation between debt service costs and the primary budget balance over the historical period.

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[34] Annual primary budget balance at the federal level measured as proportions of potential GDP. The implicit interest rate on net federal debt is defined as debt service payments less investment earnings as a proportion of the value of net federal debt.

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