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by

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Fiscal Policy under Inflation Targeting

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December 2000

Abstract

The paper discusses the role of fiscal policy as an instrument for macroeconomic stabilisation when monetary policy pursues inflation targeting. Within a theoretical model of an open economy with a traded and non-traded sector, we show that inflation targeting may lead to large sectoral imbalances when fiscal policy is passive. There is a potentially large welfare gain from an active fiscal policy, in particular when sectoral stability is included in the welfare function. However, with reasonable parameter values, a small cost of adjusting fiscal policy reduces the optimal degree of activism considerably. The reason is that a given change in output requires a large change in the fiscal policy stance under inflation targeting, because of the monetary policy reaction function.

JEL Classification: E52, E62, F41

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1. Introduction

In the last few decades monetary policy has taken over much of the role fiscal policy used to have as a tool of macroeconomic stabilisation. One might, for several reasons, argue that this development is advantageous. Experience shows that using fiscal policy to manage aggregate demand tends to lead to excess government debt, which limits the room for manoeuvre in fiscal policy over time and places large tax burdens on future generations. One reason for this is that it tends to be easier to obtain political support for an expansionary fiscal policy during recessions than for a tight fiscal policy during peaks. Moreover, even though outside lags until fiscal policy affects the economy are relatively short – arguably shorter than for monetary policy – inside lags within the decision process tend to be long, and it is often difficult to reverse fiscal policy decisions. The long inside lags imply a risk that fiscal policy measures come too late and might even become counterproductive. Several countries have therefore adopted fiscal policy rules, which are meant to provide budgetary discipline with less focus on short-term stabilisation.

Although there are arguments against using fiscal policy for aggregate demand management, there are also arguments in favour of an active fiscal policy. The general argument is put forward by Ball (1997, p. 2) in the following words: “A carpenter is more successful at his job if he uses both a hammer and a saw. So it is, I will argue, with macroeconomic policy: it is best to use both fiscal and monetary tools.”

In aggregated one-sector models, as most models of inflation targeting are, the advantage of using both monetary and fiscal policy for stabilisation purposes is not clear. The social loss in most of these models typically depends on the variability of inflation and the variability of output. Since an expansionary monetary policy and an expansionary fiscal policy both produce higher inflation and higher output (in the short run), the policy tools appear alternative, as opposed to complementary, for stabilisation purposes. The advantage of using both tools comes out clearer when considering a disaggregated model. Specifically, we assume that the aggregate economy consists of two sectors; a traded sector and a non-traded sector. The different stabilisation properties of the two tools are illustrated in Table 1.

Table 1

	Expansionary monetary policy	**Expansionary fiscal policy**
Non-traded sector	+	+
Traded sector	+	-

Monetary expansion leads to lower interest rates and exchange rate depreciation. Output in the non-traded sector increases due to the lower interest rate, and output in the traded sector increases due to the weaker exchange rate. Since output in both sectors is affected in the same direction, monetary policy has a strong effect on aggregate output. A fiscal expansion, however, gives higher output in the non-traded sector since demand increases, while output in the traded sector decreases, because an expansionary fiscal policy generates a real exchange rate appreciation. Since an expansionary fiscal policy generates an expansion in the non-traded sector and a contraction in the traded sector, fiscal policy is less suitable for stabilising aggregate output, but has a strong effect on the balance between traded and non-traded sectors. Thus, monetary policy has a comparative advantage in aggregate stabilisation, while fiscal policy has a comparative advantage in disaggregated stabilisation.

In the earlier literature, policy mix issues have in particular been discussed in connection with external balance considerations. Boughton (1989) argued, within a one-sector model, that monetary policy has a comparative advantage in *internal* stabilisation, since both a lower interest rate and a weaker exchange rate give rise to higher demand for domestic goods. The improved current account following the exchange rate depreciation is, however, partly offset by higher imports due to increased expenditure, so that monetary policy has a comparative disadvantage in *external* stabilisation. For fiscal policy, the opposite is true. A fiscal tightening leads to an improvement of the current account, both because it leads to real exchange rate depreciation and because lower expenditure gives lower imports. To the extent that the level of national savings is suboptimal, Boughton argued that fiscal policy should be concerned with current account imbalances, while monetary policy should pursue price stability. This view was shared by Genberg and Swoboda (1989), who emphasised the need to focus on the appropriate setting of *instruments*, as opposed to *targets*. Tirelli and Vines (1995) argued, within an extended Mundell-Fleming model, that the question of which policy instrument – fiscal versus monetary policy – should be used for the internal objective is a subordinate issue. However, they showed that fiscal policy must play an active role in the policy package in order to prevent dynamic instability.

By focusing on disaggregated stability issues, we show that there is a case for an active fiscal policy that does not hinge on an assumption of suboptimal national saving. Concerns about sectoral stability also seem to have received more attention in the public debate in recent years.[1] By using both monetary and fiscal tools under inflation targeting, one is able to achieve a better sectoral balance in the economy. Although it may not be clear from a theoretical point of view why sectoral stability should matter, most people seem to have an intuitive understanding of its importance. The intuitive understanding is perhaps best illustrated by considering the following example: Suppose two hypothetical policy regimes provide perfect aggregate output stability. One regime also stabilises each sector perfectly, while the other gives high variability in each sector through contraction in one sector and expansion in the other, so that aggregate stability is achieved. Most people would probably agree that the former regime is superior. The potential importance of sectoral stability is also shared by policy makers. Eddie George (1999, p. 4), the Governor of Bank of England, notes that "We are concerned – as you are – with the health of every sector of the economy, we fully appreciate the interdependence of the different sectors, and we well understand the part that greater real exchange rate stability can play in promoting more balanced economic growth."

The importance of sectoral stability may also exceed that of short term stabilisation, which we focus on in the present paper. In models with dynamic increasing returns to scale, stability may also affect investment, productivity, and long-term growth. van Wijnbergen (1984), Krugman (1987), Sachs and Warner (1995) and Torvik (2001) point out different channels through which the balance between traded and non-traded sectors in the short run affect long-term productivity and growth. Gylfason et al. (1999) show how an unstable real exchange rate that generates instability in the traded sector reduces investment, and how this translates into lower growth because of dynamic increasing returns to scale.

Although it is generally accepted that sectoral stability is important and that the policy mix affects sectoral stability, this issue has not, to our knowledge, been studied in the literature on inflation targeting. Our aim, therefore, is to develop a simple model of inflation targeting which may be used to analyse these issues. We derive the optimal fiscal policy under inflation targeting in a model with a traded and non-traded sector. The optimal fiscal policy is defined

[1] The following citation from *Reuters* (1998), which dealt with the recent economic development in the UK, provides an example of the public concern for the balance between traded and non-traded sectors and its implications for economic policy: "Buiter [one of the members of the Monetary Policy Committee of the Bank of England] said the macro-economic policy mix could, in theory, be more balanced, and highlighted the two-speed nature of the economy: 'Internationally shielded parts of the economy are doing fairly well, some very well, but the internationally exposed parts of the economy are getting hammered pretty hard'."

as the fiscal policy that minimises a given loss function where aggregate stability as well as sectoral stability are included.

The paper is organised as follows: Section 2 presents the model and the solution of the model assuming an exogenous fiscal policy. Section 3 discusses the effects of various shocks and derives the optimal fiscal policy responses to these. Concluding remarks are presented in Section 4, while an appendix discusses time-inconsistency problems in fiscal policy and possible solutions to these problems.

2. The model

We keep the model as simple as possible in order to focus on sectoral stability considerations. In doing so, we disregard important dynamic features. Specifically, we assume that monetary policy affects prices and output in the same period as it is implemented. The advantage of the simple dynamic structure is that an analytical solution to the model is tractable even with rational expectations in the foreign exchange rate market. This solution provides our benchmark from which to discuss fiscal policy under inflation targeting. An additional advantage of our simple dynamic structure is that it allows us to know with certainty that the results follow from the assumptions in the theoretical model and not from calibrated parameter values. Bharucha and Kent (1998) and Leitemo and Røisland (2000) provide calibrated inflation targeting dynamic models with a traded and non-traded sector, although these models are not intended for studying fiscal policy.

Our model extends the model in Røisland and Torvik (1999), which is a two-sector version of the one-sector models by Genberg (1989) and Rødseth (1996). The country is assumed to be small compared with the rest of the world, so that the world market price of traded goods and the world market interest rate can be taken as exogenous. All variables are in logs, except for the interest rate. Real variables are measured as deviations from a given steady state equilibrium and all shocks have zero expectation and are uncorrelated over time. We assume rational expectations where monetary and fiscal policy do not affect the real economy in the long run. In the short run, unexpected monetary or fiscal policy affects real variables due to predetermined wages. Wages are determined one period in advance so that expected unemployment equals its natural rate (given that the expectation of all shocks are zero and that the fiscal and monetary policy stance thus are not expected to deviate from their long-term equilibrium values).

The supply of non-traded goods is given by

$$(2.1)\qquad y^N = \lambda^N (p^N - w) + u^N$$

where y^N is the (log of the) supply of non-traded goods, p^N is the (log of the) price of non-traded goods and w is the nominal wage level. λ^N is a positive constant, which measures the supply elasticity with respect to the producer real wage, and u^N is a supply shock to the non-traded sector.

The supply of traded goods is given by

$$(2.2)\qquad y^T = \lambda^T (p^* + s - w) + u^T$$

where y^T is the supply of non-traded goods, p^* is the world market price and s is the nominal exchange rate. λ^T is the supply elasticity of the traded sector and u^T is a supply shock to the traded sector.

Since production is measured in logs and as deviations from steady state, aggregate production is a weighted average of production in the two sectors:

$$(2.3)\qquad y = \theta y^T + (1-\theta) y^N$$

where θ is the share of traded sector production in steady state GDP.

The real exchange rate e is given by

$$(2.4)\qquad e = p^* + s - p^N$$

The foreign exchange market is represented by uncovered interest rate parity and rational expectations, i.e.[2]

$$(2.5)\quad r = r^* + (Ee - e) + z = r^* - e + z$$

where r^* is the world real interest rate and z is a shock to the foreign exchange market, which can be interpreted as a stochastic risk premium. The second equality follows from the

[2] Note that real UIP follows from its nominal counterpart by defining $r^* = i^* - (Ep^* - p^*)$ and using the definition of e.

assumption that shocks have zero expectations, so that all real variables are expected to be in equilibrium next period.

The consumer price index, p^C, is a weighted sum of the price of traded and non-traded goods. θ is the weight on traded goods in the CPI. The relative weights on traded and non-traded goods are assumed equal to the production weights, which implies that trade is balanced in steady state equilibrium:

$$(2.6) \qquad p^C = \theta(p^* + s) + (1-\theta)p^N = p^N + \theta e$$

where the second equality follows from (2.4). Demand for non-traded goods is given by

$$(2.7) \qquad y^N = -\alpha_1 r + \alpha_2 e + x + v$$

Non-traded demand depends negatively on the non-traded sector real interest rate and positively on the real exchange rate.[3] x is a measure of the fiscal policy stance, which, for the time being, will be treated as exogenous. v is a shock to private sector demand.

The model is closed by specifying the inflation target. We follow the approach used by e.g. Person and Tabellini (1996) and Frankel and Chinn (1995) in considering strict inflation targeting. Strict inflation targeters, or "inflation nutters" (King, 1997), are, however, not observed in practice. Although making the analytical solution simpler, the assumption of strict inflation targeting may bias the results towards too much output variability. On the other hand, it may be argued that countries with explicit inflation targets give a higher priority to keeping inflation stable around the target than is the case under a discretionary policy. If so, inflation targeting is likely to involve a cost in terms of higher output variability. Empirical investigations by Cecchetti and Ehrmann (1999) suggest that inflation targeting indeed increases output volatility. The distinction between strict and flexible inflation targeting does not, however, affect the qualitative results in this paper. This issue is discussed further in subsection 3.5.

[3] As shown by Dornbusch (1983), the inclusion of both intratemporal and intertemporal substitution in a model with a traded and non-traded sector generally means that demand for non-traded goods depends on steady state production, the real exchange rate, the world market real interest rate and the real interest rate for non-traded goods. Steady state production is zero in our case. Because of uncovered interest parity in our model, the world market real interest rate simply equals the sum of the real interest rate for non-traded goods and the real exchange rate. Demand for non-traded goods can then be reduced to an expression in only two of the four variables.

We assume, for the sake of simplicity, that the central bank controls inflation perfectly. Perfect inflation control and a strict inflation target implies that inflation targeting is equal to price level targeting. The inflation target can then be specified as

(2.8) $$p^C = 0$$

It should, however, be noted that, in general, inflation targeting and price level targeting have different implications for output stability, in particular when the realistic case of imperfect inflation control is considered. Then, if inflation increases due to factors beyond the central bank's control, subsequent deflation might be required in order to reach a price level target, which is not the case with an inflation target. Since for simplicity, perfect inflation control is assumed in this paper, there is no need to reverse earlier inflation control errors, since such errors are non-existent. In this sense, the price level target in (2.8) is more comparable with an inflation target than a price level target in a model with imperfect inflation control.

The eight equations determine the endogenous variables y^N, y^T, y, p^N, e, p^C, r and s as functions of x, v, r^*, z, p^*, u^N, u^T and w.

A simple way to solve the model is to insert for the domestic interest rate, r, from equation (2.5) in equation (2.7), and then insert the definition of the real exchange rate (2.4) in order to make demand for non-traded goods solely dependent on exogenous variables and the real exchange rate. This gives the following solution:

(2.9) $$y^N = (\alpha_1 + \alpha_2)e - \alpha_1(r^* + z) + x + v$$

We see that r^* and z enter in the same way. To save notation, we will assume in the following that there are no shocks to the foreign real interest rate, i.e. $r^* = 0$.

Note that we have that $p^N = -\theta e$ by inserting the policy rule (2.8) in equation (2.6). When inserting this into (2.1), the supply-demand balance gives the following solution for the real exchange rate:

(2.10) $$e = \frac{1}{\alpha_1 + \alpha_2 + \theta\lambda^N}[-x - v + \alpha_1 z + u^N - \lambda^N w]$$

Inserting (2.10) into (2.5) and remembering that $r^* = 0$ gives the following solution for the real interest rate:

$$(2.11) \qquad r = \frac{1}{\alpha_1 + \alpha_2 + \theta\lambda^N}[x + v^N + (\alpha_2 + \theta\lambda^N)z - u^N + \lambda^N w]$$

The solution for non-traded output can be found by inserting (2.10) and (2.11) into (2.7). Production in the traded sector is found by noting that $p^T = (1\text{-}\theta)e$ from (2.4) and (2.8), inserting this into (2.2) and making use of (2.10). The solution for aggregate output is then found by making use of (2.3). It proves convenient to write the solutions as

$$(2.12) \qquad \begin{pmatrix} y \\ y^T \\ y^N \end{pmatrix} = \begin{pmatrix} a_{11}\ a_{12}\ a_{13}\ a_{14} \\ a_{21}\ a_{22}\ a_{23}\ a_{24} \\ a_{31}\ a_{32}\ a_{33}\ a_{34} \end{pmatrix} \begin{pmatrix} v - \alpha_1 z + x \\ w \\ u^N \\ u^T \end{pmatrix}$$

where

$$a_{11} = \frac{\theta(1-\theta)(\lambda^N - \lambda^T)}{\alpha_1 + \alpha_2 + \theta\lambda^N}, a_{12} = -\frac{(\alpha_1 + \alpha_2)(\theta\lambda^T + (1-\theta)\lambda^N) + \theta\lambda^T\lambda^N}{\alpha_1 + \alpha_2 + \theta\lambda^N}, a_{13} = \frac{(1-\theta)(\alpha_1 + \alpha_2 + \theta\lambda^T)}{\alpha_1 + \alpha_2 + \theta\lambda^N}, a_{14} = \theta$$

$$a_{21} = -\frac{(1-\theta)\lambda^T}{\alpha_1 + \alpha_2 + \theta\lambda^N},\ a_{22} = -\frac{(\alpha_1 + \alpha_2 + \lambda^N)\lambda^T}{\alpha_1 + \alpha_2 + \theta\lambda^N}\ \ a_{23} = \frac{(1-\theta)\lambda^T}{\alpha_1 + \alpha_2 + \theta\lambda^N},\ a_{24} = 1$$

$$a_{31} = \frac{\theta\lambda^N}{\alpha_1 + \alpha_2 + \theta\lambda^N},\ a_{32} = -\frac{(\alpha_1 + \alpha_2)\lambda^N}{\alpha_1 + \alpha_2 + \theta\lambda^N}\ \ a_{33} = \frac{\alpha_1 + \alpha_2}{\alpha_1 + \alpha_2 + \theta\lambda^N},\ a_{34} = 0$$

The intuition behind the results becomes clear with the help of figures showing output and price determination. Figure 1.a. shows supply and demand for non-traded goods, which are dependent on the non-traded price. The rising supply curve follows from equation (2.1), while the falling demand curve follows from equation (2.7). Price and output are determined by the demand-supply balance. In Figure 1.b, the supply curve in the traded sector from equation (2.2) determines output together with the world market price in domestic currency *(p* + s)*.

Figure 1.a

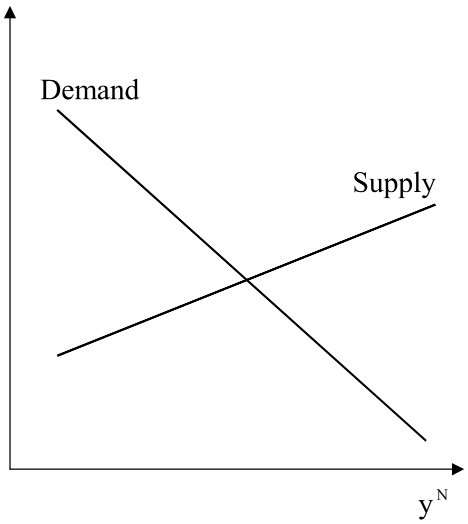
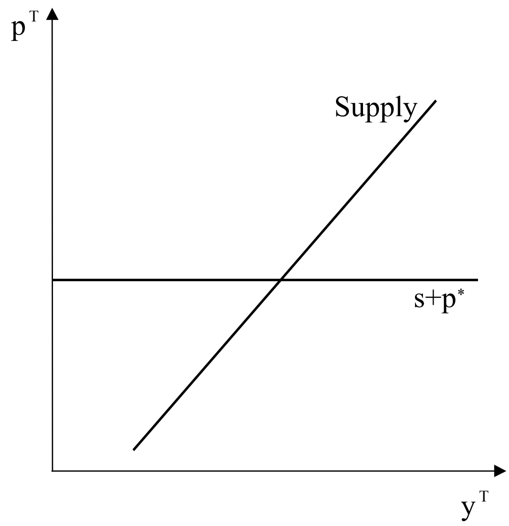


Figure 1.b



3. Optimal fiscal policy responses to shocks

The conventional wisdom is that inflation targeting stabilises output when demand shocks occur, because demand shocks drive prices and output in the same direction. When supply shocks occur, however, inflation targeting destabilises output, since such shocks drive prices and output in opposite directions. The stabilising properties of inflation targeting when demand shocks occur is, however, questioned in Røisland and Torvik (1999). Assuming an exogenous fiscal policy, it is shown that conventional wisdom holds for the non-traded sector, but not for the traded sector.

This section discusses how the sectoral stability in the economy may be improved by appropriate fiscal policy measures. In order to derive the optimal fiscal policy under inflation targeting, we need a welfare criterion.

Assume that welfare can be represented by the following loss function:

$$(3.1) \quad L = 1/2[\beta_0 \pi^2 + \beta_1 y^2 + \beta_2 (y^T)^2 + \beta_3 (y^N)^2 + \beta_4 x^2]$$

where $\pi \equiv p^C - p^C_{-1}$ is the rate of inflation. The first two terms in (3.1), inflation variability and aggregate output variability, are standard in the theoretical literature on monetary policy. Since we have the simplifying assumption that the central bank conducts strict inflation targeting, we can disregard the first term in the loss function when discussing fiscal policy. In addition to inflation and aggregate output variability, we assume that the society is concerned about sectoral stability, represented by the third and fourth terms. The last term represents social costs of changing the fiscal policy stance (for example because fluctuating tax rates may distort the choices of the private sector and lead to a misallocation of resources).

Since aggregate output, *y,* consists of a weighted sum of traded and non-traded output, we may rewrite the loss function as

$$(3.1') \quad L = 1/2[\beta_0\pi^2 + (\beta_1\theta^2 + \beta_2)(y^T)^2 + (\beta_1(1-\theta)^2 + \beta_3)(y^N)^2 + 2\beta_1\theta(1-\theta)y^T y^N + \beta_4 x^2]$$

When the society cares about aggregate output stability, i.e. $\beta_1 > 0$, the social loss depends on the term $2\beta_1\theta(1-\theta)y^T y^N$. Since $Ey^T y^N = Cov(y^T, y^N)$, the expected loss depends on the covariance between the two sectors. A positive covariance generates higher aggregate variability and thus increases the expected social loss, whereas a negative covariance generates lower aggregate variability and therefore contributes to lower expected loss. If the society only cares about sectoral output variability, the covariance between the sectors is irrelevant for the social loss.

The main issue of the paper is to discuss optimal fiscal policy when the central bank conducts inflation targeting. In practice, it can be difficult to implement the optimal fiscal policy, because the fiscal authorities may have a subjective loss function that deviates from the social loss function, or because the optimal fiscal policy may be time-inconsistent. In the main text, we assume that it is possible to implement the optimal fiscal policy, while Appendix A discusses how one may design fiscal policy rules that lead to an optimal fiscal policy that is time-consistent.

Minimising the loss in (3.1) subject to (2.12) gives the following first-order condition:

$$(3.2) \quad \beta_1 a_{11} y + \beta_2 a_{21} y^T + \beta_3 a_{31} y^N + \beta_4 x = 0$$

which gives the following solution for *x*:

$$(3.3) \quad x = b_1(v - \alpha_1 z) + b_2 w + b_3 u^N + b_4 u^T$$

where

$$(3.4)\quad b_i = -\frac{\beta_1 a_{11} a_{1,i+1} + \beta_2 a_{21} a_{2,i+1} + \beta_3 a_{31} a_{3,i+1}}{\beta_1 a_{11}^2 + \beta_2 a_{21}^2 + \beta_3 a_{31}^2 + \beta_4} \qquad i = 1,..,4$$

Despite the simple structure of the model, the solution for the optimal fiscal policy becomes complicated in the general case where all weights, β_i, are positive. In order to focus on the economic mechanisms driving the results, we first consider some special cases. Then, we discuss the general case based on reasonable parameter values.

3.1 Demand shocks; *v*

A positive shock to private sector demand shifts the non-traded demand curve upwards. Point B in Figure 2.a and 2.b illustrates the results of the shock when neither monetary nor fiscal policy responds. Output and prices in the non-traded sector increase, while the traded sector is unaffected. Since the price level increases, an inflation targeting central bank must raise the interest rate in order to achieve the inflation target. This leads to an exchange rate appreciation, shifting the price curve in Figure 2.b down to the dotted line, pushing production in the traded sector down. Both the appreciation and the higher interest rate reduce demand in the non-traded sector, but the demand curve in Figure 2.a does not shift all the way back to the original position. Lower prices on traded goods make room for higher prices on non-traded goods without threatening the inflation target. A positive demand shock and an unchanged fiscal policy thus lead to a boom in the non-traded sector ($y^N > 0$) and a recession in the traded sector ($y^T < 0$). The result of the monetary policy response is illustrated by point C in the figures. Inflation targeting with a passive fiscal policy thus stabilises the non-traded sector but destabilises the traded sector. In the realistic case where $\lambda^N > \lambda^T$, the higher production in the non-traded sector more than offsets the lower production in the traded sector, so that aggregate output increases.

The optimal fiscal policy response to a demand shock is found from equations (3.3) and (3.4):

$$(3.5)\quad \frac{\delta x}{\delta v} = -\frac{\beta_1 a_{11}^2 + \beta_2 a_{21}^2 + \beta_3 a_{31}^2}{\beta_1 a_{11}^2 + \beta_2 a_{21}^2 + \beta_3 a_{31}^2 + \beta_4} < 0$$

Irrespective of the weights attached to the various arguments in the loss function, fiscal policy should be tight when a positive demand shock occurs. In the special case where there are no costs of adjusting fiscal policy, i.e. $\beta_4 = 0$, fiscal policy should neutralise the demand shock completely.

Figure 2.a

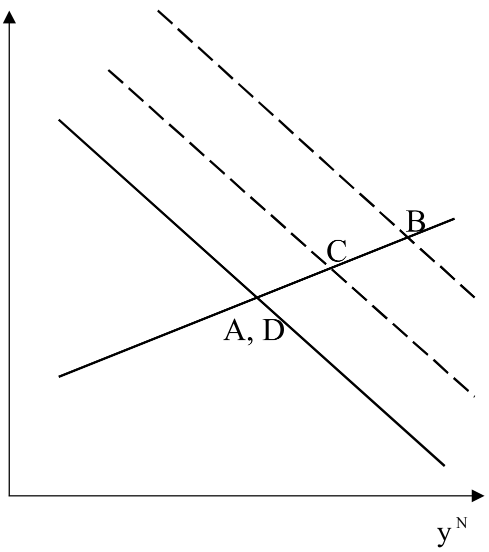
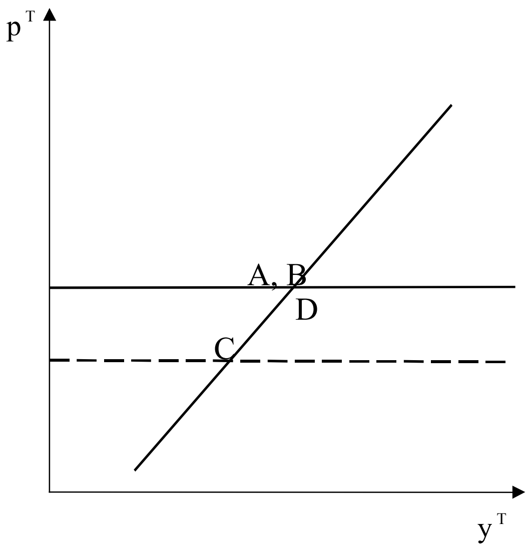


Figure 2.b



The optimal fiscal policy is then given by

$$(3.6) \quad \frac{\delta x}{\delta v} = -1$$

The demand curve thus shifts back to the initial position, and the new equilibrium is in point D, which is equal to the initial position. Since fiscal policy neutralises the demand shock completely, the interest rate and thus the exchange rate can remain unchanged. If it is costly to change the fiscal policy stance, the demand shock should not be completely neutralised by fiscal policy. Then, the interest rate must be increased in order to reach the inflation target. The result will then be somewhere in between point C and point D in Figure 2, where non-traded output has increased somewhat and traded output has decreased. The optimal fiscal policy modifies the result that inflation targeting destabilises the traded sector when demand shocks occur. Only in the case where there are no costs involved in using fiscal policy for stabilisation purposes is it optimal to fully prevent the destabilisation.

3.2 Foreign exchange shocks; *z*

A positive shock to the risk premium (or the world real interest rate) leads, for a given interest rate, to an exchange rate depreciation. The depreciation increases traded goods prices directly and non-traded goods prices indirectly through the substitution effect in demand, so that output in both sectors increase. The result without monetary or fiscal response is illustrated by point B in Figure 3.a and 3.b. Since prices on both goods have increased, the central bank must raise the interest rate in order to achieve the inflation target. For a given fiscal policy, the

Figure 3.a

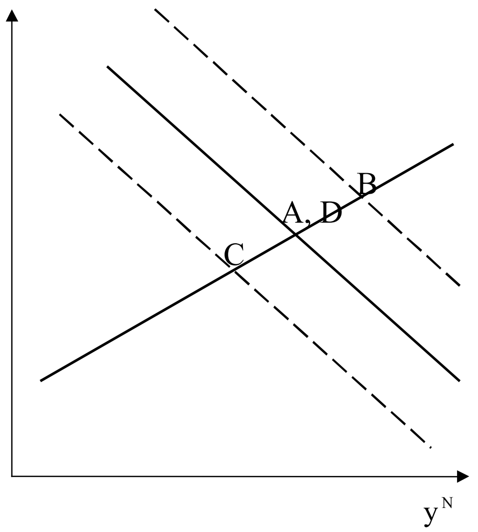
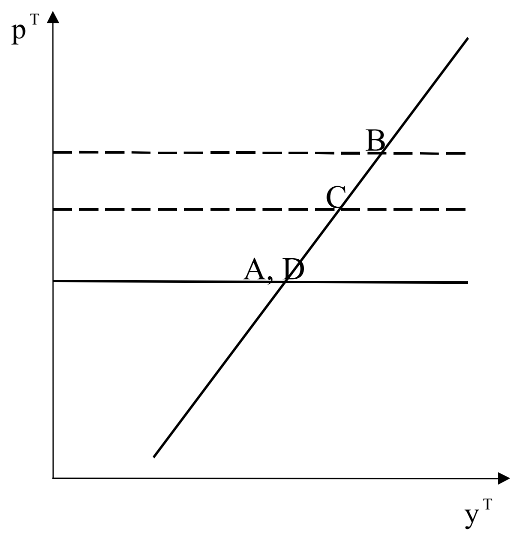


Figure 3.b



rise in the interest rate should not offset the initial depreciation completely. To see this, assume that the rise is sufficiently large to keep the exchange rate constant. Then, traded goods prices would be constant, and demand would thus not shift towards non-traded goods. However, since the interest rate would be higher, private sector demand for non-traded goods would decrease, leading to lower prices in this sector. Unchanged traded goods prices and lower non-traded goods prices imply that the rise in the interest rate would be excessive. The appropriate monetary policy response, given the fiscal policy, should let the exchange rate partly depreciate, but offset higher prices and production in the traded sector by lower prices and production in the non-traded sector. The equilibrium under inflation targeting and a neutral fiscal policy is represented by point C in the figures.

The optimal fiscal policy response to a foreign exchange shock is found from equations (3.3) and (3.4):

$$(3.7)\quad \frac{\delta x}{\delta v} = \alpha_2 \frac{\beta_1 a_{11}^2 + \beta_2 a_{21}^2 + \beta_3 a_{31}^2}{\beta_1 a_{11}^2 + \beta_2 a_{21}^2 + \beta_3 a_{31}^2 + \beta_4} > 0$$

Under inflation targeting, depreciation pressure in the foreign exchange market should thus be met by an expansionary fiscal policy. As compared to the case with a passive fiscal policy, the expansionary fiscal policy leads to higher output and prices in the non-traded sector, which necessitates a further rise in the interest rate in order to achieve the inflation target. This gives an exchange rate appreciation, which reduces production in the traded sector, compared to point C in the figure. In the case where there are no costs of changing the fiscal policy stance (β_4 = 0), the increase in the interest rate must be sufficient to maintain a constant exchange rate and thus constant output in the traded sector. In the non-traded sector, lower demand due to the rise in the interest rate is offset by the expansionary fiscal policy.

Equilibrium with an optimal fiscal policy and no fiscal adjustment costs is represented by point D in Figure 3.a and 3.b. The effects of the foreign exchange shock is then completely neutralised. When there are adjustment costs, the effects of the shock are not fully neutralised, and the result of the optimal fiscal policy response will be somewhere in between point C and D. Compared to a passive fiscal policy, stability in both the non-traded and traded sector is higher.

We have assumed that the shocks to the economy are truly exogenous. However, shocks, in particular foreign exchange shocks, may not be independent of economic policy. If the source of the depreciation pressure is low credibility of the fiscal authorities, the optimal response is obviously not to ease up fiscal policy. The combination of tight monetary policy and loose fiscal policy might then exacerbate the depreciation pressure. If, however, the source of the shock is e.g. increased focus on exchange rate risk among international investors, as experienced in the period after the crises in South-East Asia and Russia in 1997-98, the appropriate policy measure would be a higher interest rate and an expansionary fiscal policy.

3.3 Cost-push shocks; *w*

The stabilisation properties of inflation targeting (at least when strictly conducted) are often accused of being poor when supply shocks occur, since these push prices and output in opposite directions. Higher wages shift supply curves in Figure 4.a and 4.b up. With no macroeconomic policy response, the shock brings the economy to point B in the figure, with lower production in both sectors. Prices on non-traded goods increase, and under inflation targeting, the central bank must raise the interest rate. The tight monetary policy leads to an exchange rate appreciation, shifting the price line in Figure 4.b down, further decreasing output in the traded sector. The appreciation and the higher interest rate result in a negative shift in the demand curve in the non-traded sector, decreasing output further also here. As confirmed by equation (2.12), a positive shock to wages leads to reduced output in both sectors under inflation targeting, represented by point C in the figures. In the traded sector, both higher labour costs and an exchange rate appreciation induced by the rise in the interest rate leads to lower production. In the non-traded sector, higher labour costs, a higher interest rate and an exchange rate appreciation lead to reduced output.

Figure 4.a

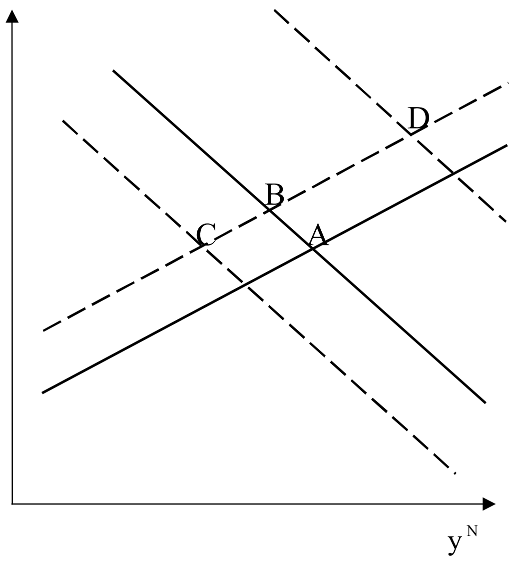
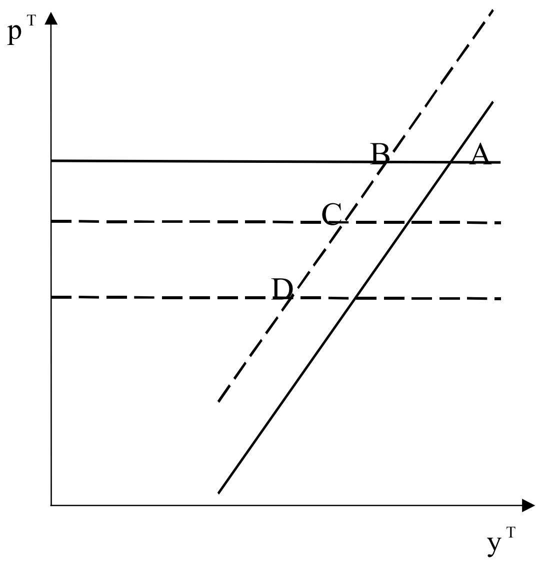


Figure 4.b



To what extent can an active use of fiscal policy counteract the destabilising effects of the monetary policy response? Suppose that the fiscal authorities respond to falling production by an expansionary fiscal policy. This shifts the non-traded sector demand curve outwards. To fulfil the inflation target, the central bank must respond with a further increase in the interest rate. The result is a further decline in traded sector output, while output in the non-traded sector increases. In the realistic case where $\lambda^N > \lambda^T$, the increase in non-traded output is larger than the decrease in traded output, so that the net effect on aggregate output is positive. In the special case where only aggregate output stability matters, i.e. $\beta_1 > 0$, $\beta_2 = \beta_3 = \beta_4 = 0$, the optimal fiscal policy response to a wage shock is found by setting $y = 0$ in equation (2.12):

$$(3.8) \quad \frac{\delta x}{\delta w_{\beta_1>0,\beta_2=\beta_3=\beta_4=0}} = \frac{(\alpha_1+\alpha_2)(\theta\lambda^T+(1-\theta)\lambda^N)+\theta\lambda^T\lambda^N}{\theta(1-\theta)(\lambda^N-\lambda^T)} > 0$$

Complete aggregate output stabilisation is represented by point D in Figure 4.a and 4.b. As seen from the figure, a positive wage shock and an expansionary fiscal policy results in a deep recession in the traded sector and a boom in the non-traded sector. Stabilising aggregate output by fiscal policy under inflation targeting thus generates large sectoral imbalances.

Suppose instead that only traded output stability matters, i.e. $\beta_2 > 0$, $\beta_1 = \beta_3 = \beta_4 = 0$. The optimal fiscal policy response is found by setting $y = 0$ from equation (2.12):

$$(3.9) \quad \frac{\delta x}{\delta w_{\beta_2>0,\beta_1=\beta_3=\beta_4=0}} = -\frac{\alpha_1+\alpha_2+\lambda^N}{1-\theta} < 0$$

Thus, if only traded sector stability matters, fiscal policy should be tight when a positive wage shock occurs. The reason is that higher wages lead to lower production in the traded sector. In order to offset the adverse cost-push effect, a depreciation in the exchange rate is required. Since monetary policy is committed to the inflation target, fiscal policy must be tight if the central bank shall lower the interest rate and thus induce an exchange rate depreciation.

For completeness, we consider the case where only stability in the non-traded sector matters, i.e. $\beta_3 > 0, \beta_1 = \beta_2 = \beta_4 = 0$. From equation (2.12) we see that the optimal fiscal policy response is given by

$$(3.10) \quad \frac{\delta x}{\delta w_{\beta_3>0,\beta_1=\beta_2=\beta_4=0}} = \frac{\alpha_1 + \alpha_2}{\theta} > 0$$

Note that the optimal fiscal policy response is lower in the case where only non-traded output stability matters compared to the case where only aggregate output stability matters. The reason is that unchanged production in the non-traded sector implies that aggregate output is lower, since production in the traded sector has decreased. In order to stabilise aggregate output, fiscal policy must be even looser, so that the non-traded sector goes into a boom, while the traded sector goes into an even deeper recession. The burden on the traded sector is thus smaller if the fiscal policy authorities aim at stabilising the non-traded sector rather than aggregate output.

3.4 Productivity shocks; u^N, u^T

If both sectors are hit by the same productivity shock, i.e. $u^N = u^T$, the effects of a positive shock are equivalent with a negative wage shock, *w*. Thus, the same conflicting objectives between stability in the traded versus the non-traded sector apply.

The sign of the optimal fiscal policy response to asymmetric supply shocks depends on the weight attached to traded sector stabilisation. Suppose first that the fiscal authorities only care about aggregate stability, i.e. $\beta_1 > 0, \beta_2 = \beta_3 = \beta_4 = 0$. The optimal fiscal policy responses are then given by

(3.11) $$\frac{\delta x}{\delta u^{N}}\bigg|_{\beta_1>0,\beta_2=\beta_3=\beta_4=0} = -\frac{(1-\theta)(\alpha_1+\alpha_2+\theta\lambda^{T})}{\theta(1-\theta)(\lambda^{N}-\lambda^{T})} < 0$$

(3.12) $$\frac{\delta x}{\delta u^{T}}\bigg|_{\beta_1>0,\beta_2=\beta_3=\beta_4=0} = -\frac{\theta(\alpha_1+\alpha_2+\theta\lambda^{N})}{\theta(1-\theta)(\lambda^{N}-\lambda^{T})} < 0$$

A positive shock to non-traded supply, u^N, leads to higher production in both sectors. The reason is that in addition to the direct effect of the shock, the central bank must lower the interest rate in order to achieve the inflation target. This produces an exchange rate depreciation, which also increases production in the traded sector. In order to stabilise aggregate output, fiscal policy must be tight. This leads to lower non-traded output, but higher traded output, since the interest rate is lowered even more. In order to stabilise aggregate output when $\lambda^N > \lambda^T$, it can be seen by inserting equation (3.11) in equation (2.12) that fiscal policy must be adjusted so that the traded sector enters a boom, while the non-traded falls into a recession. Thus, under inflation targeting and optimal fiscal policy, the non-traded sector that experiences the positive supply shock in the first place ends in a contraction when only aggregate output stability matters. The traded sector is destabilised more than under a passive fiscal policy.

A positive shock to traded output, u^T, does not trigger any direct monetary policy response, since it does not affect inflation (since prices on traded goods are given on the world market). Since the shock results in higher traded output, it also leads to higher aggregate output. To neutralise the effect of the shock on aggregate output, fiscal policy must be tight. A tight fiscal policy is met by a reduction in interest rates, and thereby exchange rate depreciation, under inflation targeting. Traded output consequently increases further, while non-traded output decreases so that aggregate output is constant. Thus, when only aggregate stability matters, the fiscal policy response destabilises the traded sector further, irrespective of which sector experiences a supply shock.

Consider then the case where the fiscal authorities only care about stability in the traded sector. The optimal fiscal policy responses are then given by

(3.13) $$\frac{\delta x}{\delta u^{N}}\bigg|_{\beta_2>0,\beta_1=\beta_3=\beta_4=0} = 1$$

$$(3.14) \quad \left.\frac{\delta x}{\delta u^T}\right|_{\beta_2>0,\beta_1=\beta_3=\beta_4=0} = \frac{\alpha_1+\alpha_2+\theta\lambda^N}{(1-\theta)\lambda^T} > 0$$

A positive shock to non-traded supply leads to higher production and lower prices in the non-traded sector. The central bank must then lower the interest rate to achieve the inflation target. This produces an exchange rate depreciation, which increases production in the traded sector. In order to stabilise traded output, fiscal policy must be sufficiently expansionary to prevent the central bank from lowering the interest rate.

A positive shock to traded production does not trigger a monetary policy response. In order to prevent higher production in the traded sector, an exchange rate appreciation is required. In order to have an exchange rate appreciation, fiscal policy must be expansionary, so that the central bank can raise the interest rate.

When stability in the non-traded sector is the only thing that is important, the optimal responses to supply shocks are given by

$$(3.15) \quad \left.\frac{\delta x}{\delta u^N}\right|_{\beta_3>0,\beta_1=\beta_2=\beta_4=0} = -\frac{\alpha_1+\alpha_2}{\theta\lambda^N} < 0$$

$$(3.16) \quad \left.\frac{\delta x}{\delta u^T}\right|_{\beta_3>0,\beta_1=\beta_2=\beta_4=0} = 0$$

A positive shock to non-traded output should give rise to a tight fiscal policy in order to neutralise the positive direct effect of the shock and the indirect effect from a lower interest rate. A shock to traded output, on the other hand, should neither trigger any fiscal policy response, nor any monetary policy response, as long as stability in the non-traded sector is the only thing that matters.

3.5 Flexible inflation targeting

We have seen that inflation targeting may give rise to large sectoral imbalances. At first sight, one may believe that this is partly the result of the strict inflation targeting regime studied. In the more realistic case of flexible inflation targeting, the central bank also takes into account aggregate output stability. This may, however, exacerbate the problem. To see this, reconsider the case of a demand shock studied above. With strict inflation targeting (and passive fiscal policy), this leads to a higher interest rate, lower production in the traded sector, higher production in the non-traded sector, and higher aggregate production provided $\lambda^N > \lambda^T$. If the central bank has output stability, in addition to inflation, in its objective function, the interest rate will increase even further in response to a demand shock, and stabilise aggregate production more than in the case with strict inflation targeting. This being the case, traded sector production becomes even more unstable than with strict inflation targeting. Therefore, flexible inflation targeting does not remove the motive for an active fiscal policy under inflation targeting, given that sectoral and not only aggregate instability is considered costly.

3.6 A numerical example

Since the analytical solution for optimal fiscal policy becomes less transparent in the general case, we will consider a numerical example. The following structural parameters need to be calibrated: θ, α_1, α_2, λ^N and λ^T. We use the manufacturing sector as a proxy for the traded sector and manufacturing production as a share of GDP as a base value for θ. This gives a value of θ close to 1/3 in most countries. For α_1 and α_2, we use the aggregate elasticities from Batini and Haldane (1998) and scale them by 3/2 in order to make the elasticities in the non-traded sector consistent with the aggregate elasticities. This gives α_1 = .75 and α_2 = .2. These are also broadly consistent with estimates used in other central banks. We choose λ^T = .5, which is close to the estimate of the elasticity with respect to wages in the manufacturing sector in Nickell and Wadhwani (1991). There are few empirical studies that cast light on plausible values for the supply elasticity in the non-traded sector. Disney and Ho (1990) estimated both λ^N and λ^T for Singapore, but the estimate for λ^N seems unreasonably small, which the authors explain by measurement errors and simultaneity in the determination of domestic demand, employment and real wage levels. However, Burgess (1988) reports estimates of the economy-wide elasticity of around 1.0, which we use as a base value. λ^N is then found from $\theta\lambda^T + (1-\theta)\lambda^N = 1.0$, which, with the above parameter values, gives λ^N = 1.25.

First consider the solutions for aggregate, traded and non-traded output when fiscal policy is neutral (passive), i.e. $x = 0$. From (2.12) and the above parameter values, we find that

(3.17) $y = .11v + .09z - .86w + .56u^N + .33u^T$

(3.18) $y^T = -.23v + .17z - .79w + .23u^N + 1.0u^T$

(3.19) $y^N = .30v - .23z - .96w + .77u^N$

According to conventional wisdom, inflation targeting stabilises output when demand shocks occur, since these drive prices and output in the same direction. The numerical exercise conducted here illustrates that aggregate output is quite stable when demand shocks occur.

However, the monetary policy response results in relatively larger fluctuations in each sector. Thus, if sectoral stability is considered important, there seems to be a potential welfare gain from an active fiscal policy that is larger than what the number for aggregate output fluctuation suggests. The same picture emerges from shocks in the foreign exchange market. As regards supply shocks, however, the two sectors move in tandem and the output fluctuations are quite large compared with the fluctuations with demand shocks. Thus, in this case also, it should clearly be of interest to investigate the optimal fiscal policy responses.

In the numerical simulations, we restrict the analysis to the case where aggregate output, traded output and non-traded output have the same weight in the loss function. The optimal fiscal policy and the solutions for aggregate, traded and non-traded output under the optimal fiscal policy are summarised in Table 2. For each type of shock, we investigate two different cases; one without any cost attached to changes in the fiscal policy stance (β_4 = 0) and one where there is a direct cost associated with using fiscal policy for stabilisation purposes (β_4 = .2). For each type of shock, we show the optimal fiscal policy response as well as effects on aggregate and disaggregated output.

Table 2. $\beta_1 = 1$, $\beta_2 = 1$, $\beta_3 = 1$

	v		z		w		u^N		u^T	
	$\beta_4 = 0$	$\beta_4 = .2$	$\beta_4 = 0$	$\beta_4 = .2$	$\beta_4 = 0$	$\beta_4 = .2$	$\beta_4 = 0$	$\beta_4 = .2$	$\beta_4 = 0$	$\beta_4 = .2$
x	-1.0	-.44	.75	.33	1.33	.59	-1.55	-.68	1.22	.54
y	0	.06	0	-.05	-.71	-.79	.38	.48	.47	.39
y^T	0	-.13	0	.10	-1.09	-.92	.59	.39	.72	.88
y^N	0	.17	0	-.13	-.56	-.79	.30	.56	.37	.16

Consider first the case where there are no costs of adjusting the fiscal policy. Fiscal policy is then sufficiently flexible to completely neutralise demand shocks and shocks in the foreign exchange market.

The fiscal policy coefficient on the wage shock is positive. Thus, while the absolute value of the output response in the traded sector equals .79 with a passive fiscal policy, it rises to 1.09 when fiscal policy is used for stabilisation purposes. The traded sector output response is also higher under an active fiscal policy when there are supply shocks to the non-traded sector. The reason for these results is that in the above set of weights and parameter values, the relative weight attached to traded sector stability is not large enough to induce a fiscal policy that decreases the effect of the shocks to the traded sector. On the contrary, the optimal fiscal policy response is a policy that reduces the effects on aggregate and non-traded output, but enhances the effect on the traded sector. In the case of a wage shock, the optimal response of an expansionary fiscal policy induces an even higher interest rate and thereby a further appreciation. With a supply shock to the non-traded sector, the fiscal policy is tight, meaning an even lower interest rate and a larger depreciation than in the case with a passive fiscal policy.

With the exception of supply shocks in the traded sector, all shocks produce more stable output in the non-traded sector when fiscal policy is adjusted to maximize the welfare function. The fiscal policy response to a positive supply shock in the traded sector should be an expansionary policy, which, under inflation targeting, requires a rise in the interest rate and thereby an appreciation, which stabilises traded output.

Consider then the case where it is costly to adjust fiscal policy. Specifically, we have chosen β_4 = .2, which might be considered as a case with positive, but moderate, fiscal adjustment costs. As seen from Table 2, even relatively small fiscal adjustment costs reduce the degree of optimal fiscal activism considerably. The reason is that the optimal degree of fiscal activism depends on the size of fiscal adjustment costs relative to the effect fiscal of policy on target variables. Under inflation targeting, an expansionary (contractionary) fiscal policy stance is met by a rise (fall) in the interest rate. For this reason, fiscal policy is less effective than under monetary policy regimes where the interest rate does not automatically respond to increased demand. Since fiscal policy is relatively uneffective, it must not be used frequently when it is associated with costs.

Figure 5

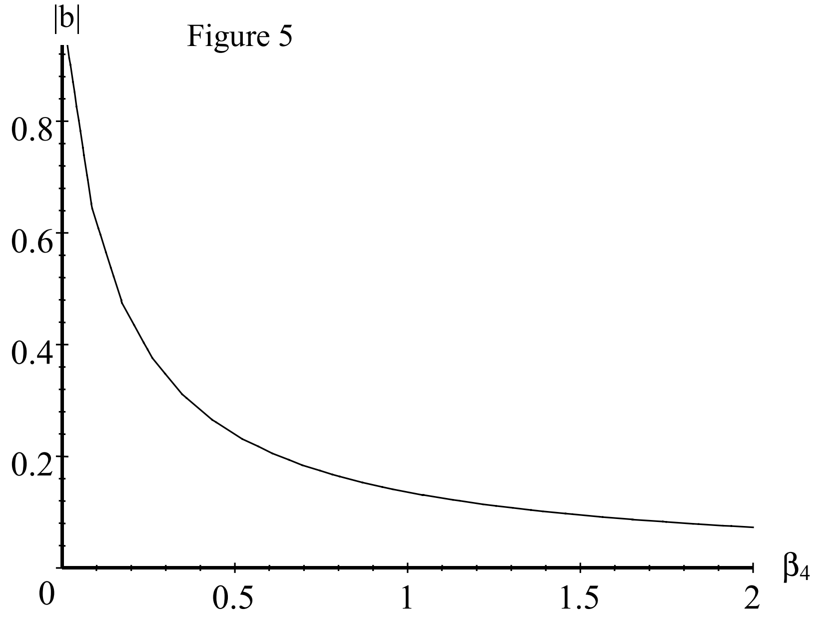


Figure 5 shows the absolute value of the coefficient on the demand shock as a function of β_4. We see that increasing β_4 marginally from $\beta_4 = 0$ reduces the (absolute value) of the response coefficient considerably. Thus, the view held by e.g. Bank of England,[4] that fiscal policy should not be used as an instrument for macroeconomic stabilisation under inflation targeting, seems to be supported somewhat by this simulation.

4. Summary and final remarks

The paper has discussed optimal fiscal policy when monetary policy is committed to an inflation target. Generally, it is better to use two instruments than one when there are conflicts between stabilising inflation and stabilising the real economy. Specifically, in a small open economy, inflation targeting might produce imbalances between traded and non-traded sectors when fiscal policy is passive. By adjusting the fiscal policy stance as a response to various shocks, an active fiscal policy can provide a better sectoral balance, at least when it comes to demand shocks. The choices with regard to supply shocks are more difficult, since there tends to be a conflict between aggregate and non-traded sector stability on the one hand, and traded sector stability on the other. A traditional counter-cyclical fiscal policy will destabilise the traded sector more than a passive fiscal policy under inflation targeting. If stability in the traded sector is considered particularly important, fiscal policy should be tight when adverse supply shocks occur.

Overall, do our results give a case for an active fiscal policy under inflation targeting? The answer is yes and no. There is a potentially large welfare gain from an active fiscal policy, particularly when the society cares about sectoral stability. However, this welfare gain depends crucially on the social costs associated with adjusting the fiscal policy stance to the relevant economic state. With reasonable parameter values, a relatively moderate cost associated with adjusting fiscal policy implies that fiscal policy should be considerably less active. Due to the fact that the effectiveness of fiscal policy is reduced under inflation targeting, the difference in social welfare between having an *optimal* fiscal policy and having a *neutral* (passive) fiscal policy diminishes quickly as the fiscal policy adjustment cost increases.

[4] See King (1999), p. 4.

We have made some simplifying assumptions that may affect the results to some extent. Specifically, we have assumed a very simple dynamic structure, where both monetary and fiscal policy affect prices and output in the same period in which they are implemented. Moreover, we have assumed that the central bank conducts strict inflation targeting. What effect would flexible, as opposed to strict, inflation targeting have on optimal fiscal policy? There may be (at least) two effects that may work in different directions. On the one hand, less strict inflation targeting would lead to a weaker monetary policy response to a change in the fiscal policy stance. This would tend to imply a more active optimal fiscal policy, since effectiveness increases. On the other hand, more flexibility in monetary policy may reduce the *need* for an active fiscal policy, given that traded sector stability is not the dominant term in the welfare function. If traded sector stability is considered particularly important, however, flexible inflation targeting may, in fact, increase the need for a more active fiscal policy, although not a traditional counter-cyclical policy.

Appendix

Fiscal policy and the time-inconsistency problem

In the main text of the paper, we assumed that it was possible to implement the optimal fiscal policy. This appendix discusses how possible time-inconsistency problems can be resolved by appropriate design of fiscal policy rules. The solutions build on the solutions to the time-inconsistency problem in monetary policy that have been proposed in the literature on institutional arrangements for central banks, see e.g. Rogoff (1985), Walsh (1995), Svensson (1997) and Røisland (2001). In addition to applying these proposals to fiscal policy, we show that dividing the aggregate economy to a traded and a non-traded sector provides some new insights. The appendix considers only one particular type of time-inconsistency problem in fiscal policy and disregards aspects like the intertemporal budget constraint. See Persson and Tabellini (1997) for a survey of intertemporal aspects of fiscal policy.

In the model presented, the fiscal policy stance, *x,* was interpreted as exogenous shock (section 2) or a linear function of exogenous shocks (section 3). For the sake of simplicity, assume that the fiscal policy shock is equal to a shock to the budget deficit, i.e.

$$x = b - Eb \qquad \textbf{(A.1)}$$

where *b* is the budget deficit. Agell et al. (1996) showed, within a model with optimising trade unions, that only unanticipated changes in the fiscal policy had effect on output. Although this result may not be robust in a model with two sectors, we assume that the budget balance in itself has no long-term effect on potential output in the two sectors.

It was assumed above that there were no time-inconsistency problems in fiscal policy, so that $Eb = b^*$, where b^* is the socially optimal budget. Suppose now that the incentives of the fiscal authorities can be represented by the following (subjective) loss function:

$$L^F = \frac{1}{2}[\beta_0 \pi^2 + \beta_1 (y - y^*)^2 + \beta_2 (y^T - y^{T*})^2 + \beta_3 (y^N - y^{N*})^2 + \beta_4 (b - b^*)^2] \qquad \textbf{(A.2)}$$

where y^*, y^{T*} and y^{N*} are positive constants that represent the difference between the socially optimal output levels and their potential (trend) levels. The reason for such differences might be labour market distortions, which generate excess unemployment. We assume for the sake of simplicity that the weights in the subjective loss function are the same as in the social loss function.

By substituting (*b-Eb)* for *x* in equation (2.12) and taking the derivative of the loss function with respect to *b*, we have the following first-order condition:

$$\beta_1 a_{11}(y - y^*) + \beta_2 a_{21}(y^T - y^{T*}) + \beta_3 a_{31}(y^N - y^{N*}) + \beta_4 (b - b^*) = 0 \qquad \textbf{(A.3)}$$

where the inflation term is disregarded, since the central bank always keeps inflation on target. Taking the expectation through **(A.3)** yields

$$\begin{aligned} Eb &= b^* + \frac{\beta_1 a_{11} y^* + \beta_2 a_{21} y^{T*} + \beta_{31} y^{N*}}{\beta_4} \\ &= b^* + \frac{\beta_1 \theta (1-\theta)(\lambda^N - \lambda^T) y^* - \beta_2 (1-\theta)\lambda^T y^{T*} + \beta_3 \theta \lambda^N y^{N*}}{\beta_4 (\alpha_1 + \alpha_2 + \theta \lambda^N)} \end{aligned} \qquad \textbf{(A.4)}$$

We see that the average budget deficit deviates from the socially optimal budget deficit. As in models of monetary policy in the Barro-Gordon tradition, over-ambitious output targets lead to a policy bias. However, within this theoretical framework, over-ambitious output targets do not necessarily lead to a bias towards an *expansionary* fiscal policy. Whether the bias is expansionary or contractionary depends on the supply elasticities in the traded and non-traded sectors and on the relative weights on the various output targets. Suppose, for example, that only aggregate output variability matters, i.e. $\beta_1 > 0, \beta_2 = \beta_3 = 0$. The bias is expansionary if the supply of non-traded goods is more elastic than the supply of traded goods, whereas the bias is contractionary if the supply of traded goods is more elastic. The reason is that in the latter case, expansionary fiscal policy has a contractionary effect under inflation targeting, since the traded sector negative output effect (because of increased interest rate leading to exchange rate appreciation) is stronger than the non-traded output effect from increased public demand. Moreover, a large weight, β_2, on the traded sector tends to give a contractionary fiscal policy bias, since a fiscal expansion leads to an exchange rate appreciation and thereby contraction in the traded sector.

In the one-sector model in Agell et al. (1996), the fiscal policy bias depends on the monetary policy regime. A fixed exchange rate leads to a higher budget deficit than a discretionary monetary policy does. Our paper, which instead considers inflation targeting, gives new insights by demonstrating that the fiscal policy bias also depends on the relative sizes of supply elasticities in the different sectors, and on the relative weight placed on the traded sector.

The time-inconsistency problem in fiscal policy, as specified here, is similar to the standard time-inconsistency problem in the rules versus discretion literature on monetary policy. The suggested solutions in this literature can therefore also be applied to time-inconsistency problems in fiscal policy. Rogoff (1985) showed that the outcome of monetary policy could be improved if the government appointed a 'conservative' central banker, who places a higher weight on inflation than the society does. In the model above, this would be equivalent to increasing β_4, which could be interpreted as designing fiscal policy rules that reduce the flexibility of fiscal policy. Although this would reduce (though not eliminate) the fiscal policy bias, it would lead to suboptimal fiscal stabilisation. Walsh (1995) showed that the inflationary bias could be removed without affecting the stabilisation properties of monetary policy by offering the central banker a "linear inflation contract". To apply this solution to our model, we add a sixth term to the subjective loss function of the fiscal authorities:

$$\begin{aligned} L^F = \frac{1}{2}[&\beta_0\pi^2 + \beta_1(y-y^*)^2 + \beta_2(y^T - y^{T*})^2 + \beta_3(y^N - y^{N*})^2 \\ &+\beta_4(b-b^*)^2 + \beta_5(b-b^*)] \end{aligned} \quad \textbf{(A.5)}$$

The last term may be interpreted as a penalty (if the bias is towards an expansionary fiscal policy) for running budget deficit. It is asymmetric, in the sense that the fiscal authorities are penalised for producing a higher deficit than the socially optimal one, and rewarded for producing a lower deficit that the socially optimal one. An example of a "contract" that contains such ideas is the Maastrict criteria for the budget balance.

Minimising (A.5) with respect to b gives the following first-order condition:

$$\beta_1 a_{11}(y-y^*) + \beta_2 a_{21}(y^T - y^{T*}) + \beta_3 a_{31}(y^N - y^{N*}) + \beta_4(b-b^*) + \beta_5 = 0 \quad \textbf{(A.6)}$$

We see that the fiscal policy bias is removed if the marginal penalty is given by

$$\begin{aligned} \beta_5 &= \beta_1 a_{11} y^* + \beta_2 a_{21} y^{T*} + \beta_{31} y^{N*} \\ &= \frac{\beta_1\theta(1-\theta)(\lambda^N - \lambda^T)y^* - \beta_2(1-\theta)\lambda^T y^{T*} + \beta_3\theta\lambda^N y^{N*}}{\alpha_1 + \alpha_2 + \theta\lambda^N} \end{aligned} \quad \textbf{(A.7)}$$

Because the penalty enters linearly, it does not affect the stabilisation properties of fiscal policy.

Instead of an asymmetric penalty implied by a linear rule, one might assign a different budget target than the socially optimal budget deficit. Specifically, the fiscal authorities' subjective loss function could be specified as

$$L^F = \frac{1}{2}[\beta_0 \pi^2 + \beta_1 (y - y^*)^2 + \beta_2 (y^T - y^{T*})^2 + \beta_3 (y^N - y^{N*})^2 + \beta_4 (b - \tilde{b})^2] \quad \textbf{(A.8)}$$

where $\tilde{b}$ is the budget target. This solution, which is mathematically equivalent to the above solution, was proposed by Svensson (1997) in the context of monetary policy.

By substituting $\tilde{b}$ for b^* in the first-order condition in (A.3) we find that the optimal budget target is given by

$$\begin{aligned} \tilde{b} &= b^* - \frac{\beta_1 a_{11} y^* + \beta_2 a_{21} y^{T*} + \beta_{31} y^{N*}}{\beta_4} \\ &= b^* - \frac{\beta_1 \theta (1-\theta)(\lambda^N - \lambda^T) y^* - \beta_2 (1-\theta) \lambda^T y^{T*} + \beta_3 \theta \lambda^N y^{N*}}{\beta_4 (\alpha_1 + \alpha_2 + \theta \lambda^N)} \end{aligned} \quad \textbf{(A.9)}$$

As long as $\lambda^N > \lambda^T$ and the weight attached to the traded sector is sufficiently small, the optimal budget target is an "ambitious" target, that is, the fiscal authorities should aim for a lower budget deficit than what is socially optimal. Because there is an expansionary bias due to the over-ambitious output targets, the budget target will not be met on average, but will instead be equal to the socially optimal budget deficit.

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