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Exchange rate versus inflation targeting: a theory of output fluctuations in traded and non-traded sectors

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Abstract

This paper develops a basic model for output fluctuations in traded and non-traded sectors under two alternative monetary policy regimes; exchange rate targeting (or monetary union) and inflation targeting. The conventional wisdom from one-sector models says that inflation targeting gives better output stabilization than exchange rate targeting when demand shocks occur, but the opposite when supply shocks occur. In a model with a traded and a non-traded sector, we show that the conventional wisdom holds for the non-traded sector. However, for the traded sector, we show that inflation targeting destabilizes output compared with exchange rate targeting when both supply and demand shocks occur. The only shocks where inflation targeting provides the better output stability for the traded sector are shocks to world market prices. The two-sector structure introduces new mechanisms that may turn around earlier results for aggregate production. For instance, a demand shock may induce higher aggregate output fluctuations with inflation targeting than with exchange rate targeting. Furthermore, a positive demand shock may prove to be contractionary under inflation targeting.

Keywords

Inflation targeting, exchange rate targeting, monetary policy, dependent economy model, output stability

1. INTRODUCTION

Two observations initiated this paper. The first observation relates to the history of inflation targeting in the United Kingdom: according to *The Economist* (leader, 25 July 1998), high domestic demand 'forced the Bank [of England] to raise interest rates several times – and hence push the pound higher. The result has been an unusually unbalanced, and hence vulnerable, economy: the strong pound choked manufacturing and exports, while

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services and consumer spending continued to boom.' The second observation is a main argument often heard against inflation targeting in Norway. It has several variants, but can be stated as something like: 'Oil revenues have created Dutch disease symptoms squeezing the traded sector far too much from a long-term perspective. Because of this the burdens placed on the sector when the economy faces new shocks should be kept to a minimum. Stability in the sector should be promoted by fixing the exchange rate rather than continuing with inflation targeting.' Both statements refer to how the monetary policy regime affects the balance between traded and non-traded sectors with economic shocks. Surprisingly, however, even a basic theory linking output fluctuations in the sectors to the choice between exchange rate and inflation targeting seems to be difficult to find. Ball (2000: 20) concludes:

> Exchange-rate fluctuations cause reallocations of resources across the tradeable and non-tradeable sectors, and these may be inefficient. Current models cannot capture this idea because they focus on aggregate variables. Progress might be made by evaluating policy rules in models that disaggregate output into tradeables and non-tradeables.

The aim of the present paper is to develop a model that takes the distinction between traded and non-traded sectors into account.

The conventional wisdom from one-sector closed economy models is that inflation targeting stabilizes output when demand shocks occur and destabilizes output when supply shocks occur. When comparing inflation targeting and exchange rate targeting, Rødseth (1996) shows that the same holds in an open economy. A positive demand shock causes both price and output to increase by moving the economy upwards along a rising supply curve. The policy response under inflation targeting is a higher interest rate. The higher interest rate reduces the output response from the demand shock for two reasons. First, the higher interest rate has a direct negative effect on demand. Second, the higher interest rate gives an exchange rate appreciation, and shifts demand away from domestically produced goods. A negative supply shock also calls for a higher interest rate under inflation targeting, and reduced demand adds to the initial contraction caused by decreased supply.

Most observers agree that output stability is one important element in the evaluation of different monetary policy regimes. Fluctuations in production can be costly through increased risk, variations in unemployment, adjustment costs and more difficult planning. But is it stability in aggregate output, or is it stability at the disaggregated level – sector level or even firm level – that matters? If all firms are identical, as implicitly assumed in one-sector models, arguments for aggregated and disaggregated output stability coincide. In real life, however, this is clearly not the case. When the economy faces shocks, usually some firms expand and some contract. Even if the aggregate fluctuation in production is small, output fluctuations at the disaggregated level can be substantial. In our view, both aggregate and sectoral stability should be taken into account. For instance, for workers it is clearly an advantage if other sectors expand when their own sector contracts, because this increases the chance of finding a job elsewhere. In this way, aggregate output fluctuations are of interest. But with higher mobility within than between sectors, the output fluctuations at the sectoral level are also of interest. The same applies to firm owners. Aggregate output stability can be important because it provides the possibility of lending capital to firms in sectors that are experiencing favourable conditions when their own sector is experiencing bad times. If investments are partly or wholly irreversible, however, output stability at the micro level may be most important. If one believes that output stability has to do with more than stability in aggregate output, one clearly has a case for studying models that depart from the one-sector assumption.

However, if one believes that the only fluctuations of relevance are fluctuations in aggregate output, one might at first sight think that a one-sector model would do the job. This turns out not to be the case, as we will show below. Even if only aggregate output variability is the relevant measure in the evaluation of monetary policy, it is necessary to look beyond a one-sector model. The reason is that this introduces mechanisms that may turn around conventional results for aggregate output fluctuations from one-sector models. Thus, irrespective of whether sectoral output fluctuations are of importance or not, there are good reasons for developing a theory that departs from the one-sector model tradition in evaluating output fluctuations.

We choose to focus on the distinction between traded and non-traded sectors. By this sector disaggregation, we capture in a simple way two groups of firms that are relatively homogeneous within each group, but that are relatively heterogeneous between the groups. Monetary policy works differently on the two sectors. While the effect of monetary policy through the interest rate is important in determining demand and output in the non-traded sector, the exchange rate is more important in determining output in the traded sector. Furthermore, the sectors face different types of shocks. Shocks to domestic demand are important for the non-traded sector, while shocks to the world market price may be more important for the traded sector.[1]

The present paper differs from earlier contributions first and foremost in that we develop a simple theory model of output fluctuations in traded and non-traded sectors with exchange rate and inflation targeting. This has to our knowledge not previously been done. Let us clarify at the outset that we do not claim to find the optimal monetary policy regime based on our two alternatives. Our ambition is far more modest. We simply want to determine how the different regimes affect output stability. In this sense the study is positive rather than normative. On the other hand, we do look upon output stability as one of the important evaluation criteria of monetary policy. If interpreted normatively, our approach is therefore closely related to that of Mankiw and Reis (2003), who consider, within a closed-economy model with different sectors, the choice of price index that gives the maximum degree of output stability. If stability in inflation is also considered important, as in the standard New Keynesian literature, the results in the present paper then may tend to lend too little support for inflation targeting (if interpreted normatively). If stability in the nominal exchange rate is considered important in addition to output stability, the results tend to be too little in favour of exchange rate targeting.

The basic model is set out and solved in Section 2. Section 3 discusses how different shocks work in the two monetary policy regimes. Concluding remarks are presented in Section 4.

2. THE MODEL

In constructing the model, three assumptions are of particular importance. First, when comparing the two different monetary policy regimes, we assume in the main part of the paper that they are both strictly interpreted, and that the targets will always be fulfilled. To show how results may change when regimes are not interpreted strictly, we compare flexible and strict inflation targeting at the end of Section 3.

Second, in contrast to the simulation models of, for example, Svensson (2000) and Leitemo and Røisland (2002), we disregard different lags for the different transmission mechanisms of monetary policy. In our model, monetary policy simply works in the same period it is implemented. Disregarding the fact that monetary policy affects, for instance, the exchange rate and supply with different lags is clearly unrealistic. On the other hand, the strength of the approach is that it is simple and allows us to find explicit solutions for the output fluctuations (as well as for the other endogenous variables such as the real exchange rate and the interest policy rule) in the different regimes. In addition, the approach allows us to know with certainty that our results follow from the assumptions in the theoretical model, and not from calibrated parameter values.

Third, we study how the economy fluctuates around an exogenously given steady-state equilibrium with a given natural rate of unemployment, i.e. it is assumed that the monetary policy regime has no effects on real variables in a steady state. This is in contrast to Holden (2003), who studies the equilibrium unemployment consequences of the choice between the two regimes, rather than the short-term output fluctuations.

Except for the distinction between the traded and non-traded sector, our model is similar to those of 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. Except for interest rates, all variables are in logs. They are measured as *deviations* from the exogenously given steady-state equilibrium, so that when the economy is in steady state all variables are equal to zero. All shocks have expectation zero and are independent over time. Since shocks are independent over time, and there are no lags in the model, all other economic variables are also independent over time. Hence, with rational expectations agents will always expect the economy to be in steady-state in the next period, i.e. the expectation of all next period variables will be zero. Nominal wages are set one period in advance to equalize the expected rate of unemployment to the natural rate of unemployment. In the absence of wage shocks, (the log of) wages will thus be set equal to zero.

The supply side of the non-traded sector is given by

$$y^N = \lambda^N(p^N - w) + u^N \tag{1}$$

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. Equation (1) would follow from a standard profit maximization problem for firms operating under perfect competition, with labour as the only variable factor of production. By solving for p^N one may alternatively interpret equation (1) is an optimal pricing rule under monopolistic competition, consistent with New Keynesian assumptions about market structure.[2] We differ, however, from the standard New Keynesian approach by assuming flexible product prices. This distinction, which simplifies the analysis, has mainly implications for how a 'period' should be interpreted and is not essential for the results. In most New Keynesian models, a 'period' is interpreted as (about) a quarter, which justifies the assumption of sticky prices. In our model, a 'period' is considerably longer. Due to our specification of inflation targeting below, a 'period' in our model could be interpreted as the usual horizon for the inflation target; that is, approximately two years. The average length of price contracts is much shorter, so that it is reasonable to treat prices as flexible within a period in our model. Although wage contracts are also normally shorter than two years, empirical evidence points towards considerable nominal wage rigidity, see for example Dwyer and Leong (2000).[3]

The supply side of the traded goods sector is equivalent to the non-traded sector and is given by:

$$y^T = \lambda^T(p^* + s - w) + u^T \tag{2}$$

where y^T is the supply of non-traded goods and, 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 the steady state, aggregate production is a weighted average of production in the two sectors:

$$y = \theta y^T + (1 - \theta)y^N \tag{3}$$

The foreign exchange market is characterized by perfect capital mobility, so that uncovered interest rate parity holds. Agents in the foreign exchange markets have rational expectations, so that expected depreciation is given by $(Es - s) = -s$, since Es equals zero by construction. The relationship between the interest rate and the exchange rate is thus given by

$$i = i^* + (Es - s) = i^* - s \tag{4}$$

where i^* is the world nominal interest rate. A weak nominal exchange rate (high s) in this period implies expected appreciation and a lower domestic than foreign interest rate.

The real exchange rate, e, is defined by

$$e = p^* + s - p^N \tag{5}$$

The consumer price index, p^C, is a weighted sum of the price of traded and non-traded goods. In a steady-state equilibrium with balanced trade, the weights equal the production weights in aggregate production. Hence, there is no difference between the consumer price index and the GDP deflator in the model.

$$p^C = \theta(p^* + s) + (1 - \theta)p^N \tag{6}$$

As shown by Dornbusch (1983), the inclusion of both intra-temporal and inter-temporal substitution in a model with a traded and a non-traded sector generally means that demand for non-traded goods depends on the real exchange rate, the world market real interest rate, the real interest rate for non-traded goods, and steady-state income. 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.[4] As we measure steady-state income as deviation from the exogenously given steady-state equilibrium it is zero.[5]

With uncovered interest parity demand for non-traded goods can now be reduced to an expression with only two of the four variables pointed out by Dornbusch (1983):

$$y^N = -\alpha_1[i - (Ep^N - p^N)] + \alpha_2 e + v^N = -\alpha_1(i + p^N) + \alpha_2 e + v^N \tag{7}$$

In equation (7), non-traded demand depends negatively on the non-traded sector real interest rate and positively on the real exchange rate. The non-traded sector real interest rate is given by the nominal domestic interest rate, i, minus the expected non-traded goods inflation. The latter is defined as the expected price level in the next period, Ep^N, minus the actual price level this period. Since Ep^N equals zero, the non-traded sector real interest rate is simply given by $(i + p^N)$. A high price in this period means that the price is expected to fall to the next period, thereby raising the real interest rate. α_1 and α_2 denote the elasticity of non-traded goods demand with respect to the real interest rate and the real exchange rate respectively, while v^N is a demand shock.

2.1 Monetary policy regimes

The model is closed by specifying the monetary policy target. With exchange rate targeting (or monetary union), the nominal exchange rate is not allowed to vary, i.e.

$$s = 0 \tag{8a}$$

With inflation targeting, the interest rate is set such that consumer price inflation is kept constant, i.e.

$$p_t^C - p_{t-1}^C = p_t^C = 0 \tag{8b}$$

where the price level in the previous period for simplicity is normalized to zero. Since a 'period' is interpreted as (about) two years, and the order of events is such that the central bank first sets the interest rate, which in turn determines output and prices, the specification (8b) is consistent with a forward-looking inflation target ('inflation forecast targeting'). However, for reasons of simplicity, we disregard shocks that occur between the moment when the interest rate is set and the moment where prices are affected by it. This implies that there are no forecast errors, so that the inflation target is always reached. An inflation target is then equivalent to a price level target.

The eight equations determine the endogenous variables y^N, y^T, y, p^N, e, p^C, i and s given the values of parameters and the exogenous shocks v^N, i^*, p^*, u^N, u^T and w.

2.2 Solution of the model

A simple way to solve the model is to insert for the domestic nominal interest rate, i, from equation (4), in equation (7), and then insert from the definition of the real exchange rate (5) in order to make demand for non-traded goods dependent only on exogenous variables and the real exchange rate. The resulting demand equation (7′) holds irrespective of monetary policy regime:

$$y^N = (\alpha_1 + \alpha_2)e - \alpha_1(i^* + p^*) + v^N \tag{7′}$$

Exchange rate targeting

Under exchange rate targeting, non-traded supply can be made a function of only exogenous variables and the real exchange rate by inserting the policy rule (8a) in equation (5), and then inserting for p^N in equation (1). By equilibrating supply and demand for non-traded goods the real exchange rate under exchange rate targeting, e_E, can be written as

$$e_E = \frac{1}{\alpha_1 + \alpha_2 + \lambda^N}[-v^N + \alpha_1 i^* + (\alpha_1 + \lambda^N)p^* + u^N - \lambda^N w] \tag{9}$$

The domestic nominal interest rate under exchange rate targeting, i_E, has to equal the world market interest rate, i.e.

$$i_E = i^* \tag{10}$$

By inserting the solution for the real exchange rate in the non-traded goods supply function, non-traded output under exchange rate targeting, $y_E{}^N$, can be written as:

$$y_E^N = \frac{1}{\alpha_1 + \alpha_2 + \lambda^N}[\lambda^N v^N - \alpha_1 \lambda^N i^* + \alpha_2 \lambda^N p^* + (\alpha_1 + \alpha_2)u^N - (\alpha_1 + \alpha_2)\lambda^N w] \tag{11}$$

By inserting the policy rule (8a) in the supply function for traded goods, traded output under exchange rate targeting, $y_E{}^T$, is given by

$$y_E^T = \lambda^T(p^* - w) + u^T \tag{12}$$

From equations (3), (11) and (12), total output under exchange rate targeting, y_E, follows as

$$\begin{aligned} y_E = & \frac{1}{\alpha_1 + \alpha_2 + \lambda^N}[(1-\theta)\lambda^N v^N - (1-\theta)\alpha_1 \lambda^N i^* + (\theta\lambda^T(\alpha_1 + \alpha_2 + \lambda_N) \\ & + (1-\theta)\alpha_2\lambda^N)p^* + (1-\theta)(\alpha_1 + \alpha_2)u^N - (\theta(\alpha_1 + \alpha_2)\lambda^T + (1-\theta) \\ & (\alpha_1 + \alpha_2)\lambda^N + \theta\lambda^T\lambda^N)w] + \theta u^T \end{aligned} \tag{13}$$

Inflation targeting

Under inflation targeting, it is found that p^N = -θe by inserting policy rule (8b) in equation (6). When inserting this in non-traded goods supply, the supply-demand balance gives the following real exchange rate, e_I, under inflation targeting:

$$e_I = \frac{1}{\alpha_1 + \alpha_2 + \theta\lambda^N}[-v^N + \alpha_1(i^* + p^*) + u^N - \lambda^N w] \tag{14}$$

Inserting for p^N in equation (5), an expression for the nominal exchange rate is found. Inserting this in equation (4), and inserting for the real exchange rate from equation (14), the interest rule under inflation targeting, i_I, can be written as

$$i_I = \frac{1}{\alpha_1 + \alpha_2 + \theta\lambda^N}[(1-\theta)v^N + (\theta\alpha_1 + \alpha_2 + \theta\lambda^N)(i^* + p^*) - (1-\theta)u^N + (1-\theta)\lambda^N w] \tag{15}$$

Inserting for the real exchange rate from equation (14) in the non-traded sector goods supply gives non-traded output under inflation targeting, ${y_I}^N$, as

$$y_I^N = \frac{1}{\alpha_1 + \alpha_2 + \theta\lambda^N}[\theta\lambda^N v^N - \theta\alpha_1\lambda^N(i^* + p^*) + (\alpha_1 + \alpha_2)u^N - (\alpha_1 + \alpha_2)\lambda^N w] \tag{16}$$

Production in the traded sector under inflation targeting, ${y_I}^T$, is found by inserting for (p^* + s) from equation (5) in equation (2), then inserting $p^N = -\theta e$, and finally using the expression for the real exchange rate from equation (14). The result is

$$y_I^T = \frac{1}{\alpha_1 + \alpha_2 + \theta\lambda^N}[-(1-\theta)\lambda^T v^N + (1-\theta)\alpha_1\lambda^T(i^* + p^*) + (1-\theta)\lambda^T u^N - (\alpha_1 + \alpha_2 + \lambda^N)\lambda^T w] + u^T \tag{17}$$

It then follows that total output under inflation targeting, y_I, is given by

$$y_I = \frac{1}{\alpha_1 + \alpha_2 + \theta\lambda^N}[\theta(1-\theta)(\lambda^N - \lambda^T)v^N - \theta(1-\theta)\alpha_1(\lambda^N - \lambda^T)(i^* + p^*) + (1-\theta)(\alpha_1 + \alpha_2 + \theta\lambda^T)u^N - (\theta(\alpha_1 + \alpha_2)\lambda^T + (1-\theta)(\alpha_1 + \alpha_2)\lambda^N + \theta\lambda^T\lambda^N)w] + \theta u^T \tag{18}$$

The effects of the different shocks in the two monetary policy regimes can now easily be found. 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 (1), while the falling demand curve follows from equation (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) determines output together with the world market price in domestic currency ($p^* + s$).

3. OUTPUT FLUCTUATIONS AND ECONOMIC SHOCKS

The solution of the model shows that the alternative regimes give different responses to economic shocks. In this section we discuss how output is affected by the various shocks under the two different regimes, and compare their stabilization properties.

3.1 A shock to demand v^N

A shock to non-traded sector demand may be the result of a shock to preferences, a shock to the household discount rate or a surprising expansion of public demand toward non-traded goods. It can be seen from equations (11), (12) and (13) that under exchange rate targeting a shock to v^N increases

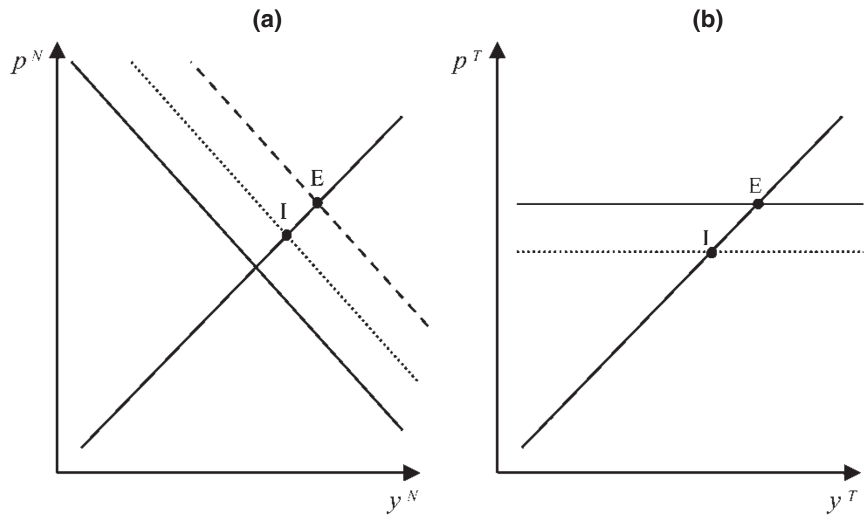

Figure 1 An increase in v^N or decrease in i*. Solid lines represent initial situation, dashed lines represent shifts under exchange rate targeting, dotted lines represent shifts under inflation targeting

output in the non-traded sector, leaves traded output constant and consequently pushes total production up. The derivative of non-traded output with respect to the demand shock is given by $[\lambda^N/(\alpha_1 + \alpha_2 + \lambda^N)]$, and the total increase in output as a fraction (1-θ) of this. The higher the supply elasticity and the lower the demand response to the real interest rate and the real exchange rate, the more output increases. In the left panel in Figure 1 the demand curve in the non-traded sector shifts to the right (the dashed curve), pushing up the non-traded price and production. The domestic interest rate must be kept constant in order to keep the nominal exchange rate at its initial value. Since the non-traded price increases, the non-traded sector real interest rate increases and the real exchange rate appreciates. This dampens the output response. The new equilibrium under exchange rate targeting is denoted by E in Figure 1, and is the same as before the shock in the traded sector.

Under inflation targeting, the higher price in the non-traded sector means that the interest rate must be increased. This affects both the traded and the non-traded sector. The higher interest rate gives an exchange rate appreciation. In Figure 1(b), the price of traded goods in domestic currency shifts down to the dotted line, and production falls. In the non-traded sector the higher interest rate and the lower price of traded goods results in an inward shift in the demand curve to the dotted curve. Since the price of traded goods has decreased, a constant aggregate price level must imply that the demand curve shifts back less than the outward shift caused by the initial demand shock. If the interest rate were raised so that the demand curve shifts back to its original position, the non-traded price would be the same as before while the traded price would have been lower. Then, the interest rate would have been too high to meet the inflation target. The new equilibrium with inflation targeting is denoted I in Figure 1.

The conventional wisdom that demand shocks give less fluctuation in output with inflation targeting than with exchange rate targeting thus holds, in isolation, for the non-traded sector. This can also be verified by the derivative of non-traded production with respect to the demand shock from equation (16), which is now given by $[\theta\lambda^N/(\alpha_1 + \alpha_2 + \theta\lambda^N)]$, less than was the case under exchange rate targeting.

However, for the traded sector the result is the opposite. The output fluctuation, following a demand shock, is larger with inflation targeting than with exchange rate targeting. Under exchange rate targeting, output in the traded sector is constant with a demand shock when nominal wages are given, while output falls under inflation targeting due to the exchange rate appreciation. The conventional wisdom, which says that inflation targeting dampens the effect of demand shocks, thus does not hold for the traded sector. Output falls more the higher the supply elasticity in the traded sector, the lower the share of non-traded output in total output, the less non-traded demand is reduced by an increased real interest rate and appreciation of the real exchange rate, and the lower the supply elasticity in the non-traded sector. A high supply elasticity in the traded sector means a large output reduction for a given appreciation of the nominal exchange rate. The other factors imply that, given the demand shock, the interest rate must increase considerably to keep the aggregate price level constant, and hence the nominal appreciation becomes strong.

Turning now to the effect on aggregate production, it is seen from equation (18) that the effect is ambiguous under inflation targeting. If the non-traded supply elasticity is higher than the traded sector supply elasticity, the demand shock means increased total production. If the opposite is the case, aggregate production falls. Thus, contrary to what standard one-sector models predict, a positive demand shock may well cause a fall in total production under inflation targeting.

3.2 A shock to the world market interest rate i^*

Note from equations (11), (12), (16) and (17) that a positive shock to the world interest rate, i^*, enters in the same way as a negative demand shock, v^N. All qualitative results, discussion and intuition from a demand shock above are thus valid for a world market nominal interest shock (of opposite sign). A rise in the world interest rate requires an equal rise in the domestic interest rate under exchange rate targeting. Leaving the exchange rate and thereby output in the traded sector unchanged, the higher interest rate reduces demand and generates a contraction in the non-traded sector.

Under inflation targeting, the domestic interest rate should be raised by less than the world interest rate, as seen from equation (15). If the interest rate were raised by the same margin as the world rate, leaving the exchange rate constant, unchanged traded goods prices and lower non-traded goods prices would imply that inflation would be lower than the target level, so that monetary policy would be too tight. Thus, the domestic interest rate has to be raised by less than the rise in the world interest rate, which results in a currency depreciation and thereby higher production in the traded sector. The combination of a depreciation and a smaller rise in the domestic interest rate than the world rate produces less variability in the non-traded sector, and more variability in the traded sector, with inflation targeting compared with exchange rate targeting.

3.3 A shock to the world market price p^*

Consider first a positive shock to the world market price, p^*, for a given world interest rate, i^*. Since the shock is temporary, the world market prices of traded goods are expected to decline, which, for a given world nominal interest rate, leads to a rise in the world real interest rate.

Under exchange rate targeting, a positive shock to the world market price leads to higher production in the traded sector, as illustrated in Figure 2(b).

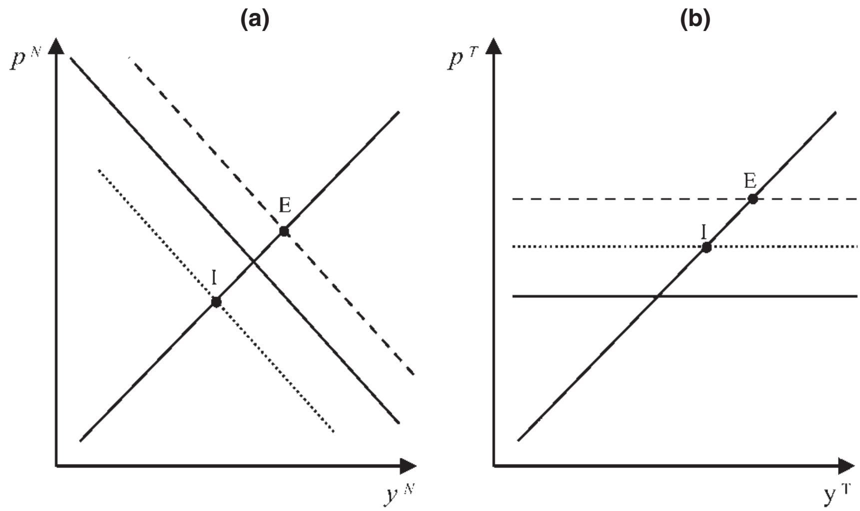

Figure 2 An increase in p^* for given i^*. Solid lines represent initial situation, dashed lines represent shifts under exchange rate targeting, dotted lines represent shifts under inflation targeting

The increase in p^T shifts demand from traded goods to non-traded goods, and the non-traded sector demand curve shifts to the right, as in Figure 2(a). Higher prices and production in the non-traded sector are the result. Thus, under exchange rate targeting, a positive shock to the world market price leads to higher production and prices in both sectors and thereby increased aggregate output.

Under inflation targeting, increased p^* has exactly the same effect as increased i^*, as can be verified by equations (14)–(18). Monetary policy has to be tightened, as an unchanged interest rate results in higher prices in both sectors. Suppose that the interest rate is raised sufficiently to induce an appreciation that offsets the higher world market price exactly, leaving p^T unchanged. The higher interest rate in combination with unchanged price of traded goods means that non-traded demand must be lower than before the shock in p^*. Thus, to fulfil the inflation target the interest rate must be raised by less than what is required to keep p^T constant. The result is therefore higher production in the traded sector, due to an increase in p^T. Since the price of traded goods has increased, the price of, and demand for, non-traded goods must have decreased. Thus, under inflation targeting a positive shock to the world market price leads to increased production in the traded sector, while production in the non-traded sector decreases.

The appreciation under inflation targeting means that the output variability in the traded sector is smaller under inflation targeting than under exchange rate targeting.[6] Non-traded output moves in opposite directions in the two cases. Under inflation targeting, an increased world market price is contractionary for the non-traded sector. In isolation, the higher real exchange rate increases non-traded demand, but this effect must be smaller than the effect of decreased demand because of a higher real interest rate.

Again, as seen from equation (18), the effect on total output is ambiguous. If the supply elasticity in the traded sector is higher than in the non-traded sector, total output increases, while it decreases if the opposite is the case. One cannot *a priori* exclude the case where the decrease in total output is larger under inflation targeting than the increase in total output under exchange rate targeting. Thus, if the supply elasticity in the non-traded sector is sufficiently high compared with the supply elasticity in the traded sector, exchange rate targeting provides the highest aggregate output stability when the traded sector is hit by shocks to the world market prices.

Suppose next, as in Rødseth (1996), that the increase in p^* is accompanied by an offsetting decrease in i^*, leaving the world real interest rate, r^*, unchanged. The shock may then be interpreted as a pure foreign nominal shock. Under exchange rate targeting the decrease in i^* must be followed by a corresponding decrease in the interest rate in order to keep the exchange rate constant. This gives rise to an additional shift in demand for non-traded goods and thereby a larger increase in total output than in the case considered above. Under inflation targeting, however, a shock to p^* for a given world real interest rate has no effect on either of the sectors. This can be seen directly from equations (14)–(18), since it is only the real interest rate ($i^* + p^*$) that enters. To see the intuition, suppose that the central bank keeps the domestic interest rate constant. Then, from equation (4), we must have that $s = i^*$. Since the nominal exchange rate appreciates by the same margin as the decrease in the world market interest rate, it appreciates exactly to keep p^T constant when p^* increases. Since the interest rate and the price of non-traded goods are unchanged, demand in the non-traded sector, and thereby the price of non-traded goods, remain constant. The inflation target is therefore achieved by leaving the domestic interest rate unchanged. Thus, under inflation targeting, a shock to the world market price for a given world real interest rate has no effect on production in any of the sectors. As in Rødseth (1996), inflation targeting therefore provides higher total output stability with pure nominal world market shocks. In the present model, output in both sectors is stabilized.

3.4 A shock to non-traded supply u^N

A positive shock to non-traded supply leads to lower prices and increased production in the sector, as illustrated by point E in Figure 3(a). Under exchange rate targeting the interest rate is not adjusted to the shock, so that the exchange rate and thereby production in the traded sector remain unchanged. Under inflation targeting, however, the interest rate must be lowered in order to reach the inflation target. This gives a depreciation, and

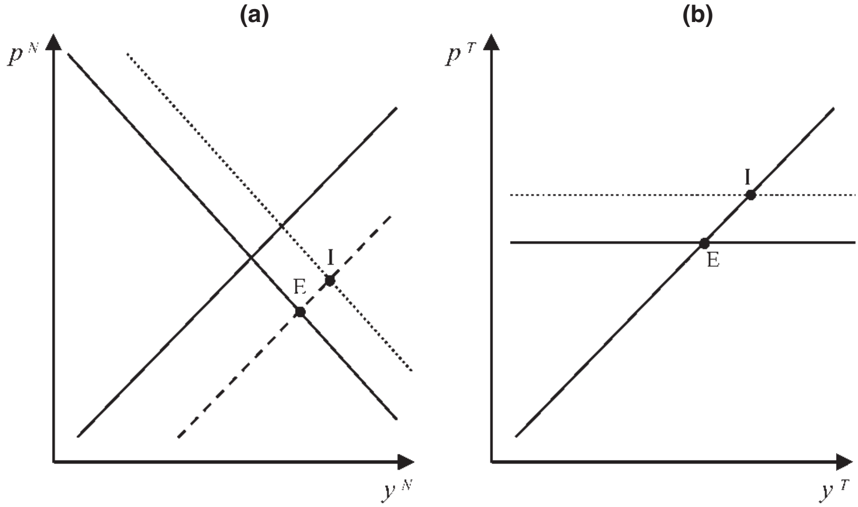

Figure 3 An increase in u^N. Solid lines represent initial situation, dashed lines represent shifts under exchange rate targeting, dotted lines represent shifts under inflation targeting

traded output increases. The combined effect of a lower interest rate and higher traded goods prices shifts the non-traded sector demand curve to the right, as illustrated by the shift to point I in Figure 3(a).

Since the increase in non-traded production is higher under inflation targeting than under exchange rate targeting, and traded production increases under inflation targeting while remaining constant under exchange rate targeting, exchange rate targeting provides higher aggregate as well as sectoral output stability with a non-traded sector supply shock.

A shock to traded goods supply, u^T, only has a direct impact on the traded sector in both regimes, because both under exchange rate targeting and inflation targeting it does not trigger a monetary policy response, since it does not affect any prices.

3.5 A shock to wages *w*

As seen from equations (11), (12), (16) and (17), a positive wage shock, w, has the same effect as a combined negative supply shock of equal size in both sectors. The effect of the shock is illustrated in Figures 4(a) and 4(b). Higher wages lead to a shift to the left in the supply curves in both sectors. Under exchange rate targeting, the central bank leaves the interest rate unchanged, so that the demand curve for non-traded goods and the price of traded goods do not change. The result is lower production in both sectors and an increase in p^N. Increased p^N means that the interest rate must be

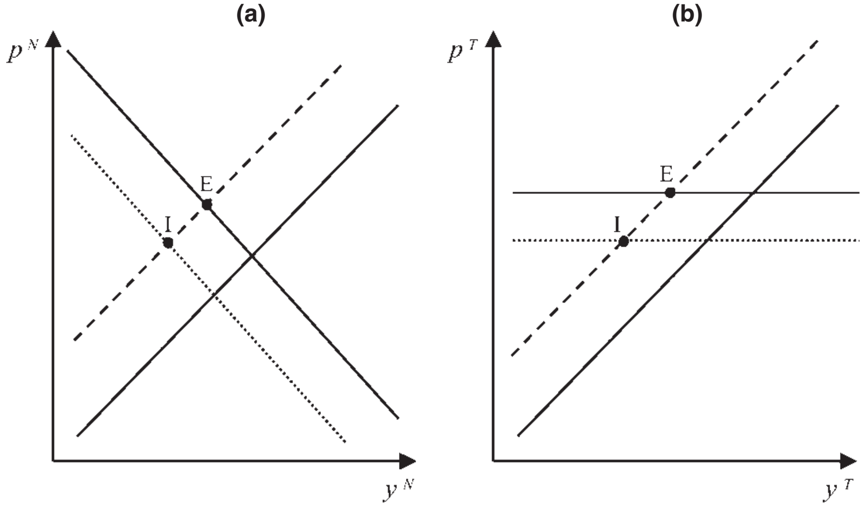

Figure 4 An increase in *w*. Solid lines represent initial situation, dashed lines represent shifts under exchange rate targeting, dotted lines represent shifts under inflation targeting

raised under inflation targeting. This gives a negative shift in the demand curve to point I in Figure 4(a). The rise in the interest rate gives an exchange rate appreciation, which pushes down traded production further. Thus, inflation targeting exacerbates the production response of an increase in wages in both sectors, and thus leads to less output stability both at the aggregate and sectoral level.

To sum up, exchange rate targeting provides both higher total and sectoral output stability in both sectors when the economy is subject to the supply shocks u^N and w. Thus, the two-sector model is consistent with Rødseth (1996). When the economy is subject to demand shocks and shocks in the foreign interest rate, the two-sector approach, we believe, adds important new insights. The conventional wisdom that demand shocks are stabilized with inflation as compared with exchange rate targeting does not hold for the traded sector. Here, the opposite is the case. Furthermore, demand shocks may have a contractionary effect under inflation targeting. With demand shocks, output in non-traded sectors is stabilized under inflation targeting while output in traded sectors is destabilized. The widespread view that demand shocks favour inflation targeting is not necessarily confirmed in a two-sector model, since the response in the traded sector points to the opposite. It is only when pure nominal foreign shocks occur – that is, shocks to p^* and i^* which leave the foreign real interest rate constant – that inflation targeting unambiguously provides the better output stability, since such shocks have no real effects under inflation targeting.

3.6 Comparison of the regimes

The above discussion shows that inflation targeting provides better output stability when pure nominal foreign shocks occur, while exchange rate targeting provides better output stability when real shocks from the supply side occur. The results from one-sector models are thus confirmed within a model with two sectors. However, as regards demand shocks (including foreign interest rate shocks), the relative performance of the two regimes is less clear. We therefore analyse the output effects of demand shocks in some greater detail.

Consider first the case where only aggregate output variability matters. We showed above that if $\lambda^N > \lambda^T$, a positive demand shock results in higher aggregate output under both inflation targeting and exchange rate targeting. Exchange rate targeting leads, however, to a larger increase in aggregate output, so that inflation targeting then provides better aggregate output stability. If $\lambda^N < \lambda^T$, on the other hand, a positive demand shock results in lower aggregate output under inflation targeting. An interesting question is if it is possible that the aggregate output fluctuation is greater with inflation targeting than exchange rate targeting. In other words, can the decrease in aggregate output under inflation targeting be larger than the increase in output under exchange rate targeting? Calculating the respective output responses from equations (13) and (18) and comparing the expressions show that the condition for this case is

$$\lambda^T > [\frac{\alpha_1 + \alpha_2 + \theta\lambda^N}{\theta(\alpha_1 + \alpha_2 + \lambda^N)} + 1]\lambda^N \tag{19}$$

Hence, the case where a demand shock causes higher aggregate output variability under inflation than exchange rate targeting, is more likely the higher the supply elasticity in the traded sector, the lower the supply elasticity in the non-traded sector, the larger the share of the traded sector in total production and the less non-traded demand responds to changes in the real interest rate and the real exchange rate.

Consider next the case where sectoral output variability also matters. As a measure of sectoral output variability consider the weighted sum of the absolute values of the production responses in the two sectors, i.e. equation (3) with absolute values of y^T and y^N. Which of the regimes provides the lowest asymmetric sector fluctuations? Making use of equations (11), (12), (16) and (17), and comparing the expressions give the result that inflation targeting provides higher asymmetric fluctuations if

$$\lambda^T > [\frac{\alpha_1 + \alpha_2 + \theta\lambda^N}{\theta(\alpha_1 + \alpha_2 + \lambda^N)} - 1]\lambda^N \tag{20}$$

Since condition (20) is less restrictive than equation (19), we see that in the case where inflation targeting results in higher aggregate output variability, it also results in higher asymmetric sector fluctuations and thereby higher sectoral output variability. However, if the supply elasticities of the two sectors are not too different, inflation targeting tends to provide lower aggregate output variability, but higher asymmetric sector fluctuations. Then, the relative performance of the two regimes depends on the importance one attaches to sectoral versus aggregate output variability. If, however, the supply elasticity in the non-traded sector is high compared with the supply elasticity of the traded sector, inflation targeting tends to provide both better aggregate output stability and sectoral output stability than exchange rate targeting.

The analysis of a demand shock contains at least three important lessons, which demonstrate the importance of comparing the two regimes in a model with both a traded and a non-traded sector. First, the standard result of inflation targeting stabilizing the economy with a demand shock is not valid for the traded sector. Second, positive demand shocks may have a contractionary effect under inflation targeting. Third, demand shocks may lead to higher total output variability under inflation targeting than under exchange rate targeting. This can be the case irrespective of whether output variability is measured by aggregate or sectoral output fluctuations. None of the mechanisms that lead to these effects can be captured in a one-sector model. Even if one believes that it is only aggregate output variability that matters, standard one-sector models may produce misleading results. The two-sector model considered here shows that differences in supply elasticities between sectors may alter standard results from one-sector models significantly. Since the supply elasticities in traded and non-traded sectors vary among different countries, the stabilization properties of alternative monetary policy regimes vary among countries even if the distribution of economic shocks is the same. For a given distribution of shocks, inflation targeting tends to provide the better output stability for countries with inelastic traded sector supply, while exchange rate targeting tends to provide the better output stability for countries with elastic traded sector supply.

3.7 Flexible inflation targeting

We have seen that, with demand shocks, inflation targeting may give rise to 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 with demand shocks. Under strict inflation targeting, a demand shock 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 stabilize 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.

4. SUMMARY AND FINAL REMARKS

A model of output fluctuations in traded and non-traded sectors dependent on the monetary policy regime has been developed. This has, we believe, introduced some new insights concerning the effects of different shocks under inflation targeting as compared with exchange rate targeting. The two-sector structure seems to produce interesting results compared with earlier literature, especially in two respects. First, with the exception of world market price shocks, both supply and demand shocks destabilize the traded sector under inflation targeting more than is the case under exchange rate targeting. Second, the effects of demand shocks may, because of their effects on the traded sector, turn around earlier aggregate output stability results with the two regimes. Demand shocks may destabilize total output more under inflation than under exchange rate targeting, and positive demand shocks may be contractionary under inflation targeting. These latter results, in contrast to the general stability results for the traded sector, depend heavily on the specific parameter values for the economy at hand. In particular, the higher the supply elasticity in the traded sector compared with the non-traded sector, the more likely are the results. The stabilization properties of inflation targeting compared with exchange rate targeting may thus be very different between countries. The results suggest that inflation targeting in small open economies may provide less output stability compared with exchange rate targeting than previous studies tend to suggest. The reason is that inflation targeting requires interest rate responses that may destabilize the traded sector when real shocks occur. It is only when pure nominal world market shocks occur, that inflation targeting unambiguously provides greater output stability.

As discussed in the introduction, we mainly consider output variability and not other possible arguments in a social loss function. Compared with the literature on inflation variability in the social loss function, a normative interpretation of our results may thus have a bias in favour of exchange rate targeting. It must also be added that part of the reason we obtain less stability with inflation targeting, compared with exchange rate targeting, than earlier studies, has to do with our simplifying assumptions. In order to concentrate on the new mechanisms in the present paper, mechanisms highlighted in other papers that pull in the opposite direction are disregarded. In contrast to the simulation models of, for example, Svensson (2000) and Leitemo and Røisland (2002), our model has an overly simple dynamic structure that may favour exchange rate targeting. It can be argued that inflation targeting may produce better dynamic stability, since disequilibria are less likely to accumulate with inflation targeting than with exchange rate targeting, as the latter implies a more passive monetary policy. Moreover, our model does not allow 'Walter's effects'[7] to work, which may also give a bias towards exchange rate targeting. Nevertheless, it is still our opinion that the effects we have focused on are of importance, and should be taken into account when the overall stabilization properties of the regimes are discussed.

NOTES

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1 Of course, there may be additional reasons for considering a distinction between sectors. For instance, with different learning by doing generated from traded and non-traded sectors, the distinction becomes important because shocks cause productivity-induced hysteresis in production levels, see for example van Wijnbergen (1984) and Torvik (2001).

2 See Clarida *et al.* (1999) for a survey of the New Keynesian literature.

3 Nominal wages are particular rigid downwards. This asymmetry is, however, disregarded in our model in order to reach simple analytical solutions.

4 To see this, start out with the nominal interest parity condition (equation (4)) and subtract expected non-traded inflation and world market inflation on both sides. This yields

$$i - (Ep^N - p^N) - (Ep^* - p^*) = i^* - (Ep^* - p^*) - (Ep^N - p^N) + (Es - s)$$

Denoting the non-traded sector real interest rate r and the world market real interest rate r^*, and inserting $Ep^* = Es = 0$ this reduces to $r + p^* = r^* + p^N - s$, which is the same as $r^* = r + e$.

5 One could, however, argue that even if steady-state income is exogenous, deviations in income from the steady state level in a period should enter the demand equation, as it does affect permanent income. If such deviations are large or if periods are long, the effect from a one period deviation in income on permanent income is not negligible. In the remainder we assume that the effect of a one period deviation in income on permanent income is negligible. One could also argue that consumption should depend on net foreign asset position, and that this is affected by the response of the current account. Such hysteresis in foreign debt and consumption is discussed by Obstfeld and Rogoff (1996), and ways to remove it are proposed by Schmitt-Grohe and Uribe (2002). Since we abstract from discussing changes in the net foreign asset position, to save space we do not include the demand function for traded goods in the model.

6 In the limiting case of a fully open economy, i.e. $\theta = 0$, exchange rate targeting means that the change in the world market price has its full effect on production, while under inflation targeting production is unchanged as the interest rate

response must ensure that the price of traded goods in domestic currency, and thus production, is unchanged.

7 The 'Walter's effect' occurs when a positive demand shock results in higher expected inflation, which reduces the real interest rate for a given nominal rate, and thus increases demand further.

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