Optimum currency areas under inflation targeting*

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Abstract

Several countries face the choice between targeting inflation independently or entering a monetary union that targets inflation. The present paper extends the theory of optimum currency areas to deal with this choice. In contrast to the conventional theory, countries are shown to form more of an optimum currency area the more asymmetric supply shocks are.

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1. Introduction

By studying the stabilisation properties of targeting inflation independently versus targeting inflation within a monetary union, this paper extends the theory of optimum currency areas (OCA). Initiated by Mundell (1961), the theory has received increased attention over the last years, mainly because of the introduction of the euro. In the literature four relationships between the members of a potential OCA is highlighted:[1] 1) the similarity of shocks; 2) the extent of trade between the potential members; 3) the degree of labour mobility; and 4) the system of fiscal transfers. As regards the similarity of shocks, Mundell (1961) focused on demand shocks in his pioneering contribution. Asymmetric demand shocks were shown to weaken the case for a monetary union. In much of the subsequent literature on OCA, *any* type of asymmetric shocks have been taken as arguments against a monetary union. For instance, when discussing whether Europe is an optimum currency area, Bayoumi and Eichengreen (1993, p. 223) conclude that "…our finding that supply shocks are larger in magnitude and less correlated across regions in Europe than in the United States underscores the possibility that the European Community may find it more difficult, initially, to operate a monetary union than the United States."

In this paper, we show that when the choice is between targeting inflation independently or within a monetary union, the presence of asymmetric supply shocks is in fact an argument in favour of a union. As regards asymmetric demand shocks, it is the case also under inflation targeting that this is an argument against introducing a common currency.

Among industrialised countries, explicit or implicit inflation targeting has become the dominant guideline for monetary policy. This has lead to an increasing literature on various aspects of inflating targeting. Although most of the theoretical literature on inflation targeting is limited to studying closed economies, increased attention is now being given to inflation targeting in open economies. One sector open economy models are developed by Rødseth (1996), Ball (1998), Batini and Haldane (1998), Svensson (1999) and others. Models with traded and non-traded goods are developed by Holden (1998), Leitemo and Røisland (1998) and Røisland and Torvik (1999). Only a few papers consider inflation targeting within a multi-country framework. Persson and Tabellini (1996) consider Stage III of the EMU within a two-

1 See e.g Frankel and Rose (1996).

country framework with focus on the relationship between the "ins" and the "outs". They do, however, not consider entering a monetary union that targets inflation as an alternative to independent inflation targeting. In our view this is the most relevant alternative to independent inflation targeting for many countries.[2] Furthermore, Persson and Tabellini consider only supply shocks, while we distinguish between supply and demand shocks. This distinction will be shown to be of crucial importance for the difference in stabilisation properties between the regimes. Canzoneri, Nolan and Yates (1997) compare inflation targeting with the ERM in a two-country-model, where one of the countries ("Germany") has low inflation and optimal degree of stabilisation and the other country ("Great Britain") lacks the credibility to implement the optimal monetary policy rule. Their focus is on credibility aspects rather than on stabilisation.

Although not considering inflation targeting, another related paper to ours is Lane (1999), who considers the stabilisation properties of a currency union versus alternative exchange rate regimes. The main difference between that paper and ours is that Lane assumes that the central banks minimise a general loss function, and that welfare in alternative regimes is compared using the same loss function as the central bank minimises. We follow the approach by Persson and Tabellini (1996), Frankel and Chinn (1995) and others by assuming that the central bank must commit to a monetary policy target for credibility reasons. The welfare implications of alternative regimes therefore differ. Moreover, the central issue in our paper is to derive implications for optimum currency areas.

The paper is organised as follows. In Section 2 we set up the model. The alternative regimes are discussed in Section 3, which also discusses some new international transmission channels introduced by inflation targeting. Section 4 is devoted to the implications for optimum currency areas, while Section 5 concludes.

2. The model

In order to facilitate comparison with the OCA literature, we apply the standard assumption of two countries of the same size. Each country has specialised in producing a single good which

[2] To support the price stability objective, the ECB has announced that money supply should be one of the operational indicators. However, it is unlikely that anticipated shocks to money demand should be allowed to

is different between the two countries. The countries are termed the home country (H) and the foreign country (F). Our model is a modified version of the two-country models formulated in Canzoneri and Henderson (1988,1991), Persson and Tabellini (1995) and Lane (1996,1999) and is, except for the multi-country framework, similar to that of Rødseth (1996). We assume that the choice of monetary policy regime has no long run real effects on the economy. All real variables are then measured as deviations from an exogenously given steady state equilibrium with some given natural rate of unemployment. To have a simple linear structure, we model these deviations in logs (except the interest rate), as in e.g. Bean (1983), Genberg (1989) and Lane (1996,1999). Shocks are assumed to have expectation zero and to be independent between periods, and there are no other lags in the model. The rational expectations value of any next period real variable is thus zero, since agents expect the economy to be in steady state in the next period.

The short run supply function for country i is given by

$$(2.1) \quad y^H = l(p^H - w^H) + u^{H*}$$

$$(2.2) \quad y^F = l(p^F - w^F) + u^{F*}$$

where y^i is the output gap in country i=H,F, p^i is the log of the price of country i's good in country i's currency, w^i is the log of the wage level in country i, and u^{i*} is a supply shock to country i. The producer real wage, $-(p^i - w^i)$, is measured as a deviation from the steady state equilibrium producer real wage.

Equations (2.1) and (2.2) may be derived from a standard profit maximisation problem. Note that we can write $w^i = Ew^i + \varepsilon^i$, where $\varepsilon^i = w^i - Ew^i$ and Ew^i denotes the expected wage. Since we have that $E(p^i - w^i) = 0$ by construction, so that $Ep^i = Ew^i$, we can write (2.1) and (2.2) as

$$(2.1') \quad y^H = l(p^H - Ep^H) + u^H = l(p^H - Ep^H) + u^H$$

$$(2.2') \quad y^F = l(p^F - Ep^F) + u^F = l(p^F - Ep^F) + u^F$$

where $u^i = u^{i*} - l\varepsilon^i$ and p^i is the rate of inflation, i.e. $p^i = p^i - p^i_{-1}$. The supply function can thus be expressed as standard expectations-augmented Phillips curves.

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affect prices and output, so that inflation targeting is, in our view, a more realistic interpretation of the monetary

The real exchange rate, *e,* is defined by the price of the foreign goods relative to the home goods. The price of the foreign goods in home currency is given by $p^U + s$, where s is the nominal exchange rate, i.e. how many home currency units one have to pay for one unit of the foreign currency. The real exchange rate is then defined by

$$(2.3) \quad e = p^F + s - p^H$$

As for other real variables, the equilibrium real exchange rate is assumed unaffected by monetary policy, and it is measured as a deviation from its exogenously given equilibrium level.

With rational expectations and perfect capital mobility, uncovered interest parity (UIP) holds. The home interest rate i^H has to be equal to the foreign interest rate i^F plus expected depreciation of the currency, i.e.

$$(2.4) \quad i^H = i^F + Es - s$$

where *Es* is the expected exchange rate next period.

The consumer price index of the home and foreign country, $p_C{}^H$ and $p_C{}^F$ respectively, are weighted averages of the prices on both goods. The share of imported goods in the price indices is given by β.

$$(2.5) \quad p_C^H = b(p^F + s) + (1-b)p^H$$

$$(2.6) \quad p_C^F = b(p^H - s) + (1-b)p^F$$

If β = ½ the shares of the two goods are the same in the two countries, so that the share of home country goods in the foreign price index is the same as in the home country price index, and vice versa. However, we shall only consider the realistic case of $0<\beta<1/2$, so that the share of home goods is higher in the home country price index than in the foreign country price index, and the share of foreign goods is higher in the foreign country price index than in the

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policy persued by the ECB than than is money supply targeting

home country price index. Indeed, if this were not the case, the price index in the two countries would be the same. With independent inflation targeting, monetary policy would then also be the same. But then there would be no difference between targeting inflation independently or in a union. Since we know that e.g. the British price index contains a larger fraction of British goods than the French price index, it is reasonable to assume that $\beta < ½$.

Since the two countries are of equal size, the CPI in a union, p_C^U, is given by

$$(2.7) \quad p_C^U = \tfrac{1}{2} p_C^H + \tfrac{1}{2} p_C^F = \tfrac{1}{2} p^H + \tfrac{1}{2} p^F$$

Aggregate demand in the two countries are given by

$$(2.8) \quad y^H = -a_1 r^H + a_2 e + v^H$$

$$(2.9) \quad y^F = -a_1 r^F - a_2 e + v^F$$

where

$$(2.10) \quad r^i = i^i - (Ep^i - p^i)$$

is the real interest rate in country $i = H,F$.

With both intraperiod and interperiod substitution, demand for home goods depends on the steady state income (which in our setting is exogenous and normalised to zero), the home goods real interest rate faced by home consumers, the home goods real interest rate faced by foreign consumers, and the real exchange rate. The latter is equal to consumers in both countries. When UIP holds, the home goods real interest rate faced by home consumers and foreign consumers is also the same, i.e. $i^H–(Ep^H- p^H)= i^F-(Ep^H-p^H-Es+s)$. α_1 and α_2 are positive constants, so that demand for home goods decreases with the real interest rate and increases with the real exchange rate. The home goods and foreign goods demand shocks are denoted v^H and v^F, respectively.

3. Alternative regimes

The model is closed by specifying the monetary policy regime. As mentioned in the introduction, we shall focus on what seems to be the most relevant alternatives for many countries today; independent inflation targeting versus monetary union inflation targeting.

Inflation targeting may be viewed as a commitment mechanism whereby the central bank faces some penalties related to deviations from the target inflation rate. By this commitment mechanism the nominal anchor in monetary policy is strengthened. An important question is whether inflation targeting also involves some costs in terms of higher output (and employment) variability. A common way to specify inflation targeting within a theoretical model is to assume that the central bank is given a loss function in which the arguments are the variability of inflation around its optimal rate and the variability of the output gap. The central bank is instructed to minimise this loss function. Rogoff (1985) specified inflation targeting as minimising a loss function where the weight placed on deviations from the optimal inflation rate is greater than the socially optimal weight. By this interpretation, Rogoff showed that inflation targeting is equivalent to appointing a ”conservative” central banker. Others have followed up this interpretation of inflation targeting (see e.g. Walsh (1998, ch. 8)). This interpretation implies that inflation targeting involves costs in terms of less output stability. The output variability costs with inflation targeting only occur for supply shocks, as these drive inflation and output in opposite directions, as opposed to demand shocks.

There have been attempts to overcome these output variability costs of inflation targeting, both in theoretical models and in actual inflation targeting frameworks. Svensson (1997) showed, within the Barro-Gordon theoretical framework, that the inferior output stabilisation properties of inflation targeting can be overcome if the government assigned a loss function where the target for inflation is lower than the optimal rate, but the weight placed on inflation variability is the same as the socially optimal weight. However, such ”conservative” inflation targets are not observed in practice.

In actual inflation targeting frameworks, some of the destabilising properties of inflation targeting under supply shocks is overcome by the use of escape clauses for specific types of supply shocks, or by removing certain components of the price index that are sensitive to

supply shocks. However, only first-round effects of certain shocks are accommodated. The central bank must still respond to second-round effects of supply shocks.

Since the main rationale for adopting explicit inflation targets is to enhance credibility in monetary policy, it is, in our view, hard to imagine how credibility can be consolidated without giving higher priority to keeping inflation stable around its target than is the case under a discretionary monetary policy. We thus follow the approach used by e.g. Persson and Tabellini (1996) and Frankel and Chinn (1994) by considering strict specifications of the regimes. The central bank sets the interest rate in order to reach the inflation target. For a model similar to ours, but with discretionary policy, see Lane (1999). With a sufficiently large weight placed on (national) inflation variability it is always a disadvantage to enter a monetary union. Inflation may then be completely insulated from supply shocks when targeting inflation independently, while the national price index will fluctuate within a union.

Under both monetary policy regimes, the model determines the endogenous *variables* y^i, p^i, e, s, i^i, $p_c{}^i$ and $p_C{}^U$, given the parameter values and the supply and demand shock variables u^i and v^i *(i=H,F).*

3.1 Independent inflation targeting

When the home and foreign country does not form a union, the two countries target inflation independently. Since we for simplicity assume that the central bank controls inflation perfectly and with no lags and conduct "strict" inflation targeting, an inflation target is in this framework the same as a price level target. The regime of independent inflation targeting, where the home country and the union target their respective CPIs, can thus be specified as follows:

$$(3.1) \quad p_C^H = p_C^F = 0$$

It should, however, be noted that inflation targeting and price level targeting have, in general, 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, a subsequent deflation might be required in order to reach a price level target, which is not case with an inflation target. Since it is for simplicity assumed perfect inflation control in this paper, there is no need to reverse earlier inflation control errors, as such errors

are non-existent. The price level target in (3.1) is in this sense more comparable with an inflation target than a price level target in a model with imperfect inflation control.

Note that (3.1) may be written as $p^H + \hat{a}e = p^F - \hat{a}e = 0$. Since $Ee = 0$ by construction, we see that the inflation target specifications imply that $Ep^H = Ep^F = 0$, which also implies that $Es = 0$ because $Ee = 0$. Since all real variables are measured as deviations from their steady state equilibria, we have that $E(p^i - w^j) = 0$. Since $Ep^i = 0$, this implies that $Ew^i = 0$. Thus, the simplifying assumption that the central bank controls the rate of inflation perfectly and target inflation strictly makes it possible to measure also the nominal variables, p^H, p^F, w^H, w^F and s as deviations from their steady state equilibria. Note, however, that this assumption does not exclude the possibility of a positive trend growth in prices, wages and the exchange rate. The nominal variables may then be interpreted as the deviation from a given trend.

Inserting $p_C^F = 0$ from equation (3.1) in equation (2.6), and solving for s yields

$$(3.2) \quad s = \frac{1-b}{b} p^F + p^H$$

Inserting this and $p_C^H = 0$ in equation (2.5), we find

$$(3.3) \quad p^F = -p^H$$

Substituting for p^F from equation (3.3) in equation (3.2) yields an expression for the nominal exchange rate under independent inflation targeting:

$$(3.4) \quad s = -\frac{1-2b}{b} p^H$$

Equilibrating supply and demand for the home and the foreign goods, respectively, and inserting for the real exchange rate from equation (2.3), yields

$$(3.5) \quad lp^H + u^H = -a_1(i^H + p^H) + a_2(p^F + s - p^H) + v^H$$

$$(3.6) \quad lp^F + u^F = -a_1(i^F + p^F) - a_2(p^F + s - p^H) + v^F$$

Inserting from equations (2.4), (3.3) and (3.4) in equation (3.5), and solving with respect to the home interest rate yields

$$(3.7) \quad i^H = \frac{1}{a_1}(v^U - u^F) + \frac{b\,l + a_1(1-b) + a_2}{a_1 b}\, p^H$$

Inserting equation (3.7) into equations (3.5) and (3.6) and solving for p^H gives

$$(3.8) \quad p^H = \frac{b}{2b\,l + a_1 + 2a_2}(v^H - v^F - u^H + u^F)$$

(3.8) into (3.7) gives the following solution for the interest rate:

$$(3.9) \quad i^H = \frac{b\,l + a_1(1-b) + a_2}{a_1(2b\,l + a_1 + 2a_2)}(v^H - u^H) + \frac{b(l + a_1) + a_2}{a_1(2b\,l + a_1 + 2a_2)}(v^F - u^F)$$

Inserting (3.8) in the supply function (2.1'), and remembering that $Ep^H = 0$, gives the following solution for home output under independent inflation targeting:

$$(3.10) \quad y_I^H = h_I u^H + (1-h_I)u^U + (1-h_I)(v^H - v^U)$$

where

$$h_I \equiv \frac{b\,l + a_1 + 2a_2}{2b\,l + a_1 + 2a_2}$$

Note that home output is affected by a weighted average of home and foreign supply shocks, where the weight attached to home supply shocks is greater than the weight attached to foreign supply shocks. The intuition can be explained as follows: A positive home supply shock gives rise to lower prices on home goods. The central banks in both counties must respond by lowering their interest rates in order to achieve their inflation targets. Since the share of home goods in the home country's price index is higher than the share of home goods in the foreign country's price index, the interest rate reduction is larger in the home country than in the foreign country. Demand for home country goods is thus stimulated more, both as a direct consequence of the larger interest rate reduction and because the home nominal (and real) exchange rate depreciates while that of the foreign country appreciates. The home supply shock has thus a more expansionary effect on home output than on foreign output. The more open the

economy, measured by β, the lower is the share of home goods in the home price index, and the higher is the share of home goods in the foreign price index. Therefore, the more open the economy, the smaller is the effect of a home supply shock on home output and the larger is the effect on foreign output.

A positive demand shock to home goods gives rise to higher prices on home goods. The central banks in both counties must raise their interest rates in order to achieve the inflation target. Due to the larger increase in the home price index, the home central bank must raise the interest rate more than the foreign central bank. The interest rate increase and the resulting appreciation of the home currency dampens the output effect of the shock in the home country. But despite the tightening of monetary policy, output will increase in the home country. The reason is the home country exchange rate appreciation. The appreciation leads to lower imported inflation, and the prices on home goods must therefore increase in order to prevent undershooting of the inflation target. A part of the demand shock must then result in higher prices and output in the home country.

Contrary to standard textbook models, e.g. Blanchard (1997), in this model the output effect of a demand shock is larger the more open the economy. The reason is that the price of imported goods have a larger weight in the CPI the more open the economy. Thus, the dampening effect on CPI inflation of an exchange rate appreciation is greater the more open is the economy, and the interest rate response to fulfil the inflation target can consequently be smaller.

Note that a positive demand shock in the foreign country has a negative effect on home output. This is contrary to traditional multi country models, see e.g. Cooper (1985), where positive foreign demand shocks lead to higher home output. The reason for the opposite result is the monetary policy response under inflation targeting. A positive demand shock in the foreign country leads to an exchange rate appreciation for the foreign country and thereby a depreciation for the home country. In order to offset higher imported inflation due to the depreciation and the higher foreign prices, prices on home goods must be brought down by a tight monetary policy.

3.2 Monetary union

In a monetary union, the home country and the foreign country have a common currency and monetary policy. The union now targets the CPI for the union. The monetary policy regime can thus be specified as

(3.11) $p_C^U = 0 \quad \wedge \quad s = 0$

Inserting equation (3.3) in equation (3.6), and solving for the common interest rate i yields

(3.12) $i = \frac{1}{a_1}(v^F - u^F) + \frac{l + a_1 + 2a_2}{a_1} p^H$

Inserting from equations (3.3) and (3.12) in equation (3.5), and solving for p^N, gives the following solution for the home price level under a monetary union:

(3.13) $p^H = \frac{1}{2(l + a_1 + 2a_2)}(v^H - v^F - u^H + u^F)$

The solution for the union interest rate is thus

(3.14) $i = \frac{1}{2a_1}(v^H - u^H + v^U - u^U)$

By inserting (3.13) into the supply function (2.1) we can write output in the home country under monetary union, y_U^H, as

(3.15) $y_U^H = h_U u^H + (1 - h_U)u^F + (1 - h_U)(v^H - v^F)$

where

$h_U = \frac{l + 2(a_1 + 2a_2)}{2(l + a_1 + 2a_2)}$

By comparing (3.10) and (3.15) we see that the difference between the solutions for output under independent inflation targeting and in a monetary union lies in the coefficients η_I and η_U. By inspection, we find that $\eta_I > \eta_U$. Thus, output is less affected by domestic supply shocks, but more affected by demand shocks and foreign supply shocks, in a monetary union. The reason for this asymmetry stems from the differences in weights in the target price indices in

the two regimes. In the CPIs of the two countries, the weight attached to home goods prices is higher than the weight attached to foreign goods prices, i.e. $\beta < ½$. In the union, however, the weights attached to the two goods prices are equal. We see from equations (3.9) and (3.14) that the average interest rate between the two countries under independent inflation targeting is always equal to the interest rate of the monetary union. Due to the higher weight attached to home goods prices under independent inflation targeting, the home central bank responds more strongly to home shocks than to foreign shocks. The interest rate differential between the home country and the foreign country becomes positive when positive home demand shocks or negative home supply shocks occur, while it (by symmetry) becomes negative when positive foreign demand shocks or negative foreign supply shocks occur.

In the case of a positive demand shock to home goods, the central bank in the monetary union must raise the interest rate such that lower prices on the foreign country's goods offset higher prices on the home country's goods. Under independent inflation targeting, however, the home central bank must raise the interest rate by more than the rise in the (common) interest rate in the monetary union, since home goods have a larger share in the home country's CPI. Likewise, the foreign country's central bank raises the interest rate by less than under the monetary union, since home goods have a smaller share than foreign goods in the foreign country's CPI. Thus, output in both the home country and the foreign country are to a larger extent sheltered from home demand shocks than is the case under monetary union.

When domestic supply shocks occur, output in the home country is less affected in a monetary union than under independent inflation targeting. The reason is that the monetary policy response to supply shocks exacerbates the effect of the supply shocks on output under inflation targeting. Under independent inflation targeting, the interest rate in the home country becomes lower than in the monetary union, and output is thus more destabilised. The decrease in the foreign country's interest rate is smaller under independent inflation targeting than under a monetary union, and output is thus more stabilised.

4. Optimum currency areas

In the previous section, we investigated the effects of different home and foreign shocks, and reasoned as if the different shocks were independent. We now leave this assumption, and turn to the question of optimum currency areas with inflation targeting. When should the countries

form a monetary union, and when should they pursue independent inflation targeting instead? In short, the conventional wisdom regarding shocks and optimum currency areas can be summarised by that the more asymmetric shocks countries face, the less of an optimum currency area they constitute. With inflation targeting we will see that this conventional wisdom holds for demand shocks, but not for supply shocks.

A welfare comparison between the alternative regimes should, ideally, include all the welfare factors that they affect. While the tradition in the OCA literature is to focus on output stability, it has become standard in the monetary policy literature to represent welfare by a loss function in which both the variability of output and inflation enter. If such a welfare measure is used in this framework, independent inflation targeting is always superior to a monetary union if one only considers the variability of inflation. Since the monetary union targets the CPI for whole union, the variability of the individual countries' CPIs is larger than if each country targets their respective CPIs. However, there are other benefits from having a common currency, such as reduction of transaction costs and exchange rate uncertainty, which, arguably, should be included in the welfare comparison. Since the gains from less country specific inflation variability under independent inflation targeting and the gains from having a single currency are difficult to measure, we have chosen to focus solely on output variability, which is common in the OCA literature.

We assume for simplicity that supply shocks and demand shocks are uncorrelated. Denoting the standard deviation in home and foreign supply shocks as σ_H and σ_F, respectively, and the coefficient of correlation between the supply shocks in the two countries as ρ, the variance of output for a given monetary policy regime *i* is given by

$$(4.1) \quad \text{var}(y_i^H) = h_i^2 s_H^2 + (1-h_i)^2 s_F^2 + 2h_i(1-h_i) s_H s_F r + (1-h_i)^2 \text{var}(v^H - v^F), \quad i = I, U$$

We have shown in the previous section that with demand shocks independent inflation targeting provides better output stabilisation for each country than does a monetary union. We will thus in the following disregard the last term in equation (4.1) and focus on supply shocks. To get the intuition of various effects clear, we will proceed in three steps. First, we assume that the variances of the supply shocks are equal in the two countries and that supply shocks in each country are independent. Second, we lift the assumption that shocks are independent. Third, we also lift the assumption that the standard deviation is the same in the two countries.

When the standard deviations in the two countries are equal and the shocks are uncorrelated, it can be seen from equation (4.1) that a monetary union yields the lowest variance of output if

$$(4.2) \quad h_U^2 + (1-h_U)^2 < h_I^2 + (1-h_I)^2 \Leftrightarrow h_U(1-h_U) > h_I(1-h_I)$$

Inserting from equations (3.10) and (3.15) this condition reduces to

$$(4.3) \quad (1-2b)2(a_1 + 2a_2) + (1-4b^2)\,l > 0$$

which is satisfied, since $\beta < ½$. Thus, with independent shocks and equal standard deviations, the stabilisation properties of an extended union are better than with independent inflation targeting. The intuition in this result can best be understood by an illustrative numerical example. Assume that in both countries the probability of a positive shock of size 1 is ½, and that the probability of a negative shock of size 1 is also ½. Since shocks are independent, we have four possible states that each enter with probability ¼: Both countries face positive shocks (PP), both countries face negative shocks (NN), the home country face a negative and the foreign country a positive shock (NP), and the home country face a positive shock and the foreign country a negative shock (PN). We know that the output response to a home shock of size 1 in regime *i* is given by h_i and to a foreign shock of size 1 by (1-η_i). Furthermore, since $\eta_I > \eta_U$, assume for instance that $\eta_I = 0{,}8$ and $\eta_U = 0{,}6$. The table below gives the output response in the four different states, as well as the calculated variance in output.

	PP	NN	NP	PN	Var(y^H)
I	0,8+0,2= 1	-0,8-0,2= -1	-0,8+0,2= -0,6	0,8-0,2= 0,6	0,68
U	0,6+0,4= 1	-0,6-0,4= -1	-0,6+0,4= -0,2	0,6-0,4= 0,2	0,52

The table is set up in the following way: Under independent inflation targeting (I) and the state PP, the home country shock contributes to an output increase of 0,8 and the union shock to an output increase of 0,2. The total output increase in this event is therefore equal to 1.

When shocks are symmetric, the output response is independent of the monetary policy regime, since the sum of the output responses equals one in both regimes. But in those instances where the shocks have opposite signs in the two countries, a monetary union produces less output

fluctuations than independent inflation targeting. Consequently, the variance of output is higher under independent inflation targeting than under a monetary union. By pursuing common rather than independent inflation targeting, the two countries take a greater advantage of shocks that have opposite signs, since the difference from home and foreign shocks is smaller under a monetary union than under independent inflation targeting. The reason for this is that the nominal exchange rate response under independent inflation targeting strengthens the output response from domestic shocks and weakens the output response from foreign shocks. This is contrary to the standard theory of optimum currency areas. There, when countries do not form a common currency area, a positive supply shock in the home country is met by an appreciation that dampens the home output response, see e.g. De Grauwe (1994, p. 41-44). But under independent inflation targeting, a positive supply shock must be met by a lower interest rate, and hence an exchange rate depreciation.

Assume next that shocks are not independent between the two countries. If supply shocks in the two countries are negatively correlated, it can be seen from equation (4.1) that this further contributes to $var(y_U^H) < var(y_I^H)$ if $\eta_U(1-\eta_U) > \eta_I(1-\eta_I)$. From (4.2) and (4.3) we already know that this condition is fulfilled. Consequently, contrary to the conventional wisdom, the more negatively correlated supply shocks are, the larger the gain from forming a common currency area. The intuition for this result can also be understood from the numerical example given above. In the example, the two policy regimes provided the same output instability when shocks were symmetric, while a monetary union reduced instability when the shocks were asymmetric. With negative correlation in shocks, the asymmetric case is the typical one, and consequently the more negatively correlated the supply shocks are, the stronger is the argument of forming a common currency area. For the same reason, when supply shocks are positively correlated, this weakens the argument for a common currency. When shocks are perfectly correlated (and the variance in supply shocks is the same) independent inflation targeting and monetary union produce the same output stability. The intuition behind this result should also be clear from the numerical example above, since in this case the events where both countries face the same shocks are the only ones of relevance.

Finally, assume that the variance of supply shocks differ between the two countries. Then, if the variance of home supply shocks is higher than that of foreign supply shocks, this will pull in the direction of an advantage for the home country to enter a union. The reason for this is simply that the output effect of home shocks is smaller under monetary union than under

independent inflation targeting, i.e. that $\eta_H > \eta_{EU}$. Since supply shocks are destabilised under inflation targeting, it is an advantage for the home country if the monetary policy response to supply shocks to a larger degree is determined by the shocks in a country with smaller variations in supply shocks. Contrary to the case above, however, in this case there is a potential conflict between the countries. While the country with a relatively high variance of supply shocks will have a more stable output with a monetary union, the opposite is the case for the other country.

The results are in some contrast to the standard ones in the OCA literature.[3] There, heterogeneity of shocks is taken as signs that countries should not form a common currency area. Under inflation targeting, this result is confirmed when it comes to demand shocks. But we have seen that when the choice is between doing independent or union inflation targeting, negative correlation in supply shocks is actually an argument in favour of entering a monetary union. Therefore, when the choice is between targeting inflation independently or within an extended union, as is the case for e.g. Britain and Sweden, it is not clear that arguments against a common currency by e.g. Krugman (1993) or arguments in favour of a common currency by e.g. Frankel and Rose (1997) are valid. The question is not how asymmetric shocks are, but how asymmetric demand shocks are compared to supply shocks.

5. Conclusion

Inflation targeting, either explicit or implicit, has become the dominant rule for monetary policy. Many countries face, or might face in the future, the choice between targeting inflation independently or entering a monetary union that targets inflation within the union. The earlier debate on optimum currency areas focused on the general choice between a common currency versus a flexible exchange rate. The question was whether the exchange rate was an appropriate adjustment instrument. The conventional answer was that adjusting the nominal exchange rate provides greater output stability when countries are hit by asymmetric shocks. The presence of asymmetric shocks would then be an argument against forming a monetary union.

[3] The result is also in some contract to results in literature not explicitly considering OCA, e.g. Lane (1999). In Lane's model, the presence of asymmetric supply shocks is an argument against forming a monetary union, and more so the larger the weight placed on inflation.

Does modelling inflation targeting explicitly add any new insights to the theory of OCA? The answer is yes, because implicit in the OCA literature is the assumption that the exchange rate is always adjusted in a way that improves output stability. However, when central banks target inflation, this is not generally true. For instance, when the economy is hit by an adverse supply shock (cost-push shock), the central bank must tighten monetary policy in order to reach its inflation target. If the inflation target is credible, the monetary tightening leads to an exchange rate appreciation, which exacerbates the negative effect of the supply shock. Only when the economy is hit by shocks that drive output and prices in the same direction, that is, demand shocks, does inflation targeting imply that the exchange rate is adjusted in a way that improves output stability. While the conventional wisdom in the OCA literature holds as regards demand shocks, the presence of asymmetric supply shocks is in fact an argument in favour of a monetary union.

Implicit in our analysis is the assumption that inflation targeting implies that the central bank must respond to supply shocks in a sub-optimal way, where the (explicit) inflation target is given higher priority than the (implicit) output target. This is, in our view, a realistic assumption, as the main rationale for introducing explicit inflation targets is to improve credibility in monetary policy. The sub-optimal response to supply shocks might, however, become less apparent when credibility is gradually achieved. When the inflation target is fully credible, the central banks may have more room for manoeuvre as regards insulating output from supply shocks without jeopardising its credibility. However, as long as there is a need for explicit inflation targets, one would expect that the inflation target is given a larger weight than would be the case if there were no time-inconsistency problems in monetary policy.

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