

European monetary union and asymmetric shocks in a new Keynesian model

By Rebecca L. Driver and Simon Wren-Lewis

Department of Economics, University of Exeter, Exeter, EX4 4RJ;
e-mail: rldriver@exeter.ac.uk

This paper attempts to quantify the costs imposed by asymmetric shocks under European Monetary Union compared to free floating. A simple two-country model is examined where policy is set in an optimal, time consistent manner. Nominal and real rigidities are present in both economies, but prices are set in a forward looking manner and expectations are rational. Results suggest that the costs of asymmetric shocks under EMU may be significantly higher than under free floating, particularly if fiscal policy is not used for demand management.

1. Introduction

The theoretical costs and benefits of European Monetary Union have been well rehearsed. The empirical importance of several of the principal benefits of EMU, including the reduction in transactions costs from changing between European currencies, have been examined in Commission of the European Communities (1990) among others. Rather less empirical work has been done on the measurement of the costs of EMU, and we seem to be far from any consensus on this issue. This is the subject of this paper.

The costs imposed by asymmetric shocks under EMU will depend on the interaction of real and nominal inertia within European economies. A number of economists have contrasted apparently high nominal inertia in US labour markets with relatively low European nominal wage rigidity, and concluded that costs within Europe resulting from nominal inertia may not be that high (e.g. Bean, 1994). There are two problems with this argument. First, it neglects nominal rigidity in price setting, which may be as empirically important as inertia in wages (see Layard, *et al.*, 1991, or Ireland and Wren-Lewis, 1994). Second, once nominal rigidity is present, the costs it imposes in restoring real equilibrium critically depend on its interaction with real inertia within the economy, and here European economies appear less flexible than others.

In assessing the importance of the interaction between real and nominal inertia, it seems reasonable to allow for the possibility that inflation is determined in a forward looking manner, and that expectations are rational. Our contribution is to examine the quantitative implications of inertia for EMU following asymmetric shocks in this New Keynesian framework. To do this we use a small calibrated two

country model, rather than a complete econometric model, as in EC Commission (1990) and Masson and Symansky (1992) for example. Both approaches have their merits: the economic processes behind results are often clearer in small models, and it is easier to conduct sensitivity analysis, while econometric models have the advantage of being directly estimated. Our analysis is also based on optimal policies, while most econometric model studies use simple policy rules.[1]

The plan of the paper is as follows. In Section 2 we outline the model we use, the form of policy regimes, and the types of shocks we consider. We consider optimal time consistent policies both within and outside EMU. We simulate a small theoretical two country model, but use parameter values drawn from empirical work. In Section 3 we compare the costs under EMU and a free float of optimal, time consistent policies following various shocks. Section 4 concludes.

2. The model and policy design

Our aim is to capture the implications of EMU in as simple a New Keynesian structure as possible. Our model therefore comprises only three countries: two European countries (labelled Germany and France for convenience only) which react to changes in each other, and a passive rest of the world. The two European economies are identical, except for potential shocks that may occur. This means that we focus on problems caused by asymmetric shocks, rather than problems generated by asymmetric structure following common shocks. (This reflects the emphasis in the literature, but our analysis could easily be extended in this direction.)

The model has some similarities in structure to the one examined in Hughes Hallett and Vines (1991 and 1993), which in based in turn on Oudiz and Sachs (1985) and McKibbin and Sachs (1991), but there are a number of differences in specification. The most important of these reflects the price mechanism. Our equation for output prices in each country is

$$\Delta p_t = E[\Delta p_{t+1}|I_t] + \alpha_1\alpha_2\, y_t \tag{1}$$

where p is the log of the domestic price level, y is the log of real output, $E[..]$ is the expectations operator, and I_t denotes information available at time t. The parameter $1/\alpha_1$ measures the relative cost of price adjustment, while α_2 is inversely related to the degree of real inertia in the economy. This forward looking, or New Keynesian, Phillips curve can be derived in a number of ways (Leith and Wren-Lewis, 1997). In this paper we use a model of wages and prices that has proved to be empirically successful.

Equation (1) is obtained by combining the following two structural relationships

$$\Delta p_t = [\Delta p_{t+1}|I_t] - \alpha_1(p_t - w_t) \tag{2}$$

$$w_t = p_t + \alpha_2 y_t \tag{3}$$

[1] An exception is Minford *et al.* (1992), who examine optimal policies with the Liverpool model.

Equation 2 represents a forward looking price equation, where inflation depends on both expected inflation and the deviation of the mark up from its desired level. We assume that the desired level of the mark up is constant. (As our model only considers deviations from steady state, we set steady state or constant values to zero for convenience.)

Equation (2) can be derived in a number of ways. The most straightforward, but in some senses least satisfactory, is to assume quadratic adjustment costs in changing prices, in which case with no discounting (2) represents the Euler equation associated with optimal price setting. A more realistic cost structure would involve menu costs and would be based on firm specific state dependent price decisions, but the aggregate implications of this set up are unclear. Equations of the form of (2) have nevertheless proved to be successful in empirical work (e.g. Price, 1992, and Martin, 1995), and no obvious alternative for a forward looking price equation that allows for nominal inertia exists in the literature. (Traditional backward looking equations involve lags that combine structural inertia with expectations adjustment, and as a result are subject to the Lucas critique.)

Equation (2) can be rewritten in the form

$$p_t = \lambda p_{t-1} + (1-\lambda)^2 \sum_{i=0}^{\infty} (\lambda^i E[w_{t+i}|I_t]) \qquad (2')$$

where λ is an increasing function of $1/\alpha_1$. From this formulation we can see that the equation has the desirable property that the greater is nominal inertia (λ or $1/\alpha_1$), the more important future levels of wages become.

Equation 3 is a wage equation, and simply relates real wages to the deviation of output from its steady state level. We assume that steady state output is also zero. The parameter α_2 measures the responsiveness of the real wage to real disequilibrium, and so is inversely related to the degree of real inertia in the labour market. A more standard formulation would add terms in wage and price inflation, but most studies show that wage inflation responds fairly quickly to price inflation in most European countries, a factor which may have led some economists to play down the role of nominal inertia more generally.

An implicit assumption in eq. (3) is that wages are a function of output rather than consumer prices. The two measures will differ in the model when the real exchange rate changes. Although it is not clear-cut which measure is more appropriate, arguments put forward in Layard *et al.* (1991) suggest that output prices are more relevant, particularly in the longer run.

The form of the equations we have used allows us to focus on the combination of nominal rigidities in the goods market and real rigidities in the labour market. The reduced form Phillips curve (1) emphasises that the impact of output disequilibrium on inflation depends on both the extent of nominal rigidity and real inertia.

The values chosen for α_1 and α_2 are going to be critical for our evaluation of the costs of EMU. Martin (1995) estimates an equation based on (2′) for a wide range of OECD countries, and estimates of λ range from 0.3 to 0.7. To ensure that we do not overstate the degree of nominal inertia, we have chosen 0.3 as our central

estimate, which implies a value of α_1 of 1.67. A wide range of studies have attempted to estimate the responsiveness of the real wage to labour market conditions: from these, a value of 0.1 for α_2 does not seem unreasonable, although we do explore the implications of changing this parameter below.[2]

An important property of New Keynesian models of inflation is that, under rational expectations, periods of falling inflation can be associated with output being above its steady-state level (see Ireland and Wren-Lewis, 1994, for example). This apparently paradoxical result is due to inflation becoming a jump variable in forward looking models. Any unexpected positive shock to output will lead to an upward jump in inflation, but if this shock is expected to be sustained for more than one period inflation will subsequently decline.

The model contains a conventional uncovered interest parity exchange rate equation of the form

$$e_t = E[e_{t+1}|I_t] - (r_t - E[\Delta p_{t+1}|I_t]) \tag{4}$$

where e is the log of the real exchange rate measured in terms of the rest-of-the-world currency and r is the nominal interest rate. As the rest of the world is passive, we can ignore its real interest rate in influencing the interest rate differential.

Equation 5 is a reduced form aggregate demand curve, where demand (y) depends on real interest rates, the real exchange rate in both countries ($e^\star$ denotes the other EU country's real exchange rate), overseas demand ($y^\star$), fiscal policy (g), and a term related to wealth (W). (All variables except the interest rate are logged.) Given the way real exchange rates are measured, both European real exchange rates appear in each European county's demand curve.

To preserve linearity there are two terms representing wealth effects. The first cumulates net investment and changes in overseas assets into the variable W. This variable is not wealth, however, because it ignores revaluation effects. The effects of revaluations of overseas assets are subsumed in the parameters on the real exchange rate terms. The final term in the price level in (5) captures changes in the value of real government debt, the nominal value of which is held constant. Investment is simply a function of real interest rates.

$$\begin{aligned} y_t = {} & \beta_1(r_t - E[\Delta p_{t+1}|I_t]) + \beta_2 e_t + \beta_3 e_t^* \\ & + \beta_4 g_t + \beta_5 W_t + \beta_6 p_t + \beta_7 y_t^* \end{aligned} \tag{5}$$

This aggregate demand curve is consistent in steady state with either a traditional Keynesian set-up, or a model based on intertemporal optimisation by consumers. The latter would, however, imply a richer dynamic relationship than the one presented here, because consumption would become a jump variable. We plan to explore this variant of the model in later work.

As the focus of this paper is not fiscal policy, we only consider balanced budget fiscal actions. Taxes are assumed to adjust to keep the stock of nominal government

[2] It is of course possible that these parameters may not be independent of the policy regime, but we have no obvious way of assessing this.

debt fixed. A traditional Keynesian consumption function would imply $\beta_4 > 0$. With intertemporal consumption, the theoretical impact of a balanced budget fiscal expansion on aggregate demand in the long run is ambiguous (Giovannini, 1988), but it is likely to be positive in practice (Wren-Lewis *et al.*, 1996). (An obvious extension to the model would be to allow for bond financed fiscal policy.)

If the budget is always balanced, changes in nominal wealth occur through investment or the accumulation of foreign assets. The latter is equal to the current account, which will be a function of the same variables that appear in (5).

$$\Delta W_t = \gamma_1(r_t - E[\Delta p_{t+1}|I_t]) + \gamma_2 e_t + \gamma_3 e_t^* + \gamma_4 g_t + \gamma_5 W_t + \gamma_6 p_t + \gamma_7 y_t^* \quad (6)$$

We consider two possible policy regimes: an EMU regime where the two European countries exchange rates and nominal interest rates are locked together, and a 'free float' regime where they are not. To maintain comparability, we assume that in both cases policy is decided cooperatively at the European level. (This ignores a possible benefit of EMU, which is that it may enhance policy cooperation.) Under free floating there are four instruments—each country's interest rate and fiscal policy—while under EMU there are three, because both countries' interest rates must move together. (We ignore any restrictions on fiscal policy that might operate under EMU, but we do examine cases in which fiscal policy is not an instrument.) These instruments are set at their optimum value to minimise an objective function when a shock becomes known, but only time consistent policies are allowed. In other words we assume that neither country has sufficient reputation to commit itself to a time inconsistent policy, so policies where re-optimisation would occur at a later date without any change in information are ruled out.

The social loss function penalises squared deviations from base in each country's output level and inflation rate (measured by consumer prices, changes in which reflect a combination of output price and exchange rate movements).[3] We assume a discount rate (δ) of 5% per annum. Deviations in fiscal stance are also penalised to prevent excessive movements in policy. Each country's preferences, as embodied in the objective function, are assumed to be identical. Following Oudiz and Sachs (1985) amongst others, the objective function for each country is

$$L_j = 0.5 \sum_{i=1}^{N} \sum_{t=1}^{T} (1/(1+\delta))^{t-1} w_i X_{it}^2 \quad (6)$$

where j is the country, t the time period, and X represents a vector of deviations from base in each variable indexed by i with weight w_i.

The model, although simple, is too complex to analyse theoretically under time consistent control, so our analysis consists of simulations over a 100 year period,

[3] As the loss function is defined as deviations from steady state, a rise in output or inflation is as costly as a fall.

Table 1 One-year 10% asymmetric demand shock: effect on social welfare over five-year period

Simulation	Regime	Germany	France	Europe
basic simulation 1.0	free float	−0.54	−0.14	−0.34
	EMU	−1.91	−1.76	−1.84
variant 1.1	free float	−0.59	−0.15	−0.37
(no fiscal action)	EMU	−4.46	−4.29	−4.37
variant 1.2	free float	−0.53	−0.13	−0.33
(2 × inflation effect)	EMU	−1.70	−1.51	−1.60
variant 1.3	free float	−0.28	−0.10	−0.19
(2 × interest rates effect)	EMU	−1.79	−1.73	−1.76
variant 1.4	free float	−0.27	−0.04	−0.15
(2 × exchange rate)	EMU	−1.69	−1.57	−1.63
variant 1.5	free float	−0.50	−0.14	−0.32
(2 × wealth effect)	EMU	−1.85	−1.72	−1.79

using the DYNGAME algorithm developed by Warwick McKibbin (see McKibbin, 1992, for further details).[4]

3. Responses to asymmetric shocks under time consistent policies

Table 1 presents the results of an asymmetric demand shock in both the EMU regime and under a free float. The shock consists of a one period 10% increase in aggregate demand in Germany. (As the model is linear, the scale of the shock is irrelevant: we choose a large shock here for clarity.) We show the effect on the social loss function evaluated over the first five years, but results over the full simulation period are very similar. The shock lasts for one period only: we consider more protracted shocks below.

The shock is uniformly more costly under EMU than free floating as we would expect. In fact this result is not inevitable because we assume time consistent rather than time inconsistent policies. It is possible in theory that the constraint imposed by the need to be time consistent could offset the effects of the constraint on optimal policies imposed by EMU, but this does not occur in practice.

The scale of the objective function is such that a value of −0.5 would be equivalent to a change in inflation of 1 point, or a 1% change in output, in the first year, and its quadratic form implies that a value of −2.0 would be equivalent to a 2% change in output in the first year. Thus in the base case Germany suffers a total welfare loss equivalent to about 2% less output for one year under EMU, compared to a loss equivalent to 1% of output under free floating. The contrast is even greater for France, which suffers significant losses under EMU, but is able to largely insulate itself from any cost under free floating.

[4] The parameter values used to calibrate the model for the baseline are contained in Appendix 1.

Table A1.0 shows the trajectories for the main variables in this simulation. Under free floating Germany eliminates most of the excess demand in year 1 through a combination of tighter fiscal and monetary policy. Higher interest rates lead to an appreciation in the DM, which also helps reduce demand, but this does incur the cost of creating disequilibrium in consumer prices. (Consumer, rather than output, inflation enters the authorities objective function.) This also explains why interest rates are not cut in year two to counteract the small deflationary impact of lower wealth: to do so would lead to an even greater increase in consumer price inflation as the exchange rate depreciates. Overall, however, the welfare costs to Germany are small considering the scale of the demand shock.

Under free floating France needs to raise interest rates to counteract the expansionary effect of higher German demand working through trade, but the increase required is about half that needed in Germany. The Franc/dollar exchange rate appreciates, but the Franc/DM rate depreciates, which adds to consumer price inflation. A larger increase in French interest rates could eliminate this rise in prices, but only at the cost of a larger fall in output.

The appreciation in the DM and the expansion in German demand lead to a current account deficit in Germany in the first year. This, coupled with a fall in investment generated by higher real interest rates, leads to a fall in wealth. This decline in wealth is only gradually eliminated over the subsequent years, and its effect on demand is offset by a persistent depreciation in the real exchange rate. This real depreciation generates a current account surplus from year two onwards, which is the mechanism by which wealth gradually recovers.

In the same simulation under EMU each country has to share an identical increase in interest rates. As a result German output is significantly above base in the first year of the shock, and vice versa for France. The change in output would be greater still if it were not for a strong countercyclical fiscal policy in both countries.

Even if governments are prepared to use fiscal policy for stabilisation purposes, they may be unable to react so quickly to a shock. Variant 1.1 reported in Table 1 shows what would happen with the same shock if fiscal policy was not used at all. Table A1.1 shows the path of key variables in this case. Our results show that costs under free floating hardly change, but costs under EMU more than double. This is not surprising, as fiscal policy had little to do in the main case under free floating, but was required to be very active in EMU. The 10% demand shock now results in a 3% increase in current year output in Germany, compared to an increase of only 0.3% under a free float. The fall in output in France is also about ten times larger under EMU compared to a free float.

The idea that macroeconomic stabilisation requires greater fiscal flexibility under EMU is a familiar argument, but these results do emphasise the quantitative importance of this point. With fiscal inflexibility, the costs imposed by an asymmetric shock under EMU are large.

Variants 1.2 to 1.5 look at how robust the costs of EMU are to changes in parameter values in the case of fiscal flexibility, and Tables A1.2–1.5 report detailed results. Perhaps the most critical parameter is the sensitivity of inflation to output. The simulation Variant 1.2 reports the result of the asymmetric demand shock after halving the degree of total inertia in wage and price setting (i.e. either doubling the sensitivity of real wages to output disequilibrium (α_2) or halving degree of nominal inertia $(1/\alpha_1)$).

Table 1 illustrates the non-linearity of the welfare effect. The costs to both countries under a free float in the base simulation and simulation 1.2 are virtually identical. This mainly reflects the fact that each country is able to eliminate most of the output effects of the demand shock through monetary and fiscal action in this regime. The costs of the asymmetric shock under EMU fall as we would expect, but by less than 15% (-1.6 compared to -1.84). As policy is no longer able to prevent output rising in Germany and falling in France in the first year, the effect of this on inflation is increased as a result of the reduction in real inertia. The larger increase in prices is deflationary, however, and so less fiscal action is required. The fact that the net effect on welfare is still large reinforces the conclusion that the potential costs of EMU following an asymmetric shock are significant.

Variant 1.3 increases the sensitivity of demand to interest rates in both countries. The increase in interest rates required to apply deflationary pressure in both policy regimes is now significantly smaller. The greater effectiveness of monetary policy reduces the size of welfare losses in both cases. However, although the size of the unnecessary interest rate increase suffered by France under EMU falls, its initial impact on the French economy increases, and so the welfare cost of EMU under this shock remains relatively high.

Variant 1.4 raises the trade elasticities in both countries. As the exchange rate now does more work on demand, the size of interest rate increases required to counteract the shock declines. This brings noticeable benefits under both regimes. However under EMU France still suffers an unnecessary appreciation, and because this now has a greater effect on output, the welfare costs under EMU remain relatively high.

Variant 1.5 doubles the effect of wealth on demand. In the main case German wealth falls under both regimes partly because of a decline in investment due to the monetary contraction, and partly because the real appreciation and excess demand produce a current account deficit. This applies modest deflationary pressure which persists through the simulation period, but this is counteracted in later years by a small real depreciation.

As there is a larger feedback from wealth to demand, the real exchange rate change required to counteract the persistent wealth effect increases. This larger change in the real exchange rate leads to a larger change in the current account, and so wealth returns more rapidly to equilibrium. Overall the welfare costs of the asymmetric shock changes little in either regime.

Table 2 Three-year 10% asymmetric demand shock: effect on social welfare over five-year period

Simulation	Regime	Germany	France	Europe
basic simulation 2.0	free float	−1.12	−0.17	−0.65
	EMU	−4.11	−3.95	−4.03
variant 2.1 (no fiscal action)	free float	−1.19	−0.17	−0.68
	EMU	−7.69	−7.68	−7.69
variant 2.2 (2 × inflation effect)	free float	−1.07	−0.16	−0.61
	EMU	−3.13	−2.99	−3.06
variant 2.3 (2 × interest rates effect)	free float	−0.71	−0.18	−0.45
	EMU	−3.99	−3.94	−3.97
variant 2.4 (2 × exchange rate)	free float	−0.45	−0.03	−0.24
	EMU	−2.99	−2.89	−2.94
variant 2.5 (2 × wealth effect)	free float	−0.98	−0.17	−0.58
	EMU	−3.90	−3.77	−3.83

The asymmetric demand shock analysed above lasted for one year only. In Table 2 we present results for a shock which lasts for three years. Like the previous shock, it is initially unanticipated, but once it occurs it is expected to last for three years. This simulation therefore adds two new elements: persistence and the anticipation of shocks. Tables A2.0–1 present detailed results for the first two simulations.

Comparing the one- and three-year shocks directly, it is interesting to note that although the new shock is of equal size and lasts three times as long as the original one, the welfare cost is less than three times as great, largely because it is partly anticipated. Under free floating, the output costs in Germany mainly occur in year 1 and year 4, when the shock disappears, but the inflation costs are more evenly spread. The tightening of German monetary policy increases steadily over the three years. This is because the maximum impact on the exchange rate occurs in year 1, representing the cumulated effect of future interest rate increases. As the exchange rate gradually depreciates after year 1 following the open arbitrage path, the direct deflationary impact of higher interest rates has to be intensified. The government cannot prevent all of the fall in output in year 4 (when the demand shock ends), because a larger cut in interest rates would increase the depreciation and raise consumer prices further. As with the one-year case, France under free floating succeeds in largely isolating itself from the effects of the shock.

The output costs under EMU are both larger and more evenly spread across the three years. Output is about 1% too high in Germany, and 1% too low in France in each year. It is interesting that moving to EMU not only raises the overall social cost of the shock in each country, but this increase occurs almost exclusively in terms of output rather than inflation disequilibrium (with some additional contribution with costs associated with an active fiscal policy). Under free floating, inflation moves partly because of the direct effect of changes in the

Table 3 One-year 2% asymmetric wage shock: effect on social welfare over five-year period

Simulation	Regime	Germany	France	Europe
basic simulation 3.0	free float	−5.05	−0.06	−2.56
	EMU	−4.62	−1.73	−3.17
variant 3.1 (no fiscal action)	free float	−5.23	−0.03	−2.63
	EMU	−5.65	−2.73	−4.19
variant 3.2 (2 × inflation effect)	free float	−4.52	−0.06	−2.29
	EMU	−3.80	−1.05	−2.42
variant 3.3 (2 × interest rates effect)	free float	−5.20	−0.04	−2.62
	EMU	−4.94	−2.12	−3.53
variant 3.4 (2 × exchange rate)	free float	−5.23	−0.02	−2.63
	EMU	−6.54	−3.46	−5.00
variant 3.5 (2 × wealth effect)	free float	−5.15	−0.06	−2.61
	EMU	−4.76	−1.90	−3.33

Franc/DM rate on consumer prices in each country, but this effect of course disappears under EMU.

The key result from Table 2 is that the costs in the EMU regime remain significantly higher than under free floating, and are particularly large if there is no active countercyclical fiscal policy (Variant 2.1). This suggests that our earlier results concerning the quantitative importance of these costs remains robust to persistence and anticipation.

Variants 2.2–2.5 once again explore robustness to changes in parameter values. Qualitative results are similar to the one year shock, but it is noticeable that the size of social costs are now more sensitive to the effect of competitiveness on trade, and the effect of demand on inflation. In each case, however, these costs remain very significant in size.

There are two other broad types of asymmetric shock that could be applied to the model: a supply shock and an exchange rate shock. As an asymmetric exchange rate shock could not take place under EMU, there is little point examining this shock under free floating. Table 3 presents the results of a shock to German wages (eq. (3)), 2% in size and lasting one year. Tables A3.0–1 present detailed results for the first two simulations.

Whereas a combination of monetary and fiscal policy can largely eliminate the harmful effects of a demand shock under a free float, this cannot be the case for a supply shock, as either inflation must rise or output must fall. Instead policy will attempt to achieve the best balance between these two in the short term, whilst eliminating any persistence after the shock has disappeared. With forward looking inflation, eliminating persistence essentially involves ensuring output is close to base after the first period, after an initial deflation designed to reduce inflation following the shock.

The shock to the wage level in Germany will lead to an immediate increase in domestic inflation and an appreciation of the real exchange rate. Both these factors

will cause output to fall, which will act to moderate, but not eliminate, the rise in domestic inflation. At the same time the real appreciation will act to reduce consumer price inflation, which together with output is the variable of interest to policy makers. The optimal policy response is therefore to raise interest rates, which acts to further appreciate the real exchange rate and reduce consumer price inflation. The deterioration in output is then partially counterbalanced by relaxing the fiscal stance. The real DM appreciation raises French output and inflation slightly in the first year, but overall the impact of the German supply shock on France is minimal under free floating.

An interesting result is that under EMU Germany is better off under this supply shock, although this is more than counterbalanced by a deterioration in French welfare. A fixed nominal exchange rate automatically deflates the economy when inflation increases, so under EMU Germany raises nominal interest rates by less than under free floating, but output and inflation fall by more. In the longer run the French and German price levels must converge, implying that deflation continues beyond the first year in Germany, but this is again achieved through competitiveness effects. (In fact output is supported in Germany by an expansionary fiscal policy.)

The fact that Germany is better off following a supply shock under EMU illustrates the importance of the time consistency constraint. Without this constraint, Germany under free floating could deflate output beyond the first year in a manner similar to the path achieved under EMU, thereby preventing the initial jump depreciation in the DM. With forward-looking inflation this future deflation would reduce current inflation. However such a policy is time inconsistent, because there would be a temptation once the reduction in inflation was achieved to renege and not deflate. This limits the ability of Germany to reduce initial inflation under free floating. Under EMU, of course, the policy is credible because the exchange rate is fixed.

The improvement in German welfare is however dependent on two factors, both of which are illustrated in Table 3. First, an active fiscal policy is required to provide some support to output when competitiveness declines. In Variant 3.1, when fiscal policy is not used, German welfare declines under EMU. Second, the result is dependent on the size of the model's competitiveness effects. In Variant 3.4 these competitiveness effects are doubled, and as a result German output costs under EMU increase considerably, despite additional fiscal support. Once again Germany is better off under free floating. France is always much better off under free floating, although as Table 3 shows the extent of the costs it suffers under EMU depend critically on the degree of nominal inertia.

4. Conclusions

Some economists have argued that, because there is relatively little nominal inertia in wage setting in Europe, the costs associated with asymmetric shocks under European Monetary Union would be small. In this paper we have examined a

rational expectations model which combines nominal inertia in price setting with real wage rigidity, and analysed how two countries might respond to an asymmetric shock using time consistent policies under EMU or a free float. Our results suggest that there are significant costs associated with Monetary Union, particularly when fiscal policy is not used as a stabilisation tool. Of course we have only looked at one side of the equation, and the benefits from EMU are also significant, but our results do at least indicate the potential importance of asymmetric shocks and nominal inertia.

This finding appears to be robust to alternative parameter values, although we did find that there might be situations in which a country experiencing a supply shock could be better off under EMU (although only at the expense of the rest of the union). Further research might explore robustness to model specification, and one interesting direction would be to incorporate intertemporal optimisation by consumers. In addition, our analysis could be extended by directly estimating the equations of the model, and conducting stochastic simulations based on historical shocks.

Acknowledgements

This research was made possible by Grant No. F.124L from the Leverhulme Trust. Our thanks to Andrew Hughes Hallett and Yue Ma and two anonymous referees for help, and Warwick McKibbin for the DYNGAME programme. Responsibility for any errors is ours alone.

References

Bean, C. (1994). 'Economic and Monetary Union in Europe', Discussion Paper No. 86, Centre for Economic Performance, London School of Economics, London.

Commission of the European Communities (1990). 'One Market, One Money: an Evaluation of the Potential Benefits and Costs of Forming an Economic and Monetary Union', *European Economy*, **44**.

Giovannini, A. (1988). 'The Real Exchange Rate, the Capital Stock, and Fiscal Policy', *European Economic Review*, **32**, 1747–67.

Hughes Hallett, A.J. and Vines, D. (1991). 'Adjustment Difficulties Within a European Monetary Union: Can they be Reduced?' in E.J. Drifill and M. Beber (eds), *One Currency for Europe*, Lothian Foundation Press.

Hughes Hallett, A.J. and Vines, D. (1993). 'On the Possible Costs of European Monetary Union', *Manchester School,* **LXI**, 35–64.

Ireland, J. and Wren-Lewis, S. (1994). 'Inflation Dynamics in a New Keynesian Model', ICMM Discussion Paper No. 24, University of Strathclyde.

Layard, R., Nickell, S. and Jackman, R. (1991). *Unemployment: Macroeconomic Performance and the Labour Market*, Oxford University Press, Oxford.

Leith, C.B. and Wren-Lewis, S. (1997). 'Policy Gradualism in a New Keynesian Model', mimeo, University of Exeter.

Martin, C. (1995). 'Inertia, Adjustment and Myopia: Price Inertia in OECD Countries', paper given at CEPR Workshop, Aarhus.

Masson, P. and Symansky, S. (1992). 'Evaluating the EMS and EMU Using Stochastic Simulations: Some Issues', in R. Barrell and J. Whitley, (eds), *Macroeconomic Policy Cooperation in Europe*, SAGE.

McKibbin, W.J. (1992). 'DYNGAME: Algorithm for Solving Dynamic Games', mimeo.

McKibbin, W.J. and Sachs, J.D. (1991). *Global Linkages: Macroeconomic Interdependence and Cooperation in the World Economy*, Brookings Institute, Washington, DC.

Minford, P., Rastogi, A. and Hughes Hallett, A. (1992). 'ERM and EMU—Survival, Costs and Prospects' in R. Barrell and J. Whitley (eds), *Macroeconomic Policy Cooperation in Europe*, SAGE.

Oudiz, G. and Sachs, J. (1985). 'International Policy Coordination in Dynamic Macroeconomic Models' in W.H. Buiter, and R.G. Marston, (eds), *International Economic Policy Coordination*, Cambridge University Press, Cambridge.

Price, S. (1992). 'Forward Looking Price Setting in UK Manufacturing', *Economic Journal*, **102**, 497–505.

Wren-Lewis, S., Darby, J., Ireland, J. and Ricchi, O. (1996). 'The Macroeconomic Effects of Fiscal Policy: Linking an Econometric Model with Theory' *Economic Journal*, **106**, 543–59.

Table A1.0 One-year 10% asymmetric demand shock. Simulation 1.0

	Year 1	Year 2	Year 3	Year 4	Year 5
Free float					
Germany					
CPI inflation	−0.67	0.67	0.05	0.00	−0.00
output price inflation	0.01	−0.03	−0.00	0.00	0.00
output	0.29	−0.19	−0.02	−0.00	0.00
nominal interest rate	4.15	0.12	−0.02	−0.03	−0.03
nominal exchange rate	−3.69	0.46	0.58	0.57	0.54
fiscal stance	−0.27	0.12	0.01	0.00	0.00
wealth	−4.43	−4.39	−4.19	−3.99	−3.80
France					
CPI inflation	0.32	−0.26	−0.05	−0.00	−0.00
output price inflation	−0.01	0.02	0.00	0.00	−0.00
output	−0.21	0.12	0.02	0.00	0.00
nominal interest rate	1.92	−0.10	−0.03	−0.02	−0.02
nominal exchange rate	−1.36	0.56	0.46	0.42	0.40
fiscal stance	0.21	−0.09	−0.01	−0.00	−0.00
wealth	−0.25	−0.13	−0.10	−0.10	−0.09
EMU					
Germany					
CPI inflation	−0.09	0.17	−0.02	−0.02	−0.01
output price inflation	0.15	−0.06	−0.04	−0.03	−0.02
output	1.26	−0.14	−0.07	−0.05	−0.04
nominal interest rate	3.03	0.01	−0.02	−0.02	−0.02
nominal exchange rate	−2.52	0.51	0.52	0.50	0.47
fiscal stance	−1.47	0.11	0.07	0.05	0.03
wealth	−3.06	−3.05	−2.99	−2.90	−2.80
France					
CPI inflation	−0.26	0.24	0.02	0.01	0.01
output price inflation	−0.15	0.05	0.04	0.03	0.02
output	−0.18	0.06	0.07	0.05	0.04
nominal interest rate	3.03	0.01	−0.02	−0.02	−0.02
nominal exchange rate	−2.52	0.51	0.52	0.50	0.47
fiscal stance	1.41	−0.08	−0.07	−0.05	−0.03
wealth	−1.63	−1.46	−1.31	−1.19	−1.10

Notes All figures represent deviations from base. For the exchange rate a positive number represents a depreciation.

Table A1.1 One year 10% asymmetric demand shock. Simulation 1.1.

	Year 1	Year 2	Year 3	Year 4	Year 5
Free float					
Germany					
CPI inflation	−0.71	0.74	0.03	−0.00	−0.00
output price inflation	0.02	−0.04	−0.00	0.00	0.00
output	0.32	−0.22	−0.01	−0.00	0.00
nominal interest rate	4.35	0.05	−0.02	−0.03	−0.03
nominal exchange rate	−3.81	0.54	0.60	0.57	0.55
fiscal stance	0.00	0.00	0.00	0.00	0.00
wealth	−4.69	−4.52	−4.30	−4.10	−3.90
France					
CPI inflation	0.36	−0.32	−0.03	−0.00	−0.00
output price inflation	−0.01	0.02	0.00	0.00	−0.00
output	−0.24	0.14	0.01	0.00	0.00
nominal interest rate	1.79	−0.07	−0.02	−0.02	−0.02
nominal exchange rate	−1.27	0.52	0.45	0.42	0.40
fiscal stance	0.00	0.00	0.00	0.00	0.00
wealth	−0.06	−0.02	−0.02	−0.02	−0.01
EMU					
Germany					
CPI Inflation	0.00	0.11	−0.05	−0.03	−0.02
output price inflation	0.31	−0.17	−0.09	−0.05	−0.03
output	2.93	−0.49	−0.25	−0.14	−0.08
nominal interest rate	3.07	−0.01	−0.02	−0.02	−0.02
nominal exchange rate	−2.54	0.53	0.52	0.50	0.47
fiscal stance	0.00	0.00	0.00	0.00	0.00
wealth	−4.06	−3.98	−3.85	−3.70	−3.54
France					
CPI inflation	−0.36	0.31	0.05	0.03	0.01
output price inflation	−0.31	0.16	0.09	0.05	0.03
output	−2.85	0.41	0.25	0.14	0.08
nominal interest rate	3.07	−0.01	−0.02	−0.02	−0.02
nominal exchange rate	−2.54	0.53	0.52	0.50	0.47
fiscal stance	0.00	0.00	0.00	0.00	0.00
wealth	−0.69	−0.56	−0.47	−0.42	−0.38

Notes All figures represent deviations from base. For the exchange rate a positive number represents a depreciation.

Table A1.2 One year 10% Asymmetric Demand Shock. Simulation 1.2.

	Year 1	Year 2	Year 3	Year 4	Year 5
Free float					
Germany					
CPI inflation	−0.65	0.59	0.05	−0.00	0.00
output price inflation	0.03	−0.10	−0.01	0.00	0.00
output	0.39	−0.28	−0.03	−0.00	0.00
nominal interest rate	4.03	0.14	−0.01	−0.02	−0.02
nominal exchange rate	−3.65	0.38	0.52	0.51	0.49
fiscal stance	−0.26	0.12	0.01	0.00	0.00
wealth	−4.42	−4.39	−4.20	−4.00	−3.81
France					
CPI inflation	0.29	−0.21	−0.04	−0.01	0.00
output price inflation	−0.03	0.05	0.01	0.00	−0.00
output	−0.25	0.14	0.02	0.00	0.00
nominal interest rate	1.97	−0.10	−0.03	−0.02	−0.02
nominal exchange rate	−1.39	0.58	0.48	0.45	0.43
fiscal stance	0.20	−0.09	−0.01	−0.00	−0.00
wealth	−0.25	−0.13	−0.10	−.010	−0.09
EMU					
Germany					
CPI inflation	−0.02	0.11	−0.04	−0.03	−0.01
output price inflation	0.27	−0.16	−0.08	−0.04	−0.02
output	1.28	−0.24	−0.10	−0.06	−0.03
nominal interest rate	3.00	0.02	−0.02	−0.02	−0.02
nominal exchange rate	−2.52	0.48	0.50	0.48	0.46
fiscal stance	−1.28	0.15	0.08	0.05	0.03
wealth	−3.23	−3.27	−3.22	−3.12	−3.01
France					
CPI inflation	−0.33	0.27	0.05	0.02	0.01
output price inflation	−0.27	0.11	0.08	0.05	0.03
output	−1.14	0.10	0.10	0.06	0.03
nominal interest rate	3.00	0.02	−0.02	−0.02	−0.02
nominal exchange rate	−2.52	0.48	0.50	0.48	0.46
fiscal stance	1.22	−0.12	−0.08	−0.05	−0.03
wealth	−1.44	−1.24	−1.08	−0.97	−0.89

Notes All figures represent deviations from base. For the exchange rate a positive number represents a depreciation.

Table A1.3 One year 10% asymmetric demand shock. Simulation 1.3.

	Year 1	Year 2	Year 3	Year 4	Year 5
Free float					
Germany					
CPI Inflation	−0.49	0.50	0.02	0.00	−0.00
output price inflation	0.01	−0.02	−0.00	0.00	0.00
output	0.19	−0.13	−0.01	−0.00	0.00
nominal interest rate	2.64	0.05	−0.01	−0.01	−0.01
nominal exchange rate	−2.37	0.27	0.32	0.31	0.30
fiscal stance	−0.15	0.07	0.00	0.00	0.00
wealth	−2.99	−2.91	−2.79	−2.66	−2.55
France					
CPI inflation	0.29	−0.26	−0.02	−0.01	0.00
output price inflation	−0.01	0.02	0.00	−0.00	−0.00
output	−0.15	0.09	0.01	0.00	−0.00
nominal interest rate	0.81	−0.06	−0.01	−0.01	−0.01
nominal exchange rate	−0.54	0.27	0.21	0.20	0.19
fiscal stance	0.13	−0.06	−0.00	−0.00	−0.00
wealth	0.31	0.34	0.33	0.31	0.29
EMU					
Germany					
CPI inflation	−0.02	0.08	−0.02	−0.02	−0.01
output price inflation	0.14	−0.06	−0.04	−0.03	−0.02
output	1.24	−0.14	−0.08	−0.05	−0.04
nominal interest rate	1.73	−0.00	−0.01	−0.01	−0.01
nominal exchange rate	−1.46	0.27	0.27	0.26	0.25
fiscal stance	−1.41	0.11	0.07	0.05	0.03
wealth	−2.05	−2.07	−2.05	−2.00	−1.95
France					
CPI inflation	−0.18	0.15	0.02	0.01	0.01
output price inflation	−0.14	0.06	0.04	0.03	0.02
output	−1.20	0.09	0.08	0.05	0.04
nominal interest rate	1.73	−0.00	−0.01	−0.01	−0.01
nominal exchange rate	−1.46	0.27	0.27	0.26	0.25
fiscal stance	1.39	−0.10	−0.07	−0.05	−0.03
wealth	−0.62	−0.50	−0.41	−0.35	−0.31

Notes All figures represent deviations from base. For the exchange rate a positive number represents a depreciation.

Table A1.4 One year 10% asymmetric demand shock. Simulation 1.4.

	Year 1	Year 2	Year 3	Year 4	Year 5
Free float					
Germany					
CPI inflation	−0.49	0.50	0.02	−0.00	−0.00
output price inflation	0.01	−0.02	0.00	0.00	0.00
output	0.16	−0.12	−0.00	−0.00	0.00
nominal interest rate	3.29	0.04	−0.01	−0.01	−0.01
nominal exchange rate	−3.02	0.27	0.32	0.30	0.29
fiscal stance	−0.12	0.06	0.00	0.00	−0.00
wealth	−4.61	−4.47	−4.26	−4.06	−3.87
France					
CPI inflation	0.18	−0.16	−0.01	−0.00	−0.00
output price inflation	−0.01	0.01	0.00	−0.00	−0.00
output	−0.09	0.06	0.00	0.00	0.00
nominal interest rate	1.72	−0.03	−0.01	−0.01	−0.01
nominal exchange rate	−1.45	0.27	0.24	0.23	0.22
fiscal stance	0.08	−0.04	−0.00	−0.00	0.00
wealth	−0.10	−0.04	−0.04	−0.04	−0.03
EMU					
Germany					
CPI inflation	−0.08	0.13	−0.02	−0.01	−0.01
output price inflation	0.14	−0.07	−0.04	−0.02	−0.01
output	1.26	−0.19	−0.09	−0.06	−0.03
nominal interest rate	2.50	0.01	−0.01	−0.01	−0.01
nominal exchange rate	−2.23	0.27	0.28	0.27	0.25
fiscal stance	−1.31	0.14	0.08	0.05	0.03
wealth	−3.22	−3.24	−3.18	−3.09	−2.98
France					
CPI inflation	−0.23	0.21	0.02	0.01	0.01
output price inflation	−0.14	0.06	0.04	0.02	0.01
output	−1.19	0.12	0.09	0.06	0.03
nominal interest rate	2.50	0.01	−0.01	−0.01	−0.01
nominal exchange rate	−2.23	0.27	0.28	0.27	0.25
fiscal stance	1.26	−0.12	−0.08	−0.05	−0.03
wealth	−1.49	−1.28	−1.12	−1.01	−0.93

Notes All figures represent deviations from base. For the exchange rate a positive number represents a depreciation.

Table A1.5 One year 10% asymmetric demand shock. Simulation 1.5.

	Year 1	Year 2	Year 3	Year 4	Year 5
Free float					
Germany					
CPI inflation	−0.61	0.67	0.04	−0.00	−0.01
output price inflation	0.01	−0.03	0.00	0.00	0.00
output	0.27	−0.19	−0.01	−0.00	0.00
nominal interest rate	4.11	0.05	−0.07	−0.08	−0.07
nominal exchange rate	−3.22	0.88	0.93	0.86	0.79
fiscal stance	−0.25	0.11	0.01	0.00	0.00
wealth	−4.25	−4.02	−3.66	−3.33	−3.03
France					
CPI inflation	0.31	−0.26	−0.04	−0.00	0.00
output price inflation	−0.01	0.02	0.00	−0.00	−0.00
output	−0.21	0.12	0.01	0.00	−0.00
nominal interest rate	1.86	−0.15	−0.07	−0.06	−0.05
nominal exchange rate	−1.04	0.82	0.67	0.60	0.55
fiscal stance	0.20	−0.09	−0.01	−0.00	0.00
wealth	−0.23	−0.10	−0.08	−0.07	−0.06
EMU					
Germany					
CPI inflation	−0.07	0.17	−0.03	−0.02	−0.01
output price inflation	0.14	−0.07	−0.04	−0.03	−0.02
output	1.25	−0.16	−0.09	−0.06	−0.04
nominal interest rate	2.98	−0.05	−0.07	−0.07	−0.06
nominal exchange rate	−2.13	0.85	0.80	0.73	0.67
fiscal stance	−1.43	0.12	0.08	0.05	0.04
wealth	−2.95	−2.83	−2.66	−2.48	−2.30
France					
CPI inflation	−0.23	0.24	0.02	0.01	0.01
output price inflation	−0.14	0.06	0.04	0.03	0.02
output	−0.18	0.08	0.09	0.06	0.04
nominal interest rate	2.98	−0.05	−0.07	−0.07	−0.06
nominal exchange rate	−2.13	0.85	0.80	0.73	0.67
fiscal stance	1.38	−0.09	−0.08	−0.05	−0.04
wealth	−1.53	−1.29	−1.09	−0.93	−0.80

Notes All figures represent deviations from base. For the exchange rate a positive number represents a depreciation.

Table A2.0 Three year 10% asymmetric demand shock. Simulation 2.0.

	Year 1	Year 2	Year 3	Year 4	Year 5
Free float					
Germany					
CPI inflation	−1.13	0.14	0.36	0.74	0.05
output price inflation	0.04	−0.03	−0.04	−0.04	0.00
output	0.40	0.05	−0.00	−0.22	−0.02
nominal interest rate	2.03	2.98	4.32	0.08	−0.07
nominal exchange rate	−7.72	−5.69	−2.71	1.60	1.69
fiscal stance	−0.32	−0.12	−0.09	0.14	0.01
wealth	−4.36	−8.79	−13.0	−12.6	−12.0
France					
CPI inflation	0.30	0.12	−0.03	−0.32	−0.05
output price inflation	−0.03	0.00	0.02	0.03	0.00
output	−0.22	−0.09	−0.05	0.14	0.02
nominal interest rate	1.94	2.01	1.76	−0.16	−0.07
nominal exchange rate	−4.30	−2.35	−0.34	1.42	1.26
fiscal stance	0.22	0.09	0.08	−0.11	−0.01
wealth	−0.26	−0.36	−0.43	−0.27	−0.24
EMU					
Germany					
CPI inflation	−0.22	0.21	0.15	0.11	−0.07
output price inflation	0.35	0.13	−0.04	−0.18	−0.12
output	1.32	1.00	0.87	−0.37	−0.23
nominal interest rate	1.99	2.49	3.04	−0.04	−0.07
nominal exchange rate	−6.01	−4.02	−1.53	1.51	1.47
fiscal stance	−1.39	−1.18	−1.15	0.32	0.22
wealth	−3.12	−6.36	−9.51	−9.44	−9.25
France					
CPI inflation	−0.61	0.05	0.18	0.31	0.07
output price inflation	−0.34	−0.15	0.02	0.17	0.13
output	−1.14	−1.03	−0.92	0.29	0.23
nominal interest rate	1.99	2.49	3.04	−0.04	−0.07
nominal exchange rate	−6.01	−4.02	−1.53	1.51	1.47
fiscal stance	1.28	1.16	1.14	−0.29	−0.22
wealth	−1.50	−2.79	−3.97	−3.44	−3.02

Notes All figures represent deviations from base. For the exchange rate a positive number represents a depreciation.

Table A2.1 Three year 10% asymmetric demand shock. Simulation 2.1.

	Year 1	Year 2	Year 3	Year 4	Year 5
Free float					
Germany					
CPI inflation	−1.20	0.18	0.38	0.78	0.02
output price inflation	0.04	−0.03	−0.04	−0.04	0.00
output	0.43	0.04	−0.01	−0.23	−0.01
nominal interest rate	2.20	3.04	4.42	0.01	−0.08
nominal exchange rate	−7.94	−5.74	−2.70	1.72	1.72
fiscal stance	0.00	0.00	0.00	0.00	0.00
wealth	−4.66	−9.19	−13.5	−12.9	−12.3
France					
CPI inflation	0.36	0.08	−0.05	−0.36	−0.03
output price inflation	−0.04	0.01	0.02	0.03	0.00
output	−0.25	−0.08	−0.05	0.15	0.01
nominal interest rate	1.91	1.98	1.68	−0.12	−0.06
nominal exchange rate	−4.20	−2.29	−0.31	1.37	1.25
fiscal stance	0.00	0.00	0.00	0.00	0.00
wealth	−0.06	−0.08	−0.09	−0.04	−0.04
EMU					
Germany					
CPI inflation	−0.05	0.25	0.10	−0.03	−0.13
output price inflation	0.65	0.19	−0.13	−0.42	−0.23
output	2.78	1.92	1.71	−1.14	−0.62
nominal interest rate	2.05	2.51	3.05	−0.06	−0.07
nominal exchange rate	−6.07	−4.02	−1.51	1.54	1.48
fiscal stance	0.00	0.00	0.00	0.00	0.00
wealth	−4.09	−8.18	−12.1	−11.8	−11.4
France					
CPI inflation	−0.79	0.02	0.24	0.44	0.13
output price inflation	−0.64	−0.21	0.11	0.41	0.23
output	−2.60	−1.95	−1.77	1.06	0.62
nominal interest rate	2.05	2.51	3.05	−0.06	−0.07
nominal exchange rate	−6.07	−4.02	−1.53	1.51	1.47
fiscal stance	0.00	0.00	0.00	0.00	0.00
wealth	−0.63	−1.09	−1.48	−1.16	−0.96

Notes All figures represent deviations from base. For the exchange rate a positive number represents a depreciation.

Table A3.0 One year 2% asymmetric wage shock. Simulation 3.0.

	Year 1	Year 2	Year 3	Year 4	Year 5
Free float					
Germany					
CPI inflation	3.04	0.16	0.01	0.00	−0.00
output price inflation	3.19	−0.01	−0.00	0.00	0.00
output	−0.79	−0.05	−0.00	−0.00	0.00
nominal interest rate	0.61	0.03	−0.01	−0.01	−0.01
nominal exchange rate	2.81	3.42	3.44	3.43	3.42
fiscal stance	0.45	0.04	0.00	0.00	0.00
wealth	−0.54	−0.48	−0.39	−0.30	−0.21
France					
CPI inflation	0.18	−0.13	−0.01	−0.00	−0.00
output price inflation	0.04	0.01	0.00	−0.00	−0.00
output	0.17	0.05	0.00	0.00	0.00
nominal interest rate	−0.09	−0.04	−0.01	−0.01	−0.01
nominal exchange rate	0.34	0.25	0.21	0.20	0.19
fiscal stance	−0.21	−0.03	−0.00	−0.00	−0.00
wealth	0.24	0.27	0.27	0.26	0.24
EMU					
Germany					
CPI inflation	2.25	−0.20	−0.15	−0.11	−0.07
output price inflation	2.74	−0.37	−0.26	−0.18	−0.13
output	−1.30	−0.67	−0.47	−0.33	−0.24
nominal interest rate	0.26	−0.01	−0.01	−0.01	−0.01
nominal exchange rate	1.57	1.83	1.83	1.82	1.81
fiscal stance	0.97	0.62	0.44	0.31	0.22
wealth	−1.17	−1.81	−2.21	−2.43	−2.54
France					
CPI inflation	0.97	0.23	0.15	0.10	0.07
output price inflation	0.49	0.37	0.26	0.18	0.13
output	0.68	0.67	0.47	0.33	0.24
nominal interest rate	0.26	−0.01	−0.01	−0.01	−0.01
nominal exchange rate	1.57	1.83	1.83	1.82	1.81
fiscal stance	−0.74	−0.62	−0.44	−0.31	−0.22
wealth	0.87	1.60	2.09	2.39	2.58

Notes All figures represent deviations from base. For the exchange rate a positive number represents a depreciation.

Table A3.1 One year 2% asymmetric wage shock. Simulation 3.1.

	Year 1	Year 2	Year 3	Year 4	Year 5
Free Float					
Germany					
CPI inflation	3.12	0.09	0.00	−0.00	−0.00
output price inflation	3.12	−0.00	0.00	0.00	0.00
output	−0.82	−0.03	−0.00	0.00	0.00
nominal interest rate	0.31	0.00	−0.01	−0.01	−0.01
nominal exchange rate	3.10	3.41	3.41	3.40	3.39
fiscal stance	0.00	0.00	0.00	0.00	0.00
wealth	−0.12	−0.05	0.03	0.11	0.18
France					
CPI inflation	0.12	−0.07	−0.00	−0.00	0.00
output price inflation	0.04	0.00	0.00	−0.00	−0.00
output	0.20	0.03	0.00	0.00	−0.00
nominal interest rate	−0.08	−0.02	−0.01	−0.01	−0.01
nominal exchange rate	0.29	0.21	0.19	0.19	0.18
fiscal stance	0.00	0.00	0.00	0.00	0.00
wealth	0.05	0.05	0.05	0.05	0.05
EMU					
Germany					
CPI inflation	2.15	−0.23	−0.14	−0.08	−0.04
output price inflation	2.54	−0.42	−0.24	−0.13	−0.08
output	−2.23	−1.09	−0.62	−0.35	−0.20
nominal interest rate	0.12	−0.01	−0.01	−0.01	−0.01
nominal exchange rate	1.70	1.81	1.80	1.79	1.78
fiscal stance	0.00	0.00	0.00	0.00	0.00
wealth	−0.47	−0.66	−0.73	−0.74	−0.71
France					
CPI inflation	1.09	0.25	0.13	0.08	0.04
output price inflation	0.69	0.42	0.24	0.13	0.08
output	1.61	1.09	0.62	0.25	0.20
nominal interest rate	0.12	−0.01	−0.01	−0.01	−0.01
nominal exchange rate	1.70	1.81	1.80	1.79	1.78
fiscal stance	0.00	0.00	0.00	0.00	0.00
wealth	0.40	0.67	0.81	0.89	0.94

Notes All figures represent deviations from base. For the exchange rate a positive number represents a depreciation.

Appendix 1

'Central' Parameter Values

$\alpha_1 = 1.67$
$\alpha_2 = 0.1$
$\beta_1 = -1.25$
$\beta_2 = 1.25$
$\beta_3 = -0.9$

$\beta_4 = 2.0$
$\beta_5 = 0.1$
$\beta_6 = -0.05$
$\beta_7 = 0.36$
$\gamma_1 = -0.3125$
$\gamma_2 = 0.3125$
$\gamma_3 = -0.225$
$\gamma_4 = -0.5$
$\gamma_5 = -0.025$
$\gamma_6 = 0.0125$
$\gamma_7 = 0.09$