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Unemployment and monetary integration - On the relevance of wage formation characteristics in a target zone regime versus an irrevocably-fixed exchange rate regime - *

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Abstract

This paper examines the relevance of wage formation characteristics for the evolution of unemployment comparing the current semi-fixed exchange rate system (EMS, described by a target zone regime) to an irrevocably-fixed exchange rate regime (EMU). The topic is analyzed in a model which emphasizes the working of the labour market and which distinguishes between three types of shocks (a shock to money demand, goods demand and goods supply). The analysis points out that the impact of wage formation on unemployment depends crucially on the kind of shock hitting the economy as well as on the exchange rate regime in force.

1. Introduction

In the past two decades, the European Community has experienced sharp increases in unemployment. By the end of 1993, average unemployment has risen above 10 per cent, compared with around 3 per cent in the early 1970s. This evolution was clearly founded in a number of negative developments that have occurred in this period, including higher oil prices, more intensive international competition (intensified by the rise of newly industrialized countries), and the worldwide recession of the late 1970s and early 1980s [e.g. OECD (1989)].

It is well-known that the wage formation process is of crucial importance for the way the economy reacts to shocks of this kind [see, e.g., Grubb et al. (1983); Klau and Mittelstädt (1986); and Van Gompel and Van Poeck (1993)]. In this paper we contribute to this literature by questioning whether in an EMU the impact of wage formation characteristics on the evolution of unemployment becomes more or less important. The topic is analyzed in a model in which the economy is disturbed by three types of shocks (a shock to money demand, goods demand and goods supply) and in which we consider the planned transition from the current system of semi-fixed parities (as represented by the EMS target zone regime) to a system of irrevocably-fixed exchange rates (i.e. a monetary union). The analysis points out that the impact of wage formation on the unemployment evolution depends crucially on the kind of shock the economy undergoes as well as on the exchange rate regime in force.

The theoretical novelty of the paper is twofold. First, since Krugman's seminal (1991) paper, relatively little research has dealt with the normative question whether a target zone regime performs better or worse than other possible regimes given a particular objective. Our paper contributes to this question by comparing unemployment in a target zone regime to unemployment in an irrevocably-fixed rate regime. Second, until now, the target zone literature lacked a well-developed description of the supply side of the economy. Our model not only contains a supply function, it also has labour demand and wage formation as ingredients.

The plan of the paper is as follows. In section 2 we model the working of the economy under both a target zone system (EMS) and a system of irrevocably-fixed exchange rates (EMU). In section 3 the regimes are compared by examining the effects of the various shocks. In section 4 the analysis is centred on questioning the relevance of wage formation characteristics for unemployment. Section 5 concludes.

2. Modelling the EMS and the EMU

When modelling the EMS and the EMU we must incorporate the basic elements associated with each regime. The most important feature of the present *European Monetary System* is the existence of narrow currency bands on the bilateral exchange rates between the participants of the Exchange Rate Mechanism (ERM). These bands are defined around the so-called central parities, which might be adjusted if necessary. Only recently, starting with Krugman (1991), successful attempts have been made in modelling explicitly the exchange rate behaviour in currency bands. These models are commonly referred to as *target zone models* and at the core is that the existence of the band and the credible commitment of the authorities to defend the exchange rate exert a stabilizing influence on the exchange rate. As in the original Krugman model, our paper only allows for interventions at the margins of the exchange rate band. This restriction is mainly dictated by algebraical considerations, though we fully recognize its consequences. Focusing on the EMS, Flood et al. (1991), e.g., find little empirical evidence for the standard target zone model of the exchange rate. For more realistic models, see Bertola and Caballero (1992) who consider the issue of repeated realignments of the exchange rate band, and Dominguez and Kenen (1992) who consider intramarginal interventions. The latter has become of importance especially since the Basle-Nyborg agreement of September 12, 1987, when facilities for intramarginal interventions were extended.

The properties of a *European Monetary Union* are given by the Delors Report and may formulated by the following two necessary conditions [EC Commission (1990, p.32)]: *(i)* Complete liberalization of capital transactions and full integration of banking and other financial markets; *(ii)* Elimination of the fluctuation margins and irrevocable locking of exchange rate parities. The first requirement is already met by most EMS countries (abolishment of capital controls on July 1, 1989), or will be met soon. The second step towards an EMU should take place gradually, rather than at once, with at the end the adoption of a single currency.

The model which encompasses both regimes is described by the following set of equations:

$$Y^d = a_1(S+P^*-P) - a_2I + \omega \tag{1}$$
$$Y^s = bN + \epsilon \tag{2}$$
$$N = -m(W-P-\epsilon) \tag{3}$$
$$U = L - N \tag{4}$$
$$P_c = vP + (1-v)(S+P^*) \tag{5}$$
$$W = g_1P_c - g_2U \tag{6}$$
$$M - P = d_1Y - d_2I - \delta \tag{7}$$
$$S^e - S = I - I^* \tag{8}$$

where Y^d: aggregate demand
Y^s: aggregate supply
S: nominal exchange rate
P: goods price
P_c: consumer price
I: nominal interest rate
N: labour demand
L: labour supply
W: nominal wage
U: unemployment rate
M: money supply
* indicates a foreign variable
^{e} indicates expected value
ω, ϵ, δ: random shocks
All variables except I, I^* and U are expressed in logs
$0 \le a_1, a_2, m, g_2, d_1, d_2$ and $0 \le b, g_1, v \le 1$

Equation (1) describes real aggregate demand for domestic output as a function of the relative prices of foreign and domestic goods and the interest rate. A rise in the foreign price relative to the domestic price (a deterioration of the terms of trade) is assumed to increase aggregate demand, while a rise in the interest rate is assumed to reduce aggregate demand.

Labour demand (equation (3)) is derived from the Cobb-Douglas production function given in equation (2)[1]. Labour supply is assumed to be exogenously given. Equation (4) defines the unemployment rate as the disequilibrium in the labour market. Consumer prices (equation (5)) are a weighted average of home and import prices. Of special importance is the wage formation process, which is presented in equation (6). This equation can be obtained from a simple bargaining story [see, e.g., Carlin and Soskice (1990, chapter 17)]. The size of the indexing parameter determines the extent to which the nominal wage is linked to consumer prices. It may reflect both an exogenous administrative process as well as the fact that, while bargaining, workers are concerned with their real wage. A second determinant is the state of the labour market, in particular the rate of unemployment. Equation (6) shows that as unemployment rises the bargained wage declines. With rising unemployment, workers become more solicitous about their jobs as compared to their wages, so their wage demands will be restrained. Moreover, employers will have a larger number of employable wokers at their disposal, so their wage offers can be expected to decline.

In equation (7) the demand for real balances is expressed as a function of income and the domestic interest rate, with money being deflated by the domestic price level. Finally, equation (8) represents the assumption of perfect asset substitution. The expected depreciation or appreciation of the currency is equal to the differential between domestic and foreign interest rates.

The model has some limits. E.g., it excludes expectations other than the expected exchange rate in the interest parity condition and it fixes the supply of labour. However, it improves on the simple monetary model of Krugman (1991) in that we consider several types of shocks and in that the supply side of the economy is modelled in detail[2].

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[1] Assuming profit maximizing firms, the real wage is equated to the marginal product of labour.

[2] When setting b to zero (a vertical supply curve) and a_1 to infinity (a horizontal demand curve), Krugman's monetary model is obtained as a special case.

Throughout the paper, each variable is defined as in deviation from its stationary level (i.e., the value obtained by setting all disturbances equal to zero). Therefore, all constants are deleted and all variables that are exogenous to the model are set equal to zero: $P^*=I^*=L=0$, while $S_p=0$ for a fixed exchange rate regime (S_p is the exchange rate parity). To solve the model explicitly for the exchange rate in a target zone, we assume that the stochastic shocks are all Brownian motion processes:

$$d\omega = \sigma_\omega dz_\omega$$
$$d\epsilon = \sigma_\epsilon dz_\epsilon$$
$$d\mu = \sigma_\mu dz_\mu$$

where σ_ω, σ_ϵ and σ_μ are the instantaneous standard deviations and dz_ω, dz_ϵ and dz_μ are independent Brownian motion processes with unit variances. ω and ϵ represent a shock to goods demand and supply, respectively. As is common in the target zone literature, the monetary shock is defined as a shock to velocity, with μ=M+δ [see Krugman (1991)].

Since a *fixed exchange rate* solution of the model is analytically easier than a target zone regime, we started solving for unemployment in an EMU. From the definition of an EMU it follows that $I=I^*=0$ (perfect capital mobility) and $S=S_p=0$ (irrevocable locking of the exchange rate). The solution for unemployment is then given by:

$$U_{EMU} = \frac{m(1-g_1v-a_1)\epsilon - m(1-g_1v)\omega}{(1+mg_2)a_1 + mb(1-g_1v)} \tag{9}$$

With an irrevocably-fixed exchange rate the money supply becomes endogenous. Velocity shocks are completely offset by the money supply and therefore have no effect on unemployment. A positive demand shock decreases unemployment, whereas the effect of a supply shock is ambiguous, depending on the sign of $1-g_1v-a_1$.

For the techniques needed to solve the model for the EMS, we heavily rely on a recent paper by Sutherland (1993). Solving the model for the *target zone regime* requires a mapping between the exchange rate and the shocks: $S = F(\omega,\epsilon,\mu)$. Applying Itô's lemma [see, e.g., Harrison (1985)] we obtain the following:

$$S^e - S = I - I^* = \tfrac{1}{2}\left[\sigma_\omega^2 F_{11}(\omega,\epsilon,\mu) + \sigma_\epsilon^2 F_{22}(\omega,\epsilon,\mu) + \sigma_\mu^2 F_{33}(\omega,\epsilon,\mu)\right] \tag{10}$$

where $F_{ii}(\omega,\epsilon,\mu)$ is the second order derivative of $F(\omega,\epsilon,\mu)$ with respect to the ith argument[3]. The model (1)-(8) can be solved to give the interest differential. Substituting the interest differential into (10) gives the following differential equation in $F(\omega,\epsilon,\mu)$:

$$\beta_1\omega + \beta_2\epsilon + \beta_3\mu + \beta_4 F(\omega,\epsilon,\mu) = \tfrac{1}{2}\left[\sigma_\omega^2 F_{11}(\omega,\epsilon,\mu) + \sigma_\epsilon^2 F_{22}(\omega,\epsilon,\mu) + \sigma_\mu^2 F_{33}(\omega,\epsilon,\mu)\right] \tag{11}$$

where

$$\beta_1 = \frac{d_1 mb(1-g_1 v) + (1+mg_2)}{N} > 0$$

$$\beta_2 = -\frac{(1-d_1 a_1)(1+g_2)m}{N} <> 0$$

$$\beta_3 = -\frac{(1+mg_2)a_1 + mb(1-g_1 v)}{N} < 0$$

$$\beta_4 = \frac{d_1 mba_1(1-g_1) + (1+mg_2)a_1 + mbg_1(1-v)}{N} > 0$$

and $N = (d_2+d_1a_2)mb(1-g_1v) + (d_2a_1+a_2)(1+mg_2) > 0$

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[3] We assume that the shocks are independent from one another, so there are no cross derivatives.

Because of analytical difficulties the differential equation (11) must be solved indirectly. Following Bertola and Svensson (1991) and Sutherland (1993), we propose an indirect route to the solution which uses a composite variable, denoted h:

$$h = \beta_1\omega + \beta_2\epsilon + \beta_3\mu \tag{12}$$

This allows us to rewrite the interest differential as

$$I-I^* = S^e-S = h + \beta_4 S \tag{13}$$

We can now write the exchange rate in the target zone as a function of h alone, i.e. $S=\overline{F}(h)$, where h evolves according to

$dh = \sigma dz$

with $\sigma^2 = \beta_1^2\sigma_\omega^2 + \beta_2^2\sigma_\epsilon^2 + \beta_3^2\sigma_\mu^2$ and

$dz = 1/\sigma \; (\beta_1\sigma_\omega dz_\omega + \beta_2\sigma_\epsilon dz_\epsilon + \beta_3\sigma_\mu dz_\mu)$

Applying Itô's lemma directly to $S=\overline{F}(h)$ gives the following ordinary differential equation:

$$h + \beta_4\overline{F}(h) = \tfrac{1}{2}\sigma^2\overline{F}''(h) \tag{14}$$

Equation (14) is solved as:

$$\overline{F}(h) = -h/\beta_4 + A_1e^{\rho h} + A_2e^{-\rho h} \tag{15}$$

where $\rho = \sqrt{(2\beta_4/\sigma^2)}$. The constants A_1 and A_2 are determined by boundary conditions, which will determine where the exchange rate reaches the edges of the band. By appealing to symmetry, $A_1 = -A_2 = A < 0$. Equation (15) solves equation (11) and is thus the solution for the exchange rate $S=F(\omega,\epsilon,\mu)=\overline{F}(h)$. The boundary conditions are given by setting the first order derivative of $\overline{F}(h)$ equal to zero for both boundaries:[4]

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[4] Notice that the hyperbolic sine (sinh) and cosine (cosh) fulfill $\sinh(x)=[e^x-e^{-x}]/2$ and $\cosh(x)=[e^x+e^{-x}]/2$, and $tgh(x)=\sinh(x)/\cosh(x)$.

$\overline{F}'(h_L) = -1/\beta_4 + 2A\rho\cosh(\rho h_L) = 0$
$\overline{F}'(h_U) = -1/\beta_4 + 2A\rho\cosh(\rho h_U) = 0$
Solving the boundary conditions for A, we obtain:

$$A = 1/2\beta_4\rho\cosh(\rho h_L) = 1/2\beta_4\rho\cosh(\rho h_U) \qquad (16)$$

Equation (15) can now be rewritten as:

$$S = \overline{F}(h) = -h/\beta_4 + \sinh(\rho h)/\beta_4\rho\cosh(\rho h_U) \qquad (15')$$

Equation (15') yields the typical '*S*-curve'. The smooth pasting conditions guarantee that $\overline{F}'(h_L)$ and $\overline{F}'(h_U)$ are equal to zero and that the *S*-curve is tangent to the band at top and bottom. There will also be an *S*-curve form relationship between the exchange rate and each shock individually. Notice that under a target zone regime, the exchange rate is zero only in the absence of shocks. This clearly contrasts to the fixed rate regime where the exchange rate is also zero in the presence of shocks. The target zone leads to ω, ϵ and μ being situated between lower and upper boundaries, ω_L, ϵ_L, μ_L and ω_U, ϵ_U, μ_U, respectively. When a shock hits its boundary the money supply is altered so that the composite variable h is prevented from diminishing below h_L or rising above h_U. The money supply will be changed according to the following rules:

$dM = -(\beta_1/\beta_3)d\omega$ for shocks to goods demand
$dM = -(\beta_2/\beta_3)d\epsilon$ for shocks to goods supply
$dM = -d\mu$ for velocity shocks.

The change in the money supply keeps the exchange rate within its band and causes the *S*-curve to shift leftwards or rightwards. The curve continues to shift to the right (left) for as long as there are positive (negative) shocks. If the shock makes a turn in the opposite direction [from positive (negative) to negative (positive)], the exchange rate is again moved into the interior of the band on the new *S*-curve.

The solution for the unemployment rate when a target zone is in force can be written as follows:

$$U_{EMS} = \frac{m[-(1-g_1)a_1+(1-g_1v)a_2\beta_4]\overline{F}(h) + m(1-g_1v)a_2h + m(1-g_1v-a_1)\epsilon - m(1-g_1v)\omega}{(1+mg_2)a_1 + mb(1-g_1v)} \tag{17}$$

The unemployment *S*-curve has some specific properties. First, contrary to the exchange rate *S*-curve, it does not smooth paste on to the edges of its band. It is easily seen that, at h_L and h_U, the derivative of equation (17) with respect to h is different from zero so the slope of the unemployment *S*-curve must be different from zero at the edges of its band.

Second, the coefficient on $\overline{F}(h)$ in equation (17) can either be positive or negative, which means that the unemployment *S*-curve can either be *'standing-up'* or *'recumbent'* within its band[5]. This difference arises since the impact of the exchange rate on unemployment happens through different channels, namely through aggregate demand and through the wage equation. On the one hand, a depreciation of the currency will decrease unemployment through its positive impact on the trade balance; it will increase unemployment by pulling up nominal wages, on the other. Since both influences are opposite in sign, there exists a critical degree of wage indexation, specifically $a_1d_2/(a_1d_2+a_2(1-v))$, at which the impact of the exchange rate on unemployment becomes positive.

[5] An *S*-curve is said to be standing-up within its band if, when hitting the band, its slope is decreasing; it is recumbent if, when hitting the band, its slope is increasing.

3. A comparison of unemployment between EMS and EMU under alternative shocks

The effects of the shocks on unemployment are obtained by simply taking the partial derivatives of equations (9) and (17) with respect to the shocks (see Appendix). Consider first the comparison of the effect of a μ shock. We have seen before that with shocks to money demand, unemployment will not change in an EMU. This is the well-known result that the goods market is completely insulated from money market disturbances when the authorities fix the exchange rate [see, e.g., Turnovsky (1983)]. It is easily shown that in the target zone regime the slope of the unemployment rate *S*-curve must be negative. Therefore, in case of a positive velocity shock, the EMS-regime is more effective in reducing unemployment, whereas for a negative shock an EMU is desirable in that it would prevent unemployment from increasing.

The effect of a supply shock, ϵ, is somewhat complicated and can only be ranked among the two regimes if a series of conditions are specified. In particular, to obtain clear results we must make assumptions regarding the signs of $1-g_1v-a_1$ and $1-d_1a_1$. The precise way in which the exchange rate and unemployment are influenced by a supply shock can best be shown graphically. We assume g_1 is rather low, such that the unemployment *S*-curve is standing-up. Let us concentrate on a positive supply shock. The sign of $1-g_1v-a_1$ determines whether unemployment will increase or decline. Figure 1 illustrates the case of an unemployment decline. As is seen, the effect of a supply shock on the exchange rate under the target zone also appears uncertain. It depends on the condition $1-d_1a_1 <> 0$, which questions whether the product of the price elasticity of goods demand and the income elasticity of money demand is less or greater than unity[6]. If the currency depreciates ($1-d_1a_1 > 0$, left panel) the effect of the supply shock on unemployment is larger under a target zone regime than that arising with a monetary union. However, the effect on unemployment

[6] The importance of this condition has already been noticed in the literature [see, e.g., Pilbeam (1991, chapter 2) and Van Gompel (1993)].

will be larger under an EMU with an appreciation of the currency ($1-d_1a_1 < 0$, right panel)[7].

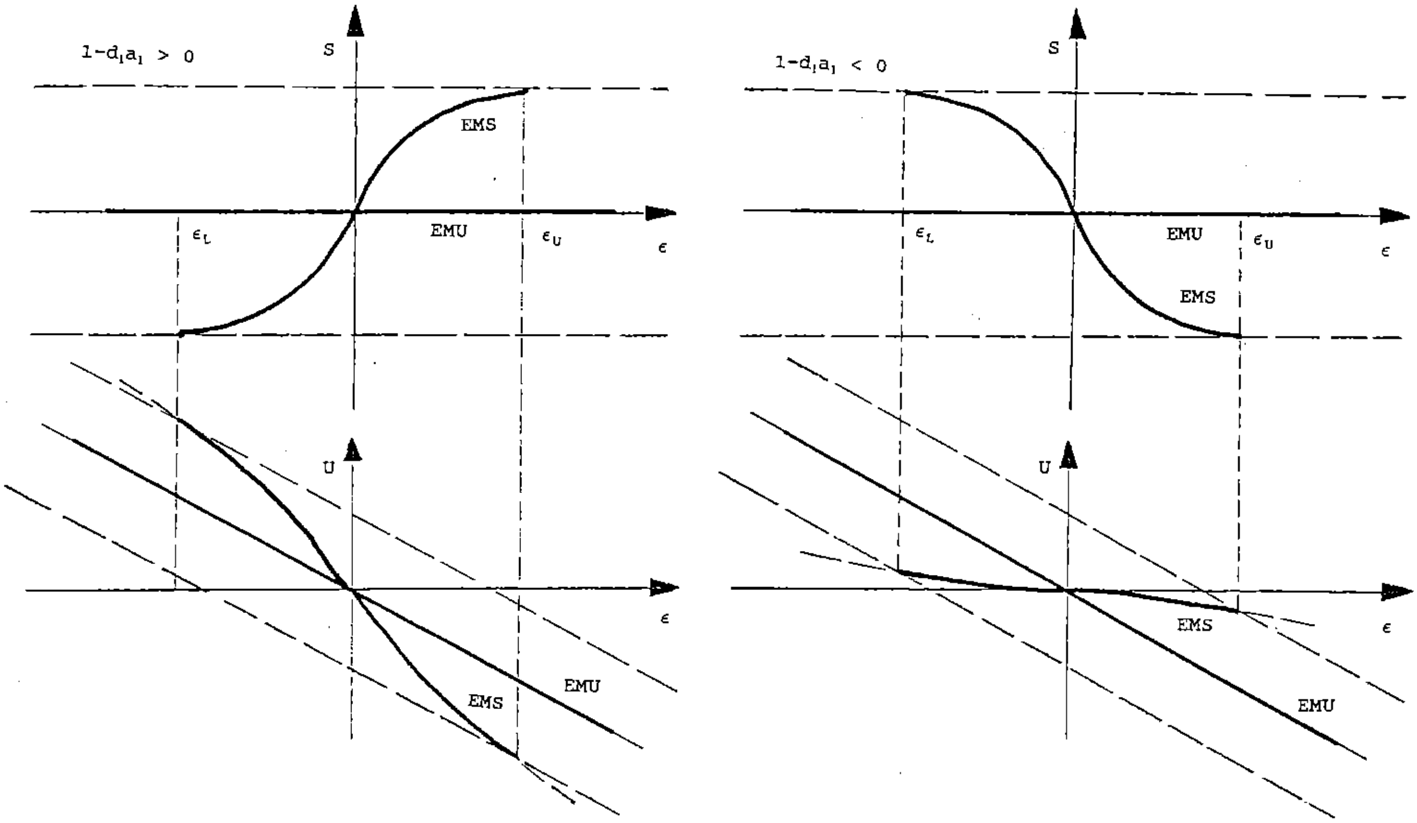

Fig. 1. Comparing EMS and EMU with shocks to goods supply: the declining unemployment case ($1-g_1v-a_1 < 0$).

Things completely change if unemployment increases ($1-g_1v-a_1 > 0$, figure 2). Now a depreciating currency, given a positive shock, makes the EMS less vulnerable to unemployment as compared to an EMU[8] (left panel), whereas the opposite holds for an appreciating currency under the EMS (right panel).

[7] Notice for completeness, that with an appreciating currency the impact of the supply shock on unemployment under the EMS may even be positive.

[8] In this case, a positive supply shock under the EMS may even result in a declining unemployment.

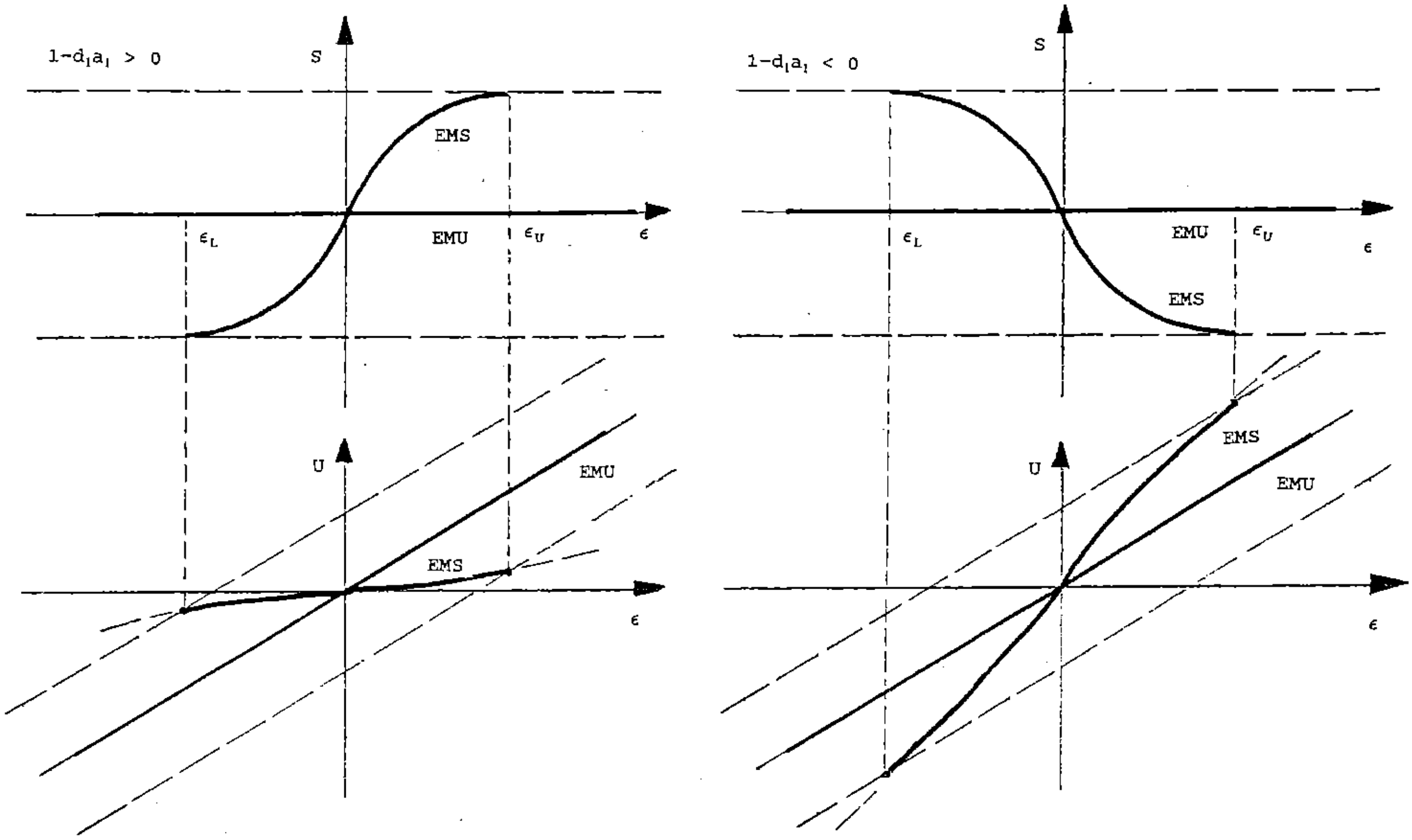

Fig. 2. Comparing EMS and EMU with shocks to goods supply: the increasing unemployment case ($1-g_1v-a_1 > 0$).

The precise way in which unemployment is influenced by a shock to goods demand is more clear. In both regimes a positive shock is always favourable to unemployment. However, the effect is smaller under a target zone regime than that arising with a monetary union. From the appendix it is clear that this result hinges on the fact that $0 \leq a_2\beta_1 \leq 1$.

4. How relevant are wage formation characteristics ?

In the previous section we have compared the unemployment effects under the two regimes. In this section we investigate the importance of the two wage equation parameters, g_1 and g_2, with a particular shock hitting the economy[9]. It is asked whether each of these parameters will have a larger effect on unemployment in an EMU as compared to the existing EMS. We show that, again, the nature of the shocks is very crucial.

Table 1

Wage formation characteristics and the exchange rate in a target zone regime

	μ		ϵ		ω	
	g_1	g_2	g_1	g_2	g_1	g_2
$1-d_1a_1 < 0$	+	+	-	?	-	+
$1-d_1a_1 > 0$	-	-	?	?	+	-

for μ, ϵ and $\omega > 0$:
-: a higher parameter g_i (i=1,2) leads to a DECLINE in S;
+: a higher parameter g_i (i=1,2) leads to an INCREASE in S;
?: no clear statement can be made, additional conditions must be formulated: $1-d_1a_1 <> v$ and $m <> 1$.

Before going into the details for unemployment, it is necessary to investigate whether the exchange rate in the EMS-target zone will behave differently according to the wage formation process. To see the sign of the impact of g_1 and g_2 on the exchange rate in the EMS with different kinds of shocks, we must calculate the partial derivate of equation (15') w.r.t. each of these parameters[10]. As table 1 shows, the effect of the shocks will be

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[9] Since the algebraical derivations are rather cumbersome, they are not given in the text. An extended version of this paper, which addresses the derivations in substantially more detail, can be obtained on simple request.

[10] Notice that the impact of the wage equation parameters at the edges of the band is to shift the boundaries μ_L, ϵ_L, ω_L and μ_U, ϵ_U, ω_U to the left or to the right. The direction of this movement is obtained by calculating the total differential of $S_{U,L} = -h/\beta_4 + tgh(\rho h_{U,L})/\beta_4\rho$. $S_{U,L}$ is a function of the boundaries $\mu_{U,L}$, $\epsilon_{U,L}$, $\omega_{U,L}$ and the parameters g_1, g_2. Keeping the exchange rate band fixed ($dS_{U,L}=0$), a change in one of the parameters will shift the boundaries of μ, ϵ and ω.

different in size for different magnitudes of the wage equation parameters. Also, the effect of the wage formation parameters depends on the kind of shock the economy undergoes. Notice that the effect of the parameters appears to be ambiguous depending on the condition $1-d_1a_1 <> 0$. This condition determines whether or not an increase in one of the wage equation parameters brings the boundaries μ_L, ϵ_L, ω_L and μ_U, ϵ_U, ω_U closer to zero, and therefore whether or not the EMS-country's money supply must be altered more quickly so as to prevent the exchange rate from rising above, or declining below, its margin.

Table 2

Wage formation characteristics and unemployment

	μ		ϵ		ω	
	g_1	g_2	g_1	g_2	g_1	g_2
EMS target zone	+	+	-	?	+	+
EMU fixed rate	0	0	-	?	+	+
EMS versus EMU	L	L	?	?	S	?

for μ, ϵ and $\omega > 0$:
-: a higher parameter g_i (i=1,2) leads to a DECLINE in U;
+: a higher parameter g_i (i=1,2) leads to an INCREASE in U;
L: the change in U due to a higher parameter g_i (i=1,2) will be LARGER in the EMS-country as compared to that in the EMU-country;
S: the change in U due to a higher parameter g_i (i=1,2) will be SMALLER in the EMS-country as compared to that in the EMU-country;
?: no clear conclusion can be formulated.

The change in unemployment due to changes in the wage formation process (given a particular shock) can be formalized by taking the partial derivative of equations (9) and (17) w.r.t. each wage formation parameter. These derivatives are compared between the two regimes to be able to make some judgements on the relative importance of the parameters. A summary of the results is given in table 2. These results can best be understood in combination with figures 3 and 4. As an illustration, we assume that $1-d_1a_1 > 0$ in both figures.

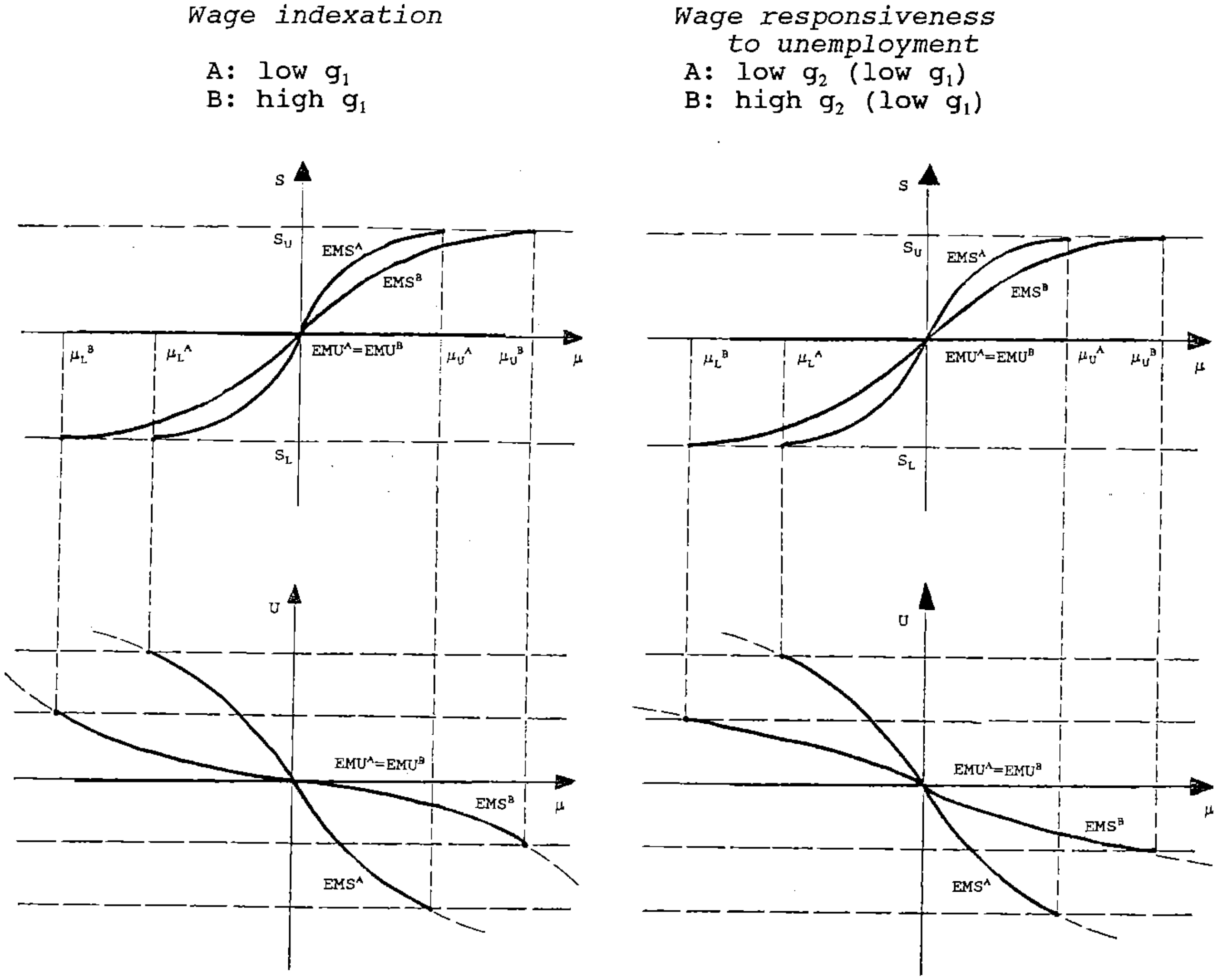

Fig. 3. Wage formation characteristics and unemployment with shocks to money demand.

Figure 3 shows the change in unemployment of a country being hit by a *shock to money demand*. From this figure it is clear that while in an EMU the wage equation characteristics are irrelevant with shocks to money demand, in the existing EMS a change in these characteristics is likely to affect the change in unemployment. The left panel shows the effects of a change in the degree of wage indexation. We already know that the precise shape of the unemployment curve under a target zone regime depends crucially on the degree of wage indexation. Indeed, according to the sign of the coefficient on $\overline{F}(h)$ in equation (17) and the direction of the exchange rate change, the unemployment curve can be standing-up or recumbent between its bands. Here, we simply assume that the degree of indexation changes from 'low' [i.e. $g_1 < a_1d_2/(a_1d_2+a_2(1-v))$] to 'high' [i.e. $g_1 > a_1d_2/(a_1d_2+a_2(1-v))$]. Hence, the unemployment *S*-curve changes from standing-up to being recumbent. In the former case, the exchange rate depreciation (for $\mu > 0$) leads to an additional decline in unemployment. Just as the increase in the exchange rate, the decline in unemployment will be declining towards the edges of the band. In the latter case, the exchange rate depreciation will reduce the decline in unemployment, who will now be increasing towards the edges of the band. The right panel shows similar effects of a change in the responsiveness of wages to unemployment. The country is assumed to have a 'low' degree of indexation and, therefore, a standing-up unemployment *S*-curve.

If the economy is hit by a *shock to goods supply*, the relative impact of changes in wage formation characteristics on unemployment depends on some of the parameter values. More in particular, we need information on the signs of $1-d_1a_1$, $1-d_1a_1-v$ and $1-m$ to make any comparison between EMS and EMU unambiguous. Hence, we do not give a graphical analysis since ambiguity is too large (see before).

With a *shock to goods demand*, again, results are not always very clear. Only with a change in the degree of wage indexation, we can be sure that the effect on the change in unemployment will be larger in the EMU-country than that in the EMS-country. Figure 4 illustrates this result, again assuming that $1-d_1a_1 > 0$. It considers an increase in the degree of indexation to the amount that the shape of the unemployment *S*-curve changes from standing-up to being recumbent. As is seen in the bottom panel, the distance between the two EMS-lines for a given shock is smaller than that between the two EMU-lines. So, the effect of the change in wage indexation on the unemployment change will be larger if a monetary union is in place. As table 2 makes clear, it was not possible to obtain a similar result for changes in wage responsiveness to unemployment.

Wage indexation

A: low g_1
B: high g_2

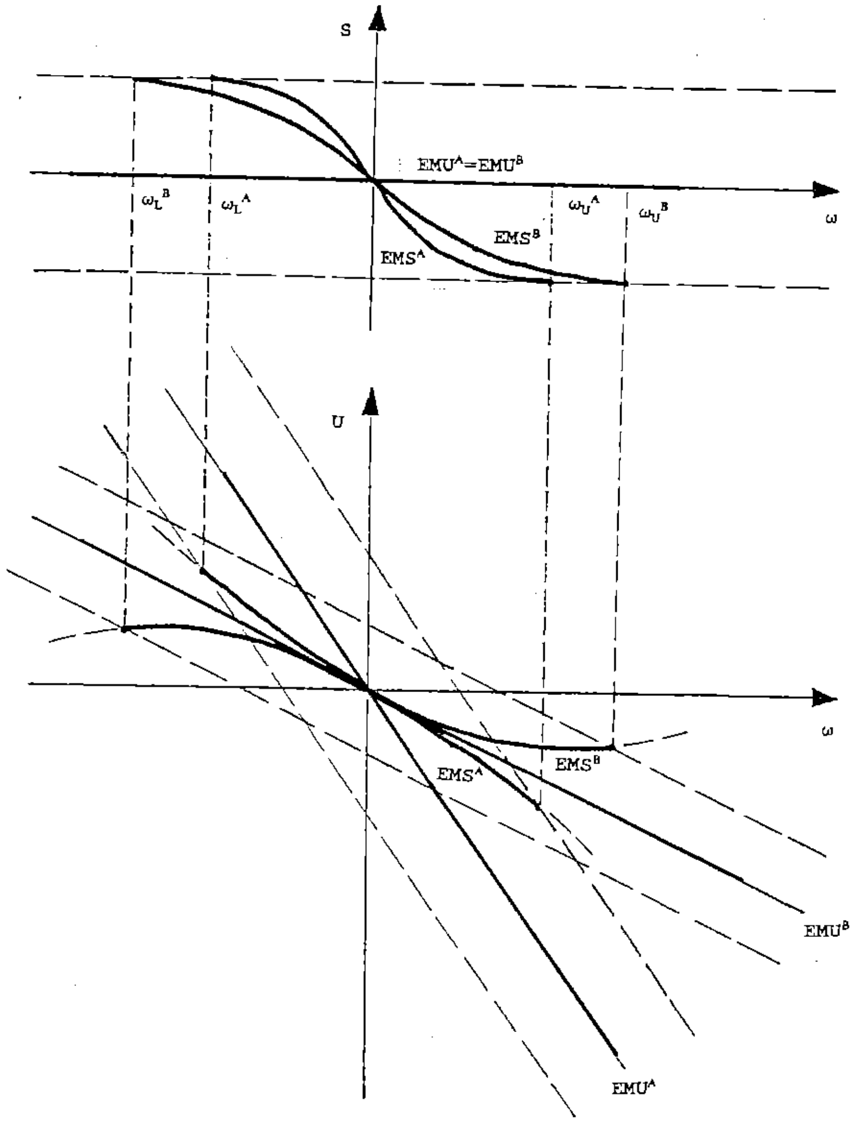

Fig. 4. Wage formation characteristics and unemployment with shocks to goods demand.

5. Conclusions

The conclusions that emerge from this paper are easily restated. First, we have shown that the impact of shocks to velocity on unemployment is smaller for a country belonging to an EMU as compared to a country belonging to the EMS, while the impact is larger with shocks to goods demand. With shocks to goods supply, no clear conclusion can be given.

Second, it is difficult to argue that particular characteristics of a country's wage formation process are more important for the unemployment performance under one exchange rate regime as compared to another. Indeed, the relevance of wage formation is likely to be enormously uncertain depending on the precise shock hitting the economy, the structural parameters of the model as well as the exchange rate regime that the country adheres. The ambiguities are summarized as follows. Wage formation characteristics in an EMU-country are highly irrelevant for unemployment when it is hit by a monetary shock (its unemployment will remain unchanged). In the EMS-country, however, wage formation does affect the unemployment change with such a shock. With shocks to goods demand, a change in wage indexation results in a larger impact on unemployment in an EMU-country as compared to an EMS-country. For changes in wage responsiveness to unemployment no clear conclusions can be drawn. Finally, with shocks to goods supply, results become very much indeterminate.

Appendix

1. Monetary shocks

$$\frac{\partial U_{EMS}}{\partial \mu} = \frac{m[-(1-g_1)a_1+(1-g_1v)a_2\beta_4]\overline{F}_\mu'\beta_3 + m(1-g_1v)a_2\beta_3}{(1+mg_2)a_1 + mb(1-g_1v)}$$

$$\frac{\partial U_{EMU}}{\partial \mu} = 0$$

$$\frac{\partial S_{EMS}}{\partial \mu} = \overline{F}_\mu' = -\beta_3/\beta_4(1-\cosh(\rho\mu)/\cosh(\rho\mu_U)) > 0$$

where $\overline{F}_\mu' = 0$ at the boundaries μ_L and μ_U
$\overline{F}_\mu'' = (\beta_3/\beta_4)(\sinh(\rho\mu)/\cosh(\rho\mu_U)) <> 0$ if $\mu >< 0$

2. Supply shocks

$$\frac{\partial U_{EMS}}{\partial \epsilon} = \frac{m[-(1-g_1)a_1+(1-g_1v)a_2\beta_4]\overline{F}_\epsilon'\beta_2 + m(1-g_1v)a_2\beta_2 + m(1-g_1v-a_1)}{(1+mg_2)a_1 + mb(1-g_1v)}$$

$$\frac{\partial U_{EMU}}{\partial \epsilon} = \frac{m(1-g_1v-a_1)}{(1+mg_2)a_1 + mb(1-g_1v)}$$

$$\frac{\partial S_{EMS}}{\partial \epsilon} = \overline{F}_\epsilon' = -\beta_2/\beta_4(1-\cosh(\rho\epsilon)/\cosh(\rho\epsilon_U))$$

where $\overline{F}_\epsilon' <> 0$ if and only if $1-d_1a_1 <> 0$ (or $\beta_2 >< 0$)
$\overline{F}_\epsilon' = 0$ at the boundaries ϵ_L and ϵ_U
$\overline{F}_\epsilon'' = (\beta_2/\beta_4)(\sinh(\rho\epsilon)/\cosh(\rho\epsilon_U)) <> 0$ if $\epsilon <> 0$

3. Demand shocks

$$\frac{\partial U_{EMS}}{\partial \omega} = \frac{m[-(1-g_1)a_1+(1-g_1v)a_2\beta_4]\overline{F}_\omega'\beta_1 + m(1-g_1v)a_2\beta_1 - m(1-g_1v)}{(1+mg_2)a_1 + mb(1-g_1v)}$$

$$\frac{\partial U_{EMU}}{\partial \omega} = \frac{-\,m(1-g_1v)}{(1+mg_2)a_1 + mb(1-g_1v)}$$

$$\frac{\partial S_{EMS}}{\partial \omega} = \overline{F}_\omega' = -\beta_1/\beta_4(1-\cosh(\rho\omega)/\cosh(\rho\omega_U)) < 0$$

where $\overline{F}_\omega' = 0$ at the boundaries ω_L and ω_U
$\overline{F}_\omega'' = (\beta_1/\beta_4)(\sinh(\rho\omega)/\cosh(\rho\omega_U)) <> 0$ if $\omega <> 0$

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