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Does monetary union reduce employment?

Suomen Pankin keskustelualoitteita
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Does monetary union reduce employment?

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Abstract

We use a two-country monetary model with unionized labor markets and open-economy spillovers to study the macroeconomic consequences of the formation of a monetary union. It is shown that the monetary regime affects the trade-off between real consumer wages and employment faced by the unions. Consequently, the equilibrium employment is endogenous and depends on the monetary regime. In particular, a switch from a floating exchange rate regime to a monetary union improves employment, provided that the degree of central bank conservatism is sufficiently high, whereas with low degrees of conservatism employment falls. Inflation is higher in a monetary union with all finite degrees of central bank conservatism. In addition, we consider an asymmetric fixed exchange rate regime as an alternative starting position for a monetary union. All results are derived assuming that labor unions are only interested in employment and real wages (not directly inflation) and that all structural parameters of the model remain unchanged when a monetary union is established.

Key words: monetary union, employment, labor unions, open-economy spillovers, central bank conservatism

JEL classification: E52, E58, F33, J51

Heikentääkö rahaliitto työllisyyttä?

Suomen Pankin keskustelualoitteita 7/2001

Anssi Rantala
Tutkimusosasto

Tiivistelmä

Tässä työssä tarkastellaan rahaliiton muodostamisen makrotaloudellisia vaikutuksia kahden maan mallissa, jossa työmarkkinat ovat järjestäytyneet ja maiden välillä on ulkoisvaikutuksia. Tarkastelut perustuvat oletukseen, että ammattiliitot eivät suoranaisesti ole kiinnostuneet inflaatiosta, vaan työllisyydestä ja reaalipalkoista, ja että talouksien rakennetta kuvaavat parametrit eivät muutu, kun rahaliitto perustetaan. Työssä osoitetaan, että valuuttakurssijärjestelmä vaikuttaa ammattiliiton havaitsemaan tavoiteristiriitaan palkan ja työllisyyden välillä. Siten tasapainotyöllisyys määräytyy endogeenisesti ja riippuu siis valuuttakurssijärjestelmästä. Siirryttäessä kelluvien valuuttakurssien järjestelmästä rahaliittoon työllisyys paranee, jos keskuspankki on riittävän konservatiivinen. Jos keskuspankki taas ei ole riittävän konservatiivinen, työllisyys heikkenee. Inflaatio on rahaliitossa huomattavampi keskuspankin konservatiivisuuden asteesta riippumatta. Lisäksi työssä tarkastellaan epäsymmetristä kiinteän valuuttakurssin järjestelmää vaihtoehtoisena alkuasetelmana ennen rahaliittoa.

Asiasanat: rahaliitto, työllisyys, ammattiliitot, avotalouden ulkoisvaikutukset, keskuspankin konservatiivisuus

JEL luokitus: E52, E58, F33, J51

Contents

1 Introduction

This paper investigates the effects of the formation of a monetary union on employment and inflation. A large literature on monetary policy games initiated by the seminal contributions of Kydland and Prescott (1977) and Barro and Gordon (1983) shows that under a wide range of assumptions monetary policy is neutral in the long run and the equilibrium rate of employment is determined only by real factors of the economy. Hence employment should not be affected by the establishment of a monetary union which is just a change of monetary regime. However, in the presence of non-atomistic labor unions the non-neutrality result of monetary policy emerges and the conservatism of the central bank will have a systematic effect on equilibrium employment.[1] This has been shown eg by Cukierman and Lippi (1999), Lippi (1999) and Soskice and Iversen (2000).

Recent papers by Grüner and Hefeker (1999) and Cukierman and Lippi (2000) analyze the effects of a monetary union on economic performance in a model with non-atomistic labor markets. They show that the establishment of a monetary union will decrease employment and increase inflation, if national labor unions are inflation averse, ie in addition to traditional real wage and employment targets labor unions are also concerned about inflation *per se*. Inflation aversion moderates wage claims and improves employment, because unions are willing to compromise over the real wage target in order to reduce inflation. In a monetary union each union perceives, that its wage demand will have a smaller effect on inflation, which makes unions more aggressive in wage setting. Higher real wages lead to lower employment through reduced demand for labor. However, this result depends crucially on the assumed inflation aversion of the labor unions. Absent that, monetary union has no effect on employment and inflation.[2]

In this paper, we show that in a model with open-economy spillovers, a switch from a floating exchange rate regime to a monetary union will affect macroeconomic performance, even when national labor unions are not averse to inflation and all structural parameters of the model remain unchanged. In particular, employment will increase, provided that the degree of central bank conservatism is sufficiently high, whereas with low degrees of conservatism employment falls. Relative inflation performance will not depend on central bank conservatism, inflation will always increase in a monetary union. In addition, we consider an asymmetric fixed exchange rate regime, where one country has unilaterally committed to a fixed exchange rate *vis-à-vis* the other country before the monetary union is established.[3] We show that in this asymmetric

[1] We will use the term 'conservatism' to describe the relative weight of inflation in the central bank objective function. Elsewhere in the literature 'independence' is occasionally used interchangeably with 'conservatism' (see eg Cukierman and Lippi (1999)). Berger, de Haan and Eijffinger (2000) discusses the difference between the two concepts.

[2] Cukierman and Lippi (2000) show that monetary union will have real effects even without inflation aversion, if there are more than one labor union in each country.

[3] An asymmetrix fix can be thought as a simple and crude description of the Exchange Rate Mechanism (ERM) in Europe. Grüner and Hefeker (1999) and Cukierman and Lippi (2000) consider also a change from the ERM to a monetary union.

fix case employment will fall in the leader country and increase in the follower country when a monetary union is established.

Our modeling framework is a two-country monetary model with open-economy spillovers and national labor unions. Each country is specialized in a production of a traded good, which are imperfect substitutes in consumption. Both goods are consumed in both countries, and their relative demand depends on the relative price between the two goods. Imperfect substitutability between the two goods creates two policy spillovers. Central banks can affect the real exchange rate with their policies, and thus their actions will have repercussions in both countries. National labor unions choose their nominal wages before monetary policies are set, and their wage setting will also affect the real exchange rate. Due to these spillovers, monetary regime will in general affect the labor union's real wage–employment trade-off, ie the real consumer wage elasticity of labor demand is endogenous in our model.[4]

Although our model specification is closely related to that of Grüner and Hefeker (1999), the mechanism behind the results is completely different. In their model, purchasing power parity is assumed to hold, and therefore economic performance under a floating exchange rate is solely determined by domestic policy actions. In a monetary union each labor union thus becomes smaller in a sense that their wage claims will have a smaller effect on the general price level, which is a policy target of the monetary authorities. As mentioned above, this makes labor unions more aggressive in a monetary union provided that they are inflation averse. In our model, this size effect is absent. Due to the spillover effects, both domestic and foreign wages affect the economic performance in both countries even in a floating exchange rate regime. The only change in the strategic environment of the labor unions is the replacement of the national central banks by a common central bank. Policy targets as well as policy instruments of the monetary policy authorities will change in a monetary union. It is thus quite intuitive that the policy reaction to a unilateral wage increase by one labor union will change as well. Changed monetary policy reaction will, in turn, induce different wage setting behavior from the labor unions. Macroeconomic consequences of a monetary union are *a priori* ambiguous, but as mentioned, they will depend on central bank conservatism.

Monetary union is an extreme form of monetary policy cooperation.[5] In literature, cooperation usually means that central banks set their policy instruments jointly so as to maximize (minimize) a weighted average of their policy objectives. Rogoff (1985b) showed, that monetary policy cooperation can be counterproductive in the presence of domestic credibility problems. In a floating exchange rate regime monetary policies are constrained by fears of inflationary real exchange rate depreciation. In a cooperative policy regime this real exchange rate effect is internalized. Therefore monetary policies are more expansionary and inflation will be higher. Monetary union differs from a cooperative policy regime in one important respect. A common central bank has only one policy instrument available. This is a crucial difference in our

[4]Holden (1999) shows that monetary regime affects the real wage–employment trade-off in a small open economy framework.

[5]For a comprehensive survey on international policy coordination, see Persson and Tabellini (1995).

setup with large wage setters. In a cooperative regime, a unilateral wage increase by one national labor union will induce asymmetric response from the two central banks, as long as the effects in the two economies are asymmetric. However, when a common central bank faces a unilateral wage increase in one country, its policy will, by definition, be symmetric. Jensen (1993) analyses monetary policy cooperation in the same setup as ours, and shows that in a cooperative regime employment is always lower than in a floating exchange rate regime.[6]

Our focus is on the direct effect of a monetary union on equilibrium employment through changes in the strategic interaction between central banks and labor unions. There are at least two additional channels through which equilibrium employment might be affected.

First, monetary integration may enhance product market integration and thus also competition via lower transaction costs, the disappearance of the exchange rate risks and easier price comparisons between countries. This has been a common argument in policy debates concerning the effects of the Economic and Monetary Union (EMU) in Europe. Intensified competition in the product markets improve employment in two ways. Labor demand becomes more elastic with respect to wages and firms' mark-ups are reduced. However, as Burda (1999) and Calmfors (2000) point out, it is not clear that increased product market integration will foster competition. On the contrary, integration may help multinational companies to penetrate the markets and therefore competition can actually decrease.

Second, incentives for labor market reforms can be affected by the establishment of a monetary union. This has been analyzed by Calmfors (1999) and Sibert and Sutherland (2000). Here, reform refers to any structural reform in the labor markets which reduces the equilibrium rate of unemployment. The government can choose the level of reform before labor unions set their wages and before monetary policy is set. The reform lowers the equilibrium rate of unemployment, but it entails a cost to the government. This cost can arise for various reasons, eg the reform reduces real wages or because workers value labor market institutions in themselves. The main argument of these papers is intuitive. Outside a monetary union a low level of reform implies that unemployment is high. In addition, in the presence of an inflation bias, inflation will be high as well. If the government chooses a low level of reform in a monetary union, the first effect is obviously the same. However, the second effect is reduced. High unemployment in one member country has only a small effect on the area-wide average level of unemployment. The common central bank cares about the average level of unemployment and thus inflation bias is smaller in a monetary union. Therefore, the government's incentives for labor market reform are reduced in a monetary union and the chosen reform level will be lower.

This paper is organized as follows. Section 2 presents the model setup. The model is solved and macroeconomic outcomes in both monetary regimes are derived in Section 3. Finally, Section 4 analyzes the macroeconomic con-

[6]Monetary policy cooperation with inflation averse labor unions is treated in Jensen (1997).

sequences of the formation of a monetary union. A switch from a asymmetric fix to a monetary union is studied in Section 5. Section 6 concludes.

2 The model

2.1 Basic structure

In this section, we describe the basic structure of the model. Our model specification in a floating exchange rate regime follows Jensen (1993, 1997), which a variant of the standard two-country monetary model studied in Canzoneri and Henderson (1988). We will extend Jensen's model to cover the case of a monetary union.

There are two equal sized countries, each specialized in the production of a traded good. All variables are in natural logarithms and are expressed as deviations from a full employment equilibrium. Foreign variables are denoted with an asterisk. Throughout the paper, we assume that all structural parameters are equal across countries.

Home and foreign output supplies, denoted by y and y^*, are deterministic functions of employments, n and n^*, subject to decreasing returns to scale

$$y = \alpha n, \qquad y^* = \alpha n^* \qquad 0 < \alpha < 1 \tag{1}$$

This formulation can be derived from a Cobb-Douglas production function by fixing the capital stock and normalizing it to unity. Labor is immobile between countries and supplied inelastically. Profit maximizing firms employ labor up to the point at which real product wages are equal to marginal products of labor

$$(w - p) = -(1 - \alpha) n, \qquad (w^* - p^*) = -(1 - \alpha) n^* \tag{2}$$

where nominal wages are denoted by w and w^*, while p and p^* are the product prices of home and foreign countries respectively.[7]

Relative output demand is a function of the real exchange rate, z

$$y - y^* = \delta z \qquad \delta > 0 \tag{3}$$

where the parameter δ can be interpreted as indexing the degree of substitutability between home and foreign goods. A large value of δ implies, that the two goods are close substitutes and therefore a small change in the real exchange rate brings about a large change in relative demand. The real exchange rate is defined as the relative price of the foreign good in terms of the domestic good, expressed in home country currency

$$z = e + p^* - p \tag{4}$$

where the nominal exchange rate, denoted by e, is the domestic price of foreign currency. Thus a decrease in z implies that domestic currency appreciates

[7] The marginal product of labor is actually $(w - p) = \ln \alpha - (1 - \alpha) n$, but the constant is omitted for notational simplicity.

in real terms. By definition, in a monetary union (the log of) the nominal exchange rate is zero, and the real exchange rate is simply

$$z = p^* - p \tag{5}$$

Assuming a constant share of imports in consumption, β, the domestic and foreign consumer price indices (CPIs) are given by

$$\pi = (1-\beta)\, p + \beta\,(e + p^*) = p + \beta z \tag{6}$$

$$\pi^* = \beta\,(p - e) + (1-\beta)\, p^* = p^* - \beta z \tag{7}$$

We restrict the value of β to lie in the interval $0 < \beta < \frac{1}{2}$, which is equivalent to assuming a home bias in consumption.[8] This seems to be a rather mild restriction, as there is a large empirical literature on the home bias in trade showing that people have a strong preference for consumption of their home goods.[9]

Money demand is assumed to be proportional to nominal income and only domestic residents hold domestic money. The money markets are in equilibrium when nominal money supplies, m and m^*, satisfy simple quantity equations

$$m = p + y, \qquad m^* = p^* + y^* \tag{8}$$

In a monetary union there is only one currency, which is held by the residents in both countries. Monetary equilibrium requires that union-wide money demand equals union-wide money supply. Following Lane (1996) we assume that money demand is proportional to average nominal income of the member countries

$$m^U = \frac{1}{2}\,(p + y) + \frac{1}{2}\,(p^* + y^*) \tag{9}$$

where m^U is the union-wide money supply. We assume that the common money supply is spread out equally on both member countries, and thus the common central bank can't affect the distribution of money supply across countries.

2.2 Labor union and central bank preferences

In each country there is a single monopoly union, which sets the nominal wage rate. Unions' utility functions are given by

$$U = \gamma\,(w - \pi) - \frac{1}{2}n^2, \qquad U^* = \gamma\,(w^* - \pi^*) - \frac{1}{2}n^{*2} \tag{10}$$

where $(w - \pi)$ and $(w^* - \pi^*)$ are the real consumer wages and n and n^* are employments expressed as deviations from the full employment equilibrium. Unions' utility depends positively on real wages and negatively on the gap

[8] This is a common assumption in the open-economy macro literature, see eg Buiter, Corsetti and Pesenti (1995), Lane (1996, 2000) and Zervoyianni (1997).

[9] See eg Obstfeld and Rogoff (2000) and references therein.

between realized and full employment levels, which is consistent with traditional labor union theory (see eg Oswald (1985)).[10] This is where our paper departs from much of the recent literature on strategic interaction between labor unions and the central bank. Usually it is assumed that labor unions care not only about the real wage and employment, but also about inflation *per se*.[11]

Why should labor unions be interested in inflation? The standard explanation is that union members have some non-indexed nominal assets or incomes other than their salaries, such as bank deposits or pensions, which values are eroded by inflation. However, for example pensioners are usually not labor union members, and it seems unlikely that unions would look after their interests. In many papers labor unions' inflation aversion is actually driving the results, and therefore a closer look on possible reasons for inflation aversion would be desirable.[12] In this paper, we abstract from inflation aversion and apply the more conventional formulation of labor union preferences given above.

Monetary policy is subject to a credibility problem in both countries and therefore central banks act in a discretionary manner. Policy preferences are given by the loss functions

$$L = \sigma n^2 + \pi^2, \qquad L^* = \sigma n^{*2} + \pi^{*2} \qquad 0 \leq \sigma < \infty \tag{11}$$

which are quadratic both in employments and CPIs. CPI inflation is defined as the difference between the log price levels in current and previous periods, $\pi - \pi_{-1}$. Without loss of generality, we can normalize the previous period price level to zero, and thus CPI and CPI inflation are equivalent in this setup. Both central banks target full employment and zero inflation.

The parameter σ reflects the relative weight placed by the central bank on employment deviations from the full employment level. The inverse of σ $\left(\frac{1}{\sigma}\right)$ thus measures the Rogoff (1985a) type of conservatism of the central bank. The smaller σ is, the more the central bank cares about inflation and the less about employment, i.e. it allows employment to deviate more from full employment level in order to push inflation closer to zero. Nominal money supplies, m and m^*, are the policy instruments of the central banks.

[10] The functional form of the utility function is admittedly quite specific. However, it yields a set of convex downward sloping indifference curves in $(n, (w - \pi))$ space when n is below full employment level. This form is widely used in log-linear models, likely because parallel shifts in labor demand curve does not affect employment. This implies that there is a natural rate of employment, which is independent of demand conditions.

[11] See Cukierman and Lippi (1999) and references therein. However, Soskice and Iversen (2000) and Coricelli, Cukierman and Dalmazzo (2000a) also abstract from labor union inflation aversion in a closed-economy setting and Coricelli, Cukierman and Dalmazzo (2000b) in a two-country monetary union model.

[12] A step into this direction is taken in Berger, Hefeker and Schöb (2001), where inflation aversion is endogenized by assuming that the outside option of the labor union is defined in nominal terms.

In a monetary union the common central bank is assumed to care only about the average employment and average inflation[13]

$$L^u = \sigma \left(\frac{n + n^*}{2} \right)^2 + \left(\frac{\pi + \pi^*}{2} \right)^2 \qquad 0 \leq \sigma < \infty \tag{12}$$

Labor unions and central banks have the same employment target. At first blush, this seems to suggest, that the central banks don't have an over-ambitious employment target and therefore there is no time-inconsistency problem in monetary policy. However, introducing a real wage target into the union's utility function brings about a trade-off between employment and the real wage. In order to attain a positive real wage, the union is willing to give up its full employment target. When unions are interested in both employment and real wages, which is consistent with the traditional labor union literature, the equilibrium rate of employment is endogenous (and below full employment) in the model.

2.3 Timing of the model

Events unfold as follows. (1) The two labor unions set their nominal wages simultaneously taking the other union's wage as given. They have full information about the reaction functions of the central banks and take them into account in the wage setting process. In other words, unions act as Stackelberg leaders against the central banks. (2) The central banks choose their money supplies simultaneously taking the other central bank's money supply as well as previously set nominal wages as given. In a monetary union the common central bank sets the union-wide money supply. (3) Production and trade take place and macroeconomic outcomes are realized.

The choice of modeling the game between labor unions and central banks as a Stackelberg game is supported by observations on real world wage setting and monetary policy practices. Wage contracts are usually negotiated to cover at least a year, whereas monetary policy can be adjusted frequently. As already mentioned, we assume that the central banks cannot credibly commit to a policy rule. In other words, we consider the time-consistent (discretionary) monetary policy. However, the behavior of the labor unions can be time-inconsistent as well. It may be the case, that after the central banks have set their money supplies, the labor unions find it optimal to renege on the wage contracts and set new higher or lower nominal wages. This possibility is ruled out by assuming that nominal wage contracts are legally binding for the whole contract period.

[13] In a symmetric case, where all structural parameters are the same across countries, we can show that similar first order conditions are obtained if the common central bank minimizes the weighted average of the national loss functions.

3 Monetary policy and wage setting

In this section, we solve the two-stage game between labor unions and central banks in both monetary regimes by backward induction. Starting from the second stage, we present equilibrium strategies for central banks in a floating exchange rate regime and for a common central bank in a monetary union case. Then we solve the wage setting problem at the first stage and derive equilibrium outcomes for macroeconomic variables.

3.1 Monetary policy in a floating exchange rate regime

First we present the reduced forms for home and foreign employments and inflations in a floating exchange rate regime.[14] These equations are obtained from equations (1)–(4) and (6)–(8).

$$n = m - w, \qquad n^* = m^* - w^* \tag{13}$$

$$\pi = (1-\alpha)\, m + \alpha w + \tfrac{\alpha\beta}{\delta}\,(m - w - m^* + w^*) \tag{14}$$

$$\pi^* = (1-\alpha)\, m^* + \alpha w^* - \tfrac{\alpha\beta}{\delta}\,(m - w - m^* + w^*) \tag{15}$$

From equation (13) we see, that a domestic wage increase has a direct effect on employment in home country, whereas foreign employment is unaltered. The home product price is increased (see equation (47) in the Appendix) in order to balance the money market. The real exchange rate appreciates so that the goods markets are in equilibrium (see equation (48) in the Appendix). This reduces domestic consumer prices and increases foreign consumer prices. The total effect on domestic CPI is ambiguous, but the foreign CPI increases, ie inflation is exported by a unilateral wage increase.

Next we consider a unilateral monetary expansion. Domestic employment increases, and to balance the money market the product price increases (see equation (47) in the Appendix). Goods market equilibrium calls for real exchange rate depreciation. Domestic consumer price index increases and foreign consumer price index decreases because of the real exchange rate depreciation.

The central bank's problem is to minimize the loss function (11) with respect to m subject to (13) and (14), taking nominal wages as given. The first-order condition can be written as

$$\pi = -\frac{\sigma}{1 - \alpha + \frac{\alpha\beta}{\delta}} n \tag{16}$$

This is the well-known Kydland and Prescott (1977) and Barro and Gordon (1983) inflation bias result. The central bank targets full employment, which in this model is zero. The lower the realized employment n is, ie the wider is the gap between the target level of employment and the equilibrium rate of employment, the higher is the rate of inflation. Also, with a given employment level, the more conservative the central bank, the lower is inflation.

[14] The reduced forms for the other endogenous variables are presented in the Appendix.

Inserting the reduced forms (13) and (14) into the first-order condition and solving it explicitly for m gives us the reaction function of the home central bank

$$m = \frac{\sigma - \Gamma\left(\alpha - \frac{\alpha\beta}{\delta}\right)}{(\sigma + \Gamma^2)} w + \frac{\Gamma\frac{\alpha\beta}{\delta}}{(\sigma + \Gamma^2)} (m^* - w^*) \tag{17}$$

where $\Gamma = \left(1 - \alpha + \frac{\alpha\beta}{\delta}\right)$. Depending on central bank conservatism, the central bank reacts to domestic wage increase either by expanding or contracting money supply. Cukierman, Rodrigues and Webb (1998) provide empirical evidence on monetary policy responses to wage increases. It turns out that in countries with highly conservative central banks, monetary policy is tightened in response to high wage settlements, whereas in countries with less conservative central banks monetary policy is accommodating.

Due to symmetry of the model, the foreign money supply schedule can be written symmetrically. The two central banks choose their non-cooperative policies simultaneously. The Nash equilibrium of the policy game is given by[15]

$$m^{Nash} = c_1 w + c_2 w^* \qquad c_1^f \lesseqgtr 0, \quad c_2^f \leq 0 \tag{18}$$

Finally, by inserting this expression into equations (13) and (14) we will get employments and inflations as functions of home and foreign nominal wages[16]

$$n = a_1^f w + a_2^f w^* \qquad a_1^f < 0, \quad a_2^f \leq 0 \tag{19}$$

$$\pi = b_1^f w + b_2^f w^* \qquad b_1^f \geq 0, \quad b_2^f \geq 0 \tag{20}$$

Both domestic and foreign wages decrease domestic employment and increase inflation. These two equations capture the monetary policy responses to unions' nominal wage claims. At the first stage of the game, labor unions rationally anticipate the policy responses and take them into account in wage setting.

3.2 Monetary policy in a monetary union

In this section, we turn to the monetary union case. As in the previous section, we first solve the reduced forms for employments and inflations from equations (1)–(3), (5)–(6) and (9). By definition, (the log of) the nominal exchange rate is now equal to zero, and the real exchange rate is simply expressed as the difference of (the logs of) the foreign and domestic product prices in equation (5). Money markets are in equilibrium when union-wide money supply equals

[15] The explicit forms of c_1 and c_2 are given in the Appendix.

[16] The explicit forms of the elasticities are given in the Appendix.

money demand, which depends on average union-wide nominal income. The reduced forms are given by[17]

$$n = m^U - \tfrac{1}{2}(w + w^*) + \tfrac{1}{2}\tfrac{\delta}{\alpha+(1-\alpha)\delta}(w^* - w) \tag{21}$$

$$n^* = m^U - \tfrac{1}{2}(w + w^*) - \tfrac{1}{2}\tfrac{\delta}{\alpha+(1-\alpha)\delta}(w^* - w) \tag{22}$$

$$\begin{aligned}\pi &= (1-\alpha)\, m^U + w - \left(\tfrac{1-\alpha}{2}\right)(w + w^*) \\ &+\tfrac{1}{2}\left(\tfrac{2\alpha\beta+(1-\alpha)\delta}{\alpha+(1-\alpha)\delta}\right)(w^* - w)\end{aligned} \tag{23}$$

$$\begin{aligned}\pi^* &= (1-\alpha)\, m^U + w^* - \left(\tfrac{1-\alpha}{2}\right)(w + w^*) \\ &-\tfrac{1}{2}\left(\tfrac{2\alpha\beta+(1-\alpha)\delta}{\alpha+(1-\alpha)\delta}\right)(w^* - w)\end{aligned} \tag{24}$$

From (21) we see, that in a monetary union employment depends directly on both domestic and foreign wages, whereas in a floating exchange regime only domestic wage enters the employment equation.[18] This can be understood by noting that money market equilibria in alternative regimes can be written as

$$m = (p + y) = (w + n), \qquad m^* = (p^* + y^*) = (w^* + n^*) \tag{25}$$

$$m^u = \tfrac{1}{2}(p + y) + \tfrac{1}{2}(p^* + y^*) = \tfrac{1}{2}(w + n) + \tfrac{1}{2}(w^* + n^*) \tag{26}$$

In a floating exchange rate regime a unilateral wage increase does not directly affect real variables in the other country, while in a monetary union both employments (and outputs) will in general be affected. From (26) we see that an increase of w generally affects both n and n^* when money supply and foreign wage are fixed.[19]

Unsurprisingly, the reduced forms reveal that an increase in the area-wide money supply has symmetric impact in both countries. Thus, the common central bank cannot affect the real exchange rate, which is solely determined by the labor unions (see equation (58)).

The common central bank chooses m^u in order to minimize the loss function (12) subject to (21)–(24). The first-order condition of the common central bank's optimization problem can be written as

$$\frac{\pi + \pi^*}{2} = -\frac{\sigma}{(1-\alpha)}\frac{(n + n^*)}{2} \tag{27}$$

which relates average inflation to average employment in the monetary union. Comparing this expression with equation (16) we find that with a given average employment level, average inflation is higher in a monetary union than under a floating exchange rate. As mentioned in Introduction, similar result is obtained in monetary policy cooperation case. In a floating exchange rate regime monetary policies are constrained by fears of inflationary real exchange

[17] Again, reduced forms for the other endogenous variables can be found in the Appendix.

[18] Employment depends indirectly on both home and foreign wages in a floating exchange rate regime, because monetary policies in both countries are affected by both w and w^*.

[19] When $\delta = 1$, the reduced form for n is equivalent in the two regimes. We will utilize this property later on, when we discuss about the intuition behind the main result of the model.

rate depreciation. In a monetary union the common central bank can't affect the real exchange rate and thus monetary policy will be more accommodating.

By solving the first-order condition explicitly for m^u gives us the reaction function of the common central bank

$$m^u = \frac{\sigma - \alpha\,(1-\alpha)}{2\left(\sigma + (1-\alpha)^2\right)}\,(w + w^*) \tag{28}$$

As expected, the central bank's reaction to wage increases is symmetric in a sense that a unilateral wage increase will induce an equal money supply reaction in both countries. If the central bank is conservative enough, it reduces money supply when nominal wages are raised.

Finally, employments and inflations as functions of the nominal wages in both countries are derived by inserting the reaction function into the reduced forms of n and π[20]

$$n = a_1^u w + a_2^u w^* \qquad a_1^u < 0, \quad a_2^u \lesseqgtr 0 \tag{29}$$

$$\pi = b_1^u w + b_2^u w^* \qquad b_1^u > 0, \quad b_2^u \lesseqgtr 0 \tag{30}$$

Now, foreign wage increase may increase employment in home country, if the central bank is relatively accommodating or the goods are close substitutes (see the Appendix). The home country nominal wage elasticity of inflation is always positive in a monetary union. An increase in home wage level increases home inflation more than foreign inflation, provided that $\beta < \frac{1}{2}$. If the central bank is very conservative, it will push the average inflation close to zero. Then the foreign inflation can become negative, whereas the home inflation will always be positive.

3.3 Wage setting and macroeconomic outcomes

The labor unions choose their wages in the first stage of the game taking the other union's wage as given. The unions have full information about the reaction functions of the central banks. This implies that the labor unions maximize their utility functions (10) subject to (19) and (20) in a floating exchange rate regime and subject to (29) and (30) in a monetary union. Solving the first-order condition for w yields the reaction function of the form

$$w = \gamma \frac{(1-b_1)}{(a_1)^2} - \frac{a_2}{a_1} w^* \tag{31}$$

In Nash equilibrium nominal wages are given by

$$w = \gamma \frac{(1-b_1)}{a_1\,(a_1 + a_2)} \tag{32}$$

Inserting the equilibrium nominal wage (32) into the reduced forms for employment (19) or (29) yields equilibrium employment

$$n = \gamma \frac{(1-b_1)}{a_1} \tag{33}$$

[20] The explicit forms are given in the Appendix.

Once equilibrium employments are derived, equilibrium inflation rates can be obtained from equations (16) and (27). Equation (33) reveals the source of underemployment and inflation in our model. The equilibrium rate of employment is always below full employment level when the labor union has a real wage target, ie $\gamma > 0$.

We follow the standard approach in labor union literature, where wages are either bargained between the labor union and the firm (right-to-manage model) or unilaterally chosen by the union (monopoly union model) and employment is determined from the labor demand curve. The slope of the labor demand curve in $(n, (w-p))$ space is $-(1-\alpha)$ (see equation (2)).[21] However, the labor union cares about the real consumer wage and employment. The real consumer wage contains also foreign product price as an element, and it turns out to be useful to study the effective labor demand curve for the union in $(n, (w-\pi))$ space[22]

$$(w-\pi) = \frac{1-b_1}{a_1} n - \frac{a_1 b_2 + (1-b_1)\, a_2}{a_1} w^* \tag{34}$$

Hence the slope coefficient, which directly determines employment in our model (see equation (33)) is $(1-b_1)/a_1$. It can be written as a function of the two nominal wage elasticities of employment, a_1 and a_2[23]

$$\frac{1-b_1}{a_1} = -(1-\alpha) - \frac{\alpha\beta}{\delta}\left(\frac{a_1 - a_2}{a_1}\right) \tag{35}$$

This formulation is especially helpful in employment comparisons presented in the next section.[24] Employment performance depends on two elasticities. The first one is the nominal wage elasticity of the real exchange rate, which is given by $\frac{\partial z}{\partial w} = \frac{\alpha}{\delta}(a_1 - a_2) \leq 0$. The stronger effect the wage has on the real exchange rate, the steeper is the effective labor demand curve. The second one is the home country nominal wage elasticity of employment, $a_1 < 0$. The larger is employment loss, the less steep is the effective labor demand curve.

[21] Since the variables are in logs, the slope coefficient can be directly converted into real product wage elasticity of labor demand, $\eta \equiv -\frac{\partial \log N}{\partial \log W/P} = -\frac{\partial n}{\partial (w-p)} = \frac{1}{1-\alpha} \in (1, \infty)$, which in our model depends only on production technology.

[22] This expression is obtained from the equations determining n and π as functions of w and w^*.

[23] Derivation of this expression can be found in the Appendix.

[24] From (34) and (35) we obtain the effective real consumer wage elasticity of labor demand $\eta_{(w-\pi)} \equiv -\frac{\partial \log N}{\partial \log W/\Pi} = -\frac{\partial n}{\partial (w-\pi)} = \frac{1}{1-\alpha+\frac{\alpha\beta}{\delta}\left(\frac{a_1-a_2}{a_1}\right)}$.

4 Monetary union

In this section, we analyze the macroeconomic consequences of the formation of a monetary union. All results are derived assuming that the structural parameters of the economy, as well as central bank and labor union preferences remain the same when a monetary union is established. In this way, we concentrate on the direct effects a monetary union will have on economic performance. The degree of central bank conservatism turns out to be a crucial factor in what happens to employment in a monetary union.

4.1 Employment and inflation effects of central bank conservatism

In the traditional Barro-Gordon analysis, employment is not affected by central bank conservatism. Labor markets are assumed to be atomistic, ie as Barro and Gordon (1983) put it "...a game between the policymaker and a large number of private-sector agents." This implies, that each agent is too small to have any effect on policy maker's behavior, and thus there is no strategic interaction between them. However, by giving up this assumption and introducing non-atomistic labor unions into the model the neutrality result disappears. Before analyzing the impact of monetary union on economic performance, we study the effects of central bank conservatism on employment and inflation in our model with open-economy spillovers.[25]

Remark 1 *An increase in the degree of central bank conservatism improves employment both in a floating exchange rate regime and in a monetary union.*

The intuition underlying this remark is simple.[26] When the central bank is more conservative, labor unions correctly anticipate tighter monetary policy and a larger fall in employment in response to their wage claims. Increased conservatism works as a deterrent to wage increases and therefore moderates the labor unions' real wage targets leading to higher employment.[27] In our model, this can be seen by differentiating the nominal wage elasticities of employment with respect to σ in both regimes

$$\frac{\partial a_1^f}{\partial \sigma} > 0, \qquad \frac{\partial a_1^u}{\partial \sigma} > 0 \tag{36}$$

Strictly speaking, this argument is correct only in the monetary union case, where the nominal wage elasticity of the real exchange rate does not depend on central bank conservatism. Under a floating exchange rate an increase in conservatism strengthens the union's ability to appreciate the real exchange rate,

[25] For a comprehensive survey on central bank conservatism (or independence), see Berger, de Haan and Eijffinger (2000).

[26] All proofs are presented in the Appendix.

[27] In the Appendix we modify our model framework by assuming atomistic bargaining. As expected, the equilibrium rate of employment will become independent of the monetary institutions.

which works into the opposite direction and tends to increase wage demands. Differentiating $(a_1 - a_2)$ with respect to σ yields

$$\frac{\partial\left(a_1^f - a_2^f\right)}{\partial\sigma} > 0, \qquad \frac{\partial\left(a_1^u - a_2^u\right)}{\partial\sigma} = 0 \tag{37}$$

However, the deterrent effect dominates and increased conservatism will improve employment also in a floating exchange rate regime. Hall and Franzese (1998) provide some empirical evidence supporting our results.[28] They show, that when bargaining structure is highly centralized, an increase in central bank conservatism improves employment. At intermediate and low levels of centralization the effect is reversed.

Remark 2 *An increase in the degree of central bank conservatism reduces inflation both in a floating exchange rate regime and in a monetary union.*

This remark is simply a restatement of the traditional inflation bias result. The more the central bank puts weight on inflation, the lower the realized inflation will be. However, there is an additional effect in our model. Remark 1 shows that central bank conservatism increases the equilibrium rate of employment, and thus narrows the gap between the employment target of the central bank and the equilibrium rate. Therefore, as the employment target of the central bank becomes less ambitious, inflation bias decreases.

4.2 Main results: employment and inflation in a monetary union

Finally, in this section we consider the relative performance of the two monetary regimes. All results are derived assuming that the structural parameters of the model and the preferences of the labor unions and the central banks remain the same when a monetary union is established. The main result of the paper is presented in the following proposition.

Proposition 3 *Assume that labor union and central bank preferences are identical across countries and do not change when a monetary union is established. Employment will improve, if the degree of central bank conservatism is above the critical value,* $\frac{1}{\overline{\sigma}}$*, where the explicit form of* $\overline{\sigma}$ *is given by*

$$\overline{\sigma} = \frac{1}{2\delta^2}\left(-\Phi + \sqrt{\Phi^2 + \Psi}\right)$$

where $\Phi = (1-\alpha)^2\delta^2 + \alpha(1-\alpha)(3\beta - 1)\delta + 2\alpha^2\beta^2$
and $\Psi = 4\delta^2\alpha(1-\alpha)^2(1-2\beta)(\alpha\beta + \delta(1-\alpha)) > 0.$

The proposition shows that the establishment of a monetary union can increase employment, even when all structural parameters of the model, including central bank conservatism, remain unchanged. This result is in sharp contrast

[28] See also Cukierman and Lippi (1999).

with earlier results concerning monetary union's impact on equilibrium employment. From expression Ψ we see that the critical value of σ is always positive, provided that the share of imports in consumption is less than one half.

Now, we develop the intuition behind this result in two steps. First, as shown in Remark 1, an increase in the degree of conservatism improves employment in both regimes. But, due to the real exchange rate effect discussed in Section 4.1, employment will improve slower in a floating exchange rate regime.[29] Second, by inspecting the two extreme cases of conservatism, ie $\sigma = 0$ and $\sigma \to \infty$ we can intuitively explain that there must be at least one critical value of central bank conservatism, which lies in the interval $0 < \overline{\sigma} < \infty$.

When the central bank is ultra-conservative ($\sigma = 0$), monetary policies are in both regimes set so that inflation will be zero. Hence, the central bank doesn't care at all about employment outcomes. An ultra-liberal central bank ($\sigma \to \infty$) targets only employment, and thus all wage increases are fully accommodated. Strictly speaking, we have to assume that σ is very large but finite, because the model is not well defined when σ is infinite. This can be verified by inspecting the wage game between unions, which reveals that the equilibrium wage becomes infinite. Intuitively, the central bank's full employment target and the union's real wage target are incompatible. The union wants to raise real wages above zero, whereas the central bank tries to accommodate the wage increase completely to achieve full employment. Hence wages increase without limit and the result is hyperinflation.

In a monetary union monetary policy is in general more accommodating than in the floating regime. However, in these two special cases monetary policies are equally accommodating in both regimes, which implies that the total employment reduction resulting from a unilateral wage increase is equal in both regimes

$$a_1^f + a_2^f = a_1^u + a_2^u \tag{38}$$

Employment is determined by the two elasticities, a_1 and $(a_1 - a_2)$, discussed in Section 3.3. To clarify the exposition let us assume for a moment that the substitution parameter δ equals unity. Then the direct link between foreign wage and domestic employment is shut down (see equations (21) and (22)) and the reduced forms for employment are equivalent in the two regimes. Now, a unilateral wage increase in home country will have the same direct effect in both regimes. Employment decreases in home country, whereas employment in the foreign country is unaffected. The direct effect on inflation is also equal in both regimes. As long as there is a home bias in consumption, an increase in home country wage increases domestic inflation more than foreign inflation.[30]

The difference between the two regimes becomes clear when we turn into monetary policy. Let us first consider the ultra-conservative central bank case

[29] The partial derivatives in equation (36) are not equal in general. Thus it could be possible that with a given σ, $\partial a_1^f / \partial \sigma$ is so much greater than $\partial a_1^u / \partial \sigma$, that employment would improve faster under a floating exchange rate regime. However, it turns out that this is not the case here.

[30] This is obtained from the reduced forms for π and π^* in Section 3.2 by setting $\delta = 1$ and noting that $\beta < \frac{1}{2}$.

($\sigma = 0$). In a floating regime both central banks are targeting zero inflation. Since the direct effect of a unilateral wage increase on domestic inflation is stronger, in equilibrium home money supply must decrease more than foreign money supply so that both central banks hit their inflation targets. In a monetary union, the common central bank has only one policy instrument, the area-wide money supply. Therefore, when it faces a unilateral wage increase, it can't stabilize the price level in both countries, but it can attain zero inflation on average.

Since monetary policies in the two regimes are equally non-accommodating on average, the reduction of the common money supply in a monetary union case is the average of the home and foreign country money supply reductions in a floating exchange rate regime.[31] Therefore, in a monetary union money supply is reduced less in home country and more in foreign country compared with the floating regime. In other words, since the response of the common central bank will always have a symmetric effect in both countries, the foreign country will bear a greater share of the total employment reduction caused by a unilateral wage increase in the home country (ie $a_1^u > a_1^f$ and $a_2^u < a_2^f$).

How is all this related to employment performance in the two monetary regimes? A switch from a floating exchange rate regime to a monetary union will have an effect both on the nominal wage elasticity of employment, a_1, and the nominal wage elasticity of the real exchange rate, $(a_1 - a_2)$. Above reasoning implies that a_1 will increase, which makes the effective labor demand curve steeper and deteriorates employment. However, $(a_1 - a_2)$ will increase exactly by two times more than a_1, and thus the total effect of a monetary union on employment will be positive when $\sigma = 0$ (see equation (35)).[32]

When the central bank is (almost) ultra-liberal ($\sigma \to \infty$), we can use the same line of reasoning to establish exactly the opposite result. Assume that the central bank targets employment only. Then we know that monetary policy is fully accommodating in both regimes. The direct effect of a unilateral wage increase in the home country is the same as above, but the conduct of monetary policy will be different.

First, let us look at the floating exchange rate case. Employment decreases only in home country, and money supply must be increased so that the wage increase is (almost) fully accommodated ($a_1^f \approx 0$).[33] Since employment in the foreign country is unaltered, the foreign central bank's reaction is very small ($a_2^f \approx 0$). In a monetary union the common central bank cannot attain full employment in both countries, because it has only one policy instrument available. But it can attain full employment on average by increasing money supply by the average of the two money supply increases in a floating regime. In this case a unilateral wage increase actually increases employment in the foreign coun-

[31] This can be verified by inspecting the coefficients of the reaction functions of the central banks presented in equation (28) for a monetary union and in equations (50)–(51) in the Appendix for a floating exchange rate regime.

[32] This is due to the fact that the employment loss of a unilateral wage increase shifts into the direction of the foreign country, while the total employment loss is unaltered. This implies that a_2 will decrease by the same amount as a_1 increases. Thus $(a_1 - a_2)$ increases by two times more than a_1.

[33] As discussed earlier, we have to assume that σ is large but finite. Then $a_1^f < 0$, $a_2^f < 0$ and $a_1^f - a_2^f < 0$ are very close to zero.

try ($a_2^u > 0$) and decreases it in the home country ($a_1^u < 0$). Hence, a switch from a floating exchange rate regime to a monetary union will decrease a_1, which tends to improve employment, but at the same time $(a_1 - a_2)$ decreases by (approximately) two times more, and thus the total effect on employment will be negative when $\sigma \to \infty$ (see equation (35)).

Reasoning in these two cases was based on the fact that monetary policies are equally accommodating in both regimes (see equation (38)). This implies that the change in monetary regime will only relocate the employment loss of a unilateral wage increase. In general, monetary policy is more accommodating in a monetary union. This means that the employment effect is not merely relocated in a monetary union, but the overall effect on employment is smaller

$$a_1^u + a_2^u > a_1^f + a_2^f \tag{39}$$

Hence, the argument used to explain the results in the two extreme cases can't be applied. However, we have provided an intuitive explanation for the fact that the effect of conservatism on employment tends to be stronger in a monetary union and for the unambiguous results in the two extreme cases. Putting these two observations together we can conclude that there is certainly at least one critical value of central bank conservatism. Proposition 3 confirms that there is only one such value.

Proposition 4 *Assume that labor union and central bank preferences are identical across countries and do not change when a monetary union is established. Inflation is higher in a monetary union provided that* $\sigma > 0$.

This proposition suggests, that inflation is higher in a monetary union if the employment gap enters the central bank loss function. In section 3.2 we already discussed the inflationary effects of a monetary union with a given employment level. Proposition 3 shows that employment in a monetary union can by higher than in a floating exchange rate regime. Thus, in that case it could be possible that inflation is lower in a monetary union. However, as stated above, inflation will be higher in a monetary union with all finite degrees of central bank conservatism.

Proposition 5 *If the index of substitutability between goods,* δ*, approaches infinity, then both employment and inflation remain unchanged when a monetary union is established. Central bank conservatism has no effect on employment and a negative effect on inflation.*

This proposition is a restatement of the monetary union neutrality result with non-inflation averse labor unions presented in the papers by Grüner and Hefeker (1999) and Cukierman and Lippi (2000). When the substitutability between goods becomes infinite, we are actually back in the single good world. The real exchange rate cannot deviate from zero (in logs), because otherwise the world demand would shift to one country. Hence, labor unions realize that they can't affect the real exchange rate with their wage claims, and the slope of the effective labor demand curve will in both monetary regimes coincide with the slope of the 'real' labor demand curve, which is determined only by technology in our model. In this case we actually obtain the traditional Barro-Gordon results concerning central bank conservatism, ie employment stays intact and inflation is decreasing in conservatism.

5 Alternative starting position: an asymmetric fix

Above we have considered a switch from a floating exchange rate regime to a monetary union. In this section we study the effects of a monetary union in a situation where one country has given up independent monetary policy and committed to a fixed exchange rate *vis-à-vis* the other country.

5.1 The setup

For analytical simplicity, we assume that the central bank of the anchor country is ultra-conservative. At first sight, this assumption may seem to be very restrictive. However, an asymmetric fixed exchange rate regime can be seen as a way to import credibility from a country where the central bank is more conservative than in the home country. The anchor country central bank is then very likely highly conservative.[34]

Since there is no capital mobility in the model, we have (implicitly) assumed that trade must be in balance in equilibrium. In a symmetric model with equal equilibrium rates of output and equal import shares we know that this is the case. However, in an asymmetric fix we can't rule out the possibility that the equilibrium rates differ, since monetary policies are clearly different in the two countries.

Home country imports can be written as $EP^*Y^{*ex} = \beta PY$ and exports as $PY^{ex} = \beta P^*EY^*$, where Y^{*ex} and Y^{ex} are import demands of home and foreign countries, respectively. Trade is in balance when $\beta PY = \beta P^*EY^*$. Taking logs yields $y - y^* = z$, which implies that we must assume $\delta = 1$ to have balanced trade when the equilibrium rates of output differ between countries. Admittedly, this restriction limits the applicability of the model considerably and brings out the problems this modeling framework has when there are structural asymmetries. However, assuming $\delta = 1$ simplifies the model, and we can write the exchange rate simply as $e = m - m^*$ (see equation (49) in the Appendix). The relative money supply then determines the nominal exchange rate, and a fixed exchange rate implies that $m = m^*$ must hold.

In the asymmetric fix case we must modify the timing of the model and now events unfold as follows. (1) The follower country central bank credibly commits to a fixed exchange rate $e = 0$. (2) The two labor unions set their nominal wages simultaneously taking the other union's wage as given. (3) The ultra-conservative central bank of the leader country minimizes its loss function by setting its money supply and taking the follower country's credible commitment to $e = 0$ into account. (4) The follower country's central bank sets $m = m^*$. (5) Production and trade take place and macroeconomic outcomes are realized.

[34] In Europe, where Germany acted as the anchor country of the ERM the Bundesbank was generally considered to be very conservative. This view is supported by empirical evidence in Cukierman, Rodrigues and Webb (1998) and Berger and Woitek (1999).

5.2 Employment and inflation in an asymmetric fix

As before, the model is solved by backward induction. In stage (4) the follower country sets $m = m^*$. Since the leader country's central bank is ultra-conservative, we know without explicitly formulating the optimization problem that in stage (3) of the game it sets m^* so that $\pi^* = 0$. The optimal money supply can be solved from the reduced form for π^* (see equation (13))

$$m^* = -\frac{\alpha}{1-\alpha}\left(\left(1-\beta\right)w^* + \beta w\right) \tag{40}$$

which reveals the asymmetry in monetary policy reactions. The leader country monetary policy responds more tightly on domestic (leader country) wage increases $\left(\beta < \frac{1}{2}\right)$ and since $m = m^*$, the follower country central bank behaves similarly. This implies that a unilateral wage increase in the follower country brings about more accommodating monetary policy than a unilateral wage increase in the leader country. Now we can derive the reduced forms for employment and inflation in both countries as

$$\begin{aligned} n &= \left(\tfrac{\alpha(1-\beta)-1}{1-\alpha}\right)w - \left(\tfrac{\alpha(1-\beta)}{1-\alpha}\right)w^* \\ &= a_1 w + a_2 w^* \qquad a_1 < 0, \quad a_2 < 0 \end{aligned} \tag{41}$$

$$\begin{aligned} n^* &= \left(\tfrac{\alpha\beta-1}{1-\alpha}\right)w^* - \left(\tfrac{\alpha\beta}{1-\alpha}\right)w \\ &= a_1^* w + a_2^* w^* \qquad a_1^* < 0, \quad a_2^* < 0 \end{aligned} \tag{42}$$

$$\begin{aligned} \pi &= \alpha\left(1-2\beta\right)w - \alpha\left(1-2\beta\right)w^* \\ &= b_1 w + b_2 w^* \qquad b_1 > 0, \quad b_2 < 0 \end{aligned} \tag{43}$$

$$\pi^* = 0 \tag{44}$$

The wage setting in stage (2) is similar to the previous analysis in Section 3, but now the nominal wage elasticities of employment are different in the two countries. Utility maximization yields reaction functions for both unions

$$w = \frac{\gamma\left(1-b_1\right)}{\left(a_1\right)^2} - \frac{a_2}{a_1}w^*, \qquad w^* = \frac{\gamma\left(1-b_1^*\right)}{\left(a_1^*\right)^2} - \frac{a_2^*}{a_1^*}w \tag{45}$$

Now, the slopes of the reaction functions are not exact inverses of each other. Therefore, the Nash equilibrium is asymmetric in a sense that wages in the two countries are different.[35] In particular, the follower country union anticipates relatively loose monetary policy and sets higher wage than the leader country union.[36] Equilibrium employments are of the same form as before,

[35] The wages are given by

$$\begin{aligned} w &= \frac{\gamma}{a_1 a_1^* - a_2 a_2^*}\left(\frac{a_1^*}{a_1}\left(1-b_1\right) - \frac{a_2}{a_1^*}\left(1-b_1^*\right)\right) \\ w^* &= \frac{\gamma}{a_1 a_1^* - a_2 a_2^*}\left(\frac{a_1}{a_1^*}\left(1-b_1^*\right) - \frac{a_2^*}{a_1}\left(1-b_1\right)\right). \end{aligned}$$

[36] From the Nash equilibrium wages and noting that $\left(a_1^* + a_2^*\right) = \left(a_1 + a_2\right)$ we obtain $\left(w - w^*\right) = \frac{\gamma}{a_1 a_1^* - a_2 a_2^*}\left(\left(a_1 + a_2\right)\left(\frac{1-b_1}{a_1} - \frac{1-b_1^*}{a_1^*}\right)\right) > 0$.

but now employment levels differ across countries so that the leader country employment is higher than in the follower country. [37] This result verifies that we must impose the restriction ($\delta = 1$) on the substitutability parameter.

An ultra-conservative central bank in the leader country ensures zero inflation. In the follower country inflation is determined by equation (43), and since the wage level is higher in the follower country, inflation is above zero

$$\pi = \alpha (1 - 2\beta) (w - w^*) > 0 \tag{46}$$

Hence, somewhat surprisingly a credible commitment to a fixed exchange rate does not imply that the inflation rates are equalized.[38]

5.3 A switch from an asymmetric fix to a monetary union

Now we will analyze the macroeconomic consequences of a monetary union in an asymmetric fix case. As noted earlier, we have made quite restrictive assumptions about the substitutability and conservatism parameters. Therefore, it must be stressed that our analysis applies only to this special case and not to a more general case with broader parameter spaces.

Proposition 6 . *Assume that the leader country central bank in an asymmetric fix and the common central bank in a monetary union are ultra-conservative* ($\sigma = 0$). *The establishment of a monetary union increases employment in the follower country and decreases employment in the leader country.*

The same qualitative result is obtained in models with inflation averse labor unions. However, the mechanism behind the results is completely different. With inflation aversion, the follower country's labor union becomes less aggressive in a monetary union, because it realizes that inflation is now affected by its wage demands, whereas in an asymmetric fix inflation is independent of its wage claim.[39] From follower country union's point of view, monetary policy is more accommodating in a monetary union. This induces wage restraint, since the union is averse to inflation. In our model, the follower country wage demand is reduced and employment improves in a monetary union, because monetary policy becomes less accommodating and thus the deterrent effect will be stronger. The leader country case is the mirror-image of the follower country case. Somewhat surprisingly, the results of the two models are qualitatively similar, although the changes in the reactions of the monetary authorities faced by the unions are completely opposite.

[37] We have $n^* = \frac{\gamma(1-b_1^*)}{a_1^*}$ and $n = \frac{\gamma(1-b_1)}{a_1}$. It is easily shown that $(n^* - n) = \gamma (1 - \alpha) \alpha^2 \beta \frac{(1-2\beta)}{(1-\alpha\beta)(1-\alpha+\alpha\beta)} > 0$.

[38] Calmfors (2000) provides some evidence from Europe supporting this result. In the 1980s nominal wage growth was faster in the follower countries of the ERM (excluding The Netherlands) than in Germany. However, this didn't hold in the 1990s anymore.

[39] The exchange rates and trade are not explicitly modeled in Grüner and Hefeker (1999) and Cukierman and Lippi (2000). The ERM is modeled as a credible commitment to the leader country's inflation rate.

Since we have assumed an ultra-conservative central bank in the leader country, and therefore also in a monetary union, inflation will stay at zero in the leader country. We have showed that despite of a credible commitment to a fixed exchange rate, the follower country inflation rate will exceed the leader country's inflation. Thus the follower country inflation will fall in a monetary union and the follower country will obtain both higher employment and lower inflation.

6 Concluding remarks

The purpose of the paper is to study the macroeconomic consequences of the establishment of a monetary union. In particular, we show that in the presence of strategic interaction between the central bank and the labor unions changes in monetary regime will have real effects. Monetary regime will affect the labor union's real wage-employment trade-off, ie the real consumer wage elasticity of labor demand is endogenous in our model. The main result of the paper is that the establishment of a monetary union improves employment, provided that the degree of central bank conservatism is sufficiently high, whereas with low degrees of conservatism employment falls. The impact on inflation is unambiguous. Inflation tends to be higher in a monetary union, because unlike in a floating exchange rate regime, monetary policy is not constrained by fears of inflationary real exchange rate depreciation.

We also analyze an asymmetric fixed exchange rate regime as an alternative starting position. The follower country is committed to a fixed exchange rate and the central bank of the leader country is assumed to be ultra-conservative. It turns out that when a monetary union is established, employment will increase in the follower country, whereas in the leader country employment will fall. Inflation is unaltered in the leader country, but it will decrease in the follower country. Hence, the follower country benefits from monetary union both in terms of employment and inflation, whereas the leader country suffers from deteriorating employment.

Our assumption of a single union in each country is of course very restrictive, but it can be justified as the simplest way to model non-atomistic labor markets. We have assumed that labor is homogenous. Therefore, it makes no sense to consider different levels of centralization of wage bargaining, since unions can't raise their wages above the average wage rate of the economy. We could follow Lippi (1999) and introduce the level of centralization of wage bargaining into the model by assuming that labor is differentiated in general and that all types of labor are needed in the production of the single good. Then each union has pricing power and the effects of centralization could be inspected. One likely consequence is that employment level would *ceteris paribus* increase with the number of unions, since each union's ability to appreciate the real exchange rate with its wage claim would be reduced. However, it is unclear how this would affect the relative employment performance of a monetary union.

The model can be used in normative analysis of a monetary union. Obviously, one has to be extremely cautious in drawing strong policy implications based on such a simple model. The single union assumption clearly limits the applicability of our model in policy analysis to countries with relatively centralized wage setting. The model seems to suggest that when a monetary union is established, it is possible to attain both higher employment and lower inflation by delegating monetary policy to a sufficiently conservative central bank. In Europe the creation of the EMU has increased the degree of central bank conservatism in most member countries. Thus, based on our model, one could speculate that the EMU may well have positive effects on equilibrium employment in many countries. Moreover, if we interpret the asymmetric fix regime as an approximation of the ERM the conclusion will, excluding Germany, remain the same.

Central bank conservatism is a free lunch in our model. In addition to reduced inflation, it also improves employment through increased effective labor demand elasticity. However, it must be stressed, that our deterministic analysis abstracts completely from potential gains from stabilization policy. As Rogoff (1985a) showed, an ultra-conservative central bank is not optimal in a presence of shocks, since output (employment) becomes too volatile. Another issue related to stabilization policy is the relative stabilization performance of a monetary union. The desirability of a monetary union will obviously depend not only on the changes in long-run average levels of economic variables, but also on its impact on the volatility of these variables.[40] Lane (2000) shows that a floating exchange rate typically outperforms the monetary union in terms of stabilization properties.[41] This confirms the intuition that exchange rate flexibility is beneficial in the presence of shocks in the economy. Interestingly enough, in an asymmetric fix the results concerning stabilization policy are pointing to the same direction as our results on long-run average performance. Monetary union is preferred to an asymmetric fix in the follower country, whereas the opposite holds for the leader country.

[40] A discussion of this issue can be found in Calmfors (1998, 2000) and Burda (1999).

[41] Coricelli, Cukierman and Dalmazzo (2000b) analyze stabilization policy in a two-country monetary union model. Their framework allows asymmetries in country sizes, labor market structures and product market competition.

A Appendix

A.1 Details of the model

The reduced forms for the other endogenous variables in the floating exchange rate regime are

$$p = (1-\alpha)\, m + \alpha w, \qquad p^* = (1-\alpha)\, m^* + \alpha w^* \tag{47}$$

$$z = \frac{\alpha}{\delta}\left(m - w - m^* + w^*\right) \tag{48}$$

$$e = \left(\frac{\alpha}{\delta} + (1-\alpha)\right)(m - m^*) + \left(\alpha - \frac{\alpha}{\delta}\right)(w - w^*) \tag{49}$$

The Nash equilibrium nominal wage elasticities of money supply in the floating exchange rate regime are

$$c_1 = \frac{\left(\sigma + \Gamma^2\right)\left(\sigma + \Gamma\left(\frac{\alpha\beta}{\delta} - \alpha\right)\right) - \left(\frac{\alpha\beta}{\delta}\Gamma\right)^2}{\Delta} \lesseqgtr 0 \tag{50}$$

$$c_2 = -\frac{\alpha\beta}{\delta}\frac{\Gamma^2}{\Delta} \leq 0 \tag{51}$$

where $\Delta = \left(\sigma + \Gamma^2\right)^2 - \left(\frac{\alpha\beta}{\delta}\Gamma\right)^2 > 0$.

The nominal wage elasticities of employment and inflation in the floating exchange rate regime are

$$a_1^f = -\frac{\Gamma\left(\sigma + \Gamma^2\right)}{\Delta} < 0 \tag{52}$$

$$a_2^f = -\frac{\alpha\beta}{\delta}\frac{\Gamma^2}{\Delta} < 0 \tag{53}$$

$$b_1^f = \frac{\sigma\left(\sigma + \Gamma^2\right)}{\Delta} \geq 0 \tag{54}$$

$$b_2^f = \frac{\alpha\beta}{\delta}\frac{\sigma\Gamma}{\Delta} \geq 0 \tag{55}$$

The reduced forms for the other endogenous variables in the monetary union case are

$$p = w + (1-\alpha)\, m^U - \frac{(1-\alpha)}{2}\left(w + w^*\right) + \frac{1}{2}\frac{(1-\alpha)\,\delta}{\alpha + (1-\alpha)\,\delta}\left(w^* - w\right) \tag{56}$$

$$p^* = w^* + (1-\alpha)\, m^U - \frac{(1-\alpha)}{2}\left(w + w^*\right) - \frac{1}{2}\frac{(1-\alpha)\,\delta}{\alpha + (1-\alpha)\,\delta}\left(w^* - w\right) \tag{57}$$

$$z = \frac{\alpha}{\alpha + (1-\alpha)\,\delta}\left(w^* - w\right) \tag{58}$$

The nominal wage elasticities of employment and inflation in the monetary

union case are

$$a_1^u = -\left(\frac{(1-\alpha)(\alpha+2(1-\alpha)\delta)+\delta\sigma}{\Omega}\right) < 0 \tag{59}$$

$$a_2^u = -\left(\frac{\alpha(1-\alpha)-\delta\sigma}{\Omega}\right) \lesseqgtr 0 \tag{60}$$

$$b_1^u = \frac{\left(\begin{array}{c}\left(\sigma+(1-\alpha)^2\right)(2\alpha(1-\beta)+(1-\alpha)\delta)\\ -(1-\alpha)^2(\alpha+(1-\alpha)\delta)\end{array}\right)}{\Omega} > 0 \tag{61}$$

$$b_2^u = \frac{\left(\begin{array}{c}\left(\sigma+(1-\alpha)^2\right)(2\alpha\beta+(1-\alpha)\delta)\\ -(1-\alpha)^2(\alpha+(1-\alpha)\delta)\end{array}\right)}{\Omega} \lesseqgtr 0 \tag{62}$$

where $\Omega = 2\left(\sigma+(1-\alpha)^2\right)(\alpha+(1-\alpha)\delta) > 0$.

A.2 Derivation of equation (35)

Under a floating exchange rate, from the reduced forms (19) and (20) we obtain

$$a_1^f = \frac{\partial m^f}{\partial w} - 1 \tag{63}$$

$$1-b_1^f = (1-\alpha)\left(1-\frac{\partial m^f}{\partial w}\right) - \frac{\alpha\beta}{\delta}\left(\frac{\partial m^f}{\partial w} - 1 - \frac{\partial m^{*f}}{\partial w}\right) \tag{64}$$

and by noting, that $\frac{\partial m^*}{\partial w} = a_2^f$ (see equations (51) and (53)) the slope coefficient can be written as

$$\frac{1-b_1^f}{a_1^f} = -(1-\alpha) - \frac{\alpha\beta}{\delta}\left(\frac{a_1^f - a_2^f}{a_1^f}\right) \tag{65}$$

Similarly, in a monetary union we have

$$a_1^u = \frac{\partial m^u}{\partial w} - \frac{1}{2} - \frac{\delta}{2(\alpha+(1-\alpha)\delta)} \tag{66}$$

$$\begin{aligned} 1-b_1^u &= -(1-\alpha)\left(\frac{\partial m^u}{\partial w} - \frac{1}{2} - \frac{\delta}{2(\alpha+(1-\alpha)\delta)}\right) \\ &\quad + \frac{\alpha\beta}{(\alpha+(1-\alpha)\delta)} \end{aligned} \tag{67}$$

$$= -(1-\alpha)a_1^u - \frac{\alpha\beta}{\delta}(a_1^u - a_2^u) \tag{68}$$

where the last row is obtained from equations (1) and (3) by noting that $z = \frac{\alpha}{\delta}(n-n^*)$ and thus $\frac{\partial z}{\partial w} = \frac{\alpha}{\delta}(a_1 - a_2)$. Applying this expression and the derivative of equation (58) with respect to z we finally get

$$\frac{\alpha}{(\alpha+(1-\alpha)\delta)} = -\frac{\alpha}{\delta}(a_1^u - a_2^u) \tag{69}$$

Inserting this into equation (67) yields (68) and hence the form of the slope coefficient is similar to the floating exchange rate case

$$\frac{1-b_1^u}{a_1^u} = -(1-\alpha) - \frac{\alpha\beta}{\delta}\left(\frac{a_1^u - a_2^u}{a_1^u}\right). \tag{70}$$

A.3 Atomistic bargaining

We modify the framework of the paper by assuming that there is a large number of unions in both countries. This assumption implies that unions take the product price and the consumer price index as given in wage setting. Labor demand of the representative firm is given by

$$w_i - p = -(1-\alpha)\, n_i \tag{71}$$

A representative union's problem is then

$$\max_{\{w_i\}} U_i = \gamma\,(w_i - \pi) - \tfrac{1}{2}\,(n_i)^2 \tag{72}$$

s.t. (71)

The first-order condition is

$$w_i - p = (1-\alpha)^2\,\gamma \tag{73}$$

which implies that the real product wage and employment are constants (insert (73) into (71)). Assuming a symmetric equilibrium, aggregation gives the corresponding equation for total employment

$$n = -\gamma\,(1-\alpha) \tag{74}$$

Hence, when labor markets are atomistic, employment depends only on labor union preferences (γ) and the real product wage elasticity of labor demand $\left(\eta = (1-\alpha)^{-1}\right)$. We are thus back in the traditional framework, where the equilibrium rate of employment is exogenous and changes in monetary institutions will not have any real effects. The establishment of a monetary union will be counterproductive in a sense that employment is unaffected and inflation will be higher than before, because the common central bank doesn't need to worry about inflationary real exchange rate depreciation.

A.4 Proofs

Proof of Remark 1. Employment levels in both regimes are given by equation (33). Equation (35) imply, that $sgn\left(\frac{\partial n}{\partial \sigma}\right) = sgn\left(\partial\left(\frac{a_2}{a_1}\right)/\partial\sigma\right)$ in both regimes. From (52) and (53) we obtain $\left(\frac{a_2}{a_1}\right)^f = \frac{\left(\frac{\alpha\beta}{\delta}\right)\Gamma}{\sigma+\Gamma^2}$ and from (59) and (60) $\left(\frac{a_2}{a_1}\right)^u = \frac{\alpha(1-\alpha)-\delta\sigma}{(1-\alpha)(\alpha+2(1-\alpha)\delta)+\delta\sigma}$. Differentiation of these expressions with respect

to σ yields $\partial\left(\frac{a_2}{a_1}\right)^f/\partial\sigma < 0$ and $\partial\left(\frac{a_2}{a_1}\right)^u/\partial\sigma = \frac{-\delta((1-\alpha)(2\alpha+2(1-\alpha)\delta))}{((1-\alpha)(\alpha+2(1-\alpha)\delta)+\delta\sigma)^2} < 0$. Hence $\frac{\partial n^f}{\partial\sigma} < 0$ and $\frac{\partial n^u}{\partial\sigma} < 0$. ■

Proof of Remark 2. Inflation in a floating exchange rate regime is given by equation (16). Differentiating this expression with respect to σ and applying Remark 1 yields $\frac{\partial\pi^f}{\partial\sigma} = \frac{\partial}{\partial\sigma}\left(-\frac{\sigma}{\Gamma}\right)n^f + \frac{\partial n^f}{\partial\sigma}\left(-\frac{\sigma}{\Gamma}\right) > 0$. Inflation in a monetary union is given by equation (27). Differentiating this expression with respect to σ and applying Remark 1 yields $\frac{\partial\pi^u}{\partial\sigma} = \frac{\partial}{\partial\sigma}\left(-\frac{\sigma}{(1-\alpha)}\right)n^u + \frac{\partial n^u}{\partial\sigma}\left(-\frac{\sigma}{(1-\alpha)}\right) > 0$. ■

Proof of Proposition 3. Employment is improved, if $n^u - n^f > 0$. Equation (35) implies, that $sgn\left(n^u - n^f\right) = sgn\left(\left(\frac{a_2}{a_1}\right)^u - \left(\frac{a_2}{a_1}\right)^f\right)$. The expression in brackets on the right hand side can be written as

$$\begin{aligned}
&\left(\frac{a_2}{a_1}\right)^u - \left(\frac{a_2}{a_1}\right)^f \\
= &\frac{\alpha(1-\alpha)-\delta\sigma}{(1-\alpha)(\alpha+2(1-\alpha)\delta)+\delta\sigma} - \frac{\frac{\alpha\beta}{\delta}\left(1-\alpha+\frac{\alpha\beta}{\delta}\right)}{\sigma+\left(1-\alpha+\frac{\alpha\beta}{\delta}\right)^2} \\
= &\delta\frac{\left(\begin{array}{c}-\delta^2\sigma^2+\left(\delta\left(\alpha(1-\alpha)-\delta(1-\alpha)^2\right)-\alpha\beta\left(3\delta(1-\alpha)+2\alpha\beta\right)\right)\sigma \\ +\alpha(1-\alpha)^2(1-2\beta)\left(\delta(1-\alpha)+\alpha\beta\right)\end{array}\right)}{\left(2\delta(1-\alpha)^2+\alpha(1-\alpha)+\sigma\delta\right)\left(\sigma\delta^2+\delta^2(1-\alpha)^2+2\alpha\beta\delta(1-\alpha)\right)}
\end{aligned}$$

The denominator is always positive, and thus the quadratic function of σ in the numerator determines the sign. Since the constant term in the numerator is positive, and the coefficient in front of the quadratic term is negative, it follows that the quadratic function has only one positive real root. Solving the quadratic equation

$$\left(\begin{array}{c}-\delta^2\sigma^2+\left(\delta\left(\alpha(1-\alpha)-\delta(1-\alpha)^2\right)-\alpha\beta\left(3\delta(1-\alpha)+2\alpha\beta\right)\right)\sigma \\ +\alpha(1-\alpha)^2(1-2\beta)\left(\delta(1-\alpha)+\alpha\beta\right)\end{array}\right) = 0$$

yields two real roots, of which only the greater is positive. Therefore, there is only one critical value of σ so that if $\sigma < \overline{\sigma}$ $\left(\frac{1}{\sigma} > \frac{1}{\overline{\sigma}}\right)$, then $n^u - n^f > 0$. ■

Proof of Proposition 4. From equations (16), (27) and (35) we obtain

$$\begin{aligned}
\pi^u - \pi^f &= \gamma\left(\begin{array}{c}\left(-(1-\alpha)-\frac{\alpha\beta}{\delta}\left(1-\frac{a_2^u}{a_1^u}\right)\right)\left(-\frac{\sigma}{1-\alpha}\right) \\ -\left(-(1-\alpha)-\frac{\alpha\beta}{\delta}\left(1-\frac{a_2^f}{a_1^f}\right)\right)\left(-\frac{\sigma}{1-\alpha+\frac{\alpha\beta}{\delta}}\right)\end{array}\right) \\
&= \frac{\alpha\beta\gamma\sigma}{\delta}\left(\frac{1}{1-\alpha}\left(1-\frac{a_2^u}{a_1^u}\right)+\frac{1}{1-\alpha+\frac{\alpha\beta}{\delta}}\frac{a_2^f}{a_1^f}\right) \geq 0
\end{aligned}$$

The result is obtained by noting that $a_1^u < a_2^u \Rightarrow 1-\frac{a_2^u}{a_1^u} > 0$ and $\frac{a_2^f}{a_1^f} > 0$. ■

Proof of Proposition 5. The nominal wage elasticities of employment in a floating exchange rate regime with infinite substitutability between goods can be written as $a^f_{1|\delta\to\infty} = -\frac{(1-\alpha)}{\sigma+(1-\alpha)^2}$ and $a^f_{2|\delta\to\infty} = 0$. Employment is then

$$n^f_{|\delta\to\infty} = \gamma\left(-(1-\alpha)-\frac{\alpha\beta}{\delta}\left(1-\frac{a_2}{a_1}\right)\right) = -\gamma(1-\alpha).$$

In a monetary union the nominal wage elasticities of employment are

$$\begin{aligned} a^u_{1|\delta\to\infty} &= -\left(\frac{2\left(1-\alpha\right)^2+\sigma}{2\left(\left(1-\alpha\right)^2+\sigma\right)\left(1-\alpha\right)}\right) \\ a^u_{2|\delta\to\infty} &= \frac{\sigma}{2\left(\left(1-\alpha\right)^2+\sigma\right)\left(1-\alpha\right)} \end{aligned}$$

It follows that $\frac{a^u_2}{a^u_1} = -\frac{\sigma}{2(1-\alpha)^2+\sigma}$, and employment is given by

$$n^u_{|\delta\to\infty} = \gamma\left(-\left(1-\alpha\right)-\frac{\alpha\beta}{\delta}\left(1-\frac{a_2}{a_1}\right)\right) = -\gamma\left(1-\alpha\right).$$

Hence $n^u_{|\delta\to\infty} = n^f_{|\delta\to\infty}$. By noting, that $\frac{\sigma}{1-\alpha+\frac{\alpha\beta}{\delta}} = \frac{\sigma}{1-\alpha}$ as $\delta\to\infty$ and applying $n^u_{|\delta\to\infty} = n^f_{|\delta\to\infty}$ to equations (16) and (27) we obtain $\pi^u_{|\delta\to\infty} = \pi^f_{|\delta\to\infty} = -\frac{\sigma}{1-\alpha}\left(-\gamma\left(1-\alpha\right)\right) = \gamma\sigma$. From the expressions of $n_{|\delta\to\infty}$ and $\pi_{|\delta\to\infty}$ we immediately obtain $\frac{\partial n}{\partial\sigma} = 0$ and $\frac{\partial\pi}{\partial\sigma} > 0$ in both regimes. ■

Proof of Proposition 6. Employments in a monetary union and in an asymmetric fix in both countries when $(\delta = 1)$ and $(\sigma = 0)$ are given by

$$\begin{aligned} n^u &= \gamma\left(1-\alpha\right)\frac{1-\frac{\alpha}{2}\left(1-2\beta\right)}{\alpha\frac{1}{2}-1} \\ n &= \gamma\left(1-\alpha\right)\frac{1}{\alpha\beta-1}, \qquad n^* = \gamma\left(1-\alpha\right)\frac{1-\alpha\left(1-2\beta\right)}{\alpha\left(1-\beta\right)-1} \end{aligned}$$

and directly from these expressions we obtain

$$n^* > n^u > n.$$

■

References

[1] Barro, R.J. – Gordon, D.B. (1983) **A Positive Theory of Monetary Policy in a Natural Rate Model.** Journal of Political Economy 91, 589–610.

[2] Berger, H. J. de Haan – Eijffinger, S.C.W. (2000) **Central Bank Independence: An Update of Theory and Evidence.** CEPR Discussion Paper No. 2353.

[3] Berger, H. – Hefeker, C. – Schöb, R. (2001) **Optimal Central Bank Conservatism and Monopoly Trade Unions.** CESIfo Working Paper No. *407*.

[4] Berger, H. – Woitek, U. (1999) **Does Conservatism Matter? A Time Series Approach to Central Banking.** CESIfo Working Paper No. 190.

[5] Buiter, W.H. – Corsetti, C. – Pesenti, P.A. (1995) **A Center-Periphery Model of Monetary Coordination and Exchange Rate Crises.** NBER Working Paper No. 5140.

[6] Burda, M.C. (1999) **European Labour Markets and the Euro: How Much Flexibility Do We Really Need?** CEPR Discussion Paper No. 2217.

[7] Calmfors, L. (1998) **Macroeconomic Policy, Wage Setting, and Employment – What Difference Does the EMU Make?** Oxford Review of Economic Policy 14, 125–151.

[8] Calmfors, L. (1999) **Unemployment, Labour-Market Reform and Monetary Union.** Forthcoming in Journal of Labor Economics.

[9] Calmfors, L. (2000) **Wages and Wage-Bargaining Institutions in the EMU – A Survey of the Issues.** Paper for the Österreichische Nationalbank Workshop on "Wage Bargaining within EMU", Vienna, October 9, 2000.

[10] Canzoneri, M.B. – Henderson, D.W. (1988) **Is Sovereign Policymaking Bad?** Carnegie-Rochester Conference Series on Public Policy 28, 93–140.

[11] Coricelli, F. – Cukierman, A. – Dalmazzo, A. (2000a) **Monetary Institutions, Monopolistic Competition, Unionized Labour Markets and Economic Performance.** CEPR Discussion Paper No. 2407.

[12] Coricelli, F. – Cukierman, A. – Dalmazzo, A. (2000b) **Economic Performance and Stabilization Policy in a Monetary Union with Imperfect Labor and Goods Markets.** CEPR Discussion Paper No. 2745.

[13] Cukierman, A. – Rodrigues, P. – Webb, S.B. (1998) **Central Bank Autonomy and Exchange Rate Regimes–Their Effects on Monetary Accommodation and Activism.** In S. Eijffinger and H. Huizinga, Eds., Positive Political Economy: Theory and Evidence, Cambridge University Press, Cambridge.

[14] Cukierman, A. – Lippi, F. (1999) **Central Bank Independence, Centralization of Wage Bargaining, Inflation and Unemployment: Theory and Some Evidence.** European Economic Review 43, 1395–1434.

[15] Cukierman, A. – Lippi, F. (2000) **Labour Markets and Monetary Union: A Strategic Analysis.** Forthcoming in Economic Journal.

[16] Grüner, H.P. – Hefeker, C. (1999) **How Will EMU Affect Inflation and Unemployment in Europe?** Scandinavian Journal of Economics 101, 33–47.

[17] Hall, P.A. – Franzese, R.J. Jr. (1998) **Mixed Signals: Central Bank Independence, Coordinated Wage Bargaining, and European Monetary Union.** International Organization 52, 505–535.

[18] Holden, S. (1999) **Wage Setting under Different Monetary Regimes.** Mimeo, University of Oslo.

[19] Jensen, H. (1993) **International Monetary Policy Cooperation in Economies with Centralized Wage Setting.** Open Economies Review 4, 269–285.

[20] Jensen, H. (1997) **Monetary Policy Cooperation May Not Be Counterproductive.** Scandinavian Journal of Economics 99, 73–80.

[21] Kydland, F.E. – Prescott, E.C. (1977) **Rules Rather than Discretion: The Inconsistency of Optimal Plans.** Journal of Political Economy 85, 473–491.

[22] Lane, P.R. (1996) **Stabilization Policy in a Currency Union.** Economics Letters 53, 53–60.

[23] Lane, P.R. (2000) **Asymmetric Shocks and Monetary Policy in a Currency Union.** Scandinavian Journal of Economics 102, 585–604.

[24] Lippi, F. (1999) **Strategic Monetary Policy with Non-Atomistic Wage-Setters: A Case for Non-Neutrality",** CEPR Discussion Paper No. 2218.

[25] Obstfeld, M. – Rogoff, K. (2000) **The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?** NBER Working Paper 7777.

[26] Oswald, A.J. (1985) **The Economic Theory of Trade Unions: An Introductory Survey.** Scandinavian Journal of Economics 87, 160–193.

[27] Persson, T. – Tabellini, G. (1995) **Double-Edged Incentives: Institutions and Policy Coordination.** In G.M. Grossman and K.Rogoff, Eds., Handbook of International Economics vol. III, Elsevier Science B.V.

[28] Rogoff, K. (1985a) **The Optimal Degree of Commitment to a Monetary Target.** Quarterly Journal of Economics 100, 1169–1190.

[29] Rogoff, K. (1985b) **Can International Monetary Policy Cooperation Be Counterproductive?** Journal of International Economics 18, 199–217.

[30] Sibert, A. – Sutherland, A. (2000) **Monetary Union and Labor Market Reform.** Journal of International Economics 51, 421–435.

[31] Soskice, D. – Iversen, T. (2000) **The Nonneutrality of Monetary Policy with Large Price or Wage Setters.** Quarterly Journal of Economics 115, 265–284.

[32] Zervoyianni, A. (1997) **Monetary Policy Games and Coalitions in a Two-Country Model with Unionised Wage Setting.** Oxford Economic Papers 49, 57–76.

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