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Wage and public expenditure setting in a monetary union[1]

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Abstract

European countries have progressively integrated from the point of view of trade and investment and have a common currency now. However, labour market and fiscal institutions have largely retained their national status. The aim of this paper is to examine:

a) the possibility for trade unions of internalising external effects stemming from wage setting in a national context;

b) the possibility for governments of internalising macroeconomic spillovers deriving from public expenditure at a national level;

c) the interactions between fiscal and monetary authorities.

We have found a certain gain in terms of employment only when unions co-operate and we are in a regime where the impact of domestic prices on employment through the terms of trade is higher than the impact of domestic prices on employment through the CPI; in this case, a gain in terms also of inflation may take place.

In the case of co-operation between governments gains may accrue only in terms of employment *or* inflation to one or the other country, if the weights put by the governments on price stability are different. This occurs because the central bank, whose overriding objective is price stability, neutralises any rise in the price levels (as well as the positive effects on employment) deriving from the rise in the government expenditures of both countries that take place as a consequence of governments' co-operation.

This paper partially answers recent concern for considering multi-player contexts and asymmetries in open economy analyses. Here, in fact, several kinds of partial coalitions and the effects of asymmetries in players' preferences are studied.

JEL codes: E62, E64, F15, F42
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1. Introduction.

European countries have progressively integrated from the point of view of trade and investment and have a common currency now. Labour market and fiscal institutions have largely retained their national status until now, but changes are on the way. On one side, European unions have committed themselves to the aim of achieving increased employment and purchasing power through cross-border co-ordination of bargaining policy (see the Doorn declaration of September 1998). On the other side, the Lisboa European Council (March 2000) for the first time has indicated common targets in terms of growth and employment. This, while allowing for co-operation of fiscal authorities respectful of the Growth and Stability Pact[2], raises the question of a possible conflict with the pre-eminent objective of the European Central Bank, i.e., the price stability.

In more general terms there are a number of policy questions that involve interactions between the different institutions operating in a monetary union such as the European Monetary Union. Among them there are the following ones:

a) the possibility for trade unions of internalising external effects stemming from wage setting in a national context;
b) the possibility for governments of internalising macroeconomic spillovers deriving from public expenditure at a national level;
c) the interactions between fiscal and monetary authorities.

Question under a) has to do with the (dis)advantages of various levels of centralised bargaining, from complete decentralisation to complete centralisation. These have been the object of an extensive literature at least since Bruno, Sachs (1985) and Tarantelli (1986)[3], but mainly in a closed-economy setting. Calmfors, Driffill (1988) and others emphasise the effects of the degree of centralisation of wage bargaining[4]. According to Calmfors and Driffill, there is wage restraint in economies with an extreme degree of decentralisation or centralisation. Complete decentralisation (wage bargaining at the firm level) would ensure a nominal wage restraint and a higher employment level through the effects of competition between unions. The foundation of co-operative wage determination or complete centralisation, i.e. wage bargaining at the level of the whole national area, derives from the possibility to internalise the effects of wage setting at the level of each single region, industry or firm on the consumer price index (CPI) of all the regions, industries or firms of the national economy. This would have the same result as complete decentralisation on wages and employment.

External effects of wage setting at a national level have the same foundation as those stemming from bargaining at a lower (sub-national) level. In wage setting at a national level perception of the inflationary consequences for a wider than national area is limited and unions tend to be aggressive, since they can beggar-their-neighbour. This is a powerful argument in favour of international wage co-operation. It is important to note, however, that international co-operation between unions – as distinct from their co-operation at a national level – introduces a new dimension, since unions no longer face, as they do in a national context, a single policy maker, the government, or a couple of policy makers, the government and the central bank. In fact there are a multiplicity of policy-makers: at least two governments and one or more central banks[5]. This complicates the picture and

[2] In an integrated monetary union with positive international spillovers of expenditure, limits to budget deficit can be satisfied at different levels of public expenditure in the member countries according to whether fiscal policy is co-ordinated or not.

[3] Tarantelli (1986) was published posthumous. Tarantelli's ideas on the advantages of centralisation in wage bargaining were laid down at least as back as 1982 (see Cukierman, Lippi, 1999). Conditions for the validity of Tarantelli's propositions have been analysed in Acocella, Ciccarone (1995).

[4] More recent contributions are Bleaney (1996), Skott (1997), Velasco, Guzzo (1999), Cukierman, Lippi (1999). Rama (1994), Corneo (1995), Soskice, Iversen (1998), Grüner, Hefeker (1999) have extended the analysis to an open economy.

[5] This point is overlooked by Cukierman, Lippi (2000), who pretend to consider an international setting whereas their model considers a multiplicity of unions and a single monetary authority, with no other (national) policy-maker.

can lead to different outcomes. Zervoyianni (1997) considers a two-country model with unions and governments and shows that: i) union co-operation still improves welfare; ii) co-operation between the unions and the governments of individual countries may fail to produce Pareto improvements. In this paper we intend to enlarge the number of policy makers involved to include both governments and the central bank[6].

Question under b) has been extensively examined in the economic literature on the advantages of international co-operation, but less so in a monetary union context, where co-operating national governments face a single monetary authority. Fiscal policy co-operation may be founded on the existence of negative or positive spillovers. When there are negative spillovers co-ordination leads to a reduction in government expenditure, whereas positive spillovers imply increased government expenditure in the co-ordinated case, if there are nominal inertia (see Mundell, 1968; Hamada, 1985; Svensson, 1987; van der Ploeg, 1993). Dixon, Santoni (1997) have recently shown that positive spillovers from government expenditure arise in a monetary union with unemployment, a fixed money supply and unionised labour markets. One of the purposes of this paper is to analyse whether the outcome is similar to Dixon and Santoni's in a setting with an active central bank and the possibility of centralised wage setting, which adds questions a) and c) to question b). In our analysis a simple model, inspired to Gylfason and Lindbeck (1986), is bent to the specificities of a monetary union where the central bank sets the nominal interest rate directly.

To keep algebra simple, only two countries are considered, some variables are assumed to be constant[7] and the assumption of symmetry as between the two countries is introduced. Many relevant questions arise when symmetry is not satisfied, but we want to stick to an assumption of symmetry to highlight the questions indicated.

In section 2 we present the model (derived in Appendix) A; in section 3 non-cooperative solutions are obtained. The effects of fiscal policy co-operation and co-operation between unions are examined in sections 4 and 5, respectively. Simultaneous co-operation between unions and governments is the object of section 6, whereas co-operation between governments and the central bank is examined in section 7. The final section presents a summary and conclusions.

2. The model.

Three types of agents (firms, unions, and fiscal authorities) operate in each country and a single central bank for the whole integrated area, which is a closed economy, sets the nominal interest rate, *r*. Since there is perfect mobility of financial capital[8], the interest rate is the same in both countries. Each country is specialised in the production of one good (or one basket of goods). Goods are imperfect substitutes. There is perfect competition between firms within each country, but imperfect competition as between firms operating in the two countries. Firms are profit maximisers and unions set monopoly wages in each country (if they do not act co-operatively) or for the whole area (if they co-operate). Governments set the balanced budget level of public expenditure in each area in a co-operative or non-co-operative way. Wages, budget levels and the interest rate are set simultaneously.

[6] To be fair, Zervoyianni considers governments whose preference functions are quadratic in both employment and inflation. This might have the same outcome as considering both governments, whose predominant objective is employment, and a central bank, having inflation as its overriding target. One of the purposes of this paper is to check the validity of such a correspondence.

[7] The strongest of these assumptions is that of a constant composition of the CPI basket in the two countries. This assumption is however common in the literature (e.g., see Sauernheimer, 1984; Monticelli, 2000)

[8] We do not consider the implications of allowing firms to be mobile as between the two countries.

Our baseline framework is an IS-AS model[9]. The model, which is derived in Appendix A, consists of two equations for each country. All variables are in logs.

$$n_i = -s\ (r - p^e_i) + a g_i + b g_j - t\ (p_i - p_j) \quad [1]$$
$$n_i = (p_i - w_i) \quad [2]$$
$$n_j = -s\ (r - p^e_j) + a g_j + b g_i - t\ (p_j - p_i) \quad [3]$$
$$n_j = (p_j - w_j) \quad [4]$$
$$v_i = (1-h)\ p_i + h\ p_j \quad [5]$$
$$v_j = (1-h)\ p_j + h\ p_i \quad [6]$$

where *i* and *j* denote the two countries, *n* is employment; *p* is the price of the composite commodity, *g* is public expenditure, *w* is the wage rate, p^e is the expected inflation rate, v is the consumer price index, or CPI. The expected rate of inflation is reasonably defined as $E_{t-1}\ v_t - v_{t-1}$ (see Preston, Pagan, 1982, p.296). Furthermore, perfect foresight and an initial price parametrically set equal to zero are assumed. Thus $E_{t-1}v_t = v_t$ and $p^e = v_t$ hold. Since our model is deterministic, the assumption of perfect foresight is equivalent to that of rational expectations[10].

The two economies work in a symmetric way. Asymmetry in the working of the two economies does not need to be stressed for the purposes of this paper. It can however be easily introduced[11]. In addition, a kind of asymmetry might arise because of possibly different preferences of unions and governments (see eqns. [12] and [13] below),

Equation [1] and [2] represent IS and AS in country *i*; equation [3] and [4] IS and AS in country *j*. Following recent literature, we take the nominal interest rate as the instrument of monetary policy, as opposed to a monetary supply aggregate[12]. This dispenses us with specifying a money market equilibrium condition (i.e., an LM curve; see Walsh, 1998, p.214). Such a model can be justified on three grounds at least. First, for reasons of tractability: getting rid of the money market simplifies the very cumbersome algebra of our model. A second justification lies in our purpose not to fix a natural level of unemployment and emphasise the possible role of unions and other agents instead. A third justification is in the fact that the European Central Bank does indeed set the nominal interest rate. (However, we cannot replicate in our model the very complex effects on real variables of setting the nominal interest rate, in particular, through expectations, and then its only influence on prices is through the activity level).

Demand is decreasing in the real interest rate (as an effect of the saving-investment behaviour by the private sector) and the product prices differential (competitiveness effects on foreign trade). It increases in home public expenditure and foreign public expenditure (exports). The latter is a shortcut, with no loss of generality, to spillovers from country *j* to country *i* taking place through country *j*'s imports. Equation [2] is a standard supply representation for profit-maximising firms.

Equations [5] and [6] define consumer price indexes. CPIs are weighted averages of prices of domestic and foreign goods. *h* is a function of the degree of openness. As customary, we assume $h < ½$.

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[9] The model can also be seen as a two-country static variant of the dynamic 'new Keynesian model', also known in the literature as the "optimizing IS/LM model" (McCallum, Nelson, 1997; Clarida, Gali, Gertler, 1999) adapted to the case where the unions act at the same time as other agents.

[10] We are aware of the fact that our assumptions about expectations can lead to specific results. We are however interested in showing the *possibility* of outcomes different from those derived in the literature. Such a possibility would also arise in our model with assumptions about expectations different from those of this paper.

[11] Introduction of a different productivity as between countries would be of specific interest from the point of view of the co-operation of unions whose members differ as to their productivity.

[12] Bernanke, Blinder (1992) and Goodfriend (1991), among others, have emphasised the role of the Federal Funds rate – the rate on overnight interbank loans – as an instrument of monetary policy in US. See De Arcangelis, Di Giorgio (1998) for similar results in the Italian case; Bernanke, Mihov (1997) for the German case; and Clarida, Gali, Gertler (1998) for a complete international comparison of several countries' monetary policies.

Solving the previous system of equations, we obtain the reduced form of the model:

$$n_i = -A_0\, r + E_1\, g_i + E_2\, g_j - (1-A_1)\, w_i + A_2\, w_j \quad [7]$$
$$v_i = -A_0\, r + D_1\, g_i + D_2\, g_j + B_1\, w_i + B_2\, w_j \quad [8]$$
$$n_j = -A_0\, r + E_2\, g_i + E_1\, g_j + A_2\, w_i - (1-A_1)\, w_j \quad [9]$$
$$v_j = -A_0\, r + D_2\, g_i + D_1\, g_j + B_2\, w_i + B_2\, w_j \quad [10]$$

where: $A_0=s/(1-s)$; $A_1=(1-s+t+hs)/[(1-s)(1-s+2t+2hs)] > A_2=(t+hs)/[(1-s)(1-s+2t+2hs)]$; $A_1 > B_1=(1-h)A_1+hA_2 > B_2=hA_1+(1-h)A_2 > 0$; $E_1=(aA_1+bA_2) > E_2=(aA_2+bA_1)$; $D_1=(1-h)E_1+hE_2 > D_2=hE_1+(1-h)E_2 > 0$.

Parameters: A_0, A_1, A_2, are the elasticities of the domestic price with respect to the nominal interest rate, nominal domestic wage, nominal foreign wage, respectively. Therefore, $(1+A_0)$, $(1-A_1)$ and $(1-A_2)$ are the elasticities of the real interest rate, the real domestic wage, the real foreign wage rate with respect to the nominal interest rate, the nominal domestic wage and the nominal foreign wage, respectively. In other words, for example, if the nominal interest rate increases by one point, the real interest rate increases by $1-(-A_0) = 1+A_0$, where 1 is the effect on the real interest rate of the rise in the nominal interest rate and A_0 is the effect of prices reduction (induced by the rise in the nominal interest rate).

Before starting the analysis of regimes, the reader should note two facts. First, all the above defined elasticities are the reduced form elasticities; therefore, these elasticities include direct and *feedback* effects of each control variable on output and the CPI (i.e., an increase in public expenditure affects output not only directly, but also indirectly, since it implies a reduction in the domestic production price, the real wage and the real interest rate – E_1 summarises all these effects).

Secondly, the elasticity of investment to the nominal interest rate increases in s, but when s tends to one the elasticity tends to be infinite. When $s = 0$ ($s = 1$), investment is inelastic (infinitely elastic) to the nominal interest rate. When $s > 1$, setting higher nominal interest rates raises employment and reduces prices. In this paper $s \in (0,1)$ is reasonably assumed.

Five different regimes are possible according to the values of the two parameters $h_v = (1-B_1)$ and $h_p = (1-A_1)$[13]. The former is the elasticity of the real wage to the nominal wage (when the real wage is calculated on the basis of the CPI). The latter is the elasticity of the real wage (and employment, since [2] and [4] hold) to the nominal wage (when the real wage is calculated on the basis of production prices).

When h_v and h_p are both positive, unions raise real wages by rising nominal wages at the cost of a lower employment level (*standard trade-off* regime).

When h_v is positive and h_p is negative, unions benefit from a complementarity between real wages and employment. This complementarity arises because of the wedge between the real wage (calculated in terms of the CPI) relevant for the unions and the real wage (calculated in terms of production prices) relevant for the firm (*wage-wedge externality* regime).

When h_v and h_p are both negative, by definition of these elasticities, an increase in nominal wages causes a more than proportional increase in v and p, and then a reduction in the real wage both in terms of production prices and the CPI. In this regime unions can raise real wages by reducing nominal wages. Employment however is still a decreasing function of real wages (‘*perverse’ trade-off* regime).

When h_p is equal to zero, nominal wage increases lead to proportional increases in production prices, leaving the real wage rate (in terms of the latter variable) unchanged. Unions can thus pursue only an objective of real wages (in terms of CPI) (*fixed employment* regime).

When h_v is equal to zero, nominal wage increases lead to proportional increases in CPI, leaving unchanged the real wage rate in terms of the latter variable. Unions could raise their satisfaction

[13] Four regimes are ruled out by the assumption $h_v < h_p$ (or $B_1 < A_1$).

only by raising the employment level which would compel them to set nominal wages at an extreme value, in order to guarantee maximum employment (*fixed real wage* regime). This regime is thus of no interest for our purposes[14].

The reader should also note that government expenditure of each country has positive (negative) spillovers on the employment (price) level of the other country.

We consider a simultaneous policy game between the central bank, national governments and national unions. These players maximise the following utility functions:

$$M = -\frac{1}{2}\left(v_i + v_j\right)^2 + s\left(n_i + n_j\right) \qquad [11]$$

$$S_k = -\frac{1}{2}\left(n_k - n_k^g\right)^2 - t_k v_i \qquad k=\{i,j\} \qquad [12]$$

$$U_k = -\frac{1}{2}\left(w_k - v_k - w_k^u\right)^2 + q_k n_k \qquad k=\{i,j\} \qquad [13]$$

where M is the utility function of the central bank, S_k and U_k are those of the government and the union of the k country, respectively; n_k^g and w_k^u are government k's and union k's bliss points, respectively.

Justifications for the use of these preference functions can be found in the relevant literature. We want to depict a situation where there are three types of institutions, unions, governments and a central bank, each caring for a different target in a pre-eminent way. We admit a multiplicity of objectives for each type, but we consider as more interesting (and realistic, with reference to the European context) the case where the relevance of different targets for each institution is not the same, which, translated into analytic terms, implies using a quadratic form for the primary objective and a linear form for the secondary one[15]. In any case the symmetry of the semilinear form in the preference functions of the central bank and the governments tends to stress the difference in the pre-eminent objective of the two institutions. The central bank's preference function, linear in employment and quadratic in the price level, emphasises the weight often put on inflation by this institution (as it is in the case of the European Central Bank). Priority given to employment by governments justifies a preference function quadratic in employment (and linear in inflation) and is consistent with a situation, like the one emerging in the past months in Europe, after the Lisboa meeting. The specification of unions' preference function, linear in employment and quadratic in the real wage, similarly emphasises the weight put on the latter variable by this institution in European labour markets; there is no apparent need to include inflation (or the price level) as an additional argument, as some authors (see Gylfason, Lindbeck, 1994) would suggest – in order to take account of effects that would occur in a realistic open economy (when a closed economy is actually modelled) – since we have considered two integrated countries: any negative consequence on employment resulting from a too aggressive wage policy is built in the working of an open economy such as the one depicted in our structural model[16].

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[14] All regimes are possible. As can be easily checked, h_v and h_p are positive for values of σ close to zero. Both are increasing in the degree of openness of the economy (captured by h and t) and decreasing in $s \in (0,1)$. Moreover, when σ rises, h_v becomes negative after h_p and both become negative for values of σ smaller than ½. Hence for $s \in [½,1)$ we are always in the *perverse trade-off* regime. For values of $s \in (0,½)$, given the degree of openness of the economy, we can be in one of the five regimes according to the size of s: For values of s close to zero the *standard trade-off* regime is more plausible while for values of s closer to ½ the *perverse trade-off* regime becomes more plausible; for intermediate values of $s \in (0,½)$, the *wage-wedge externality* regime holds (if $h>0$); the other two regimes occur when switching from one regime to another. For more details on the regimes see Appendix B.

[15] See Hughes Hallett, Rees (1983), Blinder (1997). The alternative of differentiating the marginal rate of substitution between the two objectives for the three types of institutions in functions quadratic in all their common arguments does not have the same implications (unless extreme values of the marginal rate of substitution are chosen), since it would not introduce a rank between the objectives.

[16] In addition, critical remarks to such an argument are raised by Acocella, Ciccarone (1997).

3. Non-co-operative solutions

Nash non-co-operative solutions are obtained by solving the system of equations derived from agents' maximisation problems. Each player maximises its preference function (equation [11] or equation [12] or equation [13]) with respect to its control variable, i.e. the nominal interest rate for the central bank, the nominal wage rate in each country for each union and the public expenditure in each country for each government.

Solving the central bank problem yields the following first order condition:

$$2s\,r-(a+b)(g_i+g_j)+w_i+w_j+\frac{s}{1-s}=0 \qquad [14]$$

The solutions of the unions' problems in the two countries yield the following FOCs:

$$A_0 r-(a B_1+b B_2)\,g_i-(a B_2+b B_1)\,g_j+h_v w_i-B_2 w_j-w_i^u+\frac{h_p}{h_v}q_i=0 \qquad [15]$$

$$A_0 r-(a B_1+b B_2)\,g_j-(a B_2+b B_1)\,g_i+h_v w_j-B_2 w_i-w_i^u+\frac{h_p}{h_v}q_j=0 \qquad [16]$$

The solutions of the governments' problems yield the following FOCs:

$$A_0 r-E_1 g_i-E_2 g_j+h_p w_i-A_2 w_j+n_i^g-\frac{a B_1+b B_2}{E_1}t_i=0 \qquad [17]$$

$$A_0 r-E_1 g_j-E_2 g_i+h_p w_j-A_2 w_i+n_j^g-\frac{a B_1+b B_2}{E_1}t_j=0 \qquad [18]$$

Solving the equation system ([14], [15], [16], [17] and [18]), we obtain the following result:

$$n_i^{NC}=\frac{n_i^g-n_j^g}{2}-\frac{1}{2}\frac{a B_1+b B_2}{E_1}(t_i-t_j)-\frac{w_i^u+w_j^u}{2}+\frac{1}{2}\frac{h_p}{h_v}(q_i+q_j) \qquad [19]$$

$$v_i^{NC}=\frac{(1-2h)}{4h}\left[n_i^g-n_j^g-\frac{a B_1+b B_2}{E_1}(t_i-t_j)+w_i^u-w_j^u-\frac{h_p}{h_v}(q_i-q_j)\right]+\frac{1}{2}s \qquad [20]$$

$$(w-v)_i^{NC}=w_i^u-\frac{h_p}{h_v}q_i \qquad [21]$$

Expressions similar to [19], [20] and [21] hold for country j.

According to [21], the union in i gets a real wage equal to its bliss point up to an amount whose sign is positive or negative according to the sign of h_p/h_v.

The standard proposition of monetary policy neutrality holds (i.e., the employment level in the two countries does not depend on the weight assigned by the central bank to employment)[17].

[17] On circumstances affecting non-neutrality in games involving monopoly unions see Acocella, Ciccarone (1997) and, more recently, Cukierman, Lippi (1999), Lippi (1999), Ciccarone, Marchetti (2000).

If $h_p = 0$ (*fixed employment* regime), i.e. if there are no effects of nominal wages on employment, the levels of real wages correspond to the unions' bliss points. If, in addition, $n^g_i = n^g_j$, $t_i = t_j$, $w^u_i = w^u_j = w^u$, the employment level is $-w^u$ in both countries.

If $h_p/h_v < 0$ (*wage-wedge* regime), the real wage is higher and employment is lower than in the previous case. If the indicated assumptions of symmetry of the preference functions between the two countries hold, the level of inflation, v, is dependent only on the central bank's preference for employment (a standard inflation bias is present). In this regime each union tends to gain from the positive effect on employment of a nominal wage rise (the complementarity is generated by the real wage-wedge). However, since unions act in a non co-ordinated way, they are not able to achieve the (Pareto) efficient real wage.

If $h_p/h_v > 0$ (both *standard* and *perverse trade-off* regimes), the level of real wages is lower and the employment level is higher than in the previous case[18]. Here again, if the indicated assumptions of symmetry of the preference functions between the two countries hold, the level of inflation, v, is dependent only on the central bank's preference for employment (a standard inflation bias is also present).

Let us consider the *standard trade-off* regime ($h_p/h_v > 0$) further. It occurs when both h_p and h_v are positive. Each union tries to maximise its preference function by raising its nominal wage. In doing so it considers employment losses, but it does not take account of the negative externality on the other country's real wage. This turns out to be a sort of wage illusion, not because of the central bank's reaction, but as an effect of a similar choice – and illusion – on the side of the other country's union. The two unions are really involved in a prisoner's dilemma game; they set a nominal wage which corresponds to a real wage higher than the (Pareto) efficient one.

The *perverse trade-off* regime holds when both h_p and h_v are negative. In this case each union tries to reach its optimal real wage by nominal wage reduction. Country i's union tries to beggar its neighbour fellow by decreasing its own nominal wage rate, hoping that this policy guarantees, on one side, a higher real wage (though a more than proportional reduction in the price level) and a higher employment (through the terms of trade effect), on other side[19]. This, however, again turns out to be a sort of wage illusion as an effect of a similar choice – and illusion – by country j's union. The two unions are again involved in a prisoner's dilemma.

4. Fiscal policy co-operation

The central bank and unions maximisation problems are the same as those analysed in the above section. Governments instead maximise the following common utility preference:

$$S^C = \tfrac{1}{2}S_i + \tfrac{1}{2}S_j \qquad [22]$$

Solution of the governments' problems yields the following FOCs:

$$\frac{(a+b)}{1-s}r - \left(B_1^2 + B_2^2\right)g_i - 2B_1B_2g_j + \left(h_pB_1 - A_2B_2\right)w_i - \left(A_2B_1 - h_pB_2\right)w_j + B_1n_i^g + B_2n_j^g - D_1t_i - D_2t_j \qquad [23]$$

$$\frac{(a+b)}{1-s}r - \left(B_1^2 + B_2^2\right)g_j - 2B_1B_2g_i + \left(h_pB_1 - A_2B_2\right)w_j - \left(A_2B_1 - h_pB_2\right)w_i + B_1n_j^g + B_2n_i^g - D_1t_j - D_2t_i \qquad [24]$$

[18] The two regimes have equal effect on employment and real wage, but differ in the value of nominal wages.

[19] Consider that these two effects depend on the values of t and h, respectively.

We obtain the equilibrium values of employment and the CPIs by solving the system ([14], [15], [16], [23] and [24]):

$$n_i^{GC} = \frac{n_i^g - n_j^g}{2} - \frac{1-2h}{2}(t_i - t_j) - \frac{w_i^u + w_j^u}{2} + \frac{h_p}{h_v}(q_i + q_j) \quad [25]$$

$$v_i^{GC} = \frac{(1-2h)}{4h}\left[n_i^g - n_j^g + (1-2h)(t_i - t_j) + w_i^u - w_j^u - \frac{h_p}{h_v}(q_i - q_j) \right] + \frac{1}{2s} \quad [26]$$

$$(w-v)_i^{GC} = w_i^u - \frac{h_p}{h_v} q_i \quad [27]$$

The values of gains from co-operation accruing to country i (in terms of the specific objectives and not of satisfaction) can be obtained by subtracting the values of non-co-operative solutions from the values of co-operative ones:

$$\Delta n_i^{dg} = \frac{h}{2}\frac{(a+b)}{(1-s)E_1}(t_i - t_j) \quad [28]$$

$$\Delta v_i^{dg} = \frac{(1-2h)}{4}\frac{(a+b)}{(1-s)E_1}(t_i - t_j) \quad [29]$$

$$\Delta(w-v)^{dg}{}_i = 0 \quad [30]$$

Similar expressions hold for country j.

Co-operation has an effect on employment and consumer prices only if governments have different objectives. In this case each government can exchange one objective for the other and (presumably) raise its satisfaction level. The government whose preference for price stability is higher can achieve a higher level of employment when it co-operates with the other government (since, in this case, it would share the latter's preferences, which are more employment-oriented), while the other government can achieve a lower level of inflation, through international co-operation.

The reason why co-ordination affects the outcomes of the game only if there is a difference on the weights put by the governments on price stability lies in the opposition of the pre-eminent objectives of the governments (employment) and the central bank (price stability): the latter reacts to a co-ordinated rise in government expenditure in the two countries, which results in higher levels not only of employment but also of prices in both countries. To preserve price stability the central bank raises the interest rate, thus completely *neutralising* the rise in employment and prices induced by the governments' action.

This can be seen if we express the levels of w_i and w_j as a function of r, g_i and g_j in the FOCs of the unions and substitute them into the reaction function of the central bank [14]: we get

$$r = \frac{1}{2}\frac{(a+b)}{s}(g_i + g_j) + \frac{1}{2s}(w_i^u + w_j^u) - \frac{1}{2}\frac{h_p}{h_v}\frac{(q_i + q_j)}{1-s} - \frac{s}{2} \quad [31]$$

By differentiating this expression with respect to $g = g_i+g_j$ we obtain:

$$dr = \frac{1}{2}\frac{(a+b)}{s}dg \qquad [32]$$

By totally differentiating [7] and [9], considering [32][20] and assuming $d(w_i-w_j) = 0$, we have $d(n_i+n_j) = 0$. This means that the positive effect on employment of raising government expenditures is exactly compensated by the effect on the same variable of the rise in the interest rate operated by the central bank as a reaction to the higher level of government expenditures deriving from governments' co-operation.

Contrary to conclusions drawn by Dixon, Santoni (1997), positive spillovers from government expenditure no longer arise in a monetary union with an active central bank.

5. Co-operation between unions.

In this section, we assume that unions act co-operatively, by maximising the following function:

$$U^C = ½U_i + ½U_j \qquad [33]$$

The central bank and the governments behave as described by [14] and [17]–[18], respectively. FOCs for country i and j are:

$$A_0^2 r + (D_1 h_v - D_2 B_2) g_j - (D_2 h_v + D_1 B_2) g_i - (h_v^2 + B_2^2) w_j - 2h_v B_2 w_i + h_v w_j^\mu - B_2 w_i^\mu - h_p q_j - A_2 q_i = 0 \quad [34]$$

$$A_0^2 r + (D_1 h_v - D_2 B_2) g_j - (D_2 h_v + D_1 B_2) g_i - (h_v^2 + B_2^2) w_j - 2h_v B_2 w_i + h_v w_j^\mu - B_2 w_i^\mu - h_p q_j - A_2 q_i = 0 \quad [35]$$

The equilibrium solutions in this case are obtained by solving the equation system given by ([14], [17], [18], [34] and [35]):

$$n_i^{UC} = \frac{n_i^g - n_j^g}{2} - \frac{1}{2}\frac{a B_1 + b B_2}{a A_1 + b A_2}(t_i - t_j) - \frac{w_i^u + w_j^\mu}{2} + \frac{q_i + q_j}{2} \qquad [36]$$

$$v_i^{UC} = \frac{1-2h}{4h}\left[n_i^g - n_j^g - \frac{a B_1 + b B_2}{a A_1 + b A_2}(t_i - t_j) + w_i^u - w_j^u - q_i + q_j \right] + \frac{s}{2} \qquad [37]$$

$$(w-v)_i^{UC} = w_i^u - \frac{h_p + A_2}{h_v + A_2} q_i - \frac{B_2 - A_2}{h_v + A_2}(q_i + q_j) \qquad [38]$$

Similar results can be obtained for country j.

The gains from co-operation accruing in terms of policy objectives can be obtained by subtracting the values of the non-co-operative solutions from those of co-operative ones:

$$\Delta^{du} n_i = \frac{1}{2}\frac{A_1 - A_2}{h_v}(q_i + q_j) \qquad [39]$$

[20] Equation [32] is a kind of Taylor rule derived endogenously on the basis of a maximisation process followed by the central bank.

$$\Delta^{du} v_i = -\frac{1-2h}{4}\frac{A_1 - A_2}{h_v}(q_i - q_j) \qquad [40]$$

$$\Delta^{d}\left(w - v\right)_i = -h\left(\frac{A_1 - A_2}{h_v + B_2}\right)\left(\frac{B_2}{h_v} q_i + q_j\right) \qquad [41]$$

Since $A_1 - A_2 > 0$, employment is higher (lower) than in the non-co-operative case, if $h_v > 0$ ($h_v < 0$). Correspondingly, inflation is lower (higher) than in the non co-operative case in the country whose union has a higher (lower) preference for employment, i.e., a higher (lower) q_k. Consider that the case $q_i = q_j$, $h_v < 0$ and $|h_v| < B_2$ can never be an optimal solution for the unions (since both real wages and employment decrease). From the point of view of a social planner (the government) interested in both employment and price stability, the outcome of unions' co-operation is ambiguous in general. If, however, we consider the case where $q_i = q_j$ and $h_v > 0$, unions' co-operation has an unambiguous positive effect on social welfare in each country.

The real wage differs from that in the non-co-operative case. Now each union considers the effects of its actions on the utility of its homologue. Therefore, the equilibrium real wage depends on the preferences of both unions. The real wage is always lower than in non-co-operative case, if $h_v > 0$. Moreover, if both unions put the same emphasis on employment and $h_v < 0$ the real wage is higher (lower) than in non-co-operative case, if $|h_v| > B_2$ ($|h_v| < B_2$).

These results are worth commenting in the light of the hump-shaped hypothesis suggested by Calmfors, Driffill (1988). In their analysis there are two opposing forces (competition and consideration of effects of wage changes on the CPI) which determine the outcome of wage bargaining. The same two forces operate in our model at an international level. They are expressed by the elasticity of the real wage to the nominal wage, h_v, whose value depends on parameters t (an indicator of the impact of domestic prices on employment through the terms of trade), on one side, and $(1-h)$ (the impact of domestic prices on employment through the CPI), on the other side[21]. However, these parameters are built in the structure of the economy and do not change according to the level of wage bargaining. Centralisation of wage bargaining (at an international level) leads to a reduction in nominal and real wage rates only if these parameters take appropriate values. Then our model can be interpreted as a way to demonstrate that the intuition of Calmfors and Driffill as to the two forces determining the outcome of bargaining in terms of wage and employment holds only in certain regimes (in our terms, the *standard trade-off* regime and the *wage-wedge* regime). From this point of view our results are different also from Zervoyianni's (see Zervoyianni, 1997), who finds an unambiguous positive effect on employment from wage-setting co-operation in an international context.

6. Simultaneous co-operation between unions and governments.

The solution that derives from the simultaneous co-operation of governments, on one side, and unions, on the other side, can be obtained by solving the system of equations ([14], [23], [24], [34] and [35]):

$$n_i^C = \frac{(n_i^g - n_j^g)}{2} - \frac{1-2h}{2}(t_i - t_j) - \frac{w_i^s + w_j^s}{2} + \frac{q_i + q_j}{2} \qquad [42]$$

[21] The reader should note that $\partial h_v/\partial t > 0$ and $\partial h_v/\partial(1-h) < 0$.

$$v_i^C = \frac{1-2h}{4h}\left[n_i^g - n_j^g + (1-2h)(t_i - t_j) + w_i^s - w_j^s + \frac{h_p}{h_v}(q_i - q_j) \right] - \frac{s}{2} \qquad [43]$$

$$(w-v)_i^C = w_i^u - \frac{h_p + A_2}{h_v + A_2} q_i - \frac{A_1 - A_2}{h_v + A_2} h(q_i + q_j) \qquad [44]$$

Similar expressions hold for the other country.

Gains from co-operation between unions and, at the same time, between governments are as follows:

$$\Delta^d n_i = \frac{1}{2}\frac{A_1 - A_2}{h_v}(q_i + q_j) + \frac{h}{2}\frac{(a+b)}{(1-s)E_1}(t_i - t_j) \qquad [45]$$

$$\Delta^d v_i = -\frac{1-2h}{4}\frac{A_1 - A_2}{h_v}(q_i - q_j) + \frac{1-2h}{4}\frac{(a+b)}{(1-s)E_1}(t_i - t_j) \qquad [46]$$

$$\Delta^d (w-v)_i = -h\left(\frac{A_1 - A_2}{h_v + B_2}\right)\left(\frac{B_2}{h_v} q_i + q_j\right) \qquad [47]$$

The real wage is the same of previous section, it is lower than in the non-co-operative case, if h_v>0. If this condition holds and the governments put the same emphasis on prices, the employment level is certainly higher than in the non-co-operative case. A price level different than in the non-co-operative case can result only if the preference of unions as to the real wage and those of governments as to inflation are different.

Notice that [45] is the sum of [28] and [36], whereas [46] is the sum of [29] and [37]. This implies that there are no cross institutional externalities; i.e. there are no further gains from co-operation between governments and unions than those that can accrue in the case of co-operation between either governments or unions.

7. Simultaneous co-operation between central bank and governments.

In this section, we assume that the central bank and governments act co–operatively, by maximising the following function:

$$MS = \frac{1}{3} M + \frac{1}{3} S_i + \frac{1}{3} S_j \qquad [48]$$

Following the same procedure as above we obtain the following equilibrium values:

$$n_i^{BG} = \frac{n_i^g - n_j^g}{2} - \frac{1-2h}{2}(t_i - t_j) + \frac{w_i^s + w_j^s}{2} + \frac{1}{2}\frac{h_p}{h_v}(q_i + q_j) \qquad [49]$$

$$v_i^{BG} = v_i^{GC} - \frac{1}{4}\left(n_i^g + n_j^g + w_i^u + w_j^u + q_i + q_j + t_i + t_j\right) \qquad [50]$$

$$\left(w-v\right)_i^{BG} = w_i^{\mu} - \frac{h_p}{h_v} q_i \qquad [51]$$

Similar expressions hold for the other country.

Gains from co-operation between central bank and between governments are as follows:

$$\Delta^{dgb} n_i = \frac{h}{4} \frac{\left(a+b\right)}{\left(1-s\right)E_1} \left(t_i - t_j\right) \qquad [52]$$

$$\Delta^{dgb} v_i = \frac{\left(1-2h\right)}{4} \frac{\left(a+b\right)}{\left(1-s\right)E_1} (t_i - t_j) - \frac{1}{4} \left(n_i^g + n_j^g + w_i^u + w_j^u + q_i + q_j + t_i + t_j \right) \qquad [53]$$

$$\Delta^{dgb} \left(w-v\right)_i = 0 \qquad [54]$$

These are the same outcomes derived in the case of government co-operation, except for the inflation bias, which is reduced by the second term on the right hand side of [53].

8. Summary and conclusions.

In this paper, we have analysed the effects of co-operation between unions and/or governments in a common-currency area.

We have found the possibility of a gain in terms of employment when unions co-operate if we are in a regime where the impact of domestic prices on employment through the terms of trade is higher than the impact of domestic prices on employment through the CPI.

Our model can be interpreted as a way to demonstrate that the intuition of Calmfors and Driffill (1988) as to the two forces determining the outcome of bargaining in terms of wage and employment holds only in certain regimes (in our terms, the *standard trade-off* regime and the *perverse trade-off* regime). From this point of view our results also differ from Zervoyianni (1997), who finds an unambiguous positive effect on employment from wage-setting co-operation in an international context.

In the case of co-operation between governments only, gains may derive in terms of employment *or* inflation to one or the other country, if the weights put by governments on price stability are different. From this point of view our results differ from Dixon, Santoni (1997), who find positive spillovers from government expenditure. In the case of co-operation between governments their attempt to raise expenditure and the employment level is neutralised by the central bank aiming at price stability.

Our next task is to check how robust these findings are with respect to different preference functions of the agents involved and to different hypotheses of co-operation, e.g., co-operation between a government and a union of the same country.

Appendix A. Explanation and derivation of the model.

The production function is the following.

$Y_i = N_i^{\delta} K_i^{1-\delta} \qquad \delta \in (0,1)$

In order to maximise profits, firms hire labour up to the point at which real wages are equal to the marginal product of labour. Therefore, setting the marginal product of labour equal to the real wage, taking logs and rearranging yields the demand for labour.

$n_i = -\rho\ (w_i - p_i) + \ln(\delta)/(1-\delta) + k \qquad \rho = 1/(1-\delta) > 1.$

As is customary, we put $\ln(\delta)/(1-\delta) + k = 0$, with no loss of generality.
According to the production function, employment is a decreasing function of the real wage.
The log representation of the IS curve is[22]:

$n_i = -\alpha\ (r - p_i^e) + \beta\ g_i - \gamma\ t_i + \delta\ g_j + \zeta\ (p_j - p_i)$

Where, α, β, γ, δ and ζ are IS coefficients. All of them are functions of the marginal propensity to import and to save. Employment decreases in the nominal interest rate (investment expenditure); taxation (on consumption); and product prices differential (competitiveness effects). It increases in home public expenditure and foreign public expenditure (through exports).
The balanced budget condition is the following: $G_i = T_i N_i^{\varphi}$ where φ is the elasticity of taxation with respect to employment. In logs it becomes: $g_i = t_i + \varphi\ n_i$
Therefore, the log representation of the IS curve with a balanced budget is:

$n_i = -(\alpha r - p_i^e) + \beta g_i - \gamma(g_i - \varphi n_i) + \delta g_j + \zeta(p_j - p_i)$

or: $n_i = -\dfrac{\alpha}{1-\gamma\varphi}\left(r - p_i^{\,e}\right) + \dfrac{\beta-\gamma}{1-\gamma\varphi} g_i + \dfrac{\delta}{1-\gamma\varphi} g_j + \dfrac{\zeta}{1-\gamma\varphi}\left(p_j - p_i\right)$

where we assume $\beta > \gamma$, $\gamma\varphi < 1$ and $\delta < \beta - \gamma$.
The structural form of the model can then be expressed in the following way:

$n_i = -\sigma'(r - p_i^e) + \alpha' g_i + \beta' g_j + \tau' p_j - \tau' p_i$
$n_i = \rho\ (p_i - w_i)$
$n_j = -\sigma'(r - p_j^e) + \alpha' g_j + \beta' g_i + \tau' p_i - \tau' p_j$
$n_j = \rho\ (p_j - w_j)$

where $\sigma' = \alpha/(1-\gamma\varphi)$; $\alpha' = (\beta-\gamma)/(1-\gamma\varphi)$; $\beta' = \beta/(1-\gamma\varphi)$; and $\tau' = \zeta/(1-\gamma\varphi)$.
Then dividing by ρ, we obtain:

$n_i = -\sigma\ (r - p_i^e) + \alpha g_i + \beta g_j + \tau\ (p_j - p_i)$
$n_i = (p_i - w_i)$
$n_j = -\sigma\ (r - p_j^e) + \alpha g_j + \beta g_i + \tau\ (p_i - p_j)$
$n_j = (p_j - w_j),$

where unmarked parameters are the marked parameters divided by ρ: e.g., $\sigma = \sigma'/\rho$ and the employment is now normalised for ρ.

[22] We express it directly in terms of n_i, instead of y_i. Since $y_i = \delta\ n_i + (1-\delta)\ k$ (i.e. log-production function), we can do this and incorporate δ in the parameters of the IS curve.

Appendix B

Standard trade-off regime ($A_0 < A_2$)

- $h_v = 1 - B_1 > 0$ or $B_2 > A_0$
- $h_p = 1 - A_1 > 0$ or $A_2 > A_0$

This regime holds for low values of s and for high values of t and h. This is the common textbook case: increases in nominal wage in one country raise real wages (in terms of both CPI and producer prices) and unemployment; reductions in nominal interest rate raise prices and employment.

Wage-wedge regime ($A_2 < A_0 < B_2$)

- $h_v = 1 - B_1 > 0$ or $B_2 > A_0$
- $h_p = 1 - A_1 < 0$ or $A_2 < A_0$

This regime holds when the foreign component in the consumption basket is (relatively) high and the elasticity of employment to the terms of trade is (relatively) low; i.e. it is more likely to occur when t is small and h is large. The lower is t and the higher is h, then the higher is the distance between A_2 and B_2, and (since A_0 does not depend on t and h) for a given s the higher is the probability that A_0 lies in between A_2 and B_2. However, since it depends on the wedge between the real wage in terms of CPI and the real wage in terms of production prices, when h=0 it never occurs. This regime might be the case of a developed country whose consumption basket has a large foreign content whereas the degree of substitutability between home and foreign goods is rather low, as an effect of either oligopolistic strategies or the specialisation of the two countries. In this regime increases in nominal wages in one country decrease real wages in terms of producer prices in that country (firms are not restrained from rising the prices of their products more than proportionally, since t is low), but tend to increase real wages in terms of CPI: notwithstanding the more than proportional increase in production prices, the impact of nominal wage increases on the CPI is low, since h is high.

Perverse trade-off regime ($A_0 > B_2$)

- $h_v = 1 - B_1 < 0$ or $B_2 < A_0$
- $h_p = 1 - A_1 < 0$ or $A_2 < A_0$

This regime is characterised by a very high sensitivity of prices and employment to the nominal interest rate. The sensitivity is, in fact, captured by A_0 (and thus by s). For $s > ½$ this regime always occurs while, if $s < ½$, the regime occurs when the economy is (relatively) closed (low values of t and h).

Fixed-employment regime ($A_0 = A_2$)

- $h_p = 1 - A_1 = 0$ or $A_1 = A_0$

In this regime, nominal wage increases lead to proportional increases in production prices, leaving the real wage rate in terms of the latter variable unchanged.

Fixed-real wage regime ($A_0 = B_2$)

- $h_v = 1 - B_1 = 0$ or $A_0 = B_2$

In this regime, nominal wage increases lead to proportional increases in the CPI, leaving the real wage rate in terms of the latter variable unchanged.

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