Foreign Central Bank Conservativeness and Collective Wage Bargaining

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Abstract

This paper investigates the impact of the institutional design of the foreign central bank on wage bargaining and economic performance in the presence of labor unions. The analysis of strategic interactions among central banks and labor unions is performed in a two-country open-economy framework under flexible exchange rates. The model shows that the beggar-thy-neighbor effect of foreign monetary policy on home output is always overturned by the optimal home monetary policy reaction. The implication is that the conservativeness of the foreign central bank represents a threat to home labor unions and acts as a deterrent against higher wage claims. Hence, the home economy benefits from the conservativeness of the foreign central bank through lower unemployment and inflation.

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1 Introduction

The effect of monetary policy on collective wage bargaining is the subject of a growing literature. The main conclusion of this literature is that the conduct of monetary policy

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affects the real economy even in the long run, which is contrary to the conventional view that monetary policy is neutral in the long run.[1] While this literature has focused on the design of the domestic central bank, it has neglected the impact of the institutional design of the *foreign* central bank. However, foreign monetary policy may as well have a non-neutral long run impact on the home economy. The question is how does foreign monetary policy, which interacts also with home monetary policy, affect wage bargaining in the home country and what is the impact on the home economy? This issue has not been investigated before. Our investigation reveals that the impact of foreign conservativeness differs from that of domestic conservativeness: unlike domestic conservativeness, a higher degree of foreign conservativeness is always beneficial for the home economy.[2]

The development of global capital markets and the increasing openness to international trade create a growing interest in the conduct of a foreign country's monetary policy. The issue of foreign central bank design is of key relevance for countries in the backyard of the European Economic and Monetary Union. Across most of Continental Europe, including Scandinavia, but excluding Switzerland, collective wage bargaining coverage is high and some of these countries have floating exchange rates and strong trade links with each other.

In order to study the cross-country effects of conservativeness, we introduce a two country open economy model. International trade transmits the strategic interactions between the two central banks and the labor unions under a floating exchange rate regime. The countries are parametrized for size and number of labor unions, which is a proxy for the degree of centralization of wage bargaining.

A well-known result from open economy models, such as the Mundell-Fleming or the Obstfeld and Rogoff (1995) model, is that a foreign monetary expansion may either reduce the home country's output, which is called a beggar-thy-neighbor effect, or it may increase

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[1] A survey of this literature is in Cukierman (2004).

[2] The literature identifies two opposite effects of domestic conservativeness on real wage claims. On the one hand, Soskice and Iversen (1998, 2000), Coricelli, Cukierman and Dalmazzo (2004) find that higher conservativeness induces lower real wage claims, based on the assumption that labor unions are not inflation averse. On the other hand, Skott (1997), Cukierman and Lippi (1999), Guzzo and Velasco (1999, 2002), Lawler (2000) and Lippi (2002) find that conservativeness induces higher wage claims, given that there is a monopoly labor union which is also inflation averse. Coricelli, Cukierman and Dalmazzo (2006) propose a unifying framework that embeds the different mechanisms.

home output, which is called a locomotive effect. This paper shows that even if the effect on home output is beggar-thy-neighbor, the optimal reaction of the home central bank overturns it into a locomotive effect. The reason for this is that the monetary expansion increases the utility of the home central bank, to which the best response is to reduce home unemployment proportionally with home inflation.

The main result of this paper is that foreign conservativeness improves the economic performance of the home country. This is based on the following mechanism. When a labor union sets the nominal wage, it fears the rise in the price level, mainly because that reduces its real wage and it also fears the rise in the unemployment rate. Both of these fears are amplified by the foreign central bank and these fears act as deterrent against home wage claims. A home wage increase raises the foreign consumer price level due to imported inflation. The more conservative the foreign central bank, the more it strives to reduce inflation and the tighter foreign monetary policy becomes. As it turns out, the foreign tightening reduces the utility of the home central bank. The optimal reaction the home central bank balances the burden of the utility loss between unemployment and inflation, therefore both rise. Thus, the home labor union experiences both a higher price level threat and a higher unemployment threat, which deters its wage claims. The consequence of moderate wage claims is lower unemployment and inflation in equilibrium.

The structure of the paper is as follows. Section 2 presents a two-country model of with endogenous monetary policies and labor unions. Section 3 discusses the effects of foreign conservativeness. Section 4 draws the conclusions. The Appendix presents some of the derivations and the proofs.

2   The model

There are two countries that are open to trade and capital flows. The interactions among labor unions, central banks and firms evolve in a three stage game as follows: (1) labor unions set nominal wages into binding labor contracts; (2) the central banks of the two countries set the money supplies; (3) firms set prices. The game is solved with the backward induction

procedure.[3] This timing of the game is based on Coricelli, Cukierman and Dalmazzo (2006).

2.1 Demand and supply

All variables are in logs except the unemployment rate. Aggregate demand in the home and the foreign country is

$$y = -\eta\left(p - \bar{p}\right) + \bar{y}, \tag{1}$$

$$y^* = -\eta\left(p^* - \bar{p}^*\right) + \bar{y}, \tag{2}$$

where a star denotes foreign country variables, $\eta > 1$ is the elasticity of demand, p is the price of a domestically produced basket of goods, $\bar{p}$ is the consumer price index and $\bar{y} = sy + (1-s)\,y^*$ is world income, where $s \in (0,1)$ is the relative size of a country. The budget of a consumer is the real money balances that it holds, that is, in the case of a home consumer $m - \bar{p}$ and in the case of a foreign consumer $m^* - \bar{p}^*$, where m and m^* are the nominal money balances of the two countries. The total amount of goods that can be purchased worldwide is determined by the aggregate budget of the home consumers and the foreign consumers,

$$\bar{y} = s\left(m - \bar{p}\right) + (1-s)\left(m^* - \bar{p}^*\right), \tag{3}$$

which is derived in Appendix A.1. The home consumer price index is

$$\bar{p} = sp + (1-s)\left(p^* + e\right), \tag{4}$$

where e is the exchange rate defined as the home price of a foreign currency unit. The home and foreign consumer baskets of goods have the same composition, therefore purchasing

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[3]This timing of the game is justified by the fact that as long as wages are fixed, firms will not adjust their prices fully. Hence, it is not necessary to impose by assumption price rigidity for monetary policy to have real effects in the short run, represented by the subgame of stages 2 and 3, where wages are given. Note also that in the long run equilibrium, represented by stages 1, 2 and 3, labor unions adjust nominal wages and money is neutral, but the institutional setup, i.e. the degree of central bank conservativeness is not neutral.

power parity holds,

$$e = \bar{p} - \bar{p}^*. \tag{5}$$

The production function has labor as input,

$$y = \alpha l, \tag{6}$$

$$y^* = \alpha l^*, \tag{7}$$

where l is employed labor and $0 < \alpha < 1$. Firms face monopolistic competition and as shown in Appendix A.2, they set the relative price of their goods according to

$$p - \bar{p} = \frac{\alpha(w - \bar{p}) + (1 - \alpha)\bar{y}}{\alpha + \eta(1 - \alpha)}, \tag{8}$$

$$p^* - \bar{p}^* = \frac{\alpha(w^* - \bar{p}^*) + (1 - \alpha)\bar{y}}{\alpha + \eta(1 - \alpha)}, \tag{9}$$

where constant terms are ignored, since constants do not affect the main results of this model.

The nominal money demand is an increasing function of the amount of nominal transactions in a country and it is a decreasing function of the nominal interest rate,

$$m = b(p + y) - cr, \tag{10}$$

$$m^* = b(p^* + y^*) - cr^*, \tag{11}$$

where $0 < b < 1$ and $c > 0$. As in Rogoff (1985), the income elasticity of money demand b is restricted below unity. The unemployment rate is defined as

$$u = l_0 - l, \tag{12}$$

$$u^* = l_0^* - l^*, \tag{13}$$

where l_0 and l_0^* are the constant labor supplies of the two countries. Interest rate parity

holds,

$$r = r^* + E\{e\} - e, \tag{14}$$

where $E\{e\}$ is the expected future exchange rate. Note that when labor unions set wages in the first stage of the game, they assume correctly the level of the expected future exchange rate, which they need for their calculations. Hence $E\{e\}$ is a constant in the subsequent stages of the game.

Equations (1)-(14) provide the subgame equilibrium in the third stage of the game for fourteen variables as a function of w, w^*, r, r^*, which are given from stages one and two. The variables of interest for our purpose are the unemployment rate and the price level. Ignoring constant terms, the unemployment rate is

$$u = \delta[sr + (1-s)\,r^*] + (1-s)\,\sigma\,(r - r^*) + \sigma w - (\sigma - 1)[sw + (1-s)\,w^*], \tag{15}$$

where $\delta = \frac{c}{1-b} > 0$ and $\sigma = \frac{\eta}{\alpha+(1-\alpha)\eta} > 1$, because $\eta > 1$. The signs of the partial derivatives are $u_r > 0$, $u_{r^*} \gtreqless 0$, $u_w > 0$, $u_{w^*} < 0$. Note that $u_{r^*} > 0$ if $\delta > \sigma$ which is known as a locomotive effect. Otherwise, $u_{r^*} < 0$, which is known as a beggar-thy-neighbor effect. The term δ shows the impact of the aggregate world interest rate and σ shows the impact of an exchange rate appreciation on unemployment, given the expected exchange rate, which follows from the derivative of (14), $d\,(r - r^*) = -de$.

In an open economy monetary policy has two effects on unemployment, an income effect and a substitution effect. The income effect is due to the average world interest rate, which affects the global demand for goods. The substitution effect is due to the exchange rate, which affects the substitution of the demand for goods between the two countries.

In the case of domestic monetary policy the two effects act in the same direction. A rise in the home interest rate reduces world income and appreciates the home currency, thus home unemployment increases. In the case of foreign monetary policy, the two effects act in opposite directions. A rise in the foreign interest rate reduces the world income, but it depreciates the home currency. The net effect on home unemployment depends on whether

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the substitution or the income effect is stronger.

A wage rise makes the domestic goods relatively more expensive and consumers substitute the domestic goods with foreign goods, favoring production and employment in the foreign country. Ignoring constant terms, the consumer price level is

$$\bar{p} = -(1-\alpha)\,\delta\,[sr + (1-s)\,r^*] - (1-s)\,(r-r^*) + \alpha\,[sw + (1-s)\,w^*]. \qquad (16)$$

The signs of the partial derivatives are $\bar{p}_r < 0$, $\bar{p}_{r^*} \gtrless 0$, $\bar{p}_w > 0$, $\bar{p}_{w^*} > 0$. Note that $\bar{p}_{r^*} > 0$ if and only if $\frac{1}{1-\alpha} > \delta$.

In an open economy monetary policy affects the consumer price level through two channels: (i) by affecting world income and the world demand for goods; (ii) by affecting the exchange rate, which affects the price of imported goods. When the domestic interest rate rises, these two effects add up, because income falls and the home currency appreciates, which both reduce the price level. When the foreign interest rate rises, these two effects subtract, because although the world income falls, the home currency depreciates, and the latter increases the price of imported goods. The net effect depends on the strength of the impact of the exchange rate versus the impact of world demand.

A wage rise at home or abroad has the same effect on the price level, proportional to the weight of the respective goods in the consumer basket.

2.2 Central banks

In the second stage of the game each central bank sets the money supply given nominal wages and the other central bank's money supply. The banks minimize a Kydland-Prescott-Barro-Gordon type objective function. There is no loss of generality in this static framework if we use the price level in the objective function instead of the inflation rate,

$$\min_{r} u^2 + I\bar{p}^2 \quad \text{and} \quad \min_{r^*} u^{*2} + I^*\bar{p}^{*2}, \qquad (17)$$

where the relative weights I and I^* measure the degree of conservativeness of the central banks and u and $\bar{p}$ are given in (15) and (16). The foreign unemployment rate u^* is obtained by interchanging stars as well as s and $1 - s$ in (15). The foreign price level $\bar{p}^*$ is obtained in a similar manner from (16). The first-order conditions are

$$u_r u + I \bar{p}_r \bar{p} = 0, \tag{18a}$$

$$u^*_{r^*} u^* + I^* \bar{p}^*_{r^*} \bar{p}^* = 0. \tag{18b}$$

2.3   The overturn of the beggar-thy-neighbor effect

Next we look at the impact of foreign monetary policy on the home economy. This is a crucial step in identifying the mechanism by which foreign conservativeness affects the economy. We know from (15) that foreign conservativeness has either a beggar-thy-neighbor or a locomotive effect on home unemployment. The next proposition shows that even if foreign monetary policy has a beggar-thy-neighbor effect, the optimal reaction of the home central bank overturns it into a locomotive effect.

Proposition 1 *Given nominal wages, a foreign monetary contraction, followed by the best response of the home central bank, raises both the home unemployment rate and the home price level, i.e. $\frac{du}{dr^*} > 0$ and $\frac{d\bar{p}}{dr^*} > 0$.*

Proof. *See Appendix A.5.* ■

The reason for this reaction by the home central bank is that the foreign interest rate rise reduces the utility of the home central bank. The utility falls because of the rise in the home unemployment rate or the home price level or both.[4] The optimal reaction of the home central bank is to distribute the burden evenly between unemployment and inflation, in accordance with the central bank's first-order condition. Hence the optimal reaction is either an increase or a reduction of the home interest rate, which insures that both the unemployment rate and the price level rise proportionately. Thus the final effect of a foreign

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[4]For a proof that a foreign interest rate rise reduces the utility of the home central bank, see Appendix A.6.

interest rate rise is a locomotive effect on home unemployment, meaning that the downturn of the foreign economy is followed by a downturn in the home economy. Consequently, even if the foreign monetary policy by itself has a beggar-thy-neighbor effect, the optimal reaction of the home central bank overturns it into a locomotive effect.

2.4   Labor unions

In the first stage of the game the two countries' labor unions set nominal wages concomitantly. Each country has n labor unions, which prefer a higher real wage and dislike unemployment and inflation, as in Coricelli Cukierman and Dalmazzo (2006). Labor union j minimizes the objective function with respect to its nominal wage w_j,

$$\min_{w_j} \left\{ - (w_j - \bar{p}) + \frac{A}{2} u_j^2 + \frac{B}{2} \bar{p}^2 \right\}. \tag{19}$$

By rearranging (18a) we obtain that the equilibrium inflation rate is proportional to the unemployment rate,

$$\bar{p} = -\frac{u_r}{I \bar{p}_r} u. \tag{20}$$

As shown in Appendix A.4, the equilibrium unemployment rate is

$$u = \frac{1 - \frac{1}{n}\frac{d\bar{p}}{dw}}{A\left[\sigma\left(1 - \frac{1}{n}\right) + \frac{1}{n}\frac{du}{dw}\right] + B\frac{(-u_r)}{nI\bar{p}_r}}. \tag{21}$$

This result reflects that a rise in $\frac{d\bar{p}}{dw}$ or in $\frac{du}{dw}$ reduces the unemployment rate. The elasticities $\frac{d\bar{p}}{dw}$ and $\frac{du}{dw}$ represent the threat of the price level and the unemployment rate, respectively and are obtained from the system of equations in Appendix A.3.

3   Foreign conservativeness

First we consider the special case of a monopoly labor union that is not inflation averse, which highlights the importance of foreign conservativeness, and second we consider the general case to investigate the impact of foreign conservativeness.

3.1 A monopoly labor union that is not inflation averse

In the case that there is a single labor union per country $n = 1$, which is not inflation averse $B = 0$, and assuming symmetry for simplicity $s = 1/2$, the equilibrium unemployment rate in (21) becomes

$$u = \frac{(\delta + \sigma)\left[1 + (1 - \alpha)\sigma\right] + 2(1 - \alpha)\left[1 + (1 - \alpha)\delta\right]I^*}{A\left\{2\sigma(\delta + \sigma) + \left[1 + (1 - \alpha)\sigma\right]\left[1 + (1 - \alpha)\delta\right]I^*\right\}}.$$

Strikingly, the equilibrium home unemployment rate does not depend on the degree of conservativeness of the home central bank, I. Higher conservativeness creates a tighter reaction of monetary policy to a wage increase. Therefore the labor union faces an increased threat of unemployment, but a reduced threat of the price level. In this special case, the lower price level threat exactly offsets the higher unemployment threat. Thus domestic conservativeness has no impact on equilibrium unemployment. This is supported by the existing literature, see e.g. Coricelli, Cukierman and Dalmazzo (2006) for the case of a closed economy, which corresponds to $s = 1$ in our model, yielding $u = (1 - \alpha)/A$. Nevertheless, in the present open economy model the home unemployment rate is affected by foreign conservativeness, I^*. Hence, the special case of a monopoly labor union which is not inflation averse reveals the relevance of the foreign conservativeness in contrast with the irrelevance of the domestic conservativeness for the real economy.

3.2 The general case of inflation averse labor unions

A labor union's wage rise generates a rise in the unemployment rate and in the price level. Both of these adverse effects of the wage rise deter the labor union from raising the wage above an optimal level. As it turns out, the foreign central bank accentuates both the unemployment and the price level threat.

Proposition 2 *The equilibrium home unemployment rate and the price level decrease in the conservativeness of the foreign central bank, i.e. $\frac{du}{dI^*} < 0$ and $\frac{d\bar{p}}{dI^*} < 0$. The impact is nil if $n \to \infty$, $s \to 0$ or $s \to 1$.*

Proof. *See Appendix A.7.* ∎

A home wage rise reduces foreign unemployment, (due to the substitution of the home goods with foreign goods, see (15)), and it increases the foreign price level (due to imported inflation, see (16)). As a consequence, the foreign central bank reacts by unambiguously raising the foreign interest rate. This reaction reduces the utility of the home central bank and as Proposition 1 shows, following the best response of the home central bank, both the unemployment rate and the price level rises in the home country. Since the rise in unemployment and prices is the consequence of higher wages, it represents a deterrent for the labor union against a wage rise. Therefore the interaction with the foreign central bank contributes to the moderation of the home labor union.

The more conservative the foreign central bank, the more it raises the interest rate in response to a home wage rise, because it is more eager to reduce imported inflation. That raises the loss of the home central bank, which transforms it into a higher threat of unemployment and a higher threat of inflation for the home labor union. The increased threat provides a stronger deterrence of wage claims. Hence, a rise in foreign conservativeness moderates the labor union and leads to lower unemployment and inflation in equilibrium.[5]

The impact of foreign conservativeness is robust with respect to the parameters of the model. By contrast, the impact of domestic conservativeness changes direction if the labor union's inflation aversion B is too high relative to its unemployment aversion A, as shown in Coricelli, Cukierman and Dalmazzo (2006). The reason is that in contrast with foreign conservativeness, domestic conservativeness does not increase both types of threats. A rise in domestic conservativeness generates a more contractionary monetary policy reaction against a wage rise, and hence it increases the unemployment threat but it reduces the price level threat. Thus, the sign of the impact of domestic conservativeness depends on which of the two threats dominates. If the labor union is sufficiently inflation averse, then the price threat

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[5] As the number of labor unions increases, the adverse economic impact of the wage rise is internalized to a lesser extent, leading to a weaker impact of foreign conservativeness on the home economy and the impact disappears if the number of labor unions tends to infinity. The impact of foreign conservativeness is strongest at an intermediate country size. If the home country is very large or very small relative to the foreign country, then foreign conservativeness has no impact on home unemployment and inflation.

dominates the unemployment threat. The reason is that the rise in inflation aversion, B, increases the weight of the price level relative to the unemployment rate. Since domestic conservativeness diminishes the price threat, it weakens the self-moderation of the labor union's wage claims and therefore the equilibrium unemployment rate rises. Thus, for example, if the labor union is sufficiently inflation averse, then a rise in domestic conservativeness is not beneficial, whereas a rise in foreign conservativeness is beneficial for the home economy.

Lippi (2003) shows that the impact of domestic conservativeness depends also on the elasticity of labor substitution. Lippi assumes that firms employ a basket of labor types that belong to different labor unions and the labor types are substitutable. Thus he introduces direct labor substitution between labor unions using a constant elasticity of substitution aggregate of labor. If the elasticity of labor substitution is high, then this competitive effect on the individual union's unemployment matters more compared to the impact of monetary policy on aggregate unemployment. Hence the labor union pays less attention to the unemployment threat of monetary policy relative to the price level threat of monetary policy. Consequently, domestic conservativeness reduces the price level threat inducing higher wage claims, which is not beneficial for the economy. Thus the role of labor substitution is similar to that of inflation aversion. Contrasting with the impact of domestic conservativeness, the impact of foreign conservativeness does not reverse its direction if labor substitution increases. This is due to the fact that both the unemployment threat and the price threat increase with foreign conservativeness. That is, unlike domestic conservativeness, foreign conservativeness has a robust impact, which holds even if there is direct labor substitution as in Lippi (2003).

4 Conclusions

This paper shows how the design of the foreign monetary institution affects the home economy. Here is the essence of the difference between the macroeconomic impact of domestic central bank conservativeness and foreign central bank conservativeness: Domestic conservativeness creates a threat that deters wage claims through a higher unemployment rate, but

it weakens the deterrence through a lower price level. Therefore, the labor union is deterred only if its unemployment fears play a more important role than its inflation fears. In the particular case of a monopoly labor union, which is not inflation averse, domestic conservativeness has no impact on unemployment, because the higher unemployment threat and the lower price threat exactly offset. By contrast, foreign conservativeness increases both the threat of the unemployment rate and the threat of the price level. Therefore, foreign conservativeness deters the home labor union's wage claims, even if the labor union is highly inflation averse.

This paper shows that unlike domestic conservativeness, foreign conservativeness deters home wage claims through both channels of unemployment and price level threats. Therefore, a higher level of foreign conservativeness is always better for the home economy. It follows that it is optimal from the perspective of the home country if the foreign central bank is ultra-conservative. This explains the earlier efforts of Germany to remove the liberal monetary policies in Europe by means of creating a common monetary policy. Cukierman and Lippi (2001) and Gruner and Hefeker (1999) investigate the economic impact of the monetary union assuming that the conservativeness of both countries is the same before and after the monetary union and they find an adverse economic impact of the monetary union. However, apart from this adverse effect, as this paper shows, the rise of conservativeness in Germany's neighbors but not in Germany has an unambiguous beneficial effect on Germany.

A   Appendix

A.1   The demand function in an open economy

The home consumer has a budget $m - \bar{p}$ and the foreign consumer has a budget $m^* - \bar{p}^*$. The demand by the home consumers for good j is,

$$y_j^H = -\eta \left(p_j - \bar{p}\right) + m - \bar{p}.$$

The demand by the foreign consumers for the same good j is,

$$y_j^F = -\eta \left(p_j^* - \bar{p}^* \right) + m^* - \bar{p}^*.$$

The good j sells for the same price at home and abroad, $p_j = p_j^* + e$ and purchasing power parity holds, $\bar{p} = \bar{p}^* + e$. The total demand for good j by home and foreign consumers is weighted by the relative size of each country, s and $1 - s$,

$$
\begin{aligned}
y_j &= sy_j^H + (1 - s) y_j^F \\
&= -\eta \left(p_j - \bar{p} \right) + s \left(m - \bar{p} \right) + (1 - s) \left(m^* - \bar{p}^* \right).
\end{aligned}
$$

Total world demand for all goods produced in the home country and in the foreign country is

$$
\begin{aligned}
\bar{y} &= sy + (1 - s) y^* \\
&= s \left(m - \bar{p} \right) + (1 - s) \left(m^* - \bar{p}^* \right).
\end{aligned}
$$

A.2   The firm's problem

We follow Coricelli, Cukierman and Dalmazzo (2006) by assuming that a fraction of the continuum of firms in a country employs labor from union j. The representative firm using labor union j is denoted by firm j. The production function of firm j is,

$$y_j = \alpha l_j, \tag{22}$$

where $0 < \alpha < 1$. The demand faced by firm j is

$$y_j = -\eta \left(p_j - \bar{p} \right) + \bar{y}. \tag{23}$$

Let capital letters represent the antilogs of small case variables. The real profit of firm j is

$$\frac{P_j}{\bar{P}}Y_j - \frac{W_j}{\bar{P}}L_j. \tag{24}$$

Firms face monopolistic competition and choose the price to maximize profit. By substituting the antilogs of (22) and (23) into (24) the problem of the firm becomes

$$\max_{P_j} \left(\frac{P_j}{\bar{P}}\right)^{1-\eta}\bar{Y} - \frac{W_j}{\bar{P}}\left[\left(\frac{P_j}{\bar{P}}\right)^{-\eta}\bar{Y}\right]^{1/\alpha}.$$

The infinitesimal firm takes the price level $\bar{P}$ and the wage W_j as given. Calculating the first order conditions and taking logarithms yields

$$p_j - \bar{p} = \theta + \frac{\alpha(w_j - \bar{p}) + (1-\alpha)\bar{y}}{\alpha + \eta(1-\alpha)}, \tag{25}$$

where $\theta \equiv \alpha/\left[\alpha + \eta\left(1-\alpha\right)\right]\log\left[\eta/\alpha\left(\eta-1\right)\right] > 0$. The average price over all labor unions in the home country is defined as $p = \sum_{j=1}^{n} p_j$. Taking the average of both sides of equation (25) yields equation (8).

The equations (23), (25) together with their country wide averages (1) and (8) form a system of equations, where the unknown variables are y_j, p_j, p, $\bar{p}$. From here we obtain

$$y_j = -\frac{\alpha\eta}{\alpha + (1-\alpha)\eta}\left(w_j - w\right) + y. \tag{26}$$

Using (22) and (12) in (26) implies that

$$u_j = \sigma\left(w_j - w\right) + u, \tag{27}$$

where $\sigma = \frac{\eta}{\alpha+(1-\alpha)\eta} > 1$ is the elasticity of labor with respect to the relative wage. This shows that the unemployment rate of labor union j is a function of the home country's unemployment rate and the relative wage in that country.

A.3 The system of equations that yields $\frac{du}{dw}$ and $\frac{d\bar{p}}{dw}$

Taking the derivative of equations (15) and its foreign counterpart, (16) and its foreign counterpart, (18a) and (18b) with respect to the home nominal wage w yields the following system of equations,

$$\frac{du}{dw} = u_r r_w + u_{r*} r_w^* + u_w, \tag{28}$$

$$\frac{du^*}{dw} = u_r^* r_w + u_{r*}^* r_w^* + u_w^*, \tag{29}$$

$$\frac{d\bar{p}}{dw} = \bar{p}_r r_w + \bar{p}_{r*} r_w^* + \bar{p}_w, \tag{30}$$

$$\frac{d\bar{p}^*}{dw} = \bar{p}_r^* r_w + \bar{p}_{r*}^* r_w^* + \bar{p}_w^*, \tag{31}$$

$$u_r \frac{du}{dw} + I\bar{p}_r \frac{d\bar{p}}{dw} = 0, \tag{32}$$

$$u_{r*}^* \frac{du^*}{dw} + I^* \bar{p}_{r*}^* \frac{d\bar{p}^*}{dw} = 0. \tag{33}$$

The unknown variables are $\frac{du}{dw}$, $\frac{du^*}{dw}$, r_w, r_w^*, $\frac{d\bar{p}}{dw}$, $\frac{d\bar{p}^*}{dw}$.

A.4 Derivation of equilibrium unemployment

The labor union's first-order condition is obtained from (19),

$$-\left(1 - \frac{d\bar{p}}{dw_j}\right) + Au_j \frac{du_j}{dw_j} + B\bar{p} \frac{d\bar{p}}{dw_j} = 0. \tag{34}$$

Next we calculate the value of each term in (34). Defining the average wage in the home country as $w = \sum_1^n w_j/n$ we obtain,

$$\frac{d\bar{p}}{dw_j} = \frac{d\bar{p}}{dw} \frac{dw}{dw_j} = \frac{d\bar{p}}{dw} \frac{1}{n}. \tag{35}$$

The derivative of (27) with respect to the wage is

$$\frac{du_j}{dw_j} = \sigma \left(1 - \frac{1}{n}\right) + \frac{1}{n}\frac{du}{dw}. \tag{36}$$

Substituting (35), (36) and (20) into (34) and assuming symmetry within a country, i.e. the n labor unions are equal, $u_j = u$, yields the equilibrium unemployment rate, which is shown in (21).

A.5 Proof of Proposition 1

The derivatives of equations (15), (16) and (18a) with respect to r^* are

$$\frac{du}{dr^*} = u_r r_{r*} + u_{r*}, \tag{37}$$

$$\frac{d\bar{p}}{dr^*} = \bar{p}_r r_{r*} + \bar{p}_{r*}, \tag{38}$$

$$\frac{d\bar{p}}{dr^*} = -\frac{u_r}{I\bar{p}_r}\frac{du}{dr^*}. \tag{39}$$

Solving these equations for the unknowns $\frac{du}{dr^*}$, $\frac{d\bar{p}}{dr^*}$, r_{r*} yields

$$\frac{du}{dr^*} = \frac{\bar{p}_r I \left(\bar{p}_r u_{r*} - \bar{p}_{r*} u_r\right)}{\bar{p}_r^2 I + u_r^2},$$

where $\bar{p}_r < 0$ and

$$\bar{p}_r u_{r*} - \bar{p}_{r*} u_r = -\frac{c\alpha \left(1 - s\right)}{\left(1 - b\right)\left[\alpha + \left(1 - \alpha\right)\eta\right]} < 0. \tag{40}$$

Therefore, $\frac{du}{dr^*} > 0$. Using this result in equation (39) implies that $\frac{d\bar{p}}{dr^*} > 0$ as well.

A.6 Proof that the foreign interest rate rise reduces the utility of the home central bank

The loss function of the home central bank is $\Omega = u^2 + I\bar{p}^2$. We will show that $\frac{d\Omega}{dr^*} > 0$. The derivative with respect to the foreign interest rate is

$$\frac{d\Omega}{dr^*} = 2uu_{r^*} + 2I\bar{p}\bar{p}_{r^*}.$$

However, u and $\bar{p}$ have optimal levels set by the home central bank according to its first order condition (18a). Substituting $\bar{p} = -\frac{u_r}{I\bar{p}_r}u$ into the above expression yields

$$\frac{d\Omega}{dr^*} = \frac{2u}{\bar{p}_r}\left(\bar{p}_r u_{r^*} - \bar{p}_{r^*} u_r\right) > 0,$$

because $\bar{p}_r < 0$ and $\bar{p}_r u_{r^*} - \bar{p}_{r^*} u_r < 0$, as shown in (40).

A.7 Proof of Proposition 2

The derivative of the unemployment rate in (21) with respect to foreign conservativeness is

$$\frac{du}{dI^*} = -\frac{1}{g^2}\left(\frac{1}{n}\frac{d^2\bar{p}}{dI^*dw}g + fA\frac{1}{n}\frac{d^2u}{dI^*dw}\right),$$

where $f > 0$ and $g > 0$ are the numerator and the denominator of (21), respectively. We know that $f > 0$, which means that a nominal wage rise increases the real wage, because otherwise the labor union would have no incentive to set a positive nominal wage. Likewise, $g > 0$, because otherwise the labor union would increase the nominal wage without limit. The derivative of $\frac{d\bar{p}}{dw}$ obtained from the system (28)-(33) with respect to I^* is

$$\frac{d^2\bar{p}}{dI^*dw} = \gamma\left[s\delta + (1-s)\sigma\right]\left\{(1-\alpha)\delta + s(1-s)[1-(1-\alpha)\delta]^2\right\} > 0, \qquad (41)$$

where $\gamma = Is\left(1-s\right)\left[s\sigma + \left(1-s\right)\delta\right]/D^2 > 0$ and D^2 is the square of the denominator. The derivative of $\frac{du}{dw}$ obtained from the system (28)-(33) with respect to I^* is

$$\frac{d^2u}{dI^*dw} = \gamma I\left[s\delta\left(1-\alpha\right) + \left(1-s\right)\right]^2\left[\left(1-s\right)\delta\left(1-\alpha\right) + s\right] > 0.$$

Thus the inequalities $\frac{d^2\bar{p}}{dI^*dw} > 0$ and $\frac{d^2u}{dI^*dw} > 0$ imply that $\frac{du}{dI^*} < 0$. Using this result in (20) implies that also $\frac{d\bar{p}}{dI^*} < 0$.

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