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**Wage Formation in Open Economies and the Role of
Monetary and Wage-Setting Institutions**

Markus Knell

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Editorial

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May 29, 2002

Wage Formation in Open Economies and the Role of Monetary and Wage-Setting Institutions

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Abstract

The paper studies the determinants of unemployment in a two-country-model, where real wages are the outcome of the strategic interaction between various institutional players (firms, unions, central banks). We show that: (i) the results derived in the recent literature on this topic are not generally robust against the introduction of openness; (ii) the shape of the Calmfors-Driffill curve not only depends on a country's own centralization of wage-bargaining (CWB) but rather on home and foreign characteristics; (iii) the model challenges the established belief that a shift to a monetary union (MU) will (negatively) affect unemployment in all member countries by fundamentally changing the nature of strategic interactions. Under certain assumptions our open-economy model suggests that the formation of a MU has no effect whatsoever on structural unemployment.

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1 Introduction

The labor market situation of a country is to a large part determined by the level and flexibility of real wages. In order to understand the often intricate behavior of labor market aggregates one has thus to concentrate on the determinants of real wages. This itself, however, is a complex field where the level of real wages is the outcome of at least three—strategically interdependent—processes: A wage-formation process, where firms and unions (or employers and employees) agree on a certain nominal wage; a price-setting mechanism, where firms choose their (relative) prices; and finally a monetary policy decision stage, in which the general price level is determined. All three processes thus work together to set the level of real wages and thereby of employment.

For a long time this complex process was not analyzed in a complete fashion. In the celebrated “LSE framework” (cf. Layard et al., 1991) the emphasis was laid on the wage-setting and price-setting aspects, while monetary policy reactions were almost completely ignored. In the “time inconsistency” literature on the other hand (cf. Kydland and Prescott, 1977; Barro and Gordon, 1983; Rogoff, 1985) the game between a monetary authority and a highly stylized supply side was modelled, where the latter mostly appeared in a quite simplified fashion without institutional details (cf. Franzese, 2000).¹

Only recently attempts have been undertaken to encompass all three sides of this “real-wage-determining” triangle in a single framework (cf. Cukierman and Lippi, 1999, 2001; Soskice and Iversen, 1998, 2000; Coricelli et al., 2000). This literature has challenged common beliefs about the influence of central bank independence (CBI) and of the centralization of wage-bargaining (CWB). First it was shown that the celebrated results of the “time-inconsistency” literature about a negative relation between the degree of CBI and average inflation need not hold if one takes the existence of non-atomistic actors (firms or unions) into account (cf. Lippi, 1999). Second it caused some doubts about the universality of the almost equally famous Calmfors-Driffill hypothesis (cf. Calmfors and Driffill, 1988) that the relation between unemployment and CWB is “hump-shaped”, i.e. that the rate of unemployment is lowest for very centralized and decentralized labor markets and has its maximum at an intermediate degree of centralization. In particular it was shown that the way monetary policy is conducted plays an important role in determining the form and shape of this relation (cf. Cukierman and Lippi, 1999; Soskice and Iversen, 2000; Coricelli et al., 2000). Almost all of these approaches, however, look at isolated economies and it is not clear whether the results are robust when open economy aspects are taken into consideration.²

In this paper we study the determinants of long-run wages and unemployment in

¹In addition there exists a corporatist literature which also ignores the monetary side of the game (cf. Franzese, 2000).

²Papers that consider open economy aspects in some form or another include: Holden, 1999; Rama, 1994; Danthine and Hunt, 1994; Coricelli et al., 2001.

a world with two countries that are intertwined by foreign trade. The real wages in the two countries are the outcome of the strategic interaction between three groups of institutional players: firms (that act on imperfectly competitive goods markets), unions (that can be more or less centralized) and central banks (that can follow a more or less accommodating monetary policy). The microstructure of the model is based on a framework that is frequently employed in the field of “new open economy macroeconomics”.³ This allows us to introduce open economy aspects in a consistent manner, where we can take all possible spillover-effects into consideration. This is interesting for at least three reasons:

(i) It closes a gap in the recent literature on the strategic interaction between monetary, price-setting and wage-setting institutions. In particular we can analyze the robustness of the results that appear in this literature when a microfounded open economy structure is introduced.

(ii) It is helpful to shed new light on various empirical regularities. We will examine, e.g., the shape and determinants of the famous “Calmfors and Driffill” curve in our model.

(iii) It offers a new framework to think about the possible effects of the European Monetary Union on real wages and unemployment in the various member countries. In particular we can discuss how countries differing with respect to their size and with respect to their wage-setting and monetary institutions will react to the loss of own monetary and in particular of exchange rate policy.

We show that the results derived in the recent literature on strategic institutional interaction are not generally robust with respect to the introduction of openness. In a related closed-economy framework (Coricelli et al., 2000) it was, e.g., stated that the rate of unemployment is *always* decreasing in the CWB. In our model, however, this negative relation does not hold in general and we show that it is only true for countries that are large, that have relatively uncompetitive goods markets and where the monetary policy is rather non-accommodating. Our model thus supports the hypothesis that the ongoing process of deregulation (increase in competitiveness) and globalization (increase in openness) has contributed to a situation, where a centralized wage-bargaining system is no longer advantageous.

As far as the Calmfors-Driffill hypothesis is concerned we show that the shape of the curve does not only depend on a country’s own CWB—as in the original paper (Calmfors and Driffill, 1988)—but rather on home *and* foreign characteristics. Empirical tests of the Calmfors-Driffill hypothesis that omit the role of the wage-bargaining and monetary policy institutions of a country’s main trading partners can thus be regarded as “mispecified”. This neglect could then also be responsible for their rather poor performance (cf. OECD, 1997).

Finally we investigate the likely consequences of a move towards a monetary union. A common claim is that the shift to a monetary union will affect unem-

³The model used is close to Corsetti and Pesenti (2001) and Obstfeld and Rogoff (1998). For a general survey see Lane (2001). While those models are set in a dynamic context we work with a basically static version.

ployment and inflation in the member countries even if all structural parameters (in particular the ones concerning CWB and CBI) stay the same. The main reason for this prediction is that “with the formation of the monetary union all unions become smaller relative to the monetary area [...]. This decreases their perception of the inflationary repercussions of their individual wages, inducing them to more aggressive wage demands” (Cukierman and Lippi, 2001, 541).⁴ Although the argument sounds reasonable one has to recognize that most attempts to express it in a formal way are based on closed-economy models (Soskice and Iversen, 1998; Cukierman and Lippi, 2001; Grüner and Hefeker, 1999). Not only does this beg the question why a monetary union between closed economies is formed in the first place, it also raises doubts whether and under which assumptions the argument goes through in a framework that allows for international linkages.

Our open-economy model yields the result that the only possible impact the introduction of a monetary union might have on real variables stems from eventual changes in the monetary policy of the common central bank. If the countries forming the monetary union were part of a fixed exchange rate regime before and if the common central bank of the monetary union is as non-accommodating as was the anchor central bank of the fixed exchange rate system then there is *no effect whatsoever*. The reason for this at first sight maybe counterintuitive result is the following. Even in the pre-monetary-union days unions and national central banks have taken foreign prices and foreign demand into consideration when deciding about wage-setting and monetary policy, respectively. Unions are concerned about the competitiveness (terms of trade) of the firms to which its’ members are attached and both unions and national central banks care about the overall (consumption) price index that includes prices of home-produced *and* foreign-produced goods. Due to the specific assumptions of our model these “target price levels” do not change with the formation of the monetary union and neither does the perception of these effects by the main economic actors. This is not the case in the aforementioned models, where the monetary union drives a wedge between the price level target of the common central bank (which cares about a weighted average of national price levels) and the one of national unions (that are only concerned about the national price levels).

All three strands of this paper thus suggest that the introduction of open-economy issues is not a minor change (or its neglect an unimportant omission). It rather leads to conclusions that challenge established beliefs about the robustness of theoretical results (the advantage of centralized wage-bargaining), about empirical relations (the determinants of the shape of the Calmfors-Driffill curve) and about socio-political developments (the consequences of the formation of a monetary union).

The paper is organized as follows. In section 2 we present the model which is solved in section 3. In section 4 we derive comparative static results while section 5 analyzes the predictions of the model for a fixed exchange rate regime and for a

⁴Cf. also Danthine and Hunt, 1994, 530; Hefeker, 1999, 39; Soskice and Iversen, 1998, 112.

monetary union. Section 6 concludes.

2 The Model

We assume that the world size is normalized to 1 and that firms and households over the $[0, \gamma]$ interval are located in the home country H while households and firms over the $[\gamma, 1]$ interval are located in the foreign country F . The relative size of countries H and F are thus γ and $(1-\gamma)$, respectively. Firms are monopolistic competitors and both economies are inhabited by K_H (K_F) unions that are distributed evenly across the firms. As in Coricelli et al. (2000) we assume that the firms are indexed in such a way that all firms in country H to which union j is attached are located in the subinterval $\left[\gamma \frac{j-1}{K_H}, \gamma \frac{j}{K_H}\right]$ of the interval $[0, \gamma]$, where $j = 1, 2 \dots K_H$. In country F , on the other hand, all firms to which union j^* is attached are located in the subinterval $\left[\gamma + (1-\gamma) \frac{j^*-1}{K_F}, \gamma + (1-\gamma) \frac{j^*}{K_F}\right]$ of the interval $[\gamma, 1]$, where $j^* = 1, 2 \dots K_F$. The level of real wages is the outcome of strategic interactions between the three groups of actors: unions, firms and the central bank. The sequence of events is the following. In the first stage nominal wages are chosen by the unions. In the second stage firms simultaneously choose prices, output and employment, taking as given the level of nominal wages set in the first stage. In the third stage the central bank determines the money supply (and thereby nominal demand) according to its monetary policy rule. Unions and firms know this monetary rule (and treat it as credible) and they take it into account when deciding about the level of wages and prices. Finally—a fourth stage—the nominal exchange rate adjusts such that the balance of trade is in equilibrium. The game is solved by backward induction.⁵

2.1 Preferences and the structure of demand

In the appendix we show that a microfounded framework (following Corsetti and Pesenti, 2001; Obstfeld and Rogoff, 1998) leads to the following demand function:

$$y_i^h = -\theta(p_i^h - p_H) - (p_H - p) + \gamma(m - p) + (1 - \gamma)(m^* - p^*) \quad (1)$$

$$y_i^f = -\theta(p_i^{*f} - p_F^*) - (p_F^* - p^*) + \gamma(m - p) + (1 - \gamma)(m^* - p^*), \quad (2)$$

where all lower-case letters are log-variables, y_i^h (y_i^f) is the demand for the good produced by home (foreign) firm i , p_i^h (p_i^{*f}) is the price charged by this firm, p_H (p_F^*) is the consumption-based price index for goods produced in H (F), p (p^*) is the total price index in H (F) and m (m^*) is the level of home (foreign) money supply.⁶

⁵Coricelli et al. (2000) use a different sequencing where unions move first, followed by the monetary authority and then by the firms. We believe, however, that our course of events is probably more reasonable, since prices are in general stickier than interest rates and the exchange rate.

⁶“Starred” variables are expressed in the foreign currency.

The parameter γ measures the relative size of country H and $\theta > 1$ measures the elasticity of substitution across goods produced within a country.

The price indices are given by:

$$p_H = \frac{1}{\gamma} \int_0^\gamma p^h(i) di \quad (3)$$

$$p_F^* = \frac{1}{(1-\gamma)} \int_\gamma^1 p^{*f}(i) di \quad (4)$$

$$p = \gamma p_H + (1-\gamma) p_F \quad (5)$$

$$p^* = \gamma p_H^* + (1-\gamma) p_F^* \quad (6)$$

We assume that the law of one price holds, i.e. that $p_i^{*h} + e = p_i^h$ and $p_i^{*f} + e = p_i^f$, where e is the (logarithm of the) nominal exchange rate. From the definition of the price indices (3), (5), (4), and (6) it follows that the purchasing power parity also holds for the composite commodities and the overall consumer price indices:

$$p_H^* + e = p_H, p_F^* + e = p_F \text{ and } p^* + e = p \quad (7)$$

For later reference we also note that average demand in H and F , $y_H \equiv \frac{1}{\gamma} \int_0^\gamma y^h(i) di$,

$y_F = \frac{1}{(1-\gamma)} \int_\gamma^1 y^f(i) di$, is given by the following expressions (using the definitions for the price indices):

$$y_H = (1-\gamma)(p_F - p_H) + \gamma(m - p) + (1-\gamma)(m^* - p^*) \quad (8)$$

$$y_F = \gamma(p_H - p_F) + \gamma(m - p) + (1-\gamma)(m^* - p^*) \quad (9)$$

From this we can derive a crucial relation in our model:

$$y_H - y_F = p_F - p_H \quad (10)$$

We will return to this (terms of trade) equation later when we express it in terms of unemployment-rate-differentials.

2.2 The Supply Side

Each firm has access to a linear production function:⁷

$$y_i^h = l_i^h \quad (11)$$

$$y_i^f = l_i^f, \quad (12)$$

where l_i^h (l_i^f) stands for the amount of labor employed by firm i in country H (F).

⁷Using a concave production function, i.e. $y_i^h = \beta (l_i^h)$, $\beta < 1$ would not qualitatively change our analysis but would complicate the algebra.

2.3 Monetary Policy Rules

Both central banks are assumed to follow a monetary policy rule which states how money supplies are adjusted in response to changes in the price level. In particular:

$$m = \tilde{m} + \alpha_H p \quad (13)$$

$$m^* = \tilde{m}^* + \alpha_F p^* \quad (14)$$

Here \tilde{m} and \tilde{m}^* are exogenously given (or discretionary) parts of the monetary rule while α_H and α_F measure how accommodating the monetary policy strategies are. If, e.g., a monetary authority reacts restrictively to a rise in the price level then its **degree of accommodation of monetary policy (AMP)** will be low (α will be small). We assume that $\alpha_H, \alpha_F \in [-\infty, 1]$. A negative value of α means that the central bank reacts to an increase in p by *decreasing* money supply, whereas a positive value implies that it (at least partly) accommodates the price increase.⁸ The assumption that central banks conduct their monetary policies according to the rules (13) and (14) is rather specific and needs some clarification. In particular we want to discuss first why we formulate monetary policy in terms of fixed rules rather than via the minimization of a loss function. Then we will briefly talk about the *specific form* of the rules.

A rule-based specification of monetary policy has been used by a number of authors (e.g., Soskice and Iversen, 2000; Bratsiotis and Martin, 1999), while others assume that monetary authorities actively choose their monetary policy by minimizing a loss function (e.g., Cukierman and Lippi, 1999, 2001; Coricelli et al., 2000, 2001). It is also sometimes argued that this approach is superior to the one used in our model, since the monetary reaction function is derived “explicitly from the objectives and constraints of the monetary authorities and is therefore endogenous” (Cukierman and Lippi, 2001, FN 4). We consider, however, the assumption of a fixed monetary rule to be a reasonable approximation to real world central bank behavior.⁹ In fact, empirical studies suggest that the behavior of major central banks can be accurately described by assuming that they follow monetary policy rules. Furthermore, as shown by Coricelli et al. (2000, 19), the monetary policy rules (13) and (14) can be interpreted as reduced form expressions of endogenously derived optimal monetary reaction functions. Finally also the structure of our model suggests the given formulation. Since we assume that the central bank is the last actor in our (one-period) game it will take the prices (set by the firms in the second stage) as given and it will thus set the money supply in a way as to minimize unemployment—completely independent of the developments of the price level. This is not the case in Coricelli et al. (2000), where firms make their decisions *after* the central banks, but in our set-up fixed rules are the only reasonable assumption.

⁸Coricelli et al. (2000) also suggest that this is the correct range for α . Empirical reflections on this topic can be found in Hall and Franzese Jr. (1998).

⁹Cf. Taylor (1993), also the comments by Bean (1998, 373).

The specific form of the monetary policy rules is mainly chosen to keep our derivations tractable and our results simple. Bratsiotis and Martin (1999), e.g., use a monetary policy rule that is specified in terms of the price level and of the output gap. It can be shown, however, that in their closed-economy framework this rule can be reduced to one that only contains a reaction to the price level. Similarly we can also start in our open-economy model with monetary policy rules that are specified over one nominal target (the price level or inflation) and one real target (unemployment or the output gap), e.g. (for H): $m = \tilde{m} + \alpha_H^p p + \alpha_H^u u_H$. This expression, however, can again be reduced to a monetary policy rule that only contains nominal variables, although in this case the price level of domestic goods and of foreign goods separately.¹⁰ The choice of an appropriate (or even optimal) monetary policy rule is an interesting and important topic. In our static and non-stochastic framework, however, this question is not so crucial, since different monetary policy rules will ultimately lead to the same “reduced forms” and thus—qualitatively—also to the same results.

2.4 Exchange Rate Regimes

For the most part of this paper we assume that both countries have flexible exchange rates. Then the nominal exchange rate must adjust such as to clear goods and money markets. In the set-up of our model it can be shown (see appendix) that the balance of trade always equals zero and thus the nominal exchange rate must adjust to fulfill the equilibrium condition $\frac{M}{P} = \frac{M^*}{P^*}$ (or $m - p = m^* - p^*$).¹¹ This can be stated somewhat differently as a “monetary PPP” (using (7)):

$$m = e + m^* \quad (15)$$

Under the assumption of a flexible exchange rate regime we can thus calculate the equilibrium value for the nominal exchange rate as (using [13], [14] and [15]):¹²

$$e^{flex} = \frac{\alpha_H - \alpha_F}{1 - \alpha_F} p + \frac{1}{1 - \alpha_F} (\tilde{m} - \tilde{m}^*) \quad (16)$$

In later parts of the paper, however, we will also analyze the cases where the two countries are part of a fixed exchange rate regime and of a monetary union, respectively. In the case where country H pegs its nominal exchange rate at some level

¹⁰In particular one gets: $m = \hat{m} + \left[\frac{\gamma \alpha_H^p + \alpha_H^u}{1 + \alpha_H^u} \right] p_H + \left[\frac{(1-\gamma) \alpha_H^p}{1 + \alpha_H^u} \right] p_F$, for some constant \hat{m} .

¹¹This follows from the fact that in this model $C = C^*$ and from some quantity-theory-like condition, which can also be derived from micro-principles (cf. Blanchard and Kiyotaki, 1987). That the balance of trade equals zero is a reasonable property for a long run analysis and it is also often used in different open economy frameworks to “close the model” (cf., e.g., Layard et al., 1991, 31ff.).

¹²Since our model is static this is the correct (long-run) equilibrium value. For an intertemporal model we would have to use a more elaborated framework along the lines of Obstfeld and Rogoff (1996, chap. 10).

$e^{H,tar}$ it forgoes the possibility of independent monetary policy and instead of (13) its monetary policy rule is now given by:

$$m = (1 - \alpha_F)e^{H,tar} + \alpha_F p + \tilde{m}^* \quad (17)$$

Note that in the fixed exchange rate case the monetary policy of country H “mimics” the foreign monetary policy rule, given by the “accommodation parameter” α_F .

Finally in the case of a monetary union the (common) monetary policy is given by:

$$m = \tilde{m} + \alpha \bar{p}, \quad (18)$$

where m is now the per capita money supply of the whole union, α is the accommodation parameter of the common central bank and $\bar{p} = \gamma p + (1 - \gamma)p^*$ is the union-wide target price level of the bank (i.e. a weighted average of the country-specific price levels p and p^*).

3 Solution

Since the fourth stage (the determination of the exchange rate) and the third stage (the setting of the money supplies) of the model are “predetermined” by equilibrium conditions and monetary rules we can immediately start with the second stage.

3.1 The Firms’ Problem (Stage 2)

In the second stage all firms simultaneously maximize their profits, taking as given nominal wages w_i^h and the prices set by the other firms (both in H and in F).¹³ This leads to the simple mark-up pricing rule:

$$p_i^h = \mu_i^h + w_i^h, \quad (19)$$

where $\mu_i^h = \mu \equiv \ln\left(\frac{\theta}{\theta-1}\right)$ is firm i ’s mark-up (identical for all firms).

Aggregation across firms leads to the following **price-setting equation**:

$$p_H = \mu + w_H, \quad (20)$$

where $w_H \equiv \frac{1}{\gamma} \int_0^\gamma w^h(i) di$.

¹³We first concentrate on the behavior in the home country under the flexible exchange rate regime. The behavior of foreign economic actors is equivalent and the results will only be stated below. In later sections we will deal with the fixed exchange rate and the monetary union regimes.

3.2 The Unions' Problem (Stage 1)

In specifying the wage-setting process we assume that monopoly unions choose nominal wages treating the wages chosen by the other unions as given and taking into account the subsequent pricing decisions of firms, the monetary policy rules and the equilibrium level of the exchange rate. Workers belong to one of K_H identical unions, where each union represents an equal share $\tilde{L}_j^h = \frac{\tilde{L}_H}{K_H}$ of the total labor force that has mass \tilde{L}_H . For fully decentralized wage-setting there are as many unions as firms ($K_H \rightarrow \infty$), whereas completely centralized wage-setting means $K_H = 1$. As in Bratsiotis and Martin (1999) we let the parameter $\sigma_H \equiv \frac{1}{K_H}$ denote the **degree of centralization of wage-bargaining (CWB)**, ranging from 0 (complete decentralization) to 1 (complete centralization). Furthermore we assume that the firms to which union j is attached are indexed in such a way that they are located in the subinterval $[\gamma \frac{j-1}{K_H}, \gamma \frac{j}{K_H}]$.¹⁴ The loss function of union j is given by:

$$\Omega_j = \frac{1}{2} (w_j^h - p - \tilde{\omega})^2 + \Psi_H \frac{1}{2} (l_j^h - \tilde{l}_j^h)^2, \quad (21)$$

where $\tilde{\omega}$ is the target level of real wages (that is identical across the unions), Ψ_H measures the degree of unions' relative concern for employment vis-à-vis the real wage and $\tilde{l}_j^h = \ln \tilde{L}_j^h$ is defined as above.¹⁵ Note furthermore that unions care about the *consumption* wage $w_j^h - p$ rather than the product wage $w_j^h - p_H$. This is important for some of our later results since the terms of trade play a role, due to the impact of foreign prices (and wages) on the domestic total price level p . Minimization of Ω_j leads to:

$$(w_j^h - p - \tilde{\omega}) Z_H - \Psi_H (l_j^h - \tilde{l}_j^h) \lambda_H = 0, \quad (22)$$

where $Z_H \equiv 1 - \frac{dp}{dw_j^h}$ is the elasticity of real wages with respect to nominal wages and $\lambda_H \equiv -\frac{dl_j^h}{dw_j^h}$ is the wage elasticity of labor demand.

The wage elasticity of labor demand is determined by four effects given in the following equation:

$$\begin{aligned} \lambda_H \equiv -\frac{dl_j^h}{dw_j^h} = & \theta \frac{d(p_j^h - p_H)}{dw_j^h} + (1 - \gamma) \frac{d(p_H - p_F)}{dw_j^h} - \gamma \frac{d(m - p)}{dw_j^h} \\ & - (1 - \gamma) \frac{d(m^* - p^*)}{dw_j^h} \end{aligned} \quad (23)$$

From (11) and (1) it follows that:

$$\lambda_H = \theta \frac{\partial(p_j^h - p_H)}{\partial(w_j^h - w_H)} \frac{d(w_j^h - w_H)}{dw_j^h} + \frac{dp_H}{dw_j^h} [1 - \gamma + \gamma(1 - \alpha_H)],$$

¹⁴A similar structure is also used by Coricelli et al. (2000).

¹⁵In equilibrium both the real wage and employment are below their respective targets (see below). In the neighborhood of these values the loss function is thus in fact decreasing in $(w_j^h - p)$ and in l_j^h .

In order to get expressions for the perceived impact of wage increases on prices we can rewrite the price indices (3) and (4) in the following way (cf. Coricelli et al., 2000).

$$p_H = \frac{1}{\gamma} \frac{1}{K_H} \sum_{j=1}^{K_H} \left(\frac{\int_{\gamma[(j-1)/K_H]}^{\gamma[j/K_H]} p_{ji}^h di}{\int_{\gamma[(j-1)/K_H]}^{\gamma[j/K_H]} di} \right) = \frac{1}{\gamma} \sum_{j=1}^{K_H} \int_{\gamma[(j-1)/K_H]}^{\gamma[j/K_H]} p_{ji}^h di = \frac{1}{\gamma} \int_0^{\gamma} p_i^h di \quad (24)$$

$$p_F^* = \frac{1}{1-\gamma} \frac{1}{K_F} \sum_{j=1}^{K_F} \left(\frac{\int_{LIM_L}^{LIM_H} p_{ji}^{*f} di}{\int_{LIM_L}^{LIM_H} di} \right) = \frac{1}{1-\gamma} \sum_{j=1}^{K_F} \int_{LIM_L}^{LIM_H} p_{ji}^{*f} di = \frac{1}{1-\gamma} \int_{\gamma}^1 p_i^{*f} di, \quad (25)$$

where $LIM_L \equiv \gamma + (1-\gamma)[(j-1)/K_F]$ and $LIM_H \equiv \gamma + (1-\gamma)[j/K_F]$. Since union j correctly anticipates the price-setting equation (19) and since—due to the symmetry of the problem—it also knows that all firms to which it is attached will charge the same price (i.e., $p_{ji}^h = p_j^h$) the perceived price-impact of nominal wage increases is

given by: $\frac{dp_H}{dw_j^h} = \frac{1}{\gamma} \int_{\gamma[(j-1)/K_H]}^{\gamma[j/K_H]} \frac{dp_{ji}^h}{dw_j^h} di = \frac{1}{K_H} = \sigma_H$. Using (5) we can write: $\frac{dp}{dw_j^h} = \gamma \sigma_H$

and thus $Z_H = 1 - \gamma \sigma_H$.¹⁶ Noting that $\frac{\partial(p_j^h - p_H)}{\partial(w_j^h - w_H)} = 1$ and $\frac{d(w_j^h - w_H)}{dw_j^h} = 1 - \frac{1}{K_H} = 1 - \sigma_H$ we can finally calculate that:

$$\lambda_H = \theta(1 - \sigma_H) + \sigma_H(1 - \gamma \alpha_H) > 0 \quad (26)$$

In order to interpret this result it is important to note that equation (26) represents only a reduced form while the wage elasticity of labor demand (of the firms covered by union j) actually depends on the four effects, given in (23). The first effect is that a wage increase will trigger a price increase of the firm(s) covered by the union. This rise in relative prices will result in a lower demand for the goods produced by the firm and thus in a smaller (derived) demand for labor. This **relative price effect** (RPE) is captured by the first term in (26) and in (23). The (absolute) magnitude of this effect is larger for high values of θ (i.e. for a high degree of competition on the goods market) and for small values of σ_H (i.e. for small degrees of centralization in wage-setting). Looking only at this effect in isolation implies that a high CWB leads to a smaller elasticity of labor demand and thus—*ceteris paribus*—to lower levels of employment.

But there exist three additional effects that are only present for non-atomistic unions ($\sigma_H \neq 0$) and that work in the opposite direction. The sum of these effects are captured by the term $\sigma_H(1 - \gamma \alpha_H)$ in equation (26) and we refer to this expression

¹⁶Since unions in H and F move simultaneously we have that $\frac{dp_F}{dw_j^h} = 0$.

as the (total) **real balance effect** (RBE).¹⁷ The mechanisms underlying this total real balance effect are, however, more complicated than one would expect by just looking at the simple algebraic expression in (26).

First there is a **terms of trade effect** (or “international competitiveness effect”), given by the second term in (23), that has a straightforward meaning. A higher price of domestic goods leads to a substitution effect where consumers in both countries switch from the more expensive home products to the now cheaper foreign products. The effect comes out as $(1 - \gamma)\sigma_H$ and is thus larger for more centralized unions and for smaller countries (where a larger part of the product demand stems from abroad).

Second there is a **domestic real balance effect**. An increase in domestic prices translates into a $\gamma\%$ increase in the domestic price index thereby lowering (for a fixed money supply) real balances and real demand by another $\gamma\%$ (cf. 1). This can be accommodated or further strengthened (depending on $\alpha_H \geq 0$) by the monetary policy reaction (given by (13)). The effect can be calculated as: $\gamma^2\sigma_H(1 - \alpha_H)$ and is thus increasing in the CWB, decreasing in the AMP and increasing in the country size. In small countries most demand comes from abroad and thus both the effects on domestic demand and the domestic monetary policy reaction are rather unimportant.

Finally there is also a **foreign real balance effect** (given by the last term in (23)) which is the most complicated mechanism in this framework, since it itself involves separate subeffects on foreign demand, foreign monetary policy and on the exchange rate. To start with, the increase in the price index p_H of home-produced goods also increases (for a fixed exchange rate) the foreign price level p^* which will reduce foreign real demand for the home products, where the reaction of foreign monetary policy can again mitigate or strengthen these consequences (depending on $\alpha_F \geq 0$). This effect is given by: $\gamma(1 - \gamma)\sigma_H(1 - \alpha_F)$. But in addition the (possibly different) monetary policy reactions in the two countries have an impact on the equilibrium exchange rate which can alter the influence on foreign demand. The total impact of the exchange rate on foreign demand is given by: $\gamma(1 - \gamma)\sigma_H(\alpha_H - \alpha_F)$. If the central bank in H is more accommodating (i.e. $\alpha_H > \alpha_F$) then this will lead to an increase in e , i.e. to a depreciation of H 's currency. The total foreign real balance effect can then be calculated as: $\gamma(1 - \gamma)\sigma_H(1 - \alpha_H)$. As apparent from this expression the exchange rate effect counteracts some of the other effects such that, e.g., the foreign AMP plays no role anymore.

As this discussion shows the total real balance effect consists of various, partly counteracting effects that have an influence on the demand for domestic products and that are (partly) internalized by non-atomistic unions.¹⁸ Of course one could

¹⁷We borrow the expressions for the “relative price effect” and the “real balance effect” from Coricelli et al. (2000) in order to facilitate a comparison to their (related) work. Cukierman and Lippi (1999, 2001) have called these effects in a somewhat different model the “adverse competition” and the “strategic” effects, respectively.

¹⁸Note that for $\sigma_H = 0$ the real balance effect is not present and we are left with the standard

argue that this requires a high degree of rationality and sophistication of union leaders. Nevertheless it is useful to take this framework as a benchmark case where all of these various effects are explicitly taken into account.

The total real balance effect, given by $\sigma_H(1 - \gamma\alpha_H)$, thus increases in the CWB and decreases in the AMP. As far as the country size is concerned one has to distinguish between the cases $\alpha_H \geq 0$. If the monetary policy is accommodating (in the sense that $\alpha_H > 0$) it is “better” to be small, since then the loose policy cannot have a large damaging impact on the perceived elasticity of labor demand. On the other hand it is advantageous to be a large country when the monetary policy is non-accommodating (i.e. $\alpha_H < 0$) since then the restrictive policy has a more “threatening” impact on unions’ behavior.

Summarizing the discussion so far, an increase in CWB has two effects on the elasticity of labor demand that work into opposite directions: it will reduce the elasticity through the relative price effect and increase it through the real balance effect. But these are not the only channel through which the CWB influences wages and unemployment. In deciding about the optimal nominal wage claims the unions do not only look at the reaction of labor demand, but also at the real wage ($w_j^h - p$) (cf. (22)). Thereby it is important how the unions perceive that a one unit increase in nominal wages is transformed into an increase in the real (consumption) wage. This elasticity of the union’s real wage with respect to the nominal wage is given by: $Z_H = 1 - \gamma\sigma_H$. The smaller Z_H the more moderate the union’s wage claims will be, since it understands that excessive nominal wages will only be reflected in identical price increases leaving the real wage almost unchanged. Thus more centralized (high σ_H) wage-setting institutions will lead to more wage moderation. Wage claims will also be lower in large countries (high γ), since there the impact of a “wage-price-spiral” is fully felt and perceived.

Returning now to the derivation of the wage-setting behavior we can use (22) to write the target wage of union j as:

$$w_j^h = \tilde{\omega} + p + \frac{\Psi_H \lambda_H}{Z_H} (l_j^h - \tilde{l}_j^h) = \tilde{\omega} + p - \frac{\Psi_H \lambda_H}{Z_H} u_j^h \quad (27)$$

where the unemployment rate is defined as: $u_j^h \equiv \frac{(\tilde{L}_j^h - L_j^h)}{\tilde{L}_j^h}$ and the latter equality follows from the fact that $(l_j^h - \tilde{l}_j^h) \approx -u_j^h$. Since all unions are identical in this framework we will get a symmetric solution with $u_j^h = u_H$ and $w_j^h = w_H$. Aggregation of (27) thus leads to the aggregate **wage-setting equation**: $w_H = \tilde{\omega} + p - \frac{\Psi_H \lambda_H}{Z_H} u_H$ which can also be written as:

$$w_H - p_H = \tilde{\omega} + (1 - \gamma)(p_F - p_H) - \frac{\Psi_H \lambda_H}{Z_H} u_H \quad (28)$$

Using the price-setting equation (20) and the wage-setting equation (28) we can derive the equilibrium level of unemployment (holding for the moment the terms of

relative price effect.

trades $(p_F - p_H)$ constant):

$$u_H = \frac{Z_H}{\Psi_H \lambda_H} [\mu + \tilde{\omega} + (1 - \gamma)(p_F - p_H)] \quad (29)$$

We can illustrate this in a simple, well-known picture (cf. Layard et. all, 1991). The price-setting equation (20) implies that the level of real wages is constant and given by $-\mu_H$, this is drawn as the horizontal line in Figure 1.¹⁹ The wage-setting equation on the other hand shows a negative relation between the rate of unemployment and the real (product) wage (or a positive between the latter and the rate of employment, as drawn in Figure 1). The slope of the line is determined by the fraction $\frac{\lambda_H}{Z_H}$. The larger $\frac{\lambda_H}{Z_H}$ the lower the rate of unemployment (always for given $(p_F - p_H)$). An increase in λ_H and a decrease in Z_H will thus both lead to a decrease in the unemployment rate and the consequences of a change in a country's monetary or labor market institutions can be studied by looking at these two elasticities. A decrease in accommodating monetary policy (i.e. a decrease in α_H), e.g., will increase λ_H and leave Z_H unchanged, thereby causing a reduction in the rate of unemployment. If the central bank does not accommodate increases in the price-level then a wage increase will result in a larger drop in real balances, in aggregate demand and thus also in derived labor demand. Unions will anticipate this chain of events and thus moderate their wage claims in the first place which has positive effects on employment. Since in our framework the equilibrium real wage is given by (20) the unemployment rate is the primary "disciplinary device" that moderates unions' wage claims. If unions' "fear of unemployment" increases for other reasons (e.g. via a decrease in α_H) less of this device is needed and the unemployment rate will decrease in equilibrium. The effect of an increase in centralization is less clear-cut, since it affects the slope $\frac{\lambda_H}{Z_H}$ through three channels and we will discuss this extensively in a later section.

Insert Figure 1 about here.

So far, however, we have conducted our analysis under the assumption that the terms of trade $(p_F - p_H)$ are constant. In fact they are also determined endogenously and in order to investigate the general equilibrium we have to determine the wage and price-setting equations of the foreign country.

3.3 The Foreign Country

Similar reasoning as applied in the derivations of the preceding sections gives rise to corresponding aggregate price-setting and wage-setting equations for the foreign

¹⁹Not that for a concave production function the price-setting equation would be downward sloping.

country:

$$p_F^* = \mu + w_F^* \quad (30)$$

$$\text{where again } \mu = \ln\left(\frac{\theta}{\theta - 1}\right)$$

$$w_F^* = \tilde{\omega} + p^* - \frac{\Psi_F \lambda_F}{Z_F} u_F \text{ or} \quad (31)$$

$$w_F^* - p_F^* = \tilde{\omega} + \gamma(p_H^* - p_F^*) - \frac{\Psi_F \lambda_F}{Z_F} u_F$$

$$\text{where } \lambda_F \equiv -\frac{dl_j^f}{dw_j^{*f}} = \theta(1 - \sigma_F) + \sigma_F[1 - (1 - \gamma)\alpha_F]$$

$$\text{and } Z_F \equiv 1 - \frac{dp^*}{dw_j^{*f}}$$

The equilibrium unemployment rate in F is thus given by:

$$u_F = \frac{Z_F}{\Psi_F \lambda_F} [\mu + \tilde{\omega} + \gamma(p_H^* - p_F^*)] = \frac{Z_F}{\Psi_F \lambda_F} [\mu + \tilde{\omega} + \gamma(p_H - p_F)], \quad (32)$$

where the last step follows from the fact that $p_H^* - p_F^* = p_H - p_F$. All variables are defined in the same way as the corresponding variables for H and we have assumed that home and foreign unions have the same target level of real wages $\tilde{\omega}$.

So far, however, we still have not found the equilibrium unemployment rates for H and F since both (29) and (32) still depend on the terms of trade $TOT \equiv p_F - p_H$. For closing the model we thus have to refer to equation (10) that relates the terms of trade to the ratio of the average output of the two countries. In the appendix we show that this equation can be expressed in terms of unemployment rates as:

$$TOT \equiv p_F - p_H = u_F - u_H \quad (33)$$

The ratio of unemployment rates is equal to the (logarithm of the) terms of trade. Production is lower in the country where the prices of domestically produced goods are higher which also causes a lower level of employment.

3.4 The Equilibrium

Equations (29), (32) and (33) can now be solved for the equilibrium rates of unemployment and of the terms of trade. Since we want to concentrate in the following on the relation between the structure of wage bargaining and monetary policy, both within and between countries, we assume that $\Psi_H = \Psi_F = 1$. This leads to the following three equations:

$$u_H^* = \frac{(\mu + \tilde{\omega})Z_H(\lambda_F + Z_F)}{\gamma\lambda_H Z_F + (1 - \gamma)\lambda_F Z_H + \lambda_H \lambda_F} \quad (34)$$

$$u_F^* = \frac{(\mu + \tilde{\omega})Z_F(\lambda_H + Z_H)}{\gamma\lambda_H Z_F + (1 - \gamma)\lambda_F Z_H + \lambda_H \lambda_F} \quad (35)$$

$$TOT^* = \frac{(\mu + \tilde{\omega})(\lambda_H Z_F - \lambda_F Z_H)}{\gamma\lambda_H Z_F + (1 - \gamma)\lambda_F Z_H + \lambda_H \lambda_F} \quad (36)$$

where (as a reminder):

$$\begin{aligned} \lambda_H &= \theta(1 - \sigma_H) + \sigma_H(1 - \gamma\alpha_H) > 0 \\ \lambda_F &= \theta(1 - \sigma_F) + \sigma_F[1 - (1 - \gamma)\alpha_F] > 0 \\ Z_H &= 1 - \gamma\sigma_H > 0 \\ Z_F &= 1 - (1 - \gamma)\sigma_F > 0 \end{aligned} \quad (37)$$

In the next sections we want to analyze the properties of this equilibrium.

4 The Influence of Monetary Policy and of Wage-Setting Institutions

What happens to the unemployment rates in the two countries if the CWB or the AMP in one of the two countries changes? Since a country's monetary and wage-bargaining institutions are not strictly exogenously given (although often quite persistent) one can—with some caution—also interpret the results of this section as giving the *incentives* for countries to undertake reforms of these institutions.

4.1 The Impact of Changes in Monetary Policy (AMP)

We start with the question how a move towards a more accommodating monetary policy (an increase in α_H) changes the unemployment rates. The answer is given in the following proposition.²⁰

Proposition 1 *An increase in the home (foreign) degree of accommodation of monetary policy increases unemployment in the home (foreign) country, i.e. $\frac{\partial u_H}{\partial \alpha_H} > 0$, $\frac{\partial u_F}{\partial \alpha_F} > 0$.*

Equilibrium unemployment increases in the degree of accommodation of monetary policy. The reason for this result has again to do with the (perceived) elasticities of labor demand given in (37). If unions know that high nominal wage demands will trigger a harsh reaction by the central bank then they will moderate their wage claims in the first place. Less of the “disciplinary device” unemployment is necessary when non-accommodating monetary policy serves as an alternative “disciplinary device”.

²⁰All proofs are collected in the appendix.

A similar result was derived by Coricelli et al. (2000, 14), who also show that if unions are not inflation-averse (as is the case in our model) unemployment always decreases in the degree of central bank independence (which itself is negatively correlated to the degree of accommodation). In this respect it is optimal to have an “ultra-conservative” central bank that (credibly) threatens to react extremely restrictive to the slightest rise in prices. One would assume, however, that the introduction of uncertainty, exogenous shocks etc. would change this result along the lines of the classic paper by Rogoff (1985).

The next question is how the change in one country’s monetary policy affects the other country.

Proposition 2 (i) *An increase in the degree of accommodation of home (foreign) monetary policy increases unemployment also in the foreign (home) country, i.e. $\frac{\partial u_H}{\partial \alpha_F} > 0$, $\frac{\partial u_F}{\partial \alpha_H} > 0$.* (ii) *The impact of a change in monetary policy is always larger in the country where the change originated, i.e. $\frac{\partial u_H}{\partial \alpha_H} > \frac{\partial u_F}{\partial \alpha_H}$, $\frac{\partial u_F}{\partial \alpha_F} > \frac{\partial u_H}{\partial \alpha_F}$.*

The first part of the proposition shows that the “spillover effects” of monetary policy reforms always work in the *same* direction in both countries. A more accommodating monetary policy in the home country will thus lead to higher unemployment in both the home and the foreign country, whereas a move towards a more non-accommodating policy will decrease unemployment in both nations. As the second part of the proposition shows, however, the effect is always larger in the country where the reform has taken place. In order to see this note that from (29) and (32) we get that $\left. \frac{\partial u_H}{\partial \alpha_H} \right|_{TOT} > 0$ and $\left. \frac{\partial u_F}{\partial \alpha_H} \right|_{TOT} = 0$. From (28),(20),(31) and (30) it follows that this will tend to increase p_H and decrease p_F . In principle it would be possible that this TOT effect overturns the original effect of an increase in α_H . In the present model, however, this is not the case and the “direct” effect of a change in the AMP is always larger than the “indirect” effect of a change in the TOT that is triggered by the direct effect.

4.2 The impact of Changes in Centralization (CWB)

One of the central topics in the literature on strategic interactions deals with the question how the CWB and (structural) unemployment are related. As we will see this relation is somewhat more complicated than the one between AMP and unemployment, since it involves opposing effects and leads to ambiguous conclusions.

Proposition 3 *An increase in the degree of home (foreign) wage-bargaining centralization will decrease home (foreign) unemployment if good markets are uncompetitive, monetary policy is non-accommodating and the country is large. In particular: $\frac{\partial u_H}{\partial \sigma_H} < 0$ for $P_1 \equiv \frac{1-\alpha_H\gamma}{\theta(1-\gamma)} > 1$, $\frac{\partial u_F}{\partial \sigma_F} < 0$ for $P_2 \equiv \frac{1-\alpha_F(1-\gamma)}{\theta\gamma} > 1$.*

The mechanisms behind this result are the following. Focusing on the home country an increase in the degree of centralization has a negative effect on the

elasticity of labor demand λ_H (through the relative price effect) and a positive effect (through the real balance effect) [cf. (26)]. The total effect on λ_H , is then unclear and depends on the relative size of these two effects. Furthermore an increase in σ_H also leads to a better understanding of unions that their attempts to increase the real wage are more or less useless since a rise in nominal wages will be followed by a corresponding increase in prices. An increase in σ_H will thus lower Z_H and will tend to decrease unemployment. The total impact of all three effects, however, remains unclear and depends on the parameters of monetary policy (α_H), product market competitiveness (θ) and country size (γ).

As far as monetary policy is concerned it is stated in proposition 3 that a rise in CWB will tend to reduce unemployment if monetary policy is rather non-accommodating (α_H is small). This follows from the positive effects of CWB on the elasticity of labor demand (λ_H) via the real balance effect. Larger (more centralized) unions recognize that a wage increase leads to a fall in aggregate demand, where the fall is further aggravated by a more non-accommodating central bank. The internalization of the real balance effect, caused by the increase in CWB, has a larger impact on unemployment the more “threatening” (i.e. non-accommodating) the monetary policy of the central bank. Furthermore in large countries (high γ) the domestic price level is mostly the result of the decisions of domestic price and wage setters. Therefore the wage-restraining effects of a non-accommodating monetary policy are also more pronounced there. In small countries on the other hand the unions see that their (possibly excessive) wage claims are to a large degree “exported” and that they cannot influence the behavior of foreign price-setters, wage-setters and central banks. But there is a second effect which makes an increase in CWB more positive in large countries, the Z_H effect. As said above this effect is also more pronounced if a larger part of the price index is set domestically and is thus also influenced by the decisions of domestic unions. Taking these two channels together it is thus more likely that an increase in CWB will cause a decrease in unemployment if the country is large.²¹ Still there is always a negative effect of more centralization. If unions get larger they “control” the wage negotiations of a larger part of the market, thereby lowering competition (relative price effect). This effect is bigger the more competitive the goods markets are in the first place (i.e. the higher is θ). If the relative price effect is large enough it can always overturn the positive effects of centralization.

It is interesting to relate our result to similar results in Coricelli et al. (2000) who analyze a related *closed*-economy model. Their proposition 3 (p. 22) states that the rate of unemployment always decreases in the CWB. This is also the case in our model. For $\gamma = 1$ (which corresponds to a closed-economy assumption)²² we have $P_1 > 1$ so that in this case we get that $\frac{\partial u_H}{\partial \sigma_H} < 0$, independent of the

²¹In fact the first effect of the country size is negative if the monetary policy is accommodating ($\alpha_H > 0$). But even in this case the total effect of country size is positive, since the (positive) Z_H effect is stronger than the (now negative) real-balance effect.

²²This is not quite true, since the market is larger due to the fact that both, inhabitants of H and of F , only consume goods produced in H .

other parameters of the model. Coricelli et al. (2000) argue that their model “does not generate the ‘hump-shaped’ relation between unemployment and labor market centralization stressed by Calmfors and Driffill (1988) [...]. However, this result is consistent with empirical evidence suggesting that countries with a high degree of coordination in wage setting have lower unemployment (Nickell, 1997; OECD, 1997)” (p. 22). Similar to this result our model does not produce a hump-shape relation between (home-country) unemployment and (home-country) wage centralization. It does not predict, however, that the relation is necessarily negative. For certain constellations of country size, APM and goods market competition it may well be positive. Proposition 3 thus qualifies the results of Coricelli et al. (2000) by showing that in the case of open economies the relation between unemployment and CWB can go in both directions. In Cukierman and Lippi (1999, propositions 2 and 3), on the other hand, the relation between unemployment and CWB might be hump-shaped, although only when unions are sufficiently inflation-averse. For the case where they are not concerned about inflation (as in our model) the relation is always *positive*. Again this could also occur in our model for certain parameter constellations.²³

Finally we want relate proposition 3 to empirical observations, where we first want to repeat that the results of the proposition can—with some caution—also be interpreted as stating the incentives to (de)centralize wage-bargaining, depending on $P_1 \geq 1$ and $P_2 \geq 1$. The recent years have shown (at least in Europe) various attempts and efforts to deregulate goods markets, to break up monopolies and to foster competition. In the language of our model this would be captured by an increase in θ . At the same time one could observe increasing market integration, a rise in international trade and a process of “globalization”. A larger fraction of the goods a country consumes is now produced abroad which corresponds in our model to a decrease in γ . *All* countries got more integrated and thus “smaller” in economic terms, i.e. in the sense that they depend more on foreign-produced goods.²⁴ Both developments—deregulation and globalization—have thus increased the likelihood that a decentralized wage-bargaining system is advantageous. A movement in this direction could in fact be observed in various European countries over the recent years (cf. Wallerstein and Golden, 2000; Calmfors, 2000, 6f.), thereby broadly

²³As an aside it is interesting to note that similar modelling frameworks can produce such diverse and contradicting results. Coricelli et al. (2000, 33) discuss some of the reasons that lie behind these differences. The main reason can be found in the fact that Cukierman and Lippi (1999) and Guzzo and Velasco (1999) deal with situations where the central banks can set the price level directly whereas in the framework of Coricelli et al. (2000), Bratsiotis and Martin (1999) and in our model they can only influence prices by changing the money supply and thus also nominal demand.

²⁴Strictly speaking in our model it is not possible that both countries get smaller in this sense. To capture this process in a precise manner we would have to introduce a non-traded goods sector that shrinks over the course of globalization. Nevertheless we can use the decrease of γ to approximate these developments.

confirming the predictions of our model.²⁵

The next proposition captures the impact of “other-country” changes in CWB on “own-country” unemployment.

Proposition 4 (i) *An increase in the degree of home (foreign) wage-bargaining centralization will decrease foreign (home) unemployment in all cases where it also decreases home (foreign) unemployment and vice versa, i.e. $\frac{\partial u_F}{\partial \sigma_H} < 0$ iff $\frac{\partial u_H}{\partial \sigma_H} < 0$ and $\frac{\partial u_H}{\partial \sigma_F} < 0$ iff $\frac{\partial u_F}{\partial \sigma_F} < 0$.* (ii) *We have that $\frac{\partial u_H}{\partial \sigma_H} \geq \frac{\partial u_F}{\partial \sigma_H}$ for $P_1 \leq 1$ and $\frac{\partial u_F}{\partial \sigma_F} \geq \frac{\partial u_H}{\partial \sigma_F}$ for $P_2 \leq 1$.*

The proposition implies that an increase in foreign wage centralization will lead to a reduction in domestic unemployment in all cases where it also leads to a reduction in foreign unemployment. By the same token an increase in domestic centralization will reduce foreign unemployment exactly when it also decreases domestic unemployment. Thus in our model the success of such changes (or reforms) is a “win-win” or a “lose-lose” phenomenon, not a “beggar-thy-neighbors” situation. All countries in a common market profit from a successful labor market reform in one member country and they suffer from an unsuccessful one.

As the second part of proposition 4 shows, the effect of a change in CWB is always more pronounced in the country where it originated. If an increase in home-country CWB increases unemployment in H (i.e. $P_1 < 1$) then it will also increase unemployment in F but by less than in H . And if the increase in σ_H leads to a reduction of unemployment in H and in F (i.e. $P_1 > 1$) then the latter effect is smaller than the former. The intuition behind this result is parallel to the one discussed for the result of proposition 2 (ii).

Combining propositions 3 and 4 we can now ask ourselves if it is possible to have a parameter constellation where an increase in CWB has a positive effect on unemployment, regardless of the country where this shift takes place. This question arises since $\frac{\partial u_H}{\partial \sigma_H} < 0$ is only possible if country H is “rather large” while $\frac{\partial u_F}{\partial \sigma_F} < 0$ can only happen if country F is “rather large”. For this to be the case we must thus have that $P_1 > 1$ and $P_2 > 1$. Transformation leads to the following condition: $\frac{\theta-1}{\theta-\alpha_H} < \gamma < \frac{1-\alpha_F}{\theta-\alpha_F}$. So if the two countries are not too different in size and/or if the goods markets are not too competitive such a situation might well be possible. In fact for $\theta \rightarrow 1$ the condition reduces to $0 < \gamma < 1$ (which is always fulfilled), while for $\theta \rightarrow \infty$ it becomes $1 < \gamma < 0$ (which is never fulfilled). In the case where the condition is fulfilled we can therefore conclude that the same reform (i.e., a move towards a more centralized wage-bargaining system) is positive for both countries. But the reverse case can also happen, especially when the size

²⁵This is, however, not true for the third influential parameter, since monetary policies have most probably become more non-accommodating over the recent decades, which—according to our model—should have increased the incentives to centralize the wage-bargaining system. Our model thus suggests that the first two effects (on θ and γ) must have been larger than the latter, such that the incentive to decentralize prevailed.

of countries is quite diverse. Then it could, e.g., be the case that an increase in CWB is positive for country H (and by the spillover effects also for F) while the same move (an increase in σ_F) is negative for F (and also for H). A labor market reform that is advantageous for one (large) country can thus be disadvantageous for another (smaller) country. This confirms the opinion that a “one-size-fits-all” approach to the reform of labor market institutions is problematic. In this respect our model can be viewed as lending support to the EU initiatives in this area, where, e.g., the Amsterdam Treaty fosters cooperation and the exchange of information between the member states, while explicitly stating that “the competencies of the Member States shall be respected” (article 127) and that cooperation does “not include harmonisation of the laws and regulations of the Member States” (article 128).

Finally we can relate the results of our model to the Calmfors-Driffill hypothesis, where the *relative* performance of countries with respect to their (structural) unemployment rate is contrasted to their (own) degree of wage bargaining centralization (σ_H in the language of our model). Empirical tests of this hypothesis have been rather unsuccessful or at least controversial (OECD, 1997, S. 83). Our model, however, suggests that the neglect of open-economy issues could be (partly) responsible for the poor empirical performance of the original Calmfors-Driffill hypothesis. In particular we get that country F has a higher unemployment rate than country H if $P_3 \equiv \frac{\lambda_H}{\lambda_F} \frac{Z_F}{Z_H} > 1$. The country ranking with respect to unemployment rates thus depends not only on the own CWB (σ_H and σ_F , respectively), but rather on the CWB in both countries, the AMP in both countries, the relative country size γ and the competitiveness of the goods market θ . The result itself is perhaps not very surprising if one considers that we work with a general equilibrium model. Nevertheless we think it is important to note that even our simple model suggests that the original version of the Calmfors-Driffill hypothesis omits crucial variables and that the ranking of unemployment rates depends, e.g., not only on a country’s own CWB (σ_H) but also on its *relative* CWB vis-à-vis the one of the foreign country (σ_F).

5 Different Monetary Regimes

So far we have studied the case of an international monetary regime where exchange rates are flexible and determined by the relative money supplies of the two countries (cf. equation (16)). In this section we want to investigate how the results change for a fixed exchange rate regime and for a monetary union. It is frequently argued that the formation of the European Monetary Union (EMU) could change wage formation and thus structural and cyclical unemployment rates in the member countries (cf. Soskice and Iversen, 1998; Cukierman and Lippi, 2001). Since this is a broad and important issue we will only briefly discuss some results in the following, while a more extensive treatment can be found in Knell (2001).

5.1 Fixed Exchange Rate Regime

First we want to look at the case where country H follows a fixed exchange rate policy vis-à-vis country F and (credibly) pegs its currency at some level $e^{H,tar}$. As shown in section 2.4 this means that it forgoes the possibility of conducting an independent monetary policy and that it has to “mimic” the monetary policy of the foreign country. Instead of the autonomous rule (13) its monetary policy rule is now given by: $m = (1 - \alpha_F)e^{H,tar} + \alpha_F p + \tilde{m}^*$ (this is equation (17)).

As apparent from (34) and (35) the crucial parameters determining unemployment in our model are the elasticities of labor demand (λ) and the elasticities of the unions’ real wage with respect to the nominal wage (Z). These can be calculated from the demand equations of the two countries (parallel to the derivations for the flexible exchange rate regime):

$$y_i^h = -\theta(p_i^h - p_H) - (p_H - p) - (1 - \alpha_F)p + \tilde{m}^* + (1 - \alpha_F)e^{H,tar} \quad (38)$$

$$y_i^f = -\theta(p_i^{*f} - p_F^*) - (p_F^* - p^*) - (1 - \alpha_F)p^* + \tilde{m}^* \quad (39)$$

Using (38) and (39) and assuming that all other parameters stay constant it is straightforward to calculate the crucial elasticities:

$$\begin{aligned} \lambda_H^{fix} &= \theta(1 - \sigma_H) + \sigma_H(1 - \gamma\alpha_F) > 0 \\ \lambda_F^{fix} &= \lambda_F = \theta(1 - \sigma_F) + \sigma_F(1 - (1 - \gamma)\alpha_F) > 0 \\ Z_H^{fix} &= Z_H = 1 - \gamma\sigma_H > 0 \\ Z_F^{fix} &= Z_F = 1 - (1 - \gamma)\sigma_F > 0 \end{aligned} \quad (40)$$

It thus follows that a fixed exchange rate regime is equivalent to the case where H copies the monetary policy of country F . In analyzing this regime we can therefore use the results of section 4 with $\alpha_H^{fix} = \alpha_F$. Furthermore, without loss of generality and for ease of exposition, we assume that $\alpha_H^{flex} > \alpha_F$, i.e. that the autonomous monetary policy of H was more accommodating than the one of F . This is meant to reflect the case of the EMS where the member countries were induced to follow the monetary policy of the German Bundesbank, arguably the least accommodating central bank in the area.

Using propositions 1 and 2 we can now investigate the effect of the introduction of a fixed exchange rate regime on the labor market performance of the two countries. Since (from assumption) $\alpha_H^{flex} > \alpha_F$ and $\frac{\partial u_H}{\partial \alpha_H} > 0$, $\frac{\partial u_F}{\partial \alpha_H} > 0$ we can conclude that unemployment rates will decrease in both countries, where the decrease in H is larger (cf. proposition 2(ii)). The regime change is thus advantageous for both countries (a “Pareto improvement”), although we want to note again that due to the absence of any shocks our model is not suitable for studying the stabilizing properties of the various exchange rate regimes.

5.2 Monetary Union

In this section we want to move one step further and investigate what impact the formation of a monetary union (MU) will have on the labor market performance of the member countries. In fact it is often argued that the formation of EMU will affect unemployment and inflation in all member countries even if the structural parameters stay the same. The main reason for this prediction is that “with the formation of the monetary union all unions become smaller relative to the monetary area (i.e. the monetary union reduces the wage share of each single union). This decreases their perception of the inflationary repercussions of their individual wages, inducing them to more aggressive wage demands” (Cukierman and Lippi, 2001, 541; similarly: Hefeker, 1999, 39). Even the European Commission has taken up this line of reasoning and refers to it in a recent publication (cf. Cukierman and Lippi, 2001, FN1). The argument itself was formalized, e.g., by Soskice and Iversen (1998), Grüner and Hefeker (1999) and Cukierman and Lippi (2001). In all of these papers, however, the member countries of the monetary union are *only* linked through a common central bank. Neither before the formation of the MU nor afterwards do they have any trade connections or other international linkages. Therefore changes in the price levels abroad do not have an impact on the home country via competitiveness or consumption wage effects but only indirectly via the fact that the common central bank will react to the induced effects on the union-wide price level. Clearly this is an unrealistic scenario that furthermore begs the question why these countries should have formed a MU in the first place since the standard arguments for such a far-reaching decision are normally based on expected trade-enhancing effects. In our model on the other hand we do have international trade before and here the move from a fixed exchange rate regime (like the EMS) to a monetary union (like EMU) does not give rise to the unemployment-increasing effects stated above. If the common central bank will follow the same monetary policy rule as the anchor country in the fixed exchange rate regime (i.e. $\alpha = \alpha_F$) then, in fact, there is *no* change at all.

In order to see this we have to look at the demand functions in the MU, where the central bank follows the monetary rule: $m = \tilde{m} + \alpha\bar{p}$, (cf. equation (18))²⁶ and where the union-wide price level is given by $\bar{p} = \gamma p + (1 - \gamma)p^*$. Since a monetary union means that the nominal exchange rate is permanently fixed at $E = 1$ (or $e = 0$) the demand functions can be written as:

$$y_i^h = -\theta(p_i^h - p_H) - (1 - \gamma)(p_H - p_F) + (m - \bar{p}) \quad (41)$$

$$y_i^f = -\theta(p_i^f - p_F) - \gamma(p_F - p_H) + (m - \bar{p}) \quad (42)$$

Due to the preference structure the price level in both countries is the same, $p = p^*$,

²⁶Note that in our framework m measures the *per capita* money supply.

and following the steps from the previous sections we can derive:

$$\begin{aligned}
\lambda_H^{MU} &= \theta(1 - \sigma_H) + \sigma_H(1 - \gamma\alpha) > 0 \\
\lambda_F^{MU} &= \theta(1 - \sigma_F) + \sigma_F(1 - (1 - \gamma)\alpha) > 0 \\
Z_H^{MU} &= 1 - \gamma\sigma_H > 0 \\
Z_F^{MU} &= 1 - (1 - \gamma)\sigma_F > 0
\end{aligned} \tag{43}$$

So there is no change in the λ 's and Z 's as compared to the fixed exchange rate regime if one assumes that $\alpha = \alpha_F$, i.e. if the common central bank behaves the same way as the central bank of the former anchor-country. The formation of the MU has real effects only insofar as the degree of AMP changes (i.e., e.g., if $\alpha < \alpha_F$), but this is also the case if a country enters a less accommodating fixed exchange rate regime.²⁷ At first this result seems counterintuitive and in the following we want to explain why the aforementioned claims about the detrimental effects of a MU in the face of strategic interactions do not arise in our model.

The main reason for our result is the simple fact that for an open economy the move towards a MU is not such a big change after all. Due to the fact that both competitiveness (measured by the terms of trade) and the consumption wage are dependent on foreign prices and foreign demand the optimizing unions have always looked across the border and they have always taken the international situation into consideration when deciding about their nominal wage claims. Furthermore the traditional argument seems to ignore the fact that national central banks also react to foreign wage settlements insofar as these are included in import prices and thus in the domestic price level. These international linkages will dampen the negative consequences of the formation of a MU. Specific assumptions of our model lead to the extreme conclusion that the effect of a MU is nil.

In particular this is due to our preference structure where the price level is the same in all countries, i.e. $p = p^* = \bar{p} = \gamma p_H + (1 - \gamma)p_F$. From this we can see that it does not make a difference whether a central bank targets the price level of one single country or a (population-weighted) average \bar{p} of the whole union.²⁸ Put differently the price level that is relevant for the unions (namely the consumer price indices p and p^* , respectively) are the same ones that are targeted by the central bank, both before and after the formation of the MU. In the existing studies on MU (Cukierman and Lippi, 2001; Soskice and Iversen, 1998) it is typically maintained—contrary to our model—that national unions only look at national prices, while the common central bank looks at a weighted average of all price levels. But this only holds for the (unrealistic and often only implicitly made) assumption that the MU is formed by closed economies. A second assumption that is crucial for our result is of course that unions have perfect foresight and perfect information about the

²⁷If the MU substitutes a flexible exchange rate regime the impact on the unemployment rates depends on $\alpha_H \gtrless \alpha$, $\alpha_F \gtrless \alpha$ and the other parameters of the model (cf. Knell, 2001).

²⁸In fact it does not even matter which weights the common central bank uses. A “country-weighted” average, e.g., leads to the same result: $\frac{1}{2}p + \frac{1}{2}p^* = \bar{p}$.

monetary rules of both central banks and about the equilibrium exchange rate and that they act in a completely rational way. Finally we want to note that this result could be sensitive to the way how monetary policy is formulated. We have modelled central bank behavior via fixed monetary policy rules instead of assuming that they minimize a loss function that includes inflation and unemployment (cf. section 2.3). These (and other) assumptions could be relaxed in order to reintroduce real effects of the formation of a MU into our model, but these extensions are left for future research.

This, however, does not mean that we would not expect any impact of EMU on the level of euro area structural unemployment. As argued, among others, by Calmfors (1998, 2000), Mélitz (1997), Pissarides (1997) and Burda (1999) the formation of EMU is likely to lead to changes in the economic and institutional environment of European goods and labor markets. In section 4.2 we have briefly discussed how EMU-induced changes in the economic environment (deregulation, globalization) could trigger changes in the institutional environment (decentralization of wage-bargaining) which will of course have an impact on structural unemployment (cf. Knell, 2001). The effect of the changes in the strategic environment could, however, be smaller than commonly expected.

6 Conclusion

In this paper we have studied the determinants of unemployment in a world with two countries that are connected by foreign trade. We have shown that some of the results appearing in the recent literature on strategic interactions are not robust with respect to the introduction of an open economy structure. Furthermore we have shown that the model implies that the shape of the Calmfors-Driffill curve not only depends on a country's own CWB but rather on home and foreign characteristics. The last important result of our paper is related to the consequences of the formation of a monetary union. Models that are set in a closed economy strategic interaction framework normally reach the conclusion that the formation of a monetary union will alter the incentives and strategic interactions of the economic agents (in particular of unions and monetary policy makers) and will lead to a more aggressive wage-setting behavior and to higher structural unemployment. We show that this result is not generally valid in an open economy framework. In particular our model suggests that if the countries forming the monetary union were part of a fixed exchange rate regime before and if the common central bank of the monetary union is as non-accommodating as was the anchor central bank of the fixed exchange rate system then there is no unemployment effect whatsoever.

7 Appendix

Structure of the model:

The demand structure of our model is based on Corsetti and Pesenti (2001) and Obstfeld and Rogoff (1998). We assume that the world size is normalized to 1 and that firms and households over the $[0, \gamma]$ interval are located in the home country H while households and firms over the $[\gamma, 1]$ interval are located in the foreign country F . The relative size of countries H and F are thus γ and $(1 - \gamma)$, respectively. Furthermore we assume (as discussed, e.g., in Tille, 2001) that there are two *types* of goods and each country specializes in the production of one type. Each type of goods, however, is produced in a continuous variety of *brands*. Finally we assume that the degree of substitutability across types of goods is 1 while the one across brands is given by θ .

In particular we use the following utility function (for a representative household, suppressing the index i):²⁹

$$U = C \equiv \frac{C_H^\gamma C_F^{1-\gamma}}{\gamma^\gamma (1-\gamma)^{1-\gamma}} \quad (44)$$

Thereby C_H and C_F are utility subindexes of home and foreign goods, respectively, given by:

$$C_H = \left[\left(\frac{1}{\gamma} \right)^{\frac{1}{\theta}} \int_0^\gamma (C_h(i))^{\frac{\theta-1}{\theta}} di \right]^{\frac{\theta}{\theta-1}} \quad (45)$$

$$C_F = \left[\left(\frac{1}{1-\gamma} \right)^{\frac{1}{\theta}} \int_\gamma^1 (C_f(i))^{\frac{\theta-1}{\theta}} di \right]^{\frac{\theta}{\theta-1}} \quad (46)$$

where $\theta > 1$. The elasticity of substitution across goods produced within a country is thus given by θ , while the one between the composite home and foreign goods is 1 (cf. Tille, 2001), implying that there is less substitutability across types than across brands. For the foreign country a similar preference structure holds, i.e. $U^* = C^* \equiv \frac{(C_H^*)^\gamma (C_F^*)^{1-\gamma}}{\gamma^\gamma (1-\gamma)^{1-\gamma}}$, where C_H^* and C_F^* are again CES-subindexes of composite home and foreign commodity bundles.

The Home-currency consumption-based price index and the two price subindexes are given by:

$$P = P_H^\gamma P_F^{1-\gamma} \quad (47)$$

$$P_H = \left[\frac{1}{\gamma} \int_0^\gamma (P_h(i))^{1-\theta} di \right]^{\frac{1}{1-\theta}} \quad (48)$$

$$P_F = \left[\frac{1}{1-\gamma} \int_\gamma^1 (P_f(i))^{1-\theta} di \right]^{\frac{1}{1-\theta}}, \quad (49)$$

²⁹The indices C_H and C_F must therefore be understood as per capita values.

where $P_h(i)$ is the price charged by the home firm i , P_H (P_F) is the home-currency consumption-based price index for goods produced in H (F), P is the total price index in H and P^* is the total price index in F (expressed in foreign currency). Again, equivalent expressions hold for the foreign-currency consumption-based price indices. We assume that the law of one price holds across all individual goods, i.e. $P_h(i) = \varepsilon P_h^*(i)$ and $P_f(i) = \varepsilon P_f^*(i)$ where $P_h^*(i)$ ($P_f^*(i)$) denotes the price of home (foreign) goods in the foreign country and ε is the nominal exchange rate. The indices (48), (49) and (47) thus imply that purchasing power parity holds for the overall consumption price indices:

$$P = \varepsilon P^* \quad (50)$$

This leads to the following equations for the (world) demand for (individual) home and foreign goods:

$$Y_h(i) = \left(\frac{P_h(i)}{P_H} \right)^{-\theta} \left(\frac{P_H}{P} \right)^{-1} C_W \quad (51)$$

$$Y_f(i) = \left(\frac{P_f(i)}{P_F} \right)^{-\theta} \left(\frac{P_F}{P} \right)^{-1} C_W \quad (52)$$

where $C_W \equiv [\gamma C + (1 - \gamma)C^*]$ and C (C^*) is total consumption of a representative household in H (F). Since in this model it holds that $C = C^* = C_W$ (see Obstfeld and Rogoff, 1998) we can use the aggregate conditions to derive that:

$$\frac{P_H Y_H}{\gamma} = \frac{P_F Y_F}{1 - \gamma} \text{ or} \quad (53)$$

$$P_H y_h = P_F y_f, \quad (54)$$

where $Y_H \equiv \int_0^\gamma Y_h(i) di$ and $Y_F \equiv \int_\gamma^1 Y_f(i) di$, while y_h and y_f stand for the demand faced by a representative firm in H and F , respectively.

Furthermore we assume some quantity-theory-like relation between money and (nominal) demand³⁰, i.e. $M = C/P$ and $M^* = C^*/P^*$, such that we can write the demand functions for the individual country goods as:

$$Y_i^h = \left(\frac{P_h(i)}{P_H} \right)^{-\theta} \left(\frac{P_H}{P} \right)^{-1} \left[\gamma \frac{M}{P} + (1 - \gamma) \frac{M^*}{P^*} \right] \quad (55)$$

$$Y_f(i) = \left(\frac{P_f(i)}{P_F} \right)^{-\theta} \left(\frac{P_F}{P} \right)^{-1} \left[\gamma \frac{M}{P} + (1 - \gamma) \frac{M^*}{P^*} \right] \quad (56)$$

From the equilibrium relation $C = C^*$ it thus follows that $\frac{M}{P} = \frac{M^*}{P^*}$ or (from 50):

$$M = \varepsilon M^* \quad (57)$$

³⁰This can also be derived in a maximizing framework (cf. Blanchard and Kiyotaki, 1987).

Finally we linearize the demand functions (by taking logarithms of (55) and (56) and by using a first-order Taylor approximation around $\frac{M}{P} = \frac{M^*}{P^*} = \frac{\tilde{M}}{\tilde{P}}$). We get the following expressions:

$$\begin{aligned} y_i^h &= -\theta(p_i^h - p_H) - (1 - \gamma)(p_H - p_F) + \gamma(m - p) + (1 - \gamma)(m^* - p^*) \\ y_i^f &= -\theta(p_i^{*f} - p_F^*) - \gamma(p_F^* - p_H^*) + \gamma(m - p) + (1 - \gamma)(m^* - p^*) \end{aligned}$$

where all small letters represent variables in log-terms. In addition we define the price levels as:

$$\begin{aligned} p_H &= \frac{1}{\gamma} \int_0^\gamma p_i^h di \\ p_F^* &= \frac{1}{1 - \gamma} \int_\gamma^1 p_i^{*f} di \\ p &= \gamma p_H + (1 - \gamma) p_F \\ p^* &= p - e \end{aligned}$$

This is the structure of the model we use in the paper.³¹

Equation (33): We assume that each firm has access to a labor force of mass \tilde{L}_i^h , where we also assume that this firm-specific pool of workers is the same for all firms, i.e. $\tilde{L}_i^h = \tilde{L}_h$, $\tilde{L}_i^f = \tilde{L}_f$ and $\tilde{L}_h = \tilde{L}_f = \tilde{L}$. The total labor force in the two countries is therefore given by: $\tilde{L}_H = \int_0^\gamma \tilde{L}_h di = \gamma \tilde{L}$ and $\tilde{L}_F = \int_\gamma^1 \tilde{L}_f di = (1 - \gamma) \tilde{L}$. Furthermore each of these individual labor supplies is represented by one union j , where we have K_H (K_F) unions in H (F). Thus one can write aggregate production as: $Y_H = \sum_{j=1}^{K_H} \int_{\gamma[(j-1)/K_H]}^{\gamma(j/K_H)} Y_{ij}^h di$ and $Y_F = \sum_{j=1}^{K_F} \int_{LIM_L}^{LIM_H} Y_{ij}^f di$ (where $LIM_L \equiv \gamma + (1 - \gamma)[(j - 1)/K_F]$ and $LIM_H \equiv \gamma + (1 - \gamma)[j/K_F]$). Using the (linear) production functions and the fact that in equilibrium each firm will employ an identical number of workers, i.e. $L_i^h = L_h = \tilde{L}_h(1 - u_H)$ and $L_i^f = L_f = \tilde{L}_f(1 - u_F)$ we get: $Y_H = \gamma \tilde{L}_h(1 - u_H)$ and $Y_F = (1 - \gamma) \tilde{L}_f(1 - u_F)$. From (10) we know that: $\frac{P_H Y_H}{\gamma} = \frac{P_F Y_F}{1 - \gamma}$ which implies that $\frac{P_H \gamma \tilde{L}_h(1 - u_H)}{\gamma} = \frac{P_F (1 - \gamma) \tilde{L}_f(1 - u_F)}{1 - \gamma}$. Using the approximation that $\ln(1 - u_H) \approx -u_H$ and $\ln(1 - u_F) \approx -u_F$ we can finally derive: $TOT \equiv p_F - p_H = u_F - u_H$, which is equation (33) in the text.

Proposition 1: This follows from the partial derivatives:

$$\begin{aligned} \frac{\partial u_H}{\partial \alpha_H} &= -\frac{(\mu + \tilde{\omega})(\lambda_F + Z_F)(\lambda_F + \gamma Z_F) Z_H \frac{\partial \lambda_H}{\partial \alpha_H}}{D^2} \\ \frac{\partial u_F}{\partial \alpha_F} &= -\frac{(\mu + \tilde{\omega}) Z_F (\lambda_H + Z_H) (\lambda_H + (1 - \gamma) Z_H) \frac{\partial \lambda_F}{\partial \alpha_F}}{D^2} \end{aligned}$$

where $D \equiv \gamma \lambda_H Z_F + (1 - \gamma) \lambda_F Z_H + \lambda_H \lambda_F > 0$. Since all the λ 's and Z 's are positive (cf. (37)) and $\frac{\partial \lambda_H}{\partial \alpha_H} = -\gamma \sigma_H < 0$ and $\frac{\partial \lambda_F}{\partial \alpha_F} = -(1 - \gamma) \sigma_F < 0$ the result follows.

³¹Note the formulas for p_H and p_F^* are not precisely correct, but they are good approximations.

Proposition 2:

We can calculate:

$$\begin{aligned}\frac{\partial u_H}{\partial \alpha_F} &= -\frac{(1-\gamma)(\mu+\tilde{\omega})Z_F Z_H(\lambda_H+Z_H)\frac{\partial \lambda_F}{\partial \alpha_F}}{D^2} \\ \frac{\partial u_F}{\partial \alpha_H} &= -\frac{\gamma(\mu+\tilde{\omega})Z_F Z_H(\lambda_F+Z_F)\frac{\partial \lambda_H}{\partial \alpha_H}}{D^2}\end{aligned}$$

$\frac{\partial u_H}{\partial \alpha_F} > 0$ and $\frac{\partial u_F}{\partial \alpha_H} > 0$ follows again from the (negative) signs of $\frac{\partial \lambda_H}{\partial \alpha_H}$ and $\frac{\partial \lambda_F}{\partial \alpha_F}$. Furthermore $\frac{\partial u_H}{\partial \alpha_H} - \frac{\partial u_F}{\partial \alpha_H} = -\frac{(\mu+\tilde{\omega})\lambda_F Z_H(\lambda_F+Z_F)\frac{\partial \lambda_H}{\partial \alpha_H}}{D^2} > 0$ and $\frac{\partial u_F}{\partial \alpha_F} - \frac{\partial u_H}{\partial \alpha_F} = -\frac{(\mu+\tilde{\omega})\lambda_H Z_F(\lambda_H+Z_H)\frac{\partial \lambda_F}{\partial \alpha_F}}{D^2} > 0$ which proves the second part of the proposition.

Proposition 3:

The impact on home unemployment follows from the fact that:

$$\frac{\partial u_H}{\partial \sigma_H} = \frac{(\mu+\tilde{\omega})(\lambda_F+Z_F)(\lambda_F+\gamma Z_F)\left(\lambda_H\frac{\partial Z_H}{\partial \sigma_H} - Z_H\frac{\partial \lambda_H}{\partial \sigma_H}\right)}{D^2}$$

Now $\frac{\partial Z_H}{\partial \sigma_H} = -\gamma < 0$ and $\frac{\partial \lambda_H}{\partial \sigma_H} = -\theta + 1 - \gamma\alpha_H \geq 0$ for $1 - \gamma\alpha_H \geq \theta$. So the total effect on unemployment is not clear. In fact even in the case where we limit the range of α_H to $0 \leq \alpha_H \leq 1$ we get an inconclusive result. In this case $\frac{\partial \lambda_H}{\partial \sigma_H} < 0$ (since $\theta > 1$) but the sign of the nominator is still not clear, since $\lambda_H\frac{\partial Z_H}{\partial \sigma_H}$ is negative and $-Z_H\frac{\partial \lambda_H}{\partial \sigma_H}$ is positive. We can calculate, however, that $\frac{\partial u_H}{\partial \sigma_H} < 0$ for $P_1 \equiv \frac{1-\alpha_H\gamma}{\theta(1-\gamma)} > 1$, as stated in the proposition, where $\frac{\partial P_1}{\partial \gamma} > 0$, $\frac{\partial P_1}{\partial \theta} < 0$, $\frac{\partial P_1}{\partial \alpha_H} < 0$. Parallel reasoning can be used to study the impact of foreign CWB on foreign unemployment, where:

$\frac{\partial u_F}{\partial \sigma_F} = \frac{(\mu+\tilde{\omega})(\lambda_H+Z_H)(\lambda_H+(1-\gamma)Z_H)\left(\lambda_F\frac{\partial Z_F}{\partial \sigma_F} - Z_F\frac{\partial \lambda_F}{\partial \sigma_F}\right)}{D^2}$. Note that the size of country F increases in $(1-\gamma)$.

Proposition 4:

The first part of the proposition follows from the fact that

$$\begin{aligned}\frac{\partial u_H}{\partial \sigma_F} &= \frac{(\mu+\tilde{\omega})(1-\gamma)Z_H(\lambda_H+Z_H)\left(\lambda_F\frac{\partial Z_F}{\partial \sigma_F} - Z_F\frac{\partial \lambda_F}{\partial \sigma_F}\right)}{D^2} \\ \frac{\partial u_F}{\partial \sigma_H} &= \frac{(\mu+\tilde{\omega})\gamma Z_F(\lambda_F+Z_F)\left(\lambda_H\frac{\partial Z_H}{\partial \sigma_H} - Z_H\frac{\partial \lambda_H}{\partial \sigma_H}\right)}{D^2}\end{aligned}$$

where $\left(\lambda_F\frac{\partial Z_F}{\partial \sigma_F} - Z_F\frac{\partial \lambda_F}{\partial \sigma_F}\right)$ and $\left(\lambda_H\frac{\partial Z_H}{\partial \sigma_H} - Z_H\frac{\partial \lambda_H}{\partial \sigma_H}\right)$ have already appeared in the proofs of proposition 3. Furthermore:

$$\begin{aligned}\frac{\partial u_H}{\partial \sigma_H} - \frac{\partial u_F}{\partial \sigma_H} &= \frac{(\mu+\tilde{\omega})\lambda_F(\lambda_F+Z_F)\left(\lambda_H\frac{\partial Z_H}{\partial \sigma_H} - Z_H\frac{\partial \lambda_H}{\partial \sigma_H}\right)}{D^2} \\ \frac{\partial u_F}{\partial \sigma_F} - \frac{\partial u_H}{\partial \sigma_F} &= \frac{(\mu+\tilde{\omega})\lambda_H(\lambda_H+Z_H)\left(\lambda_F\frac{\partial Z_F}{\partial \sigma_F} - Z_F\frac{\partial \lambda_F}{\partial \sigma_F}\right)}{D^2}\end{aligned}$$

so we get that: $\frac{\partial u_H}{\partial \sigma_H} \geq \frac{\partial u_F}{\partial \sigma_H}$ for $P_1 \leq 1$ and $\frac{\partial u_F}{\partial \sigma_F} \geq \frac{\partial u_H}{\partial \sigma_F}$ for $P_2 \leq 1$.

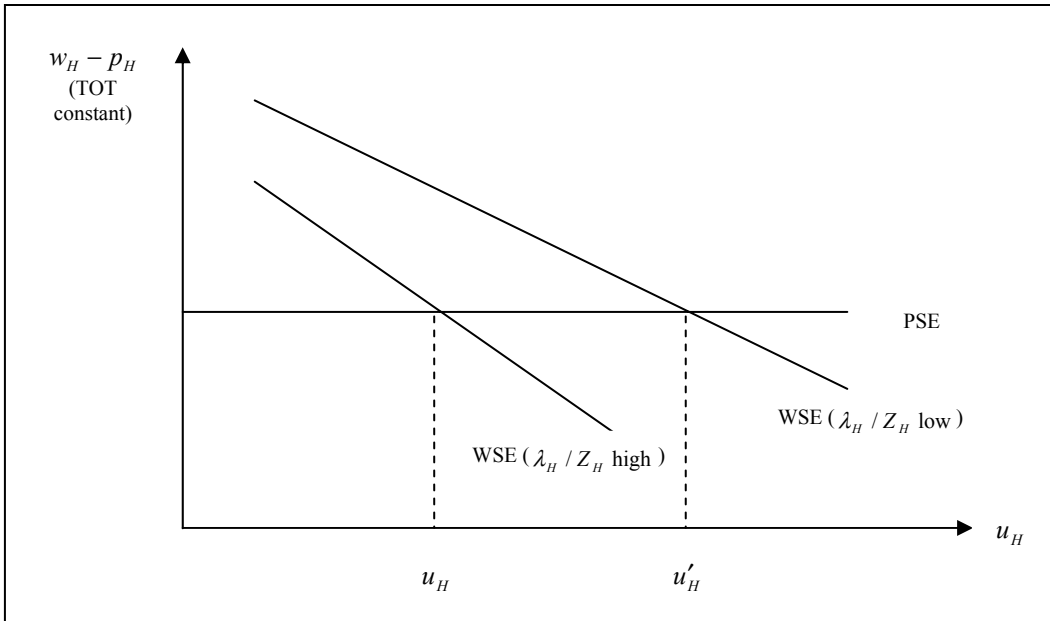
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Figure 1



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