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Abstract

The study examines the incentives of two monopoly labour unions for international cooperation under floating exchange rates and in a monetary union. The framework consists of a two-country model of international spillovers, where the impact through the real exchange rate is of central importance. The labour unions care about real wages and employment but not about inflation. The main results of the model are: 1) Irrespective of the monetary regime, cooperation is always beneficial for the labour unions; however, the non-cooperative solution is the one-shot game Nash equilibrium. 2) At a given level of employment, inflation is higher in the monetary union than in the floating rate regime. 3) In a floating rate regime, cooperation is more advantageous in case of an accommodative than a conservative central banker. In a monetary union, such an unambiguous result does not emerge. And finally 4) in a repeated game, the highest discount rate to maintain cooperation is very high and is not dependent on the monetary regime.

Key words: monetary policy, labour unions, EMU

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Contents

1 Introduction

High unemployment since the beginning of the 1970s has been a persistent problem in many European countries. This permanence is not caused by a continuous recession in the continent: the past 30 years have seen both ups and downs in the economy. As a consequence, economists are inclined to appoint the European unemployment problem to structural sources, such as rigid regulations and wages.

In the theory of labour markets, the prevalence of higher than market clearing wages is most often appointed to efficiency wages or to the existence of labour unions. In Europe in particular, the tendency among workers to combine forces by forming labour unions has historically been strong, and the end of the 1960s saw an upsurge of the power of the unions across the continent.[1] The Nordic economies with corporatist wage bargaining systems can be seen as a culmination of this development.

Recently, the European Monetary Union (EMU) has come into existence. The beginning of a common monetary policy has changed the European setting significantly: There is no scope for an independent monetary policy of a single country. Moreover, the economic developments in the member countries are taken into account on average, so that only a partial monetary policy response to developments in a single country can be expected. Such a fundamental change in policy regime could change the behaviour of labor unions.

This paper examines the strategic interaction between central banks and labour unions in a theoretical model, where the labour unions are assumed to care about employment but not about inflation. In particular, transition from a floating exchange rate regime into a two-country monetary union in the presence of internationally immobile labour and a home bias in consumption of goods is studied. The focus is set on the incentives of the two monopoly labour unions for international cooperation.

Since the rise of interest in wage setting institutions in the 1980s, several researchers have begun to stress the significance of binding wage contracts and nominal wage rigidity as a source of non-neutrality of monetary policy. The macroeconomic implications of labour unions' strategic behaviour are studied in a large number of recent papers. The significance of the structure of the wage bargaining system has evoked two hypotheses: The corporatist approach, popularised by Bruno and Sachs (1985), finds a negative empirical relationship between the degree of centralisation of wage bargaining on the one hand and inflation and unemployment on the other. In contrast, Calmfors and Driffill (1988) propose there to be a hump-shaped relation between the centralisation scale and the above mentioned macroeconomic variables. The intuition behind this result emphasises the competition effect in the case of atomistic labour markets, on the one hand, and the ability to internalise externalities in case of a small number of unions, on the other. Both effects moderate wage demands.

Turning to the interaction between a central bank and wage bargaining institutions in a closed economy, important results can be found in Cubitt (1992), Cukierman and Lippi (1999a), Guzzo and Velasco (1999),[2] Coricelli et al (2000)

[1] Eg Layard et al (1991, 3–4) point to the increased influence of labour unions in Europe from 1968 onwards and around 1980 in particular.

[2] For comments on Guzzo and Velasco (1999), see Lippi (1999).

and Soskice and Iversen (2000). Despite the apparent differences in the assumptions, the main outcomes affirm the theoretical hypothesis of Iversen (1999): for an economy with many labour unions, appointing a conservative central banker leads to the best macroeconomic outcomes, whereas an accommodating central bank is suitable for a corporatist economy.

Monetary unification is here examined from the point of view of the real exchange rate effect. Despite the creation of a monetary union, labour remains immobile and a home bias, ie a preference for home country products, exists in the product markets. In addition, there is imperfect substitutability between the goods. In this setting, international spillovers emerge. The two-country monetary policy cooperation model of Rogoff (1985a) argues that monetary policy cooperation might be counterproductive in the presence of a third party that does not cooperate. Cooperation increases the incentives of the central banks to inflate, which is anticipated by the wage setters, respectively. It follows that monetary policy does not have any systematic effect on employment, but inflation is higher. However, because the stabilisation outcomes are the best under cooperation, Rogoff (1985a) also concludes that cooperation, as long as the credibility problem towards the private sector is solved, is always superior to any non-cooperative outcome. Jensen (1993) and (1997) considers the two-country spillover model in unionised economies, and Rantala (2001) introduces a monetary union into the model, thus examining the strategic interaction between the labour unions in the two countries. For the macroeconomic background, comprising thus international spillovers and highly concentrated wage setting, this paper relies on Rantala (2001).

Cooperation among labour unions in an open economy has been studied by Holden (1991), Zervoyianni (1997) and Forteza (1998), among others. This paper bears the most resemblance with Zervoyianni (1997), where the benefit of international cooperation among the labour unions is studied in the Rogoff (1985a) two country setting. It turns out that international cooperation between the labour unions in the presence of monetary policy cooperation increases the joint welfare of the two unions. Here, the main differences as to the approach of Zervoyianni (1997) are that unions commit to a nominal wage, on the one hand, and that the employment targets of the unions and the central banks are equal and the time inconsistency problem arises solely from the existence of a real wage target of a labour union, on the other. In addition, instead of monetary policy cooperation, a monetary union is considered here.

Throughout the work, the focus will be on the behaviour of the labour unions. This is unusual: the general approach so far has been to examine the macroeconomic outcomes. In other words, a lot of research has been made with regard to the effect of centralisation of wage setting on macroeconomic performance, but less attention has been given to the conditions in which centralisation among labour unions might happen. This becomes problematic in particular when policy implications concerning the ideal type of wage bargaining structure are considered. Some researchers[3] have also pointed this out in their studies. My objective is to enlighten these conditions in a setting where monetary policy becomes common for the countries. With the help of a theoretical model, utility levels in different states of the world will be compared in order to determine the best behavioural pattern for the labour unions.

[3] See eg discussion in Calmfors and Driffill (1988, 48).

In this paper, I consider the role of the real exchange rate in monetary policy under different monetary regimes. Whether EMU influences political labour market reform is left out of the study.[4] Neither does the paper take a stand with regard to the effects of the EMU on wage bargaining through product market integration.[5] Finally, the centralisation problem is limited here to examining incentives for international cooperation of the two monopoly unions; hence I do not consider sectoral or decentralised bargaining.

Chapter 2 begins with a brief introduction to the situation in Europe. In Chapter 3, a two-country game between the central banks and the labour unions in the model of Rantala (2001) is modified to include labour union utility comparisons in a floating exchange rate regime and in a monetary union. Both one-period and repeated game situations are considered. Finally, in chapter 4, some conclusions are presented.

2 European unemployment and EMU

In this chapter, developments in the European unemployment, efforts to explain them and trends in unionisation among workers are presented. Special attention is paid to the Northern European economies. After that, possible consequences of the EMU on the labour market are briefly contemplated.

2.1 Unemployment in Europe

In order to understand the situation in Europe, unemployment rates as well as the share of long-term unemployment from total unemployment in selected countries are presented in Table 1. At first sight, high unemployment in Europe does not seem to be a tradition; indeed, the average unemployment rate remained below the figures of the United States and Canada in the 1970s and 1980s. Nevertheless, in the 1990s the situation has reversed. As to the length of unemployment, the European countries, with the exception of Sweden, exhibit very high figures. At first glance, the European unemployment problem thus seems very much to be that of long-term unemployment.

Many mainstream economists[6] have appointed the upsurge of unemployment in Europe in the 1970s and in the 1980s, firstly, to supply side disturbances, and secondly, to bad policies. To begin with the supply side, the oil crisis together with high wages resulting from the increase in labour union power from 1968 onwards were renowned as the main culprits. The consequence of these supply shocks was rising unemployment combined with high inflation. On the demand management side, taming inflation was a priority for many policy makers in the late 1970s and early 1980s; the resulting austere policies further aggravated the labour market situation.

[4] See eg Berthold and Fehn (1998), Calmfors (1998) and Saint-Paul and Bentolila (2000).
[5] For effects of product market integration on wage bargaining systems, see eg Danthine and Hunt (1994) and Naylor (1999). Studies of monetary integration when purchasing power parity holds include Grüner and Hefeker, Cukierman and Lippi (1999b) and Coricelli et al (2000).
[6] See eg Bruno and Sachs (1985) and Blanchard et al (1986).

The prevalence of long-term unemployment in Europe has equally received theoretical attention. *Hysteresis*, as defined in eg Blanchard and Summers (1986, 15), signifies "the substantial persistence of unemployment and protracted effects of shocks on employment." This aspect, clearly present in Europe, is also central in Lindbeck and Snower (1988) and Layard et al (1991), among others. Although labour unions are often mentioned as a source of hysteresis, in particular because the employed insiders set the wages above the market clearing level, the case is not so simple.[7] As in Layard et al (1991), another plausible source is not the existence of the labour unions in itself but the organisation of wage setting in a country together with the length of unemployment benefits. This view, largely shared among the economists, has given rise to the literature on the effects of the level of wage bargaining, a concept that is also central in this work.

Table 1. **Unemployment and long-term unemployment in selected OECD-countries**

Country	Unemployment*				Long-term unemployment**		
	1970	1980	1990	1999	1983	1990	1999
Austria	1,5	1,9	3,2	3,8			31,7
Belgium	1,9	8,1	8,9	11,7	66,3	68,7	60,5
Denmark	0,7	6,9	8,4	5,6	33,0	29,9	20,5
Finland	1,9	4,7	3,2	10,2	19,8	9,2***	29,6
France	2,5	6,5	9,1	11,3	42,2	38,0	40,3
Germany	0,6	3,2	4,8	8,7	39,3	46,8	51,7
Greece	4,2	2,8	7,0		35,0	49,8	55,3
Ireland	5,8	7,4	13,0	5,8	36,9	66,0	55,3
Italy	5,3	7,7	11,5	11,5	57,7	69,8	61,4
Netherlands	1,0	6,2	7,6	3,6	50,5	49,3	43,5
Norway	0,8	1,7	5,3	3,2	6,3	20,4	6,8
Portugal	2,5	7,8	4,6	4,7	..	44,8	41,2
Spain	2,5	11,5	16,3	15,9	52,4	54,0	51,3
Sweden	1,5	2,0	1,6	7,2	10,3	12,1	30,1
United Kingdom	2,2	5,7	6,9	6,0	47,0	34,4	29,6
E.E.C/EU15	2,5	6,1	8,2	9,3		48,6	47,5
Canada	5,6	7,5	8,1	7,6	9,9	7,2	11,6
Japan	1,1	2,0	2,1	4,7	12,9	19,1	22,4
United States	4,8	7,1	5,6	4,2	13,3	5,5	6,8

* As percentage of total labour force.
** 12 months and over, defined as percentage of total unemployment.
*** Refers to year 1991.
Sources: OECD (1992, 32–33) for unemployment in 1970 and OECD (2000, 24–25) for 1980–1999, OECD (1994b, 206) for long-term unemployed in 1983 and OECD (2001, 227) for 1990–1999.

[7] Eg Blanchard and Summers (1986) conclude that the effect of insider wage setting arises only in bad times, of which the oil shock is an example. Moreover, the presence of labour unions does not prove to be crucial in giving rise to insider power.

The above mentioned researches argue for a "Two-handed approach",[8] that is, remedies that affect both the supply and demand side of the labour market. Demand management shall in particular change the equilibrium in a hysteresis situation, on the one hand, and prevent inequality from rising, on the other. The prevention of increasing inequality and poverty has gained support in the 1990s.[9] In contrast, the OECD Jobs Study (OECD 1994a) sees rigid labour market structures as the origin of the unemployment problem and advocates for a radical deregulation. However, this view is politically less popular.

2.2 Labour unions

From the above mentioned elements, labour unions and the organisation of wage setting are the focus of this work. Table 2 presents four indices related to collective bargaining in selected countries. Union density refers to the percentage of labour force being unionised. Bargaining coverage comprises the percentage of workers whose terms of employment are determined by a collective agreement. Centralisation of wage bargaining describes the level at which bargaining occurs, a value of 3 referring to national level and a value of 1 to firm-level bargaining. Finally, coordination among the collective bargaining partners is equally classified to vary from high consensus (a value of 3) to uncoordination (a value of 1).

Table 2 shows a strong presence of labour unions in Europe, especially when measured by the degree of centralisation. According to Iversen (1999, 28) bargaining systems that are centralised to some degree possess *strategic capacity*, ie they are able to affect the welfare of the other parties in the economy. Moreover, economy-wide bargaining was introduced or it continued to function in several European countries[10] during the 1980s and early 1990s (OECD 1997, 186). Hence it seems evident that labour unions have strategic significance in Europe.

The Nordic Countries[11] together with Austria and Germany appear to distinct themselves as the most centralised and coordinated countries in Table 2. Layard et al (1991, 52) also rank these countries as having the most coordinated wage setting and Iversen (1999, 7) comes up with almost the same ranking on a centralisation scale.[12] Inspected closer, however, these countries show a very mixed picture: in the Nordic Countries, state intervention plays a role and the level of bargaining has varied radically from year to year. In contrast, Austria presents a stable pattern, where the same labour organisations have persisted over the years. (Iversen 1999, 6–10) The presence of state intervention makes the assumption of the importance of the employment objective more realistic. The Nordic Countries thus become the most natural real world benchmark for the model developed in this work.

[8] The term is introduced by Blanchard et al (1986). In addition, Bruno and Sachs (1985) argue for integrated demand and supply policy, and Blanchard and Summers (1986) and Layard et al (1991) stress the importance of demand policies in the short run in presence of hysteresis.
[9] See eg Alogoskoufis et al (1995), OECD (1997).
[10] Portugal, Spain, Finland, the Netherlands and Norway.
[11] Here Denmark, Finland, Norway and Sweden.
[12] In Iversen (1999, 7), the Netherlands are considered more centralised than Germany.

Table 2. **Collective bargaining in selected OECD countries**

Country	Union density		Bargaining coverage		Centralisation**		Coordination**	
	1980	1994*	1980	1994*	1980	1994	1980	1994
Austria	0.56	0.42	0.98	0.98	2+	2+	3	3
Belgium	0.56	0.54	0.90	0.90	2+	2+	2	2
Denmark	0.76	0.76	0.69	0.69	2+	2	2.5	2+
Finland	0.70	0.81	0.95	0.95	2.5	2+	2+	2+
France	0.18	0.09	0.85	0.95	2	2	2–	2
Germany	0.36	0.29	0.91	0.92	2	2	3	3
Italy	0.49	0.39	0.85	0.82	2–	2	1.5	2.5
Netherlands	0.35	0.26	0.76	0.81	2	2	2	2
Norway	0.57	0.58	0.75	0.74	2	2+	2.5	2.5
Portugal	0.61	0.32	0.70	0.71	2–	2	2–	2
Spain	0.09	0.19	0.76	0.78	2+	2	2	2
Sweden	0.80	0.91	0.86	0.89	3	2	2.5	2
United Kingdom	0.50	0.34	0.70	0.47	2	1.5	1.5	1
Canada	0.36	0.38	0.37	0.36	1	1	1	1
Japan	0.31	0.24	0.28	0.21	1	1	3	3
United States	0.22	0.16	0.26	0.18	1	1	1	1

* Depending on the country in question, data is gathered on a year from the interval of 1990–1995.

** Centralisation and cooperation figures are indices of the OECD for the bargaining level and the degree of cooperation. A value of 1 denotes the decentralised / uncoordinated system and a value of 3 the centralised / coordinated system.

Source: OECD (1997, 71)

2.3 Effects of monetary integration on labour markets

The 1990s has been marked by increasing economic integration in Europe. In particular, the EMU began its existence in 1999. Given the labour market situation in the area, the question of whether achieving the monetary union is compatible with attempts to decrease unemployment in the unionised European labour markets has intrigued many, and not the least the candidate countries.

Indeed, the worry about employment and the adjustment to low inflation receive central attention in the reports of Finland (EMU 1997) and Sweden (SOU 1996) that evaluate the effects of the membership in the EMU. Both are unanimous that more nominal wage flexibility is needed in order to be able to adjust to asymmetric shocks in the monetary union. This should be achieved by more flexible wage negotiations, which both reports consider unlikely in the Nordic Countries where strong price and wage rigidities traditionally prevail. Sweden's report (SOU 1996) ends up not to recommend participation because of the threat of growing unemployment in an already bad employment situation. According to the report, joining the monetary union must be preceded by structural labour market reforms in order to reach a more productivity-oriented wage policy.

Apart from the official reports of the candidate countries, the concern for rigidities is equally expressed by Fritsche et al (1999), who state increasing flexibility as the condition for a functioning EMU-wide labour market. One way to achieve more reasonable wage setting would be international cooperation

between the labour unions in the Euro area. Traxler (1999) studies this option after having stated that regardless of the abilities of the labour unions to internalise the externalities resulting from wage bargaining, non-cooperative outcomes will yield suboptimal results for the whole area. He also points out the unlikelihood of achieving coordination with the present institutions. The Social Policy Protocol in the Maastricht Treaty does not include pay policy in the negotiable issues, and the role of European-wide bargaining organisations is minor. (Traxler 1999, 115–116, 127–128)

To sum up, in the EMU, the risks for higher unemployment exist; on the other hand, good organisation in the labour markets may lead to more employment. In this regard, the interaction between the European Central Bank (ECB) and the labour unions forms an essential part of the problem. In the following, I consider these aspects more in depth from a theoretical point of view.

3 A model of labour union cooperation

The purpose of the model is to incorporate the strategic behaviour of the central banks and the labour unions in two identical, originally open economies that form a monetary union. I focus on three questions: First, would it be beneficial for the two labour unions to cooperate across border, and is cooperation an equilibrium solution? Second, does the outcome depend on the monetary regime? And finally, given the absence of contract-enforcing institutions, what are the incentives for the labour unions to stay in the cooperative equilibrium, when the game is repeated infinitely?

The model is based on the Rogoff (1985a) monetary policy games strand of literature. In particular, the two-country monetary policy cooperation model is modified to allow for cooperation in the private sector. The model used here has its roots in Canzoneri and Henderson (1988), and with its modifications it follows Jensen (1993, 1997) for the modelling of the wage setting and Rantala (2001) for the monetary union extension.

In a rather similar setting, Jensen (1993) argues that under monetary policy cooperation, the attempts of the single monopoly unions to affect the real exchange rate by raising the nominal wages are the most intensive, which should lead to lower welfare. Cooperation between the labour unions disposes of this channel of effect, which moderates the wage claims. Consequently, it could be expected that cooperation between the labour unions would be more advantageous in the monetary union than in the floating rate regime.

In the following, the first Section sets the basic structure of the economy as well as the rules and the preferences of the game. In Sections 3.2 and 3.3 the game is played. Sections 3.6 and 3.7 discuss the outcomes that can be derived from the one-period game. Finally, the game is extended to comprise multiple periods in Section 3.8.

3.1 The structure of the game

3.1.1 The macro model

The economy consists of two identical countries that are initially open economies with floating exchange rate regimes. Each country specialises in production of one traded good. The model is specified as follows:

$$y = \alpha n \quad y^* = \alpha n^* \quad 0 < \alpha < 1 \tag{3.1}$$

$$(w - p) = -(1-\alpha)n \quad (w^* - p^*) = -(1-\alpha)n^* \tag{3.2}$$

$$w_c = w - \pi \quad w_c^* = w^* - \pi^* \tag{3.3}$$

$$y - y^* = \delta z \quad \delta > 0 \tag{3.4}$$

$$z = e + p^* - p \tag{3.5}$$

$$\begin{aligned} \pi &= (1-\beta)p + \beta(e + p^*) = p + \beta z \\ \pi^* &= \beta(p - e) + (1-\beta)p^* = p^* - \beta z \quad 0 < \beta < \tfrac{1}{2} \end{aligned} \tag{3.6}$$

$$m = p + y \quad m^* = p^* + y^* \tag{3.7}$$

All variables are natural logarithms and expressed as deviations from full employment equilibrium. An asterisk denotes foreign country variables. It is assumed that all structural parameters are the same in both countries and that labour is immobile between the countries. Output supply (3.1), denoted by y (and by y* in the foreign country, respectively) is derived from a Cobb-Douglas production function, where the capital stock is fixed and normalised to unity. Firms are perfectly competitive, and their profit maximising behaviour results in labour demand function (3.2).[13] Employment is denoted by n (n*), nominal wage by w (w*), and product price by p (p*). Real consumption wage w_c (w_c*) is defined in equation (3.3) as nominal wage minus the consumer price index (CPI) π (π*). Output demand in each country is connected with the real exchange rate z in equation (3.4). The parameter δ is an expression of the degree of substitutability between home and foreign goods: a large value of δ implies close substitutability in a way that a small change in the real exchange rate results in a large change in relative demand. The domestic price of foreign good is denoted by the nominal exchange rate e. The real exchange rate is thus defined in equation (3.5) so that a decrease means real appreciation of the domestic currency. In the definition (3.6) of the CPI the restriction of the value of the parameter β captures the assumption of a home bias in consumption. Only domestic residents hold domestic money in the model. In equilibrium, real money balances m–π equal real income p+y–π. Hence the money market equilibrium is reached when the nominal money supply m (m*) is equal to nominal income.

[13] Irrelevant constants are omitted from the model by Jensen (1993).

In the monetary union, the logarithm of the nominal exchange rate is zero, and money supply becomes union-wide. A key assumption is that the common money supply is spread out in equal proportions in both countries, and the distribution cannot thus be affected. These modifications can be expressed as follows:

$$z = p^* - p \tag{3.8}$$

$$m^U = \tfrac{1}{2}(p + y) + \tfrac{1}{2}(p^* + y^*) \tag{3.9}$$

3.1.2 Utility functions of the labour unions and the central banks

There exists a single monopoly labour union in each country. The unions' utility functions are defined as follows:

$$U = \gamma w_c - \tfrac{1}{2}n^2 \quad U^* = \gamma w_c^* - \tfrac{1}{2}n^{*2} \tag{3.10}$$

The labour unions care about the real consumer wages and about the deviations from full employment equilibrium. As a consequence, there is a trade-off between real wage and employment in a way that the labour union is willing to trade some employment for higher real wages. As long as the labour unions aim at a positive real wage, full employment will not be reached.

In contrast, unlike in some research papers, labour unions in this model do not care for inflation explicitly. This could be rationalised eg by arguing that the unions dislike inflation only after having committed to a nominal wage and their concern is therefore directed towards the resulting real wage. In other words, they want to secure the optimal trade-off between the real wage and employment. This assumption is congruent with the very recent development in the central bank and labour union interaction literature.[14]

In cooperation, the two labour unions maximise a common utility function. Here I depart from Rantala (2001), who does not consider the utility levels of the labour unions nor cooperation incentives. The common utility function will be formed in the standard way, assuming that bargaining power is equal across the two countries:[15]

$$U^C = \tfrac{1}{2}(U + U^*) = \tfrac{1}{2}\left(\gamma(w_c + w_c^*) - \tfrac{1}{2}(n^2 + n^{*2})\right) \tag{3.11}$$

The loss functions of the national central banks are given as follows:

$$L = \sigma n^2 + \pi^2 \quad L^* = \sigma n^{*2} + \pi^{*2} \quad 0 \le \sigma < \infty \tag{3.12}$$

When the CPI inflation is defined as $\pi - \pi_{-1}$ and the previous price level is normalised to zero, the CPI and the CPI inflation are equivalent. The central banks aim at full employment and zero inflation. The parameter σ represents the weight the central bank puts on achieving high employment. The smaller the

[14] See Coricelli et al (2000), (2001) and Rantala (2001).
[15] See eg Zervoyianni (1997).

parameter σ, the more effort the central bank puts on subduing inflation. The inverse of the parameter, $\frac{1}{\sigma}$, thus expresses the degree of conservatism of the central bank in style of Rogoff (1985b).

Note that the employment objectives of the labour unions and the central banks coincide. Because of the real wage target of the labour union, the target level is however not reached, and there is therefore room for the central bank to strive for a surprise inflation, even without explicit distortions in the economy. The tool of the central bank is money supply.

In the monetary union, the common central bank targets average inflation and employment in the two countries:

$$L^U = \sigma\left(\frac{n + n^*}{2}\right)^2 + \left(\frac{\pi + \pi^*}{2}\right)^2 \quad 0 \le \sigma < \infty \tag{3.13}$$

3.1.3 Modelling the game

The timing of the game is as follows: the labour unions set the nominal wages simultaneously, taking the other union's wage decision as given and being aware of the inflation targeting rule of the central bank. Based on the nominal wage decision, the central banks then set the money supplies, taking the other central bank's money supply as given. Finally, production and trade take place and output and employment are realised.

In the monetary union, the two central banks become one and there are thus no simultaneous moves in that phase. As to the labour unions, they have two options: either to cooperate or not to cooperate. These two options are studied in both monetary regimes. The strategic game is one of complete and imperfect information in the floating rate regime and equally in the monetary union when the labour unions do not cooperate. However, cooperation increases information so that the case of monetary union and coordinating labour unions becomes a game of perfect information.

3.2 Monetary policy

The game is solved by backward induction, starting from the second stage, that is, the monetary policy decision. After that, the wage setting problem is solved.

3.2.1 Floating exchange rate regime

The reduced forms for home and foreign equilibrium employments, CPI inflations and real wages are derived from the equations (3.1–3.7):[16]

$$n = m - w \quad n^* = m^* - w^* \tag{3.14}$$

[16] The reduced forms for other endogenous variables are presented in Appendix 1.

$$\pi = (1-\alpha)m + \alpha w + \frac{\alpha\beta}{\delta}(m - w - m^* + w^*)$$
$$\pi^* = (1-\alpha)m^* + \alpha w^* - \frac{\alpha\beta}{\delta}(m - w - m^* + w^*) \tag{3.15}$$

$$w_c = (1-\alpha)(w-m) - \frac{\alpha\beta}{\delta}Um - w - m^* + w^*)$$
$$w_c^* = (1-\alpha)(w^* - m^*) + \frac{\alpha\beta}{\delta}Um - w - m^* + w^*) \tag{3.16}$$

From equation (3.14) it is clear that only monetary policy and nominal wages in home (foreign) country have a direct impact on the home (foreign) employment. In contrast, CPI inflation in equation (3.15) and real consumption wages in equation (3.16) are partly determined by the differences in home and foreign money supplies and nominal wages. This spillover effect operates through the real exchange rate (see equation (A1.3) in Appendix 1) and depends in addition on the amount of foreign (home) goods consumed in home (foreign) country.

The central banks minimise their loss functions (3.12) subject to the equilibrium employment and CPI inflation equations (3.14) and (3.15). From the first order condition, it follows that

$$\pi = -\frac{\sigma}{1-\alpha+\frac{\alpha\beta}{\delta}}n \tag{3.17}$$

Hence inflation is always positive when the central bank cares about employment (when $\sigma > 0$).

The reaction function for the central bank is obtained by inserting the equilibrium employment and CPI inflation equations (3.14) and (3.15) into the first order condition (3.17) and solving it for the money supply:

$$m = \frac{\sigma - \Gamma\left(\alpha - \frac{\alpha\beta}{\delta}\right)}{\left(\sigma + \Gamma^2\right)}w + \frac{\Gamma\frac{\alpha\beta}{\delta}}{\left(\sigma+\Gamma^2\right)}(m^* - w^*)$$
$$\Gamma = 1 - \alpha + \frac{\alpha\beta}{\delta} > 0 \tag{3.18}$$

The reaction function for the foreign central bank is symmetrical. The non-cooperative policies are chosen simultaneously, and the non-cooperative Nash equilibrium that results can be presented as follows:[17]

$$m^{Nash} = c_1^f w + c_2^f w^* \qquad c_1^f \lesseqgtr 0, \quad c_2^f < 0 \tag{3.19}$$

The lower-case index f signifies the floating rate regime. The elasticities in Appendix 1 show that a fully accommodating central bank increases money supply in order to pursue its employment goal when the home nominal wages are

[17] The explicit forms of the elasticities are given in Appendix 1.

increased. In contrast, the reaction to a foreign wage increase is always negative. Inserting this expression into the reduced equations (3.14), (3.15) and (3.16) will produce the following equations:[18]

$$n = a_1^f w + a_2^f w^* \quad a_1^f < 0, a_2^f < 0 \tag{3.20}$$

$$\pi = b_1^f w + b_2^f w^* \quad b_1^f \geq 0, b_2^f \geq 0 \tag{3.21}$$

$$w_c = d_1^f w + d_2^f w^* \quad d_1^f \lesseqgtr 0, d_2^f \leq 0 \tag{3.22}$$

The first two equations capture the response of the central bank to the nominal wage claims of the labour unions in terms of employment and inflation. The third equation expresses the effect of the wage claims on the real consumption wage.

The equations above clearly demonstrate the spillover effect in the open economy: nominal wages set in the home (foreign) country affect real variables of the foreign (home) country even in the floating exchange rate case. Although a wage increase in foreign country directly only affects the foreign employment (see equation 3.14), an impact on the employment at home will be transmitted through the monetary policy reaction of the home central bank.

3.2.2 Monetary union

The reduced forms, derived from equations (3.1)–(3.4), (3.6), (3.8) and (3.9) are as follows:[19]

$$\begin{aligned} n &= m^U - \tfrac{1}{2}(w + w^*) + \tfrac{1}{2}\frac{\delta}{\alpha + (1-\alpha)\delta}(w^* - w) \\ n^* &= m^U - \tfrac{1}{2}(w + w^*) - \tfrac{1}{2}\frac{\delta}{\alpha + (1-\alpha)\delta}(w^* - w) \end{aligned} \tag{3.23}$$

$$\begin{aligned} \pi &= (1-\alpha)m^U + w - \left(\frac{1-\alpha}{2}\right)(w + w^*) + \tfrac{1}{2}\left(\frac{2\alpha\beta + (1-\alpha)\delta}{\alpha + (1-\alpha)\delta}\right)(w^* - w) \\ \pi^* &= (1-\alpha)m^U + w^* - \left(\frac{1-\alpha}{2}\right)(w + w^*) - \tfrac{1}{2}\left(\frac{2\alpha\beta + (1-\alpha)\delta}{\alpha + (1-\alpha)\delta}\right)(w^* - w) \end{aligned} \tag{3.24}$$

$$\begin{aligned} w_c &= (\alpha - 1)m^U + \left(\frac{1-\alpha}{2}\right)(w + w^*) - \tfrac{1}{2}\left(\frac{2\alpha\beta + (1-\alpha)\delta}{\alpha + (1-\alpha)\delta}\right)(w^* - w) \\ w_c^* &= (\alpha - 1)m^U + \left(\frac{1-\alpha}{2}\right)(w + w^*) + \tfrac{1}{2}\left(\frac{2\alpha\beta + (1-\alpha)\delta}{\alpha + (1-\alpha)\delta}\right)(w^* - w) \end{aligned} \tag{3.25}$$

From the equation (3.23) it can be seen that in the monetary union, both the wages set in the home as in the foreign country as well affect employment directly.

[18] See Appendix 1 for the elasticities.
[19] The reduced forms of the other endogenous equations are found in Appendix 2.

The common central bank minimises the loss function (3.13) subject to the reduced form equations (3.23) and (3.24). The first order condition is:

$$\frac{\pi + \pi^*}{2} = -\frac{\sigma}{(1-\alpha)}\frac{(n + n^*)}{2} \tag{3.26}$$

Comparing this result with equation (3.17) reveals that with a given level of employment, inflation is higher in the monetary union than in the floating rate regime. The common central bank is thus more accommodating than the national ones. Hence the monetary union case reproduces the Rogoff (1985a) monetary cooperation result: when monetary policy is symmetric in both countries, the real exchange rate does not deteriorate following a monetary expansion. This may result in cooperation being counterproductive: Expansionary policies become more lucrative and the incentives to inflate increase. When the private sector anticipates this, wage demands become higher. As a consequence, inflation will become higher at a given employment level.

Solving the money supply from equation (3.26) results in the following reaction function for the common central bank:

$$m^U = \frac{\sigma - \alpha(1-\alpha)}{2\left(\sigma + (1-\alpha)^2\right)}(w + w^*) \tag{3.27}$$

Money supply reaction is thus symmetric, and a unilateral wage rise results in a change in money supply in both countries. A consequence is that the reaction is perforce too slack in the country where wages were raised and too tight in the other country. This manifests the difference between monetary policy cooperation and monetary union: in a monetary union, the common central bank has only one policy instrument in use, whereas the two cooperating central banks can still react asymmetrically to a unilateral wage increase. If the central bank is highly inflation averse, ie the parameter σ is small enough, this reaction can be a reduction of money supply to every wage increase.

Inserting the reaction function (3.27) into the reduced form equations (3.23)–(3.25) results in the following functions:[20]

$$n = a_1^u w + a_2^u w^* \qquad a_1^u < 0, \quad a_2^u \lesseqgtr 0 \tag{3.28}$$

$$\pi = b_1^u w + b_2^u w^* \qquad b_1^u > 0, \quad b_2^u \lesseqgtr 0 \tag{3.29}$$

$$w_c = d_1^u w + d_2^u w^* \qquad d_1^u > 0 \quad d_2^u \lesseqgtr 0 \tag{3.30}$$

The lower-case index u signifies here the variables in the monetary union. The spillover effects are thus in vigour equally in the monetary union. The effect of a foreign nominal wage increase on macroeconomic performance in the home country is, however, more ambiguous than in the floating rate regime. From Appendix 1 it can be seen that the foreign country nominal wage elasticity of home employment is positive when the central bank cares sufficiently about

[20] Explicit forms are given in Appendix 2.

employment or when the degree of substitutability between the home and foreign goods is large. The closer substitutes the products are, the more the wage rise in the foreign country increases the competitiveness of the home producer and increases employment. Likewise, a more accommodative central bank increases money supply more in case of a wage rise (see equation (3.27)). Moreover, the effect of a foreign wage increase on inflation at home also depends on the conservativeness of the central bank and on the degree of integration of the product markets: were there no home bias in consumption, any positive values of σ would result in positive foreign wage elasticity of inflation. With a home bias, the condition becomes less strong.[21]

Note also that a nominal wage increase at home now induces a positive rate of inflation regardless of the degree of conservativeness of the central bank. The reason is that with the common money supply, the central bank is able to control inflation only on the average.

An increase in home nominal wages raises the real consumption wages at home, but the effect of a foreign wage increase is ambiguous. If the central bank is extremely conservative, this effect is positive and becomes larger the stronger the home bias is. This means in practice that the common central bank contradicts the CPI increase induced by the foreign price rise, and the effect in the home country would be a reduction in money supply. However, it is more likely that the central bank has an employment objective and that the effect of a foreign wage increase on the home country real wage is negative.

3.3 Wage setting

The labour unions maximise their utility functions subject to employment and real wage constraints in the floating rate regime and in the monetary union, respectively. At this phase, no difference is made between the monetary regimes, and the elasticities are just denoted by a letter without upper indices. In this section, the utility maximisation when the labour unions act independently and when they cooperate is presented. The non-cooperative outcome can be found in Rantala (2001). In contrast, the cooperative solution and the utility comparisons that follow are here calculated to my knowledge for the first time in this setting.

3.3.1 Wage setting without cooperation

In non-cooperation, labour unions maximise the utility function (3.10) subject to the constraints (3.20) and (3.22) in the case of the floating rate regime and (3.28) and (3.30) in the monetary union. From the first-order condition, it follows that

$$w = \gamma \frac{d_1}{a_1^2} - \frac{a_2}{a_1} w^* \tag{3.31}$$

From the non-cooperative Nash equilibrium, the following equilibrium nominal wages in home and foreign country result:

[21] See Appendix 2.

$$w^N = w^{*N} = \gamma \frac{d_1}{a_1(a_1 + a_2)} \tag{3.32}$$

The index N denotes a variable in a non-cooperative situation. Employment and real consumption wage are obtained by inserting the equilibrium nominal wage into the employment and real wage equations (3.20) and (3.22) in the floating rate regime and (3.28) and (3.30) in the monetary union:

$$n^N = n^{N*} = \gamma \frac{d_1}{a_1} \tag{3.33}$$

$$w_c^N = w_c^{N*} = \gamma \frac{d_1(d_1 + d_2)}{a_1(a_1 + a_2)} \tag{3.34}$$

The resulting equilibrium employment lies below the full employment level. This is due to the competing objectives of full employment and higher real wage in the utility functions of the labour unions.

3.3.2 Cooperative wage setting

Cooperation is here achieved by a joint maximisation of the common utility function. The maximising problem becomes:

$$\begin{aligned} &\text{Max } U^C = \tfrac{1}{2}(U + U^*) = \tfrac{1}{2}\left(\gamma(w_c + w_c^*) - \tfrac{1}{2}(n^2 + n^{*2})\right) \\ &\text{s.t.} \quad n = a_1 w + a_2 w^* \qquad n^* = a_1 w^* + a_2 w \\ &\qquad w_c = d_1 w + d_2 w^* \quad w_c^* = d_1 w^* + d_2 w \end{aligned} \tag{3.11'}$$

The resulting reaction functions will respectively be

$$w = \gamma \frac{d_1 + d_2}{a_1^2 + a_2^2} - \frac{2a_1 a_2}{a_1^2 + a_2^2} w^* \tag{3.35}$$

$$w^* = \gamma \frac{d_1 + d_2}{a_1^2 + a_2^2} - \frac{2a_1 a_2}{a_1^2 + a_2^2} w \tag{3.36}$$

The following symmetrical nominal wages are obtained:

$$w^C = w^{*C} = \gamma \frac{d_1 + d_2}{(a_1 + a_2)^2} \tag{3.37}$$

The index C denotes a variable in a cooperation situation. By inserting this nominal wage into the employment and real consumption wage equations (3.20) and (3.22) in a floating rate regime and (3.28) and (3.30) in the monetary union, the following equilibrium outcomes result:

$$n^C = n^{C*} = \gamma \frac{d_1 + d_2}{a_1 + a_2} \tag{3.38}$$

$$w_c^C = w_c^{C*} = \gamma \frac{(d_1 + d_2)^2}{(a_1 + a_2)^2} \tag{3.39}$$

Here, too, the equilibrium employment is below full employment.

When comparing the equilibrium outcomes in cooperation and non-cooperation, it can be noted that in cooperation, labour unions systematically take the spillover effect into account. This can be seen when comparing ie the equations (3.32) and (3.37): the wage and employment elasticities of the other union have a larger influence on the cooperative wage solution. A comparison between the employment and real wage outcomes results in the same notion. This reflects the increased internalisation of externalities between the two economies.

3.4 Utility comparisons

In the following, the consequences of the two possibilities for the labour unions, ie cooperation or acting alone, are studied. After that, the incentives for deviating from the cooperative solution when the other union does not are considered.

3.4.1 The benefits from cooperation

In order to study the effect of cooperation, I subtract the utility in non-cooperation from that in cooperation. As the home and foreign labour union utilities are symmetrical, I consider here only the utility of the home union. The operation results in the following:

$$U^C - U^N = \frac{1}{2}\gamma^2 \left(\frac{(a_1 d_2 - a_2 d_1)^2}{a_1^2 (a_1 + a_2)^2} \right) \geq 0 \tag{3.40}$$

The utility of a labour union in cooperation is thus always larger or as large as the utility in non-cooperation. This result is valid irrespective of the monetary regime. The following conclusion can be drawn:

Proposition 1: *It is beneficial for both unions to cooperate both in the floating rate regime as in the monetary union as well.*

The proposition manifests the general result that in presence of international spillovers, there are externalities that are not necessarily internalised when the actors are not behaving cooperatively. In our model, these externalities do not disappear but rather change with the monetary policy regime.[22]

[22] This is because the elasticities differ in the two regimes; see Appendices 1 and 2.

3.4.2 The cheating outcome

It remains to be seen whether the labour unions can reach even better outcomes than the cooperative one. In the following it is inspected what happens when the other labour union, relying on the belief of the other one that a cooperative solution will be obtained, chooses the non-cooperative solution. I will call this situation cheating.

In the case of cheating, the maximising problem for the cheater union becomes

$$\text{Max } U \quad \text{s.t.} \quad w^* = w^{*C} \tag{3.41}$$

From the first-order condition it follows that

$$w^F = \gamma\left[\frac{d_1(a_1+a_2)^2 - a_1a_2(d_1+d_2)}{a_1^2(a_1+a_2)^2}\right] \tag{4.42}$$

$$n^F = \gamma\frac{d_1}{a_1} = n^N \tag{4.43}$$

$$w_c^F = \gamma\left[\frac{d_1^2(a_1+a_2)^2 + (a_1^2d_2 - a_1a_2d_1)(d_1+d_2)}{a_1^2(a_1+a_2)^2}\right] \tag{4.44}$$

The index F denotes here the outcomes when the home union cheats while the foreign union remains in the cooperative outcome.[23] For the foreign union, ie the one that will be cheated, inserting the resulting nominal wage into the reduced equations will produce the following outcomes:

$$w^{*F} = \gamma\frac{d_1+d_2}{(a_1+a_2)^2} = w^{*C} \tag{3.45}$$

$$n^{*F} = \gamma\frac{a_1(a_1-a_2)(d_1+d_2)+a_2d_1(a_1+a_2)}{a_1^2(a_1+a_2)} \tag{3.46}$$

$$w_c^{*F} = \gamma\frac{d_1d_2(a_1+a_2)^2 + (a_1^2d_1 - a_1a_2d_2)(d_1+d_2)}{a_1^2(a_1+a_2)^2} \tag{3.47}$$

The foreign labour union thus sets the cooperative nominal wage. Comparing the real consumption wages (3.44) and (3.47), they differ only for the first term of the addition: For the cheater labour union, the first term in (3.44) is always positive. For the cheated one, however, the multiple of home and foreign country wage

[23] The letter F signifies here the verb 'to fink'.

elasticities in (3.47) becomes negative in most cases, the resulting real wage thus being smaller than that of the cheater.

Because of the symmetry it is not necessary to examine the outcomes the other way round. Hence we denote the cheating utility outcome for the cheater as U^F and for the cheated one as U^{*F}. In order to look at the incentives to cooperate and to cheat, we list here the four payoffs for the possible actions:

$$U^F = \frac{1}{2}\gamma^2 \frac{a_1^2(d_1+d_2)^2 + (a_1d_2 - a_2d_1)^2}{a_1^2(a_1+a_2)^2} \tag{3.48}$$

$$U^C = \frac{1}{2}\gamma^2 \frac{(d_1+d_2)^2}{(a_1+a_2)^2} \tag{3.49}$$

$$U^N = \frac{1}{2}\gamma^2 \frac{2a_1d_1(d_1+d_2) - d_1^2(a_1+a_2)}{a_1^2(a_1+a_2)} \tag{3.50}$$

$$U^{*F} = \frac{1}{2}\gamma^2 \frac{2a_1^2\left((a_1^2d_1 - a_1a_2d_2)(d_1+d_2) + d_1d_2(a_1+a_2)^2\right) - \left(a_1^2(d_1+d_2) + a_2(a_2d_1 - a_1d_2)\right)^2}{a_1^4(a_1+a_2)^2} \tag{3.51}$$

The incentive to cheat can be measured by subtracting the utility in cooperation from the utility in cheating:

$$U^F - U^C = \frac{1}{2}\gamma^2 \frac{(a_1d_2 - a_2d_1)^2}{a_1^2(a_1+a_2)^2} > 0 \tag{3.52}$$

It is thus clear that an incentive to cheat exists. Comparing this equation with the equation (3.40) reveals that the gain from cheating vs. cooperation is equally sized with the gain resulting from cooperation vs. non-cooperation. From the equations (3.40) and (3.52) it follows that we can arrange the utilities:

$$U^F > U^C > U^N \tag{3.53}$$

The utility of cheating is thus larger than that of cooperating, which on its turn is superior to the utility in a non-cooperative situation. In addition, the equation (3.32) showing the optimal wage solution when the other union does not cooperate, it is clear that the utility of the cheated labour union is inferior to the non-cooperative solution. In this case, the following statement can be made:

Proposition 2: *The resulting Nash equilibrium in the one-period game will be the non-cooperative one. No matter what the other one does, it always pays off not to cooperate.*

In section 3.6 it will be studied whether the incentives could be altered when the game is repeated infinitely. Before that, however, the effects of the monetary regime are considered in the following section.

3.5 The effect of the monetary regime

Due to the complexity of calculations, it is not easy to draw comprehensive conclusions from the effect of the monetary union on labour union welfare. In the following, effects on employment and inflation are first examined. Second, two special cases of an extremely conservative and a fully accommodating central bank are studied in both monetary regimes.

3.5.1 Employment and inflation

From the equations (3.17) and (3.26) it could be said that at a given level of employment, monetary policy in the monetary union is more accommodating than in the floating rate regime.[24] This conclusion implies that the total employment reduction from a wage increase will in general be more moderate in the monetary union than in the floating rate regime, that is:[25]

$$a_1^u + a_2^u > a_1^f + a_2^f \quad 0 < \sigma < \infty, \quad a_1 + a_2 < 0 \tag{3.54}$$

Following the same logic, it can be noticed that the total inflation reaction will be larger:

$$b_1^u + b_2^u > b_1^f + b_2^f \quad 0 < \sigma < \infty \tag{3.55}$$

The inflation result was already stated earlier when comparing the equations (3.17) and (3.26). In short, we can reformulate this result in the following proposition:

Proposition 3: *At a given level of employment, inflation is higher in the monetary union than it is in a floating rate regime.*

As to the effect on utilities and incentives to cooperate, these results do not suffice so that a conclusion could be made. On the one hand, for a given wage increase, the reduction in employment will be more moderate in the monetary union. On the other, higher inflation implies that the resulting real wage will be lower. In sum, cooperation would be beneficial in both regimes, but it is not straightforward to say how this benefit is affected by a change in the monetary regime.

[24] This conclusion assumes that the weight on employment in the central bank loss functions (3.12) and (3.13) differs from zero and infinity.

[25] Rantala (2001, 20–23) draws the same conclusion with regard to the total employment reduction.

3.5.2 The effect of the degree of conservativeness

In order to investigate the situation closer, I present two extreme cases: when the central bank is fully conservative ($\sigma = 0$), on the one hand, and when it is fully accommodating ($\sigma \to \infty$), on the other. It is then examined whether the degree of conservativeness has any effect on the benefits of labour union cooperation.

In the floating rate regime, in presence of a fully conservative central bank, the signs of the wage elasticities of employment and real consumption wage are as follows:

$$\sigma = 0 \to a_1^f < 0, \quad a_2^f < 0, \quad b_1^f = b_2^f = 0, \quad d_1^f \lesseqgtr 0, \quad d_2^f = 0 \tag{3.56}$$

As the central bank controls inflation perfectly,[26] a wage increase in either country results in lower employment in both countries. The effect of home nominal wage increase on home real wage is ambiguous and depends on the degree of substitutability between the goods and on the size of the impact of the wage increase on employment. When the products are close enough substitutes, employment decreases, and an increase in nominal wages has a positive effect on home real wages. Finally, since an increase in foreign country nominal wages does not increase CPI at home, the effect on home real consumption wage is zero.

A comparison between formulae (3.32)–(3.34) and (3.37–3.39) reveals that in the case of a fully conservative central bank and a floating rate regime, cooperation between the unions moderates nominal wage demands, leading to a smaller deviation from full employment and eventually higher real consumption wages.

In case of a fully accommodating central bank, the elasticities become:

$$\sigma \to \infty \to a_1^f < 0, \quad a_2^f < 0, \quad b_1^f > 0, \quad b_2^f > 0, \quad d_1^f > 0, \quad d_2^f < 0 \tag{3.57}$$

If the central bank is fully accommodating, nominal wage increases both in foreign and home country lead to lower employment in both countries. This time, however, the impact on inflation is also positive. Moreover, a home wage increase raises the real consumption wage at home, whereas a foreign wage increase decreases it through the rising CPI.

Again, comparing the equilibrium outcomes (3.32)–(3.34) in cooperation and (3.37)–(3.39) in non-cooperation reveals that nominal and real consumption wages are lower in cooperation and employment is closer to full employment. Nevertheless, in case of a fully accommodating central bank, cooperation moderates wage claims and lowers real wages to a greater amount than in the case of a conservative central bank. This is because the labour unions anticipate that the central bank accommodates all wage claims. When acting alone, the labour union would thus be able to impose high nominal wages with little regard on their effect on the real consumption wages of the other union. Cooperation leads to internalisation of this externality. Finally, it can be concluded that in a floating rate regime, cooperation leads to smaller deviations from full employment, regardless of how conservative the central bank is.

[26] Ie π=0.

In a monetary union, the elasticities when the degree of conservativeness of the central bank is varied are:

$$\sigma = 0 \rightarrow a_1^u < 0, \quad a_2^u < 0, \quad b_1^u > 0, \quad b_2^u < 0, \quad d_1^u > 0, \quad d_2^u > 0 \tag{3.58}$$

$$\sigma \rightarrow \infty \rightarrow a_1^u < 0, \quad a_2^u > 0, \quad b_1^u > 0, \quad b_2^u > 0, \quad d_1^u > 0, \quad d_2^u < 0 \tag{3.59}$$

When the central bank is fully conservative, a symmetric reaction to an asymmetric wage increase leads to decreasing employment in both countries and increasing real consumption wages. The common central bank is able to achieve zero inflation only on the average.[27] In case of a fully accommodating central bank, a nominal wage increase in home country diminishes employment at home, but as the symmetrical monetary policy reaction pumps money in the foreign economy as well, employment there increases. Accordingly, a higher average inflation raises the home real consumption wage and diminishes the foreign one.

Comparing the equilibrium outcomes in monetary union does not unfortunately tell us much, because the total effect on wages and employment remains ambiguous regardless of whether the common central bank is accommodating or conservative. However, the Appendix 3 shows that when the labour unions cooperate, the calculations for equilibrium outcomes become easier. In case of a fully conservative central bank and labour union cooperation, the nominal wage equals the real consumption wage, and the outcomes are solely dependent on the importance that the labour union puts on its employment objective.

Finally, it is interesting to see how the degree of conservativeness influences the gain from labour union cooperation. Comparing the utility difference of equation (3.40) in different regimes produces the following outcome:

Proposition 4: *In a floating rate regime, cooperation is more advantageous when the central bank is extremely accommodating than when it is fully conservative. In a monetary union, the results remain ambiguous.*

3.6 Repeating the game

As was shown earlier, it would pay off for the two unions to cooperate instead of acting alone. Nevertheless, international cooperation between labour unions is still a non-cooperative game in reality. In the absence of an institution that could enforce legally binding contracts between the two unions, there exists an incentive for both unions to cheat and, in so doing, to reap a bigger pay-off.

In the following, a sequence of one-period games continuing to infinity is composed in order to find out the conditions that would make the cooperative solution an equilibrium outcome. The objective is to study the incentives of the labour unions to deviate from the cooperative outcome in a game that is structurally non-cooperative. The outcomes are then compared in the two monetary regimes.

[27] See Appendix 3.

In order to keep the cooperation in vigour, the labour unions follow a trigger strategy:

– Cooperate, if cooperation has held the previous period;
– If the other labour union has cheated in the previous period, choose the non-cooperative solution forever.

The condition for the cooperation outcome to hold is that the discounted payoff for cooperation is bigger than that of cheating in one period and returning to the non-cooperative solution ever after. In other words, the unions must appreciate the income in the future high enough so that they are willing to give up a bigger utility at the present time period. Formally, this can be expressed as:

$$U^F + \frac{qU^N}{1-q} < \frac{U^C}{1-q} \tag{3.60}$$

where q is the discount factor. The relation between the discount factor and the discount rate r is defined as follows:

$$q = \frac{1}{1+r} \tag{3.61}$$

The lower the discount rate, the more the unions appreciate the future payoffs. In order to maintain cooperation, the discount factor of the labour unions needs to be sufficiently large:

$$q > \frac{U^C - U^F}{U^N - U^F} \tag{3.62}$$

After inserting the utility formulae into the equation (3.62), all parameters vanish and the resulting discount factor will become

$$q > \frac{1}{2} \tag{3.63}$$

From the definition of the discount factor, we easily derive the needed discount rate to be

$$r < 1 \tag{3.64}$$

In other words, even with quite high discount rates, it pays off to cooperate. Moreover, the needed discount rate is independent from the monetary regime. From this we can make the following conclusion:

Proposition 5: *Maintaining labour union cooperation in a repeated game is fairly easy. The discount rate is unaffected by the monetary regime.*

4 Conclusions

In this work, a theoretical model of international labour union cooperation in a floating exchange rate regime and in a monetary union is studied. The starting point is to consider a situation in open economies that join a monetary union. Good examples of such countries are the Nordic Countries, of which Finland has already joined the EMU. One important characteristic of these countries is fairly centralised wage setting.

The one-period game presented in Section 3 demonstrates that cooperation always produces higher utility for the labour unions, but the non-cooperative solution is the Nash equilibrium: in the absence of cooperation-enforcing institutions, the best response to any action for each labour union is not to cooperate. As to the interaction between the labour unions and the central banks, it turns out that inflation is higher in the monetary union than in the floating rate regime. The higher inflation result of Rogoff (1985a) is thus also reproduced if the central banks not only cooperate but form a monetary union with a common and symmetrically divided money supply.

In order to overcome the problem of unsustainability of the cooperative solution, a repeated game is constructed in the model. It turns out that cooperation is easily sustainable when the game is repeated infinitely. Moreover, cooperation in the repeated game is equally worthwhile for the unions under floating exchange rate regime and in a monetary union as well. In fact, the differences between the utilities in non-cooperation, cooperation and cheating remain the same in proportion in both regimes. Therefore, despite the non-neutrality of money in the model,[28] the change of the monetary regime does not have any effect on the incentives of the labour unions to maintain cooperation when the game is repeated infinitely.

In the floating exchange rate regime, cooperation proves to be more advantageous for the labour unions in case of a fully accommodating central bank than in case of a fully conservative one. The outcome affirms the results obtained in the earlier research, explicitly modelled by Iversen (1999): the game theoretic equilibria towards which the unionised economies converge are either a fully conservative central bank with several sectoral labour unions or an accommodating central bank with a very centralised wage setting. In the case of a monetary union, the impact of the degree of conservativeness of the central bank on the effects of cooperation between the unions in ambiguous.

In the following, some limitations of the model are briefly discussed. To begin with the hypothesis of labour union cooperation being more beneficial in the monetary union than in the floating rate regime, no clear answer can be found. The repeated game proves the incentives for cooperation to remain the same when the monetary regime changes, but the levels of the utilities are not easy to compare.

Moreover, the difference of monetary union as to monetary policy cooperation is not enlightened here. It seems that a unilateral wage increase, inducing a symmetric reaction in a monetary union, should result in lower welfare for the other country. Consequently, welfare under the cheating outcome should in

[28] The equilibrium employment levels differ in most cases in the two monetary regimes (see also Rantala 2001).

principle be higher for the cheater and lower for the cheated labour union in a monetary union than under policy coordination.

Finally, the result of the repeated game bears some limitations. In the one-shot game, the log of the price level of the previous period is normalised to zero, which results in the CPI and the CPI inflation being equivalent. This assumption carries over to the repeated game. Strictly speaking, the repeated game result is thus valid only in case of a fully conservative central banker or price level targeting.

To end with, I present some suggestions for further research. First, in this paper, the focus is on labour and money markets, but the product markets are simply assumed perfectly competitive. Coricelli et al (2001) study the effects of a monetary union using a model with monopolistic competition. However, as compared to the setting used in this paper, their model does not allow for deviations from the purchasing power parity. The model of this paper as such would, however, become quite complicated under monopolistic competition. The role that the structure of the product markets would play in the setup of this paper thus remains a challenge for further research.

Second, a highly concentrated wage setting is here translated as having a single monopoly union in each country. In the real life, however, no European country, for example, represents completely centralised wage bargaining.[29] Modifying the setting to allow for monopoly labour unions in each sector and in each country would be an interesting adjustment.

Third, the model uses a setting with two interdependent countries as an approximation. Nevertheless, this setting best describes a case of two rather large economies that interact closely with each other. This would probably be the case between eg France and Germany, but not the Nordic economies that are relatively small and thus do not influence the price developments in each other to such amount. In addition, a more realistic description of these economies joining the EMU could be achieved by using an asymmetric setting.

Finally, with regard to the fact that a kind of inflation targeting occurs in EMU, the model should be modified to include a publicly announced target inflation rate. The phenomenon could be modelled as the central bank moving first in the game, announcing that independent of the nominal wage rate and using money supply in order to achieve a fixed inflation target (see Soskice and Iversen 2000). In sum, introducing sectoral bargaining, formalising the monetary regime as having a public inflation target would bring interesting insights into the model.

In the light of the result obtained in this paper, it seems that cooperation among labour unions should be advantageous. However, such an international cooperation in Europe is very rare. One plausible reason is the costs that incur from cooperation. Another is that there still exist legal differences and boundaries between the countries. Finally, the objectives of the European labour unions probably have been dependent to some extent on those of the monetary authority that they have faced. Until the convergence period and the beginning of the EMU, there has been a variety of central banker types in Europe. It is thus only recently that the issue might have become worth consideration.

[29] See Table 2 in Chapter 2.

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Appendix 1

Floating rate regime

The reduced form equations for other endogenous variables are:

$$e = \left(\frac{\alpha}{\delta} + (1-\alpha)\right)(m - m^*) + \left(\alpha - \frac{\alpha}{\delta}\right)(w - w^*) \tag{A1.1}$$

$$p = (1-\alpha)m + \alpha w \qquad p^* = (1-\alpha)m^* + \alpha w^* \tag{A1.2}$$

$$z = \frac{\alpha}{\delta}(m - w - m^* + w^*) \tag{A1.3}$$

The wage elasticities of money supply in the floating rate regime are as follows:

$$c_1 = \frac{\left(\sigma + \Gamma^2\right)\left(\sigma + \Gamma\left(\frac{\alpha\beta}{\delta} - \alpha\right)\right) - \left(\frac{\alpha\beta}{\delta}\Gamma\right)^2}{\Delta} \tag{A1.4}$$

$$\begin{aligned} c_2 &= -\frac{\alpha\beta}{\delta}\frac{\Gamma^2}{\Delta} < 0 \\ \Delta &= \left(\sigma + \Gamma^2\right)^2 - \left(\frac{\alpha\beta}{\delta}\Gamma\right)^2 > 0 \end{aligned} \tag{A1.5}$$

The wage elasticities of employment, inflation and real wage are:

$$a_1^f = -\frac{\Gamma\left(\sigma + \Gamma^2\right)}{\Delta} < 0 \tag{A1.6}$$

$$a_2^f = c_2 = -\frac{\alpha\beta}{\delta}\frac{\Gamma^2}{\Delta} < 0 \tag{A1.7}$$

$$b_1^f = \frac{\sigma\left(\sigma + \Gamma^2\right)}{\Delta} \geq 0 \tag{A1.8}$$

$$b_2^f = \frac{\alpha\beta}{\delta}\frac{\sigma\Gamma}{\Delta} \geq 0 \tag{A1.9}$$

$$d_1^f = \frac{\Gamma^2\left(\delta^2\left(\sigma + \Gamma^2\right) - (\alpha\beta)^2\right)}{\delta^2\Delta} \tag{A1.10}$$

$$d_2^f = -\frac{\alpha\beta\sigma\Gamma}{\delta\Delta} \leq 0 \tag{A1.11}$$

Appendix 2

Monetary union

The reduced form equations of other endogenous variables:

$$p = w + (1-\alpha)m^U - \frac{(1-\alpha)}{2}(w + w^*) + \frac{1}{2}\frac{(1-\alpha)\delta}{\alpha + (1-\alpha)\delta}(w^* - w) \tag{A2.1}$$

$$p^* = w^* + (1-\alpha)m^U - \frac{(1-\alpha)}{2}(w + w^*) - \frac{1}{2}\frac{(1-\alpha)\delta}{\alpha + (1-\alpha)\delta}(w^* - w) \tag{A2.2}$$

$$z = \frac{\alpha}{\alpha + (1-\alpha)\delta}(w^* - w) \tag{A2.3}$$

The wage elasticities of employment, inflation and real wage are as follows:

$$a_1^u = -\left[\frac{(1-\alpha)(\alpha + 2(1-\alpha)\delta) + \delta\sigma}{\Omega}\right] < 0 \tag{A2.4}$$

$$a_2^u = -\left[\frac{\alpha(1-\alpha) - \delta\sigma}{\Omega}\right] \tag{A2.5}$$

$$b_1^u = \frac{\left((\sigma + (1-\alpha)^2)(2\alpha(1-\beta) + (1-\alpha)\delta) - (1-\alpha)^2(\alpha + (1-\alpha)\delta)\right)}{\Omega} > 0 \tag{A2.6}$$

$$b_2^u = \frac{\left((\sigma + (1-\alpha)^2)(2\alpha\beta + (1-\alpha)\delta) - (1-\alpha)^2(\alpha + (1-\alpha)\delta)\right)}{\Omega} \tag{A2.7}$$

$$d_1^u = \frac{(\alpha-1)^2(\alpha + (1-\alpha)\delta) + (2\alpha\beta + (1-\alpha)\delta)(\sigma + (1-\alpha)^2)}{\Omega} > 0 \tag{A2.8}$$

$$d_2^u = \frac{(\alpha-1)^2(\alpha + (1-\alpha)\delta) - (2\alpha\beta + (1-\alpha)\delta)(\sigma + (1-\alpha)^2)}{\Omega} \tag{A2.9}$$

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

Appendix 3

The effect of conservativeness in the monetary union

In the monetary union, the following sums are of interest:

$$\begin{aligned} a_1^u + a_2^u &= -\left(\frac{(1-\alpha)(\alpha+2(1-\alpha)\delta)+\delta\sigma}{\Omega}\right)-\left(\frac{\alpha(1-\alpha)-\delta\sigma}{\Omega}\right) \\ &= -\left(\frac{(1-\alpha)(2\alpha+2(1-\alpha)\delta)}{2(\sigma+(1-\alpha^2))(\alpha+(1-\alpha)\delta)}\right) = -\frac{(1-\alpha)}{(\sigma+(1-\alpha)^2)} < 0 \end{aligned} \tag{A3.1}$$

$$\begin{aligned} b_1^u + b_2^u &= \frac{(\sigma+(1-\alpha)^2)(2\alpha+2(1-\alpha)\delta)-2(1-\alpha)^2(\alpha+(1-\alpha)\delta)}{\Omega} \\ &= \frac{2(\alpha+(1-\alpha)\delta)(\sigma+(1-\alpha)^2-(1-\alpha)^2)}{2(\sigma+(1-\alpha)^2)(\alpha+(1-\alpha)\delta)} = \frac{\sigma}{\sigma+(1-\alpha)^2} \geq 0 \end{aligned} \tag{A3.2}$$

$$d_1^u + d_2^u = \frac{2(\alpha-1)^2(\alpha+(1-\alpha)\delta)}{2(\sigma+(1-\alpha)^2)(\alpha+(1-\alpha)\delta)} = \frac{(1-\alpha)^2}{(\sigma+(1-\alpha)^2)} > 0 \tag{A3.3}$$

If $\sigma = 0$, it follows that:

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

$$b_1^u + b_2^u = 0$$

$$d_1^u + d_2^u = 1$$

The equilibrium outcomes become then easy to calculate and are as follows:

$$w^C = \gamma(1-\alpha)^2$$

$$n^C = -\gamma(1-\alpha) < 0$$

$$w_c^C = \gamma(1-\alpha)^2 = w^C$$

$$U^C = \frac{1}{2}\gamma^2(1-\alpha)^2$$