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MONETARY REGIMES, LABOUR MOBILITY AND EQUILIBRIUM EMPLOYMENT

by

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Monetary Regimes, Labour Mobility and Equilibrium Employment*

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Abstract

This paper analyses the impact of the monetary regime on labour markets in a small open economy, by considering the game between large wage setters and an independent central bank in a two-sector model with potential labour mobility between sectors. Two monetary regimes are considered: membership in a monetary union and an inflation target combined with a flexible exchange rate. A key result is that when there is perfect labour mobility between sectors, the monetary regime does not matter for real wages, employment or profits. Moreover, introducing labour mobility substantially reduces wages and increases employment. Other findings are that when labour is immobile between sectors: (i) the real wage in the tradables sector is higher under inflation targeting than in a monetary union, while the reverse applies to the non-tradables sector; (ii) inflation targeting generates higher employment and profits than membership in a monetary union; and (iii) both workers and firms in the two sectors in general prefer inflation targeting to membership in a monetary union.

Keywords: Inflation Targeting, Monetary Union, Equilibrium Employment, Labour Mobility

JEL-classification: E24, J50

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1 Introduction

Over the last decade, interest in the macroeconomic consequences of different monetary regimes has been unprecedented. In addition to the debate on optimal currency areas, spurred by the launch of the Economic and Monetary Union (EMU), advocates of price stability have suggested that inflation or price level targeting may have desirable long-run effects on the economy by promoting sustainable growth and higher employment.

In light of this debate, several studies have considered the interaction between monetary authorities and labour markets. It has been shown that when wage setting is non-atomistic, a game between large wage setters and the central bank emerges. The monetary regime then indeed matters for labour market outcomes; see for instance Cukierman and Lippi (1999), Soskice and Iversen (2000), Coricelli et al (2000) and Calmfors (2001). A simple mechanism modelled in the previous literature is that in the presence of a liberal central bank, inflation-averse trade unions may have an incentive to set wages at a low level in order to avoid inflation (Cukierman and Lippi 1999). Another, perhaps more plausible, mechanism suggested in the literature is that a conservative central bank may act as a deterrent to wage increases: by threatening to pursue contractionary monetary policy in response to high wage claims, the central bank creates an incentive for wage restraint because large unions will then face higher cost of increasing wages in terms of lower employment (Soskice and Iversen 2000, Corricelli et al. 2000 and Lippi 2003). Although the majority of previous studies model closed economies, exceptions include Vartiainen (2002) and Holden (2003), who model the game between large wage setters and an independent central bank in two-sector models of a small open economy where labour is sector-specific. These studies show that inflation targeting is likely to generate higher employment and welfare than credible exchange rate targeting.

In this paper, I argue that it is impossible to establish whether there are sustainable effects of the monetary regime on labour markets in a framework with sector-specific labour. In order to ensure that what has been observed in the theoretical literature are permanent effects rather than short-run deviations from long-run equilibrium, one needs to allow for worker migration across sectors of the economy. If wages differ across sectors, rational workers should move to sectors where their expected income is higher, given the opportunity. Therefore, the impact of the monetary regime on labour markets may be exaggerated in models where labour is immobile across sectors of the economy.

This paper extends the previous theoretical literature on the interaction between large wage setters and the central bank in small open economies by considering a labour market set-up featuring the realistic assumption of labour mobility between the tradables and non-tradables sectors. I distinguish between the regimes of inflation targeting combined with a flexible exchange rate and membership in a monetary union and derive equilibrium implications of the regime on real wages and equilibrium employment.

A key result is that with perfect labour mobility between sectors, the monetary regime does not matter for real wages, employment or profits. Moreover, I show that introducing labour mobility substantially reduces wages and increases employment. Other findings are that when labour is immobile between sectors: (i) real wages are higher under inflation targeting than in a monetary union in the tradables sector, while the reverse applies to the non-tradables sector; (ii) inflation targeting generates higher employment and profits than membership in a monetary union; and (iii) both workers and firms in the two sectors in general prefer inflation targeting to membership in a monetary union.

The rest of the paper is organised as follows: The basic model is presented and solved in Section 2. Results and numerical solutions are presented in Section 3 and Section 4 concludes.

2 The Model

Consider a small open economy consisting of a tradables (T) and a non-tradables (N) sector, where subscript $i = N, T$ indicates sector. The economy is inhabited by a large number of identical households that consume the two goods and provide labour to two sets of identical firms. The sector-specific wage is set by Nash bargaining between one large union and one employer's federation in each sector. In the labour market the individual takes wages as given.

The monetary target is given and credible to all players. The timing of events is as follows: In stage one wages are set simultaneously in the two sectors under the assumption that wage setters take the nominal wage set in the other sector as given. In stage two, the response of the central bank will depend on the outcome of the wage set in the previous stage. Under inflation targeting, the central bank sets the nominal exchange rate, E, in order to keep the aggregate price level, P, constant, i.e. $d\ln P = 0$. If the country is a member of a monetary union $d\ln E = 0$ by definition and there is no monetary policy response to the claims made by wage setters. Finally, in stage three, production, consumption and employment are determined as a consequence of the wage setting outcome in stage two. In stage three workers decide in which sector to apply for a job if there is labour mobility. The model is solved by backward induction and the equilibrium is subgame perfect.

2.1 Production, Consumption and Employment

In the last stage of the model, profit-maximising firms decide on how much to produce and utility-maximising households decide on how much to consume. On the labour market, workers take wages as given and decide in which sector to apply for a job. Below, I model these choices of individual agents.

2.1.1 Firms

Firms in each sector produce a homogeneous good with labour and capital as inputs. A representative firm in sector i maximises real profits subject to a technology constraint and thus chooses employment solving the following optimisation problem

$$\max_{N_i} \left(P_i Y_i - W_i N_i\right)/P \tag{1}$$

subject to

$$Y_i = \frac{1}{\delta_i} N_i^{\delta_i}$$

where $i = N, T$, $\delta_i \in (0,1)$. The first order condition for profit maximisation gives labour demand in sector i:

$$N_i = \left(\frac{W_i}{P_i}\right)^{-\eta_i} \tag{2}$$

where $\eta_i = (1-\delta_i)^{-1} > 1$. The corresponding supply function in sector i is given by:

$$Y_i = \frac{1}{\delta_i}\left(\frac{W_i}{P_i}\right)^{-\sigma_i} \tag{3}$$

where $\sigma_i = \frac{\delta_i}{1-\delta_i}$ is the output elasticity with respect to the real product wage. The profit function is

$$\Pi_i = \frac{1}{\eta_i - 1} \frac{W_i}{P} \left(\frac{W_i}{P_i} \right)^{-\eta_i}. \quad (4)$$

For simplicity I assume that firms are owned by a group of capitalists in each sector who share profits equally among them.

2.1.2 Households

A household solves the following optimisation problem

$$\max_{C_N, C_T} C_N^{\gamma} C_T^{1-\gamma}$$

subject to

$$I/P = (P_N C_N + P_T C_T)/P.$$

where P is the aggregate price level. Real income is taken as given:

$$I/P = \begin{cases} w_i \text{ if employed in sector } i \\ \pi_i \text{ if capitalist in sector } i \end{cases}$$

where π_i is real income from profits of capitalists in sector i. Solving the problem yields the demand functions

$$\begin{aligned} C_N &= \gamma \frac{I}{P_N} \quad (5) \\ C_T &= (1-\gamma) \frac{I}{P_T}. \end{aligned}$$

The aggregate price level is given by

$$P = P_N^{\gamma} P_T^{1-\gamma}. \quad (6)$$

The budget share of non-traded goods can be seen as a measure of openness in the economy, or rather a measure of closedness, so that when $\gamma \to 1$, the economy is a completely closed economy with production of only non-tradables.

Market clearing in each sector implies $C_i = Y_i$, where Y_i is aggregate supply.[1] In what follows I make the simplifying assumption that production technology is the same in the two sectors i.e.

[1] Note that market clearing in the non-traded sector $C_N = Y_N$ implies balanced trade. Too see that this is fulfilled in equilibrium, use the fact that nominal output is equal to aggregate nominal income, i.e $P_N Y_N + P_T Y_T = P_N C_N + P_T C_T$. Since $C_N = Y_N$ it follows that $C_T = Y_T$.

$\delta_N = \delta_T \equiv \delta$, which implies that after using the expressions for sectoral equilibria, the demand functions (5) and the supply functions (3), I obtain the following condition for "relative" market clearing:

$$\frac{P_N}{P_T} = \left[\frac{\gamma}{1-\gamma}\left(\frac{W_N}{W_T}\right)^{\sigma}\right]^{\frac{1}{1+\sigma}}. \tag{7}$$

2.1.3 The Labour Market

Below I model the case when there is no labour mobility and the case when there is perfect labour mobility, respectively. Note that the first case is equivalent to the static models in Holden (2003) and Vartiainen (2002). Throughout the paper the case of no labour mobility will be treated as the benchmark case when investigating how allowing for labour mobility affects the impact of the monetary regime on real wages and employment.

No Labour Mobility

Consider first the case where there is no labour mobility. There is a fixed labour force M in the economy, without loss of generality normalised to one. Workers take wages as given and jobs are randomly assigned among the workforce. Let M_i be the number of union members (the labour force) in sector i and let N_i be the number of employed workers in sector i. Consequently, the number of unemployed workers in sector i, U_i, is given by $U_i = M_i - N_i$. When referring to real wages I let lower case letters denote real variables, i.e. $w_i = \frac{W_i}{P}$. I let b denote the utility of unemployment and assume that it is exogenously given. b can be thought of as the value of home production. A representative union member is assumed to care about expected income, i.e. a weighted average of income in the two states employment and unemployment. The expected utility of a representative member in sector i is thus given by

$$V_i = \frac{N_i}{M_i} w_i + \left(1 - \frac{N_i}{M_i}\right) b \tag{8}$$

for $i = N, T$. Note that the utility of a worker is always positive as long as $w_i > b$. In order to ensure that a worker prefers employment to unemployment I assume that this condition always holds in equilibrium.

Perfect Labour Mobility

Next consider the case when there is perfect labour mobility. Union members take wages as given when deciding in which sector to apply for a job. A job seeker can only apply for a job in one of the sectors. Let f be the flow of workers from sector T to sector N. The expected income of a worker looking for a job in sector N and T, respectively is:

$$V_N = \frac{N_N}{M_N + f} w_N + \left(1 - \frac{N_N}{M_N + f}\right) b \tag{9}$$

$$V_T = \frac{N_T}{M_T - f} w_T + \left(1 - \frac{N_T}{M_T - f}\right) b \tag{10}$$

Since there is perfect labour mobility, I need to impose a no-arbitrage condition stating that there will be no utility gains to be made by moving to the other sector in equilibrium, that is

$$V_N = V_T.$$

Using expressions (9) and (10), the no-arbitrage condition can be written

$$\frac{N_N}{M_N + f} w_N + \left(1 - \frac{N_N}{M_N + f}\right) b = \frac{N_T}{M_T - f} w_T + \left(1 - \frac{N_T}{M_T - f}\right) b$$

Solving for f I obtain:

$$f = \frac{M_T N_N (w_N - b) - M_N N_T (w_T - b)}{N_N (w_N - b) + N_T (w_T - b)}. \tag{11}$$

Note that when there membership is equal in the two sectors, $M_N = M_T$ and wage and employment levels are the same in the two sectors, $w_N = w_T$ and $N_N = N_T$, there will be no worker migration, $f = 0$. The intuition is that when wages and employment levels are equal, workers receive the same utility of being a job seeker in either of the two sectors and thus have no incentive to move to the other sector to look for employment.

2.2 Monetary Policy

In stage two, the central bank maintains $d \ln P = 0$ under inflation targeting by adjusting the nominal exchange rate, E.[2] The central bank recognises that the law of one price holds for tradable

[2] In theory, I might consider some other policy instrument than the exchange rate for the central bank, such as the nominal interest rate, but I would then have to model an explicit link between the interest rate and domestic demand, which would complicate the model.

goods, $P_T = EP_T^*$ where P_T is the price of the tradable good in domestic currency, E is the nominal exchange rate in domestic currency per unit of foreign currency and P_T^* is the foreign price of tradable goods in foreign currency. P_T^* is taken as exogenously given. In what follows, I do not evaluate in detail how the central bank sets the nominal exchange rate, but merely recognise that it always succeeds in its attempts so that the monetary target is attained.[3] In a monetary union, the central bank does not act since the nominal exchange rate is fixed, $d\ln E = 0$.

Henceforth, let subindex m denote the monetary regime, $m = M, I$ for the regimes monetary union and inflation targeting, respectively.[4] To evaluate the regime-specific impact of wages on prices, I need to derive closed-form expressions for how supply and demand mechanisms in the goods markets determine the responsiveness of price levels to wage changes under the two regimes. For future reference, I shall refer to the elasticities of the producer prices with respect to nominal wages, i.e. $\left(\frac{\partial \ln P_i}{\partial \ln W_i}\right)_m$ and $\left(\frac{\partial \ln P_i}{\partial \ln W_j}\right)_m$, as "producer price effects", and the elasticity of the consumer price level with respect to nominal wages, $\left(\frac{\partial \ln P}{\partial \ln W_i}\right)_m$ and $\left(\frac{\partial \ln P}{\partial \ln W_j}\right)_m$, as "consumer price effects".

Taking logs of the relative goods market equilibrium condition for relative prices (7) and differentiating the expression with respect to P_N, P_T, W_N, W_T gives:

$$d\ln P_N - d\ln P_T = \frac{\sigma}{1+\sigma}\left(d\ln W_N - d\ln W_T\right). \tag{12}$$

Together with the expression for the aggregate price level (6), (12) determines the elasticities of prices with respect to wages under the two monetary regimes. Taking logs and differentiating (6) implies

$$d\ln P = \gamma d\ln P_N + (1-\gamma) d\ln P_T. \tag{13}$$

Under *inflation targeting* the consumer price effects are zero by definition i.e. $d\ln P = 0$. However, nominal wages induce changes in producer price levels. Setting $d\ln P = 0$ and substituting, in turn, $d\ln P_N = -\frac{1-\gamma}{\gamma} d\ln P_T$ and $d\ln P_T = -\frac{\gamma}{1-\gamma} d\ln P_N$ into (12) and rearranging gives the following

[3] Differentiating the law of one price and the consumer price index, note that the reaction function of the central bank can be written as $d\ln E = -\frac{1}{(1-\gamma)}\left[\gamma d\ln P_N + (1-\gamma)\, d\ln P_T^*\right]$ under inflation targeting.

[4] Note that all endogenous variables are regime-specific.

producer price elasticities for the tradable and non-tradable sectors, respectively:

$$\begin{aligned}
\left(\frac{d\ln P_T}{d\ln W_T}\right)_I &= \frac{\gamma\sigma}{1+\sigma} \\
\left(\frac{d\ln P_T}{d\ln W_N}\right)_I &= -\frac{\gamma\sigma}{1+\sigma} \\
\left(\frac{d\ln P_N}{d\ln W_N}\right)_I &= \frac{(1-\gamma)\,\sigma}{1+\sigma} \\
\left(\frac{d\ln P_N}{d\ln W_T}\right)_I &= -\frac{(1-\gamma)\,\sigma}{1+\sigma}.
\end{aligned}$$

Note that the price elasticities are computed under the assumption that $\frac{d\ln W_i}{d\ln W_j} = 0$. The reason for this is that when analysing wage setting in the model, I need to describe how the union in sector i perceives the effects of its wage decisions on sector j and this condition must hold in Nash equilibrium.

In a *Monetary Union* $d\ln E = 0$ by definition. As long as there is no foreign inflation, this implies $d\ln P_T = 0$ according to the law of one price. Imposing $d\ln P_T = 0$ on (12) implies:

$$\begin{aligned}
\left(\frac{d\ln P_N}{d\ln W_N}\right)_M &= \frac{\sigma}{1+\sigma} \\
\left(\frac{d\ln P_N}{d\ln W_T}\right)_M &= -\frac{\sigma}{1+\sigma}.
\end{aligned}$$

Inserting these expressions into (13) gives the consumer price effects in a monetary union:

$$\begin{aligned}
\left(\frac{d\ln P}{d\ln W_N}\right)_M &= \frac{\gamma\sigma}{1+\sigma} \\
\left(\frac{d\ln P}{d\ln W_T}\right)_M &= -\frac{\gamma\sigma}{1+\sigma}.
\end{aligned}$$

Summing up, the regime-specific elasticities of prices with respect to wages, i.e. the consumer and producer price effects, are given by the expressions in Table 1. Column 1 displays the elasticities under inflation targeting and column 2 the elasticities in a monetary union.

Under inflation targeting, the consumer price effect is always zero by definition, i.e. $\left(\frac{d\ln P}{d\ln W_i}\right)_I = 0$. The mechanisms at work are as follows. Suppose that there is a wage increase in the non-tradables sector. This negative supply shock generates inflation pressure, which the central bank offsets by appreciating the nominal exchange rate. The appreciation leads to lower prices in the tradables sector, and the inflation target is attained. Similarly, if there is a wage increase in the tradables

Table 1: Producer and Consumer Price Effects under the Two Regimes

	Regime (m)	Inflation Target (I)	Monetary Union (M)
$1-\varphi_{Nm}$	$\left(\frac{d\ln P_N}{d\ln W_N}\right)_m$	$\frac{(1-\gamma)\sigma}{1+\sigma}$	$\frac{\sigma}{1+\sigma}$
$1-\psi_{Nm}$	$\left(\frac{d\ln P_T}{d\ln W_N}\right)_m$	$-\frac{\gamma\sigma}{1+\sigma}$	0
$1-\epsilon_{Nm}$	$\left(\frac{d\ln P}{d\ln W_N}\right)_m$	0	$\frac{\gamma\sigma}{1+\sigma}$
$1-\varphi_{Tm}$	$\left(\frac{d\ln P_T}{d\ln W_T}\right)_m$	$\frac{\gamma\sigma}{1+\sigma}$	0
$1-\psi_{Tm}$	$\left(\frac{d\ln P_N}{d\ln W_T}\right)_m$	$-\frac{(1-\gamma)\sigma}{1+\sigma}$	$-\frac{\sigma}{1+\sigma}$
$1-\epsilon_{Tm}$	$\left(\frac{d\ln P}{d\ln W_T}\right)_m$	0	$-\frac{\gamma\sigma}{1+\sigma}$

sector, there is a reduction in output, leading to lower aggregate income and lower demand for non-tradable goods. The fall in demand for non-tradables causes deflationary pressure in the non-tradables sector and on the aggregate level. Therefore, the central bank depreciates the nominal exchange rate in order to raise the price of tradables in domestic currency. Hence, the aggregate price level is unchanged and the inflation target attained.

In a monetary union, the central bank does not react to the wage-setting outcome, since the nominal exchange rate is fixed. If the nominal wage in the non-tradables sector is raised by one percent the price of non-tradables increases with a factor of $\left(\frac{d\ln P_N}{d\ln W_N}\right)_M = \frac{\sigma}{1+\sigma}$ due to the negative effect on supply. The aggregate price level increases with a factor that is proportional to the producer-price effect, with the proportionality coefficient given by the budget share of non-tradables.

In the tradables sector the producer price effect is zero.[5] However, a wage increase in the tradables-sector, causes a negative supply shift, which for a given price level, decreases tradables-sector output. This in turn leads to a fall in aggregate nominal income, which generates a fall in demand for non-tradables This reduces the price of non-tradables, and consequently also the consumer price, $\left(\frac{d\ln P}{d\ln W_T}\right)_M = -\frac{\gamma\sigma}{1+\sigma}$.

[5] According to the law of one price $d\ln P_T = d\ln E + d\ln P_T^*$ and hence $d\ln E = d\ln P_T^* = 0$ implies $d\ln P_T = 0$.

2.3 Wage Setting

In the first stage of the game, wages are set by Nash bargaining between one large union and one employer's federation in each sector. Wages are set simultaneously in the two sectors, and when bargaining over the wage in sector i, wage setters assume that the wage in the other sector W_{jm} does not respond to W_{im}. The union cares about the utility of its own members, taking into account that it is large enough to influence employment, as given by the labour demand function, and the producer price of the own sector and the aggregate price level. When perfect labour mobility is introduced, the union in sector i recognises that some of its members may move to sector j and maximisation is then subject to an additional constraint: the no-arbitrage condition governing the relative labour force distribution (11).

No Labour Mobility

I assume that the union in sector i is utilitarian and cares about the sum of utilities of its members, i.e. $M_i V_i$. If the bargaining parties fail to reach an agreement workers will obtain the value of unemployment so that the fall-back utility is $\Lambda_{i0} = M_i b$. Union rents from reaching an agreement can then be written:

$$\begin{aligned}\Lambda_i - \Lambda_{i0} &= M_i \left(\frac{N_{im}}{M_i} w_{im} + \left(1 - \frac{N_{im}}{M_i} \right) b \right) - M_i b \\ &= N_{im} \left(w_{im} - b \right)\end{aligned}$$

The objective of the employer's federation is to maximise real profits of the representative firm as given by (4). I assume that fall-back profits are zero, $\Pi_0 = 0$. Letting λ_i be the relative bargaining power of the union in sector i, I may therefore define the Nash-product to be maximised in the bargaining as:

$$\Omega_i = \left[N_{im} \left(w_{im} - b \right) \right]^{\lambda_i} \left[\Pi_{im} \right]^{1-\lambda_i} .$$

The nominal wage in sector i is given by the solution to

$$\max_{\ln W_{im}} \lambda_i \ln \left[N_{im} \left(\frac{W_{im}}{P_m} - b \right) \right] + (1 - \lambda_i) \ln \left[(\eta - 1)^{-1} \frac{W_{im}}{P_m} \left(\frac{W_{im}}{P_{im}} \right)^{-\eta} \right]$$

subject to

$$
\begin{aligned}
N_{im} &= \left(\frac{W_{im}}{P_{im}}\right)^{-\eta} \\
P_m &= P(W_{Nm}, W_{Tm}) \\
P_{im} &= P_i(W_{Nm}, W_{Tm}).
\end{aligned}
$$

Let $\varphi_{im} = \left(1 - \frac{d\ln P_i}{d\ln W_i}\right)_m$ and $\epsilon_{im} = \left(1 - \frac{d\ln P}{d\ln W_i}\right)_m$. The first order condition for maximisation is

$$\lambda_i \left[-\eta\varphi_{im} + \frac{w_{im}\epsilon_{im}}{(w_{im} - b)}\right] + (1 - \lambda_i)\left[\epsilon_{im} - \eta\varphi_{im}\right] = 0 \tag{14}$$

The first order condition states that the union's marginal gain of an incremental wage increase must balance the marginal loss of the employer's federation of a wage increase. Note that both parties benefit from a positive producer price effect: The union's employment loss generated by a marginal wage increase is partly offset and nominal profits of firms increase. Similarly, both parties lose from a positive consumer price effect since it decreases real wages and real profits. Solving for the real wage I obtain:

$$w_{im} = \left[1 + \frac{\lambda_i\epsilon_{im}}{\eta\varphi_{im} - \epsilon_{im}}\right] b \tag{15}$$

where $m = I, M$ for the two regimes. Note that (15) represents two equations since $i = N, T$. The regime-specific price-elasticities φ_{im} and ϵ_{im}, show how monetary policy influences wage setting, and are therefore key parameters of interest. They display how unions may be constrained by the central bank, as it sets the nominal exchange rate in order to offset wage pressure threatening the monetary target. Consequently, equilibrium wages are governed by the regime-specific elasticities displayed in Table 1.

Perfect Labour Mobility

When there is perfect labour mobility, the union still seeks to maximise the expected utility of its members. Consider the union in sector i. Let M_{ii} denote the number of workers who decide to stay in sector i and seek employment which implies that $M_i - M_{ii}$ workers move to sector j to look for a job. Consequently, the union in sector i seeks to maximise:

$$M_{ii}V_i + (M_i - M_{ii})\,V_j$$

But since the union recognises that in equilibrium, it will always be true that $V_i = V_j$ through worker migration, the objective function of the union is still given by

$$\Lambda_i = M_i V_i$$

If parties fail to reach an agreement, members obtain the value associated with being unemployed so that fall-back utility is $\Lambda_{i0} = M_i b$. The objective functions of the two unions may then be written:

$$\begin{aligned}\Lambda_N - \Lambda_{N0} &= M_N \left[\frac{N_{Nm}}{M_N + f_m}(w_{Nm} - b)\right] \\ \Lambda_T - \Lambda_{T0} &= M_T \left[\frac{N_{Tm}}{M_T - f_m}(w_{Tm} - b)\right]\end{aligned}$$

Note that if there were no flows, $f_m = 0$, the unions' objective functions would be the same as in the case with no mobility. Moreover, the maximisation is now subject also to (11). The nominal wage solves:

$$\max_{\ln W_{im}} \lambda_i \ln\left[\Lambda_i - \Lambda_{i0}\right] + (1-\lambda_i)\ln\left[(\eta-1)^{-1}\frac{W_{im}}{P_m}\left(\frac{W_{im}}{P_{im}}\right)^{-\eta}\right]$$

subject to

$$\begin{aligned}N_{im} &= \left(\frac{W_{im}}{P_{im}}\right)^{-\eta} \\ f_m &= \frac{M_T N_{Nm}(w_{Nm}-b) - M_{Nm} N_{Tm}(w_{Tm}-b)}{N_{Nm}(w_{Nm}-b) + N_{Tm}(w_{Tm}-b)} \\ P_m &= P(W_{Nm}, W_{Tm}) \\ P_{im} &= P_i(W_{Nm}, W_{Tm}).\end{aligned}$$

When there is perfect labour mobility, wage setters in sector i internalise the fact that their wage decision affects the distribution of the labour force across sectors. Moreover, they need to take into account that their wage decisions affect also prices in sector j. Therefore, it will prove useful to introduce some additional notation. Let $(1 - \frac{d\ln P_j}{d\ln W_i})_m = \psi_{im}$ (so that $(1 - \frac{d\ln P_i}{d\ln W_j})_m = \psi_{jm}$). The first-order conditions for the union in the non-tradables and tradables sector, respectively, are:

$$\lambda_N\left[-\eta\varphi_{Nm} - \frac{\frac{\partial f_m}{\partial \ln W_{Nm}}}{(M_N + f_m)} + \frac{w_{Nm}\epsilon_{Nm}}{(w_{Nm}-b)}\right] + (1-\lambda_N)\left[\epsilon_{Nm} - \eta\varphi_{Nm}\right] = 0 \qquad (16)$$

$$\lambda_T\left[-\eta\varphi_{Tm} + \frac{\frac{\partial f_m}{\partial \ln W_{Tm}}}{(M_T - f_m)} + \frac{w_{Tm}\epsilon_T}{(w_{Tm}-b)}\right] + (1-\lambda_N)\left[\epsilon_{Tm} - \eta\varphi_{Tm}\right] = 0 \qquad (17)$$

where $\frac{\partial f_m}{\partial \ln W_{im}}$ is the effect on worker flows. The first term within brackets is the marginal effect on union rents of a one percent wage increase. When the assumption of immobile labour is relaxed, the additional terms $\frac{\partial f_m}{\partial \ln W_{Nm}} / (M_N + f_m)$ and $\frac{\partial f_m}{\partial \ln W_{Tm}} / (M_N - f_m)$ enter the first order conditions of the unions in sectors N and T, respectively. The intuition is that when the wage in sector i increases, there will ceteris paribus be an inflow of workers to that sector, increasing the stock of workers competing for employment, thus reducing union rents from an agreement in the sector.

It will prove useful to consider the following relationship between the producer price effects under regime m: By inserting the price elasticities from table 1 under the different regimes, one may show that

$$\varphi_{im} - \psi_{im} = -\frac{(\eta - 1)}{\eta} < 0 \tag{18}$$

$\forall i, m$. This is equivalent to

$$\frac{\partial \ln P_{jm}}{\partial \ln W_{im}} < \frac{\partial \ln P_{im}}{\partial \ln W_{im}}$$

The pass-through to j-sector prices, P_{jm}, is always smaller than the direct impact of a wage increase on prices in the own sector. The reason is that the effect on j-sector prices stems from an indirect effect on aggregate income, while the effect on i-sector prices is the direct result of a negative shift in supply. The result (18) implies $(1 - \eta(1 + \varphi_{im} - \psi_{im})) = 0 \ \forall i, m$. Using this result, the effect on net worker flows from the tradables sector to the non-tradables sector of a wage increase in the two sectors can be written:

$$\frac{\partial f_m}{\partial \ln W_{Nm}} = (M_N + M_T) N_{Nm} N_{Tm} b \frac{[(w_{Nm} - b)(1 - \epsilon_{Nm}) + (w_{Tm} - b)\epsilon_{Nm}]}{[N_{Nm}(w_{Nm} - b) + N_{Tm}(w_{Tm} - b)]^2} > 0 \tag{19}$$

And for the tradables sector:

$$\frac{\partial f_m}{\partial \ln W_{Tm}} = -(M_N + M_T) N_{Nm} N_{Tm} b \frac{[(w_{Tm} - b)(1 - \epsilon_{Tm}) + (w_{Nm} - b)\epsilon_{Tm}]}{[N_{Nm}(w_{Nm} - b) + N_{Tm}(w_{Tm} - b)]^2} < 0. \tag{20}$$

Ceteris paribus, a wage increase in the non-tradables sector causes a net inflow of workers to the non-tradables sector since there is utility to be gained by migrating to that sector. In analogy, the reverse holds true for an increase in wages in the tradables sector. Henceforth, let ˜ denote the case of perfect mobility. It follows from the first order conditions of the unions that the wage curves can be written

$$\widetilde{w}_{Nm} = \left[1+\frac{\lambda_N \epsilon_{Nm}}{\eta\varphi_{Nm}-\epsilon_{Nm}+\lambda_N \frac{\partial f_m/\partial \ln W_{Nm}}{(M_N+f_m)}}\right] b$$

$$\widetilde{w}_{Tm} = \left[1+\frac{\lambda_T \epsilon_{Tm}}{\eta\varphi_{Tm}-\epsilon_{Tm}-\lambda_T \frac{\partial f_m/\partial \ln W_{Tm}}{(M_T-f_m)}}\right] b$$

where $\partial f_m/\partial \ln W_{im}$ is given by the above expressions. Again, the price elasticities φ_{im} and ϵ_{im} display the influence of the monetary regime on wage setting. Unions and employers' federations bargaining with each other internalise the impact wage increases have on aggregate price levels and take into account that the extent to which prices are allowed to increase is restricted by the monetary target. Unions now internalise also the impact their wage claims have on prices in sector j since they take into account that some of their members may move there, but since these effects and the producer price effects in the own sector cancel out according to (18), ψ_{im} does not matter for the optimal wage.

Substituting for equilibrium net flows, f_m, and $\partial f_m/\partial \ln W_{im}$ I obtain the following expressions for the wage curves in the two sectors:

$$\widetilde{w}_{Nm} = \left[1+\frac{\lambda_N \epsilon_{Nm}}{[\eta\varphi_{Nm}-\epsilon_{Nm}]}\right] b - \frac{\widetilde{N}_{Tm}}{\widetilde{N}_{Nm}}\left[\frac{\lambda_N(1-\epsilon_{Nm})}{[\eta\varphi_{Nm}-\epsilon_{Nm}]} b + (\widetilde{w}_{Tm}-b)\right] \tag{21}$$

$$\widetilde{w}_{Tm} = \left[1+\frac{\lambda_T \epsilon_{Tm}}{[\eta\varphi_{Tm}-\epsilon_{Tm}]}\right] b - \frac{\widetilde{N}_{Nm}}{\widetilde{N}_{Tm}}\left[\frac{\lambda_T(1-\epsilon_{Tm})}{[\eta\varphi_{Tm}-\epsilon_{Tm}]} b + (\widetilde{w}_{Nm}-b)\right]. \tag{22}$$

The wage curves are now functions of employment in the two sectors and of wages in the other sector. The curves are concave in employment-real wage space:

$$\frac{\partial \widetilde{w}_{im}}{\partial \widetilde{N}_{im}} = \frac{\widetilde{N}_{jm}}{\widetilde{N}_{im}^2}\left[\frac{\lambda_i(1-\epsilon_{im})}{[\eta\varphi_{im}-\epsilon_{im}]} b + (\widetilde{w}_{jm}-b)\right] > 0$$

$$\frac{\partial^2 \widetilde{w}_{im}}{\partial \widetilde{N}_{im}^2} = -2\frac{\widetilde{N}_{jm}}{\widetilde{N}_{im}^3}\left[\frac{\lambda_i(1-\epsilon_{im})}{[\eta\varphi_{im}-\epsilon_{im}]} b + (\widetilde{w}_{jm}-b)\right] < 0.$$

The fact that the wage in sector i is a decreasing function of wages and employment in sector j may at first seem counter-intuitive. Consider for instance the union in the non-tradables sector. From the FOC of the union it follows that if $\frac{\frac{\partial f_m}{\partial \ln W_{Nm}}}{(M_N+f_m)}$ increases, the union chooses a lower wage since the marginal gain of a wage increase decreases. Therefore key to understanding why w_{Nm} is a decreasing function of N_{Tm} and w_{Tm} is studying the sensitivity of f_m with respect to w_{Nm}, $\frac{\partial f_m}{\partial \ln w_{Nm}}$, and the level of f_m. I next consider, in turn, the effects of an increase in wages or employment in the tradables sector on $\frac{\partial f_m}{\partial \ln w_{Nm}}$ and on f_m, respectively. One may show that

$$\begin{aligned} \frac{\partial}{\partial w_{Tm}}\left(\frac{\partial f_m}{\partial \ln W_{Nm}}\right) &> 0 \text{ if and only if} \\ \epsilon_{Nm} N_{Nm}\left(w_{Nm}-b\right) - 2N_{Tm}\left(1-\epsilon_{Nm}\right)\left(w_{Nm}-b\right) - N_{Tm}\epsilon_{Nm}\left(w_{Tm}-b\right) &> 0 \end{aligned}$$

$$\begin{aligned} \frac{\partial}{\partial N_{Tm}}\left(\frac{\partial f_m}{\partial \ln W_{Nm}}\right) &> 0 \text{ if and only if} \\ N_{Nm}\left(w_{Nm}-b\right) - N_{Tm}\left(w_{Tm}-b\right) &> 0. \end{aligned}$$

The sensitivity of flows to w_{Tm} and N_{Tm} may be positive or negative depending on wage levels,

employment rates and the consumer price effects. If employment and wages are higher in the non-tradables sector than in the tradables sector, an increase in N_{Tm} increases the sensitivity of flows to an increase in w_{Nm}. This in turn causes unions to set a lower wage.

Turning to the level of net flows, it is straightforward to show that

$$\begin{aligned} \frac{\partial f_m}{\partial w_{Tm}} &< 0 \\ \frac{\partial f_m}{\partial N_{Tm}} &< 0. \end{aligned}$$

When wages or employment in the tradables sector increase, f_m decreases, i.e. there will be a lower stock of workers in the non-tradables sector and for a given level of $\frac{\partial f_m}{\partial \ln W_{Nm}}$, the term $\frac{\frac{\partial f_m}{\partial \ln W_{Nm}}}{(M_N+f_m)}$ increases. This means that the marginal gain of a wage increase to unions in the non-tradables sector decreases and they set a lower wage. In other words, there will be a higher percentage increase in union rents of a one percent wage increase for a given change in the labour stock, $\frac{\partial f_m}{\partial \ln W_{Nm}}$, if the stock f_m is small to begin with. Since the net effect is uncertain it is useful to consider the total effect on the term $\frac{\frac{\partial f_m}{\partial \ln W_{Nm}}}{(M_N+f_m)}$. One may show that

$$
\begin{aligned}
\frac{\partial}{\partial N_{Tm}}\left(\frac{\partial f_m/\partial \ln W_{Nm}}{M_N+f_m}\right) &> 0 \\
\\
\frac{\partial}{\partial w_{Tm}}\left(\frac{\partial f_m/\partial \ln W_{Nm}}{M_N+f_m}\right) &> 0 \text{ if and only if} \\
N_{Nm}\epsilon_{Nm} - N_{Tm}\left(1-\epsilon_{Nm}\right) &> 0
\end{aligned}
$$

This means that even if wage levels and employment rates are such that $\frac{\partial}{\partial N_{Tm}}\left(\frac{\partial f_m}{\partial \ln W_{Nm}}\right) < 0$ the effect on flows $\frac{\partial f_m}{\partial N_{Tm}}$ always dominates so that when N_{Tm} increases, the unions marginal gain of increasing w_{Nm} decreases, which causes them to set a lower wage. Thus, w_{Nm} is a decreasing function of N_{Tm}. The net effect on the term of an increase in w_{Tm} is uncertain. Due to symmetry a similar argument applies to unions in the tradables sector.

When comparing wage levels with and without mobility respectively it is trivial to prove the following proposition:

Proposition 1 *Wages are always lower when there is perfect mobility than when labour is immobile between sectors, i.e.*

$$w_{im} > \widetilde{w}_{im}$$

$\forall i, m$.

Proof. The wage curves (15) and (21)-(22) imply $w_{im} > \widetilde{w}_{im}$ if and only if $\left[\frac{\lambda_i(1-\epsilon_{im})}{[\eta\varphi_{im}-\epsilon_{im}]}b + (\widetilde{w}_{jm} - b)\right] > 0$. In equilibrium this holds true $\forall j, m$ and the proposition follows. ■

The key to understanding the above proposition lies in recalling that unions take into account that some of their members may move to the other sector, but also that some of the members of the other union may move to their sector. This provides incentive for wage restraint since they know that if they set wages too high there will be an inflow of workers from the other sector (i.e. workers who are members of the other union) competing for jobs in their sector, thus reducing employment probabilities and utility for their own members.

2.3.1 Decentralised Wage Setting

Suppose now that wages are set by unions that are so small that the wages they set are unable to influence the aggregate price levels. Clearly, the monetary regime will not matter for real wages or employment under this assumption, but it may be useful to compare the non-atomistic outcome to the decentralised equilibrium. When wage setters are small, they do not need to take into account that their wage decisions will affect price levels and the equilibrium wage is therefore obtained by imposing $\epsilon_{im} = \varphi_{im} = 1$ on (15), and the wage curve in the case with no mobility reads

$$\widehat{w}_{im} = \left[1 + \frac{\lambda_i}{\eta - 1}\right] b. \tag{23}$$

This equilibrium will serve as a useful benchmark when solving the model numerically.

2.4 Non-neutrality of the Monetary Regime

Why does the monetary regime potentially matter when setting is non-atomistic? The first order conditions for the union in sector i, (14) and (16), respectively, define reaction functions: the real wage in sector i, w_{im}, as functions of the real wage in sector j, w_{jm}. Moreover, the consumer price level, P_m, will be a function of nominal wages in the two sectors and of the monetary regime. Thus, the aggregate price level will differ across regimes, $P_I \neq P_M$. In Nash equilibrium, the union in sector i assumes that the *nominal* wage in sector j is fixed, but since the consumer price level will differ across regimes, so will the perceived consumer *real* wage in sector j, i.e. $w_{jM} \neq w_{jI}$. The union in sector i therefore perceives that it is solving different maximisation problems under the two regimes. Consequently, also the real wage in sector i will be regime specific, $w_{iM} \neq w_{iI}$ according to the reaction function in sector i.

For future reference, note the asymmetric features of a monetary union: When the exchange rate is fixed, wages in the tradables sector may increase infinitely without any increase in the price of tradables and without any reaction from the central bank. Moreover, a wage increase in the non-tradables sector generates an increase in the price for non-tradables, also with no response from the central bank. Under inflation targeting however, the central bank is equally concerned with inflationary pressure from both sectors and makes sure that the inflation target is attained by adjusting the nominal exchange rate.

In order to evaluate the impact of the monetary regime in this setting I need to derive the general equilibrium. This is done in the next section.

2.5 Equilibrium

To simplify, I need to get rid of the producer real wage that enters the labour demand curves. By using the definition of the aggregate price level (6) and inserting the equilibrium relative price (7) I can rewrite the labour demand curves in terms of consumer real wages as follows:

$$N_{Nm} = w_{Nm}^{-\eta}\left(\frac{w_{Nm}}{w_{Tm}}\right)^{(1-\gamma)\sigma}\left(\frac{\gamma}{1-\gamma}\right)^{(1-\gamma)} \tag{24}$$

$$N_{Tm} = w_{Tm}^{-\eta}\left(\frac{w_{Nm}}{w_{Tm}}\right)^{-\gamma\sigma}\left(\frac{\gamma}{1-\gamma}\right)^{-\gamma}. \tag{25}$$

In equilibrium four equations determine the following endogenous variables: w_{Nm}, w_{Tm}, n_{Nm} and n_{Tm}. The equations are the labour demand curves in each sector, (24) and (25), the sectoral wage curves (15) or (21) and 22 (evaluated for $i = N, T$ and the equilibrium price elasticities in Table 1).

No Labour Mobility

In the case with immobile labour, the wage curves are independent of employment rates and wages in the other sector. Thus, wages are given by:

$$w_{Nm} = \left[1 + \frac{\lambda_N \epsilon_{Nm}}{\eta\varphi_{Nm} - \epsilon_{Nm}}\right] b \tag{26}$$

$$w_{Tm} = \left[1 + \frac{\lambda_T \epsilon_{Tm}}{\eta\varphi_{Tm} - \epsilon_{Tm}}\right] b. \tag{27}$$

Wages in the two sectors are a positive mark-up on the value of unemployment. Given wages, employment rates are determined according to (24) and (25).

Perfect Labour Mobility

Next consider the case when there is perfect labour mobility. Note that the relative employment rate is what matters for equilibrium wages. Dividing (24) by (25) implies:

$$\frac{\widetilde{N}_{Nm}}{\widetilde{N}_{Tm}} = \left(\frac{\widetilde{w}_{Tm}}{\widetilde{w}_{Nm}}\right)\left(\frac{\gamma}{1-\gamma}\right). \tag{28}$$

Substituting the expression for relative employment (28) into the wage curves (21) and (22) gives two linear equations in two unknowns, $\widetilde{w}_{Tm}$ and $\widetilde{w}_{Nm}$. I may therefore solve for equilibrium real wages on reduced form:

$$\widetilde{w}_{Nm} = \left[\frac{\eta\varphi_{Tm} - \epsilon_{Tm} + \eta\varphi_{Nm} - \epsilon_{Nm} - \lambda\left(1 - \epsilon_{Nm} - \epsilon_{Tm}\right)}{\left(\eta\varphi_{Nm} - \epsilon_{Nm}\right)\epsilon_{Tm} + \left(\eta\varphi_{Tm} - \epsilon_{Tm}\right)\left(1 - \epsilon_{Nm}\right)}\right]\gamma b \tag{29}$$

$$\widetilde{w}_{Tm} = \left[\frac{\eta\varphi_{Tm} - \epsilon_{Tm} + \eta\varphi_{Nm} - \epsilon_{Nm} - \lambda\left(1 - \epsilon_{Nm} - \epsilon_{Tm}\right)}{\left(\eta\varphi_{Nm} - \epsilon_{Nm}\right)\left(1 - \epsilon_{Tm}\right) + \left(\eta\varphi_{Tm} - \epsilon_{Tm}\right)\epsilon_{Nm}}\right]\left(1 - \gamma\right) b. \tag{30}$$

Wages are still a markup on the value of unemployment, but the markup is now interacted with the relative size of the non-tradables sector, γ. As in the case with immobile labour, employment rates are determined according to (24) and (25).

3 Analysis

In this section I first compare the equilibria under the two different regimes analytically and then solve the model numerically. Finally I address the issue of which interest groups in the economy benefit from the two regimes.

3.1 Real Wage Rankings Across Regimes and Sectors

Inserting the equilibrium price elasticities given in Table 1 and simplifying, gives the reduced-form expressions for regime-specific consumer real wages given in Table 2 below.

First note that it is easy to verify Proposition 1 by looking at reduced-form wages: Wages are always lower when there is perfect labour mobility than when labour is immobile between sectors. The reason is that mobility creates incentive for wage restraint: if unions set wages too high there will be an inflow of workers to the sector, reducing union rents from a wage agreement.

Next, I evaluate the impact of different regimes by comparing different wage levels under inflation targeting and in a monetary union. I start by looking at the ranking of different regimes in a given sector and then look at how wages differ across sectors under a given regime.

Table 2: Equilibrium Real Wages under the Two Regimes

No Mobility	
w_{NI}	$\left[\frac{\lambda+\gamma\sigma}{\gamma\sigma}\right] b$
w_{TI}	$\left[\frac{\lambda+(1-\gamma)\sigma}{(1-\gamma)\sigma}\right] b$
w_{NM}	$\left[\frac{\lambda(1+\sigma)+\gamma\sigma(1-\lambda)}{\gamma\sigma}\right] b$
w_{TM}	$\left[\frac{(1+\sigma)(\sigma+\lambda)-\gamma\sigma(1-\lambda)}{\sigma(1-\gamma+\sigma)}\right] b$
Perfect Mobility	
$\widetilde{w}_{NI}$	$\left[\frac{\lambda+\sigma}{\sigma}\right] b$
$\widetilde{w}_{TI}$	$\left[\frac{\lambda+\sigma}{\sigma}\right] b$
$\widetilde{w}_{NM}$	$\left[\frac{\lambda+\sigma}{\sigma}\right] b$
$\widetilde{w}_{TM}$	$\left[\frac{\lambda+\sigma}{\sigma}\right] b$

Proposition 2 *When labour is immobile between sectors, the ranking of regimes within each sector is as follows:*

$$
\begin{aligned}
w_{TI} &> w_{TM} \\
w_{NM} &> w_{NI}
\end{aligned}
$$

Proof. Given in Appendix. ■

The wage ranking stated in the proposition is consistent with previous literature, see Holden (2003). In the tradables sector the result is explained by the fact that the positive producer price effect under inflation targeting is stronger than the negative consumer price effect in a monetary union. In the non–tradables sector the positive producer price effect is so much stronger in a monetary union than under inflation targeting, that the mitigating consumer price effect in a monetary union is neutralised.

I next evaluate how wages differ across sectors under a given regime.

Proposition 3 *When labour is immobile between sectors, the ranking of sectoral wages under a given regime is as follows:*

$$\begin{aligned} w_{TI} &\geq w_{NI} \text{ if and only if } \gamma \geq \frac{1}{2} \\ w_{NM} &\geq w_{TM} \text{ if and only if } \gamma \leq \frac{(1+\sigma)}{2}. \end{aligned}$$

Proof. Given in Appendix. ■

Under inflation targeting, the wage will be higher in the tradables sector than in the non-tradables sector if the latter is larger. Recall that there are no consumer price effects present to deter wage-setters from raising the wage under this regime, only producer price effects. Perhaps the easiest way to think about this result is by considering wage setters in the tradables sector. When they raise wages, the fall in aggregate income that follows will cause deflationary pressure in the non-tradables sector, threatening the inflation target. The central bank will therefore depreciate the nominal exchange rate, which raises prices in the tradables sector. This in turn increases nominal profits for the employer's federation in the tradables sector and mitigates the negative impact on N-sector employment caused by the wage increase. The deflationary pressure in the non-tradables sector is stronger the larger the sector, and so is the devaluation that follows. Therefore, the larger the non-tradables sector (the larger γ), the larger the devaluation, and thus the stronger the incentives for wage setters in the tradables sector to raise wages.

As for the intuition in a monetary union, the term $\frac{(1+\sigma)}{2}$ is clearly a threshold value for the relative size of the non-tradables sector. Since there is no central bank to deter wage setters in this sector from raising the wage infinitely, they will do so until the consumer price effect (decreasing real wages and profits) becomes sufficiently damaging to them. In other words, wage setters in the non-tradables sector exploit their strategic advantage of being small as long as $\gamma \leq \frac{(1+\sigma)}{2}$.

Proposition 4 *When there is perfect labour mobility, there is wage equality across sectors and regimes, i.e.*

$$\widetilde{w}_{NI} = \widetilde{w}_{TI} = \widetilde{w}_{NM} = \widetilde{w}_{TM}.$$

Proof. The proposition follows directly from Table 2. ■

When there is perfect labour mobility between sectors, there is always wage equality across sectors and regimes, i.e. the regime does not matter. This is not a trivial result, since it is the expected utility of a worker that should be the same in the two sectors by construction. It may be shown that the reason there is wage equality under the two regimes, is that by substituting for equilibrium relative labour demand given by (28) in (16) and (17), the unions in the two sectors face the same first order condition regardless of regime.

3.1.1 A Crucial Assumption

The result that the regime does not matter as stated in Proposition 4, hinges on the assumption of the utility of the unemployed being exogenously given in *real* terms. In contrast, think of the case where the utility of the unemployed is interpreted as an unemployment benefit.[6] Under the assumption that the *nominal* unemployment benefit, B, is exogenously given there is an additional effect present in the unions' first order conditions arising from the fact that the real unemployment benefit, defined as $b = \frac{B}{P}$, is regime-specific due to the impact of wages on prices.[7] The unions' first order conditions then define the following reaction functions: the wage in sector i as a function of the real wage in sector j and of the real unemployment benefit b. When setting the wage, unions assume that the nominal benefit B is exogenous. Since the response of the price level is regime-specific, so is the real unemployment benefit, b, and consequently the wage set in sector i. It turns out that with an exogenous nominal benefit level and perfect mobility, wages are equalized across sectors under inflation targeting, but not in a monetary union. The intuition is that under inflation targeting, the consumer price effects are zero, and since they are the effects governing the real unemployment benefit, the additional effect in the unions' first order conditions described above, disappear. In a monetary union, however, there are consumer price effects present and this causes the wage outcome under this regime to differ from the outcome under inflation targeting.

[6] One way of modeling the financing of such an unemployment benefit would be to introduce a constant tax rate levied on all labour income (both wage income and unemployment benefits). A term equal to $(1-\tau)$, where τ is the tax rate, would then enter multiplicatively in equation (8), and thus not affect the maximisation problem of wage setters. One way of closing the model in this case would be to introduce an exogenously given number of pensioners (with the same Cobb-Douglas utility function as workers) into the model and assume that the tax on labour income is used to finance both unemployment benefits and pensions. The pension level would then be determined residually so that budget balance is always obtained.

[7] I focus on this case at length in an earlier version of the paper. Derivations are now given in Appendix.

3.2 Numerical Solutions

The aim of this section is to compute equilibrium employment rates and to assess the quantitative importance of the mobility assumption by means of numerical illustrations.

3.2.1 Parameters

First, consider the parameters governing the labour demand curves. The level of the labour share in production, δ is set equal to 0.5. Due to the asymmetric features of a monetary union, I suspect that the degree of closedness, i.e. the relative size of the non-tradables sector γ is crucial for which sector performs better under the two regimes and this is also shown to be true for models with immobile labour, see Larsson and Zetterberg (2003). Therefore it is important to let this parameter assume many different values ranging from 0 (a super-open economy with only production of tradables) to 1 (a super-closed economy with only production of non-tradables). As a benchmark I will consider the completely symmetric case when the two sectors are equally sized, i.e. letting $\gamma = 0.5$. I need to calibrate the value of being unemployed so that it generates reasonable unemployment rates. Consider the case when wage setting is completely decentralised and labour is immobile between sectors. The wage curve is then given by:

$$\widehat{w}_i = \left[1 + \frac{\lambda_i}{\eta - 1}\right] b$$

In order to keep b constant over different degrees of openness etc. I need to calibrate something like an economy average. I therefore impose complete symmetry across sectors, i.e., $\lambda_N = \lambda_T = \lambda$ and $\gamma = 0.5$, i.e. I assume that sectors are equally large. From the wage curves it follows that there is then real wage equality across sectors, i.e. $w_N = w_T$. Moreover, the labour demand curves in the two sectors are identical and given by the following:

$$n_i = w^{-\eta}.$$

I next impose five percent unemployment in the economy, i.e. set $n_i = 0.475$. Substituting for w from the wage curve I obtain:

$$0.475 = \left[\frac{\eta - 1 + \lambda}{\eta - 1}\right]^{-\eta} b^{-\eta}.$$

Solving for b:

$$b = (0.475)^{-\frac{1}{\eta}} \left[\frac{\eta - 1}{\eta - 1 + \lambda} \right].$$

Finally, the relative bargaining power of unions, λ_i, is set equal to 0.5, i.e. I consider symmetric bargaining.

3.2.2 Results

Numerical solutions to the model are given in Table 3 below.

[Table 3 about here]

First note that the results verify Proposition 4: There is always wage equality across regimes and sectors under perfect mobility. However, employment rates differ across sectors since they are governed by labour demand which in turn depends on the relative size of the non-tradables sector.

Also Proposition 1 is easily verified: wages in the two sectors are always lower under perfect labour mobility. The results suggest that as a consequence of the reduction in wages, employment in the two sectors is higher with mobile labour.

When labour is immobile between sectors, aggregate employment is always higher under inflation targeting than under exchange rate targeting. The model generates unrealistically low employment levels with immobile labour, but aggregate employment rates are much improved and reach much more realistic values under perfect labour mobility.

The results with immobile labour demonstrate the symmetric properties of inflation targeting: Wage levels and employment rates are symmetric around $\gamma = 0.5$ in the sense that the wage in the non-tradables sector when $\gamma = 0.4$ is equal to the wage in the tradables sector when $\gamma = 0.6$. The intuition is related to the fact that the central bank is equally concerned with wage pressure from the two sectors under this regime and γ and $1 - \gamma$ is a measure of the magnitude of the inflationary pressure generated by a wage increase in the non-tradables and tradables sectors, respectively. Thus, the extent to which wage setters in the two sectors are punished by the central bank for excessive wage claims is directly proportional to γ. The pattern in a monetary union is not as symmetric but nevertheless quite clear. In accordance with Proposition 2 wages in the non-tradables sector are always higher in a monetary union than under inflation targeting, while the reverse holds true for the tradables sector.

Turning to the ranking across sectors under a given regime and with immobile labour, note that under inflation targeting, wages in the tradables sector are only higher than wages in the non-tradables sector when $\gamma = 0.6$ which is consistent with Proposition 3. For the parameterisation considered here, the results in Table 3 suggest that in a monetary union, wages are always higher in the non-tradables sector than in the tradables sector. This is also consistent with Proposition 3 since with $\delta = 0.5$ I obtain $\frac{1+\sigma}{2} = 1$ which implies $w_{NM} > w_{TM}$ for all $\gamma < 1$.

3.3 Political Economy Analysis

In this section I perform some political economy analysis by evaluating which groups benefit from an inflation target and membership in a monetary union, respectively. Table 4 displays implied expected income levels of a worker and profits of firms in the two sectors under different regimes and assumptions about mobility.

[Table 4 about here]

Consider first the results with immobile labour. The results suggest that when there is no labour mobility, the expected income of a worker in the non-tradables sector is higher in a monetary union than under inflation targeting. This is mainly due to the fact that wages are always higher under that regime. Employment in the non-tradables sector is lower in a monetary union than under inflation targeting, but the difference across regimes is not sufficiently large to offset the difference in wages. Similarly, the expected income of a worker in the tradables sector is always higher under inflation targeting than in a monetary union. Turning to firms' profits, the results show that profits in both sectors are higher under inflation targeting than in a monetary union when labour is immobile between sectors. The result that firms in both sectors would prefer inflation targeting to membership in a monetary union may seem inconsistent with the notion that many advocates of a monetary union are found among firms and entrepreneurs in the tradables sector. However, the arguments typically made in favour of a monetary union, such as elimination of exchange rate risk, reduction of transaction costs and so forth, are not present in the model. Moreover, I analyse the incentives for wage restraint under the two regimes, and the subsequent effects on employment and profits but do not analyse shocks or evaluate the stabilising properties of the two monetary regimes.

Introducing mobility, expected income is equal in both sectors by assumption, and this is verified by the numerical results in Table 4. Since expected income is also equalised across regimes, a worker in any of the two sectors is indifferent between the two regimes. Moreover, profits are equalised due to wage equality and also a firm in either of the two sectors is indifferent between inflation targeting and membership in a monetary union.

Finally, Table 4 suggests that when labour mobility is introduced, profits always increase due to the reduction in wages and subsequent increase in employment established in Table 3.

Summing up, the model suggests that with immobile labour, all groups prefer inflation targeting to membership in a monetary union except for workers in the non-tradables sector who then prefer a monetary union to inflation targeting. When labour mobility is introduced, workers as well as firms in the two sectors are indifferent between the two regimes since they generate the same expected income and profits. This is a key result.

4 Concluding Remarks

I have presented a theoretical model of the impact of the monetary regime on wage setting and employment in a small open economy when there is potential labour mobility between sectors. I compare the outcomes under inflation targeting and in a monetary union when the exchange rate is irrevocably fixed. The monetary regime affects equilibrium wages and employment rates since wage setters take into account whether or not the central bank will react to their wage claims under a given monetary regime.

The main result of the paper is that when perfect labour mobility is introduced, the monetary regime does not matter for equilibrium real wages, profits or employment. As a consequence, workers as well as firms in the two sectors are indifferent between the two regimes since they generate the same expected income and profits. Introducing labour mobility substantially increases aggregate employment as a consequence of the reduction in wages that follows from the migration of workers between sectors.

With immobile labour, I show that the consumer real wage in the tradables sector is higher under inflation targeting than in a monetary union, while the consumer real wage in the non-tradables sector is higher in a monetary union than under inflation targeting. Moreover, the real wage is higher in the larger sector under inflation targeting, while in a monetary union the wage is higher in the non-tradables sector than in the tradables sector provided that the economy is sufficiently open (i.e. the non-tradables sector is not too large). The numerical solutions to the model suggest that, with immobile labour, aggregate employment levels are higher under inflation targeting than in a monetary union.

When investigating which interest groups in the economy benefit from which regimes under no labour mobility, a striking result is that the only group that prefers a monetary union to inflation targeting is workers in the non-tradables sector, who benefit from a fixed exchange rate since it generates higher expected income than inflation targeting. The fact that inflation targeting is preferred also by workers and firms in the tradables sector may at first seem contradictory to the notion that firms and entrepreneurs engaging in international trade often provide arguments in favour of membership in the EMU. However, in the policy debate, advocates of a monetary union generally refer to features not included in my model, such as elimination of exchange rate risk and transaction costs.

There are several interesting extensions to the model to be considered. First, I would like to allow for the fact that a large country in a monetary union may not treat the response of the nominal exchange rate as exogenous. This feature could be accounted for in the model by letting the response of the nominal exchange rate in the economy be proportional to the size of the country. Second, it would be interesting to consider complete centralisation in the model, i.e. a setting in which one single union sets nominal wages for the two sectors. Finally, a setting which has a lot of real-world relevance is the case where unions set wages sequentially, i.e. where one of the unions acts as a Stackelberg leader relative to the other.

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Tables

Table 3: Numerical Solutions of the Model, $\delta = 0.5$, $\lambda = 0.5$

	Regime	Monetary Union		Inflation Targeting	
		No mobility	Perfect mobility	No mobility	Perfect mobility
γ					
0.2	n_N	0.0311	0.1567	0.0532	0.1567
	n_T	0.425	0.6268	0.4581	0.6268
	n	0.4561	0.7835	0.4888	0.7835
	w_N	5.3202	1.451	3.3856	1.451
	w_T	1.5584	1.451	1.5719	1.451
	f		-0.3		-0.3
0.3	n_N	0.0717	0.2625	0.1132	0.2625
	n_T	0.3826	0.6125	0.4107	0.6125
	n	0.4543	0.875	0.5239	0.875
	w_N	3.708	1.451	2.5795	1.451
	w_T	1.6217	1.451	1.6582	1.451
	f		-0.2		-0.2
0.4	n_N	0.1287	0.3724	0.1872	0.3724
	n_T	0.3308	0.5586	0.3446	0.5586
	n	0.4595	0.931	0.5318	0.9310
	w_N	2.9019	1.451	2.1764	1.451
	w_T	1.6928	1.451	1.7734	1.451
	f		-0.1		-0.1
0.5	n_N	0.1997	0.475	0.2672	0.475
	n_T	0.2723	0.475	0.2672	0.475
	n	0.472	0.95	0.5344	0.9500
	w_N	2.4183	1.451	1.9346	1.451
	w_T	1.7734	1.451	1.9346	1.451
	f		0.0		0.0
0.6	n_N	0.2805	0.5586	0.3446	0.5586
	n_T	0.2101	0.3724	0.1872	0.3724
	n	0.4906	0.931	0.5318	0.9310
	w_N	2.0958	1.451	1.7734	1.451
	w_T	1.8655	1.451	2.1764	1.451
	f		0.1		0.1

Table 4: Expected Income and Firm Profits in the Two Sectors, $\delta = 0.5$, $\lambda = 0.5$

	Regime	Monetary Union		Inflation Targeting	
		No mobility	Perfect mobility	No mobility	Perfect mobility
γ					
0.2	V_N	1.2383	1.3462	1.2245	1.3462
	V_T	1.4698	1.3462	1.5212	1.3462
	Π_N	0.1656	0.2274	0.18	0.2274
	Π_T	0.6623	0.9094	0.72	0.9094
0.3	V_N	1.3604	1.3905	1.3322	1.3905
	V_T	1.4680	1.3905	1.5348	1.3905
	Π_N	0.2659	0.3809	0.2919	0.3809
	Π_T	0.6204	0.3809	0.6811	0.8887
0.4	V_N	1.4651	1.4176	1.4199	1.4176
	V_T	1.4473	1.4176	1.5228	1.4176
	Π_N	0.3733	0.5404	0.4073	0.5404
	Π_T	0.5600	0.8106	0.611	0.8106
0.5	V_N	1.5468	1.4268	1.4842	1.4268
	V_T	1.4063	1.4268	1.4842	1.4268
	Π_N	0.4829	0.6892	0.5169	0.6892
	Π_T	0.4829	0.6892	0.5169	0.6892
0.6	V_N	1.6004	1.4176	1.5228	1.4176
	V_T	1.3447	1.4176	1.4199	1.4176
	Π_N	0.5879	0.8106	0.611	0.8106
	Π_T	0.5879	0.5404	0.4073	0.5404

Appendix

A1 Proofs

Proposition 2 When labour is immobile between sectors, the ranking of regimes within each sector is as follows:

$$\begin{aligned} w_{TI} &> w_{TM} \\ w_{NM} &> w_{NI} \end{aligned}$$

Proof. According to Table 2 $w_{TI} > w_{TM}$ if and only if

$$\begin{aligned}
\left[\frac{\lambda + (1-\gamma)\sigma}{(1-\gamma)\sigma}\right] b &> \left[\frac{(1+\sigma)(\sigma+\lambda) - \gamma\sigma(1-\lambda)}{\sigma(1-\gamma+\sigma)}\right] b \Leftrightarrow \\
[\lambda + (1-\gamma)\sigma][\sigma(1+\sigma) - \gamma\sigma] &> (1-\gamma)\sigma[(1+\sigma)(\sigma+\lambda) - \gamma\sigma(1-\lambda)] \Leftrightarrow \\
[\lambda + (1-\gamma)\sigma][\sigma(1+\sigma) - \gamma\sigma] &> (1-\gamma)\sigma[(1+\sigma)\sigma - \gamma\sigma + \lambda(1+\sigma) + \lambda\gamma\sigma] \Leftrightarrow \\
\lambda[\sigma(1+\sigma) - \gamma\sigma] &> (1-\gamma)\sigma\lambda(1+\sigma+\gamma\sigma) \Leftrightarrow \\
1+\sigma-\gamma &> (1-\gamma)(1+\sigma+\gamma\sigma) \Leftrightarrow \\
\sigma &> (1-\gamma)(\sigma+\gamma\sigma) \Leftrightarrow \\
1 &> (1-\gamma)(1+\gamma) \Leftrightarrow \\
1 &> \left(1-\gamma^2\right) \Leftrightarrow \\
\gamma^2 &> 0
\end{aligned}$$

Similarly: $w_{NM} > w_{NI}$ if and only if

$$\begin{aligned}
\left[\frac{\lambda(1+\sigma) + \gamma\sigma(1-\lambda)}{\gamma\sigma}\right] b &> \left[\frac{\lambda+\gamma\sigma}{\gamma\sigma}\right] b \Leftrightarrow \\
\lambda(1+\sigma) + \gamma\sigma(1-\lambda) &> \lambda + \gamma\sigma \Leftrightarrow \\
\lambda\sigma(1-\gamma) &> 0
\end{aligned}$$

which holds true $\forall \gamma \in (0,1)$ and the proposition follows. ■

Proposition 3 When labour is immobile between sectors, the ranking of sectoral wages under a given regime is as follows:

$$\begin{aligned} w_{TI} &\geq w_{NI} \text{ if and only if } \gamma \geq \frac{1}{2} \\ w_{NM} &\geq w_{TM} \text{ if and only if } \gamma \leq \frac{(1+\sigma)}{2} \end{aligned}$$

Proof. According to Table 2 $w_{TI} \geq w_{NI}$ if and only if

$$\begin{aligned} \left[\frac{\lambda + (1-\gamma)\,\sigma}{(1-\gamma)\,\sigma}\right] b &\geq \left[\frac{\lambda + \gamma\sigma}{\gamma\sigma}\right] b \Leftrightarrow \\ \gamma\left[\lambda + (1-\gamma)\,\sigma\right] &\geq (1-\gamma)\left[\lambda + \gamma\sigma\right] \Leftrightarrow \\ \lambda\gamma + (1-\gamma)\,\sigma\gamma &\geq \lambda\,(1-\gamma) + (1-\gamma)\,\gamma\sigma \Leftrightarrow \\ \gamma &\geq (1-\gamma) \Leftrightarrow \\ \gamma &\geq \frac{1}{2} \end{aligned}$$

Moreover, $w_{NM} \geq w_{TM}$ if and only if

$$\begin{aligned} \left[\frac{\lambda\,(1+\sigma) + \gamma\sigma\,(1-\lambda)}{\gamma\sigma}\right] b &\geq \left[\frac{(1+\sigma)\,(\sigma+\lambda) - \gamma\sigma\,(1-\lambda)}{\sigma\,(1+\sigma-\gamma)}\right] b \Leftrightarrow \\ [1+\sigma-\gamma]\left[\lambda\,(1+\sigma) + \gamma\sigma\,(1-\lambda)\right] &\geq \gamma\left[(1+\sigma)\,(\sigma+\lambda) - \gamma\sigma\,(1-\lambda)\right] \Leftrightarrow \\ (1+\sigma)\left[\lambda\,(1+\sigma) + \gamma\sigma\right] &\geq \gamma\left[(1+\sigma)\,(\sigma+\lambda) - \gamma\sigma\,(1-\lambda) + \lambda\,(1+\sigma) + \gamma\sigma\,(1-\lambda)\right] \Leftrightarrow \\ \left[\lambda\,(1+\sigma) + \gamma\sigma\right] &\geq \gamma\left[\sigma + \lambda + \lambda\right] \Leftrightarrow \\ (1+\sigma) &\geq 2\gamma \Leftrightarrow \\ \frac{(1+\sigma)}{2} &\geq \gamma \end{aligned}$$

and the proposition follows. ■

A2 Nominal Value of Unemployment Exogenously Given

The nominal wage solves:

$$\max_{\ln W_{im}} \lambda_i \ln \left[\Lambda_i - \Lambda_{i0}\right] + (1-\lambda_i) \ln \left[(\eta-1)^{-1} \frac{W_{im}}{P_m} \left(\frac{W_{im}}{P_{im}}\right)^{-\eta}\right]$$

subject to

$$\begin{aligned}
N_{im} &= \left(\frac{W_{im}}{P_{im}}\right)^{-\eta} \\
f_m &= \frac{M_T N_{Nm}\left(w_{Nm}-b\right) - M_{Nm} N_{Tm}\left(w_{Tm}-b\right)}{N_{Nm}\left(w_{Nm}-b\right) + N_{Tm}\left(w_{Tm}-b\right)} \\
P_m &= P(W_{Nm}, W_{Tm}) \\
P_{im} &= P_i(W_{Nm}, W_{Tm}).
\end{aligned}$$

The first-order conditions for the union in the non-tradables and tradables sector, respectively, are:

$$\begin{aligned}
\lambda_N \left[-\eta\varphi_{Nm} - \frac{\frac{\partial f_m}{\partial \ln W_{Nm}}}{(M_N + f_m)} + \frac{w_{Nm}\epsilon_{Nm} + b\left(1-\epsilon_{Nm}\right)}{\left(w_{Nm}-b\right)}\right] + (1-\lambda_N)\left[\epsilon_{Nm} - \eta\varphi_{Nm}\right] &= 0 \quad (31) \\
\lambda_T \left[-\eta\varphi_{Tm} + \frac{\frac{\partial f_m}{\partial \ln W_{Tm}}}{(M_T - f_m)} + \frac{w_{Tm}\epsilon_{T} + b\left(1-\epsilon_{T}\right)}{\left(w_{Tm}-b\right)}\right] + (1-\lambda_N)\left[\epsilon_{Tm} - \eta\varphi_{Tm}\right] &= 0 \quad (32)
\end{aligned}$$

where

$$\begin{aligned}
\frac{\partial f_m}{\partial \ln W_{Nm}} &= \frac{\left(M_N + M_T\right) N_{Nm} N_{Tm}\left(w_{Tm}-b\right) b}{\left[N_{Nm}\left(w_{Nm}-b\right) + N_{Tm}\left(w_{Tm}-b\right)\right]^2} > 0 \\
\frac{\partial f_m}{\partial \ln W_{Tm}} &= -\frac{\left(M_N + M_T\right) N_{Nm} N_{Tm}\left(w_{Nm}-b\right) b}{\left[N_{Nm}\left(w_{Nm}-b\right) + N_{Tm}\left(w_{Tm}-b\right)\right]^2} < 0.
\end{aligned}$$

The first order conditions (31) and (32) show why there is wage equality under inflation targeting but not in a monetary union. Under inflation targeting, $\epsilon_{NI} = \epsilon_{TI} = 1$ and the additional term stemming from the effect on b vanishes. Thus, one may think of the case with an exogenous B under inflation targeting as a special case of the value of unemployment being given in real terms. In a monetary union $\epsilon_{iM} \neq 1$ and this difference in consumer price outcomes across regimes causes also real wages under inflation targeting to differ from real wages in a monetary union.

Substituting for equilibrium net flows, f_m, and $\partial f_m / \partial \ln W_{im}$ and letting $\hat{}$ denote the case with perfect mobility under the assumption of an exogenous B, I obtain the following expressions for the wage curves in the two sectors:

$$
\begin{aligned}
\widehat{w}_{Nm} &= \left[1+\frac{\lambda_N}{\eta\varphi_{Nm}-\epsilon_{Nm}}\right]b-\frac{\widehat{N}_{Tm}}{\widehat{N}_{Nm}}\left(\widehat{w}_{Tm}-b\right) \\
\widehat{w}_{Tm} &= \left[1+\frac{\lambda_T}{\eta\varphi_{Tm}-\epsilon_{Tm}}\right]b-\frac{\widehat{N}_{Nm}}{\widehat{N}_{Tm}}\left(\widehat{w}_{Nm}-b\right).
\end{aligned}
$$

Substituting the expression for relative employment (28) into the wage curves above yields equilibrium real wages on reduced form:

$$
\begin{aligned}
\widehat{w}_{Nm} &= \left[1+\frac{\lambda_N}{\eta\varphi_{Nm}-\epsilon_{Nm}}\left(1+\frac{\eta\varphi_{Tm}-\epsilon_{Tm}}{\lambda_T}\right)\right]\gamma b \\
\widehat{w}_{Tm} &= \left[1+\frac{\lambda_T}{\eta\varphi_{Tm}-\epsilon_{Tm}}\left(1+\frac{\eta\varphi_{Nm}-\epsilon_{Nm}}{\lambda_N}\right)\right](1-\gamma)\,b.
\end{aligned}
$$

Evaluating the wage curves for the equilibrium price elasticities I obtain:

$$
\begin{aligned}
\widehat{w}_{NI} &= \widehat{w}_{TI}=\left[\frac{\lambda+\sigma}{\sigma}\right]b \\
\widehat{w}_{NM} &= \left[\frac{\lambda+\sigma}{\sigma}\right][1+\sigma]\,b \\
\widehat{w}_{TM} &= \left[\frac{\lambda+\sigma}{1-\gamma+\sigma}\right]\left[\frac{1+\sigma}{\sigma}\right][1-\gamma]\,b.
\end{aligned}
$$

Thus, $w_{iI} \neq w_{iM}$ for $i = N, T$, i.e. the monetary regime matters for equilibrium real wages when the value of being unemployed is treated as exogenously given in nominal terms.

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