On Labour Mobility and the Neutrality of Money in Unionised Economies*

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Abstract

A recent literature suggests that when wage setters are non-atomistic, strategic interaction between trade unions and the central bank may cause the monetary regime to matter for the labour market outcome, see Cukierman and Lippi (1999), Soskice and Iversen (2000), Vartiainen (2002), Holden (2003), Lippi (2003), Corricelli et al (2006), Gnocchi (2006) and references therein. I show that when labour mobility is introduced in a game between large wage setters and the central bank in a small open economy, the monetary regime is of no importance for real wages, employment or profits. The result suggests that if worker mobility is sufficiently high, any labour market effects of monetary regimes are likely to be temporary at best.

Keywords: Inflation Targeting, Monetary Union, Labour Mobility, Neutrality of Money

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1 Introduction

A growing literature has recently challenged the paradigm of the neutrality of money by arguing that strategic interaction between non-atomistic wage setters and central banks may cause the monetary regime to matter for the real economy, see Cukierman and Lippi (1999), Soskice and Iversen (2000), Vartiainen (2002), Holden (2003), Lippi (2003), Corricelli et al (2006) and references therein.[1] The models in these papers typically consider the one-shot game between large wage setters and an independent central bank and are almost exclusively static in nature.[2] In this paper I make a simple claim: once labour mobility is introduced in a model of strategic interaction between large wage setters and a central bank in a small open economy, the monetary regime no longer matters for the labour market outcome. This suggests that the effects of the monetary regime are likely to be exaggerated in the aforementioned strand of literature with immobile labour. An alternative interpretation of my finding is that the monetary regime is likely to have merely transitory effects on labour markets as worker migration plausibly restores money neutrality in the long run.

Since the early 1990s, interest in the macroeconomic consequences of alternative monetary regimes has been unprecedented. The failure of previous attempts to sustain a system of fixed exchange rates has spurred substantial monetary reform over the last fifteen years. Parallel to the launch and implementation of the European Economic and Monetary Union (EMU), several countries have chosen to relinquish their fixed exchange rates by combining a floating currency with explicit inflation targeting. Since pioneered by New Zealand in 1990, inflation targeting has been adopted by, among others, Australia, Canada, Sweden, Norway and the UK. Consequently, the impact of alternative monetary regimes on macroeconomic performance has also attracted great interest in the research literature.

The starting point for the academic debate is the paradigm of money neutrality, stating that monetary policy has merely transitory effects, if any, on real variables such as employment and output. Students of unionised labour markets have recently come to question this classic result. The reason is that in the presence of an independent central bank, non-atomistic

[1] See Calmfors (2001) for a review.

[2] A notable exception is Gnocchi (2006) who considers a dynamic setting.

wage setters start to interact strategically. One mechanism put forward in the literature is that if unions are inflation averse, a liberal central bank may cause incentive for wage restraint and raise employment as unions internalise the inflationary effects of their wage claims, see Guzzo and Velasco (1999) and Cukierman and Lippi (1999). Conversely, Soskice and Iversen (2000) argue that a conservative central bank causes wage restraint and higher employment because of a deterrence effect. The idea is that a conservative central bank can discipline wage setters by threatening to pursue contractionary monetary policy when faced with excessive wage hikes. If such a monetary contraction reduces employment, it increases the cost associated with raising wages and provides incentive for wage restraint, see also Corricelli et al (2006). The aforementioned studies consider settings without cooperation between wage setters. Holden (2005) argues that a liberal central bank may create incentive for increased coordination and therefore lead to a lower equilibrium real wage. As a consequence, the deterrence effect may be present in labour markets with a low degree of cooperation but offset in labour markets with a strong element of corporatism. Although the majority of the literature considers 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 small open economies. These studies show that inflation targeting is likely to generate higher employment and welfare than credible exchange rate targeting.

I argue that when seeking to analyse sustainable effects of the monetary regime on labour market outcomes, models with sector-specific labour are too restrictive. To analyse permanent effects, one needs to allow for worker migration across sectors of the economy. If wages differ across sectors, rational workers will move to sectors where their expected income is higher. Therefore, the impact of the monetary regime on labour markets may be exaggerated in models where labour is immobile.[3]

This paper extends the previous literature on the interaction between large wage setters and the central bank in small open economies by considering a labour market set-up allowing for labour mobility between the tradables and non-tradables sectors. I distinguish between

[3] Lippi (2003) addresses a similar concern by modeling a closed economy with imperfect labour substitutability in production. He argues that for plausible parameter values, a sufficiently high degree of substitutability partly offsets the deterrence effect in Soskice and Iversen (2000). My analysis differs from Lippi (2003) in several respects.

national 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. The set-up draws on Holden (2003) but workers are presented with the option of migrating across sectors.

The main finding of the paper is that with perfect labour mobility across sectors, the monetary regime is of no importance for real wages, employment or profits. I also show that introducing labour mobility substantially reduces wages and increases employment.

The rest of the paper is organised as follows: The basic model is presented and solved in Section 2. Results are presented in Section 3. 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 the 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 through 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 in the other sector as given. In stage two, the response of the central bank depends on the wage set in the previous stage. Under inflation targeting, the central bank sets the nominal exchange rate, E, to keep the aggregate price level, P, constant. If the country is a member of a monetary union, then the nominal exchange rate is unchanged by definition and there is no monetary policy response to wage setting. Finally, in stage three, production, consumption and employment are determined as a consequence of the wage setting outcome in stage two. In this stage, workers also 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 how much to produce and utility-maximising households decide how much to consume. In 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 as the only input. 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

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

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

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

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

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

The aggregate price level is given by

$$P = P_N^{\gamma} P_T^{1-\gamma}. \tag{6}$$

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 only production of non-tradables.

Market clearing for non-tradables together with the aggregate budget constraint imply that $C_i = Y_i$, where Y_i is aggregate supply.[4] In what follows, I make the simplifying assumption that production technology is the same in the two sectors, i.e. $\delta_N = \delta_T \equiv \delta$. Using $C_i = Y_i$, the demand functions (5) and the supply functions (3), I obtain the following condition for "relative" market clearing:

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

[4] Note that market clearing in the non-traded sector $C_N = Y_N$ implies balanced trade. To see this, 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 $C_T = Y_T$.

2.1.3 The Labour Market

Below, I model the case with no labour mobility and the case with perfect labour mobility, respectively.[5] Throughout the paper, the case of no labour mobility will be treated as the benchmark case when investigating how labour mobility affects the impact of the monetary regime on real wages and employment.

2.1.4 No Labour Mobility

Consider first the case with no labour mobility. There is a fixed labour force M in the economy, which without loss of generality is normalised to one. Workers take wages as given and jobs are randomly assigned among workers. 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 it to be exogenously given. b can be thought of as the value of home production. A representative union member cares 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 $i = N, T$. To ensure that a worker prefers employment to unemployment, I assume that $w_i > b$ always holds in equilibrium.

2.1.5 Perfect Labour Mobility

Next, consider the case of 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 stock of workers who have migrated from sector T to sector N. The

[5] Note that the first case is equivalent to the static models in Holden (2003) and Vartiainen (2002).

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 impose a no-arbitrage condition stating that in equilibrium, there will be no utility gains from moving to the other sector, that is

$$V_N = V_T. \tag{11}$$

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

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

Solving for f I obtain:

$$f = \frac{M_T N_N (w_N - b) - M_N N_T (w_T - b)}{N_N (w_N - b) + N_T (w_T - b)}. \tag{12}$$

When membership, wages and employment levels are equal in the two sectors, i.e. when $M_N = M_T$, $w_N = w_T$ and $N_N = N_T$, there is no worker migration, i.e. $f = 0$. In this situation, workers receive the same utility from being a job seeker in either of the 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 national inflation targeting by adjusting the nominal exchange rate, E.[6] Since the model is static, I cannot distinguish between price level targeting and inflation targeting, but use the term inflation targeting throughout the paper. The central bank recognises that the law of one price holds for tradable goods, i.e. $P_T = EP_T^*$ 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

[6] 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.

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.[7] Membership in a monetary union can be modelled as an irrevocably fixed nominal exchange rate, i.e. $d \ln E = 0$.

Let subindex m denote the monetary regime, $m = M, I$ for the regimes monetary union and inflation targeting, respectively.[8] To evaluate the regime-specific impact of wages on prices, I 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:

$$d \ln P_N - d \ln P_T = \frac{\sigma}{1+\sigma} \left(d \ln W_N - d \ln W_T\right). \tag{13}$$

Together with the expression for the aggregate price level (6), (13) determines the elasticities of prices with respect to wages under the two monetary regimes. Taking logs and differentiating (6) I obtain

$$d \ln P = \gamma d \ln P_N + (1-\gamma) d \ln P_T. \tag{14}$$

The price elasticities are computed under the assumption $\frac{d \ln W_i}{d \ln W_j} = 0$. This follows because the equilibrium concept is Nash. When the wage is set in sector i, the nominal wage in sector j is taken as given. The equilibrium consumer and producer price effects are given in Table 1.

Under *inflation targeting,* the consumer price effects are zero by definition i.e. $d \ln P = 0$. However, nominal wage changes induce changes in producer prices. 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 (13) and rearranging gives the producer price elasticities in column (1).

[7] Differentiating the law of one price and the consumer price index, it follows that $d \ln E = -\frac{1}{(1-\gamma)} \left[\gamma d \ln P_N + (1-\gamma) d \ln P_T^*\right]$ under inflation targeting.

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

Table 1: Producer and consumer price effects under the two regimes

Regime (m)	Inflation Target (I)	Monetary Union (M)
	(1)	(2)
$\left(\frac{d\ln P_N}{d\ln W_N}\right)_m$	$\frac{(1-\gamma)\sigma}{1+\sigma}$	$\frac{\sigma}{1+\sigma}$
$\left(\frac{d\ln P_T}{d\ln W_N}\right)_m$	$-\frac{\gamma\sigma}{1+\sigma}$	0
$\left(\frac{d\ln P}{d\ln W_N}\right)_m$	0	$\frac{\gamma\sigma}{1+\sigma}$
$\left(\frac{d\ln P_T}{d\ln W_T}\right)_m$	$\frac{\gamma\sigma}{1+\sigma}$	0
$\left(\frac{d\ln P_N}{d\ln W_T}\right)_m$	$-\frac{(1-\gamma)\sigma}{1+\sigma}$	$-\frac{\sigma}{1+\sigma}$
$\left(\frac{d\ln P}{d\ln W_T}\right)_m$	0	$-\frac{\gamma\sigma}{1+\sigma}$

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 (13) and re-arranging yields the elasticities in column (2).

Under inflation targeting, the central bank ensures that the consumer price effects are zero. The mechanisms at work are as follows. Suppose that there is a wage increase in the non-tradables sector. This negative supply shock generates price 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 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 on both the price of non-tradables and the consumer price index. Therefore, the central bank depreciates the nominal exchange rate 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, there is no exchange-rate response to domestic wage changes. If the nominal wage in the non-tradables sector is raised by one percent, the price of non-tradables increases with a factor $\left(\frac{d\ln P_N}{d\ln W_N}\right)_M = \frac{\sigma}{1+\sigma}$ due to the negative effect on supply. The aggregate price level increases with a factor 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.[9] However, a wage increase in the tradables-sector causes a negative supply shift, which reduces tradables-sector output. This, in turn, leads to a fall in aggregate real income, which generates a fall in demand for non-tradables. This reduces the price of non-tradables and consequently, also the consumer price, so that $\left(\frac{d\ln P}{d\ln W_T}\right)_M = -\frac{\gamma\sigma}{1+\sigma}$.

2.3 Wage Setting

In the first stage of the game, wages are set through Nash bargaining between one large union and one employers' 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}, as discussed above. 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, the producer price of the own sector and the aggregate price level. In the case of perfect labour mobility, 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 allocation of the labour force.

2.3.1 No Labour Mobility

I assume that the union in sector i is utilitarian and cares about the sum of expected 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 employers' federation is to maximise real profits of the representative firm as given by (4). I assume that fall-back profits are zero, i.e. $\Pi_0 = 0$. Letting λ_i be the

[9] 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 $d\ln P_T = 0$.

relative bargaining power of the union in sector i, I define the Nash-product to be maximised in 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

$$\lambda_i\left[-\eta\varphi_{im} + \frac{w_{im}\epsilon_{im}}{(w_{im} - b)}\right] + (1-\lambda_i)\left(\epsilon_{im} - \eta\varphi_{im}\right) = 0 \tag{15}$$

The first-order condition states that the union's marginal gain of a wage increase must balance the marginal loss of the employers' federation. 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 so is the profit loss of firms. 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:

$$w_{im} = \left[1 + \frac{\lambda_i\epsilon_{im}}{\eta\varphi_{im} - \epsilon_{im}}\right]b. \tag{16}$$

Note that (16) represents two equations since $i = N, T$. The regime-specific price-elasticities φ_{im} and ϵ_{im}, show how the monetary regime influences wage setting, and are therefore key parameters of interest. They display how wage setters 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.

2.3.2 Perfect Labour Mobility

When there is perfect labour mobility, the union still seeks to maximise the sum of expected utilities of its members. Consider the union in sector i. Let M_{ii} denote the number of workers who stay in sector i and seek employment. Then $M_i - M_{ii}$ workers move to sector j to look for a job in that sector. 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 hold that $V_i = V_j$ because of worker migration, the objective function of the union is still given by

$$\Lambda_i = M_i V_i$$

If the parties fail to reach an agreement, members obtain the value associated with being unemployed, so that fall-back utility is $\Lambda_{i0} = M_i b$. This presumes that if parties fail to reach an agreement, workers in sector i cannot apply for a job in sector j. This can be taken to represent an implicit agreement between employers not to undermine each others' bargaining positions by hiring from the workforce of other employers during a conflict. The objective functions of the two unions may be written:

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

The maximisation is now also subject to (12), which determines f_m.

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

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

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. They also take into account that their wage decisions may affect prices in sector j. The first-order conditions for the union in the non-tradables and tradables sector, respectively, are:

$$\lambda_N \left[-\eta\varphi_{Nm} - \frac{\frac{\partial f_m}{\partial \ln W_{Nm}}}{(M_N + f_m)} + \frac{w_{Nm}\epsilon_{Nm}}{(w_{Nm} - b)}\right] + (1-\lambda_N)(\epsilon_{Nm} - \eta\varphi_{Nm}) = 0 \tag{17}$$

$$\lambda_T \left[-\eta\varphi_{Tm} + \frac{\frac{\partial f_m}{\partial \ln W_{Tm}}}{(M_T - f_m)} + \frac{w_{Tm}\epsilon_{T}}{(w_{Tm} - b)}\right] + (1-\lambda_T)(\epsilon_{Tm} - \eta\varphi_{Tm}) = 0 \tag{18}$$

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 there and thus, reducing union rents in the sector.

The effect on net worker migration 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

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

Ceteris paribus, a wage increase in the non-tradables sector causes a net inflow of workers to the 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. The first-order conditions for wage setting imply

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

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

where $\partial f_m / \partial \ln W_{im}$ is given by the above expressions. Unions now also internalise the impact of their wage claims on prices in sector j since they take into account that some of their members may move to that sector, but one may show that these effects and the producer price effects in the own sector cancel out, implying that they do not matter for the optimal wage.

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

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

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

Real wages are now functions of employment in the two sectors and of wages in the other sector. One may show that wages are increasing in employment in the own sector and that the wage curves are concave in employment-real wage space:

$$\frac{\partial \widetilde{w}_{im}}{\partial \widetilde{N}_{im}} > 0$$

$$\frac{\partial^2 \widetilde{w}_{im}}{\partial \widetilde{N}_{im}^2} < 0.$$

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 (16) and (21)-(22) imply that $w_{im} > \widetilde{w}_{im}$ if and only if $\frac{\lambda_i(1-\epsilon_{im})}{(\eta\varphi_{im}-\epsilon_{im})} b + (\widetilde{w}_{jm} - b) > 0$. In equilibrium, this holds true $\forall j, m$ and the proposition follows. ■

Key to understanding the above proposition is 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 an incentive for wage restraint since unions 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 own sector, thus reducing employment probabilities and utility of their own members.[10]

2.4 Equilibrium

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

$$N_{Nm} = w_{Nm}^{-\eta}\left(\frac{w_{Nm}}{w_{Tm}}\right)^{(1-\gamma)\sigma}\left(\frac{\gamma}{1-\gamma}\right)^{(1-\gamma)} \tag{23}$$

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

In equilibrium, four equations determine the four endogenous variables: w_{Nm}, w_{Tm}, N_{Nm} and N_{Tm}. The equations are the labour demand equations in each sector, (23) and (24), the sectoral wage equations (16) or (21) and (22) (evaluated for $i = N, T$ and the equilibrium price elasticities in Table 2.1).

2.4.1 No Labour Mobility

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

$$w_{Nm} = \left[1 + \frac{\lambda_N \epsilon_{Nm}}{\eta\varphi_{Nm} - \epsilon_{Nm}}\right] b \tag{25}$$

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

Wages in the two sectors are a positive mark-up on the value of unemployment. Given wages, employment rates are determined according to (23) and (24).

[10] Numerical results, available on request, suggest that the difference between the cases with immobile and mobile labour are substantial and hence that mobility is quantitatively important.

2.4.2 Perfect Labour Mobility

Next, consider the case of perfect labour mobility. Dividing (23) by (24) implies:

$$\frac{\widetilde{N}_{Nm}}{\widetilde{N}_{Tm}} = \left(\frac{\widetilde{w}_{Tm}}{\widetilde{w}_{Nm}}\right)\left(\frac{\gamma}{1-\gamma}\right). \tag{27}$$

Substituting the expression for relative employment (27) into the wage equations (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:

$$\widetilde{w}_{Nm} = \left[\frac{\eta\varphi_{Tm} - \epsilon_{Tm} + \eta\varphi_{Nm} - \epsilon_{Nm} - \lambda\left(1 - \epsilon_{Nm} - \epsilon_{Tm}\right)}{\left(\eta\varphi_{Nm} - \epsilon_{Nm}\right)\epsilon_{Tm} + \left(\eta\varphi_{Tm} - \epsilon_{Tm}\right)\left(1 - \epsilon_{Nm}\right)}\right]\gamma b \tag{28}$$

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

Wages are still a markup on the value of unemployment, but the markup is now interacted with sector sizes. As in the case with immobile labour, employment rates are determined according to (23) and (24).

2.4.3 Decentralised Wage Setting

I next derive the wage curve under the assumption of atomistic wage setting. Suppose that wages are negotiated in bargaining units that are so small that the wages set are unable to influence prices. Clearly, the monetary regime will be of no importance for real wages or employment under this assumption. 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 (16), and the wage in the case with no mobility reads

$$\widehat{w}_{im} = \left[1 + \frac{\lambda_i}{\eta - 1}\right] b. \tag{30}$$

The real wage is a constant mark-up on the real value of unemployment.

3 Analysis

In this section, I compare the equilibria under the two different regimes analytically.

Table 2: Equilibrium real wages

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	
$\widetilde{w}_{NI}$	$\left[\frac{\lambda+\sigma}{\sigma}\right] b$
$\widetilde{w}_{TI}$	$\left[\frac{\lambda+\sigma}{\sigma}\right] b$
$\widetilde{w}_{NM}$	$\left[\frac{\lambda+\sigma}{\sigma}\right] b$
$\widetilde{w}_{TM}$	$\left[\frac{\lambda+\sigma}{\sigma}\right] b$

3.1 Equilibrium Real Wages

Inserting the equilibrium price elasticities in Table 1 and simplifying, gives the reduced-form expressions for regime-specific consumer real wages given in Table 2. It is easy to verify Proposition 1 by looking at reduced-form wages: wages are always lower when labour is mobile.

As discussed above, the monetary regime does matter for equilibrium real wages and employment when labour is immobile. Since this case has been analysed in detail by Holden (2003) and Vartiainen (2002), the ranking of regime-specific real wages within a given sector is only briefly summarised here.[11] A key result from the model without mobility is that in the tradables sector, real wages are higher under inflation targeting than in a monetary union, while the reverse ranking applies to the non-tradables sector. 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.

[11] Larsson (2007) discusses the real wage ranking across sectors, within a given regime.

Turning to the main focus of the paper at hand, i.e. the case with perfect labour mobility, it is straightforward to prove the following result.

Proposition 2 *When there is perfect labour mobility, there is wage equality across sectors and regimes, i.e.*

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

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 is of no importance.[12] The result is not self-evident, since it is the expected utility of a worker that should be the same in the two sectors and not wages - according to the no-arbitrage condition (11). However, it turns out that the first-order conditions for wage setters are the same in the two sectors regardless of regime. This can be seen by substituting for equilibrium relative labour demand (27) into (17) and (18).

An alternative interpretation of this result follows from noticing that the case with perfect labour mobility is equivalent to assuming either complete decentralisation or complete centralisation. Since both unions fully internalise the impact of their wage decisions when workers are free to migrate, they set the same nominal wages as one single union would choose. This means that Proposition 2 is consistent with the previous literature stating that when there is complete centralisation, the monetary regime does not matter for the real wage outcome. Since the two settings generate the same outcome, the result suggests that labour mobility can substitute for complete centralisation. This is also a novel finding.

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 with and without labour mobility between sectors. I have compared the outcomes under inflation targeting and in a monetary union when the exchange rate is irrevocably fixed. When labour is immobile, the monetary regime affects

[12] The result that the regime is of no importance hinges on the assumption of the utility of the unemployed being exogenously given in real terms. The case where the utility of the unemployed is interpreted as an unemployment benefit is discussed in Larsson (2007).

equilibrium wages and employment rates since wage setters take into account how the central bank will react to their wage claims.

The main result is that with perfect labour mobility, the monetary regime is of no importance 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. Labour mobility substantially increases aggregate employment as a consequence of the moderation induced in wages. Another key result is that perfect labour mobility can substitute for complete centralisation.

There are several interesting extensions to the model to be considered. First, one could 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, a setting with great relevance in reality is the case where unions set wages sequentially, i.e. where one of the unions acts as a Stackelberg leader relative to the other.

Finally, I would like to emphasise that although the model is stylised and real-world labour mobility is less than perfect, the analysis illustrates an important point: worker migration is likely to offset effects over time. Monetary institutions may indeed have short-term effects on wage formation, but their importance is likely to be exaggerated in models with immobile labour.

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