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Wage setting under different Monetary regimes

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Preliminary version, comments welcome

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Abstract

In a model with a traded and a non-traded sector and centralised wage setting within each sector, it is shown that the monetary regime affects the trade-off between consumer real wages and employment and profits. Thus, the monetary regime affects the outcome of the wage negotiations, and consequently also the equilibrium level of unemployment. An exchange rate target is likely to involve lower wages and higher employment in the traded sector, and higher wages and lower employment in the non-traded sector, than does a price target.

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I. Introduction

In recent years several countries have chosen to adopt a monetary regime with an explicit focus on price stability. At the same time there has been a growing literature that analyse the workings of an economy with an explicit price or inflation target, cf eg Leiderman and Svensson (1995) and Bernanke and Mishkin (1997). Various regimes have been explored according to comparisons based on the level and variability of the rate of inflation, and the variability of output and possibly other variables. In the analysis, the equilibrium level of output is usually taken as given, based on the view that the equilibrium rate of unemployment (and the associated equilibrium levels of employment and output) is determined in the labour market. Thus, the equilibrium level of output cannot be affected by monetary policy.[1]

In this paper I shall argue that the choice of monetary regime may indeed affect the equilibrium levels of output and employment in an economy with non-atomistic wage setting. The reason is that different monetary regimes involve different reaction functions of the central bank to the outcome of the wage setting. The difference in reaction functions will in general imply that large wage setters face a different trade-off between consumer real wages and employment and profits. In a regime where the monetary policy dampens the negative effects on employment and profits of a marginal increase in the consumer real wage, the wage bargaining is likely to result in a high real wage level, and an associated low level of employment and output.

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[1] Sometimes, however, there is a caveat concerning the possible existence of hysteresis, which would imply that the variability in output has persistent effects on the output level. Less often, there is also remark on the more general view that stability per se is likely to have beneficial long-run effects, and thus may also affect the level of output. The present paper does not rely on hysteresis effects nor on effects of stability per se.

I have chosen to compare two regimes; an exchange rate target regime and a price level target regime (a target for the consumer price level).[2] From a theoretical point of view, these regimes serve well in illustrating the consequences of the choice of monetary regime. From a practical point of view, these two regimes are for many countries the two most plausible alternatives. In Europe, Denmark, Sweden and UK have still not decided whether to join the European Monetary Union (which for a single country essentially involves an exchange rate target, even if the monetary union itself has an inflation target). In Norway, there is an ongoing debate on whether the current regime aimed at exchange rate stability should be replaced by a regime with an explicit inflation target (cf Christiansen and Qvigstad, 1997). The regimes do not differ with respect to the underlying monetary target, which is low inflation in both regimes; fixed exchange rates are often seen as a means of importing price stability from a low inflation country.

The basic model of the paper is static, where wages are set in negotiations between unions and employers, and where employment then is given by the labour demand function of the firms. Thus, the equilibrium levels of employment and output are given in the labour market. Furthermore, changes in parameters (or monetary regime) that imply that the wage bargaining result in higher wages have a negative effect on employment and output. These are standard properties of models with an equilibrium rate of unemployment/equilibrium level of employment, cf eg Layard, Nickell and Jackman (1991) or Dixon (1987).

Compared to the standard literature on equilibrium unemployment, an important modification in the present paper is that there is an explicit distinction between firms in the

[2] As the model is static, and none of the specified agents are assumed to care about inflation per se, a price level target is identical to an inflation target in the theoretical model in the present paper.

traded and non-traded sectors. This distinction seems important in a comparison of different monetary regimes, as the implications of a given monetary policy are likely to be very different in these two sectors. Under an exchange rate target, higher wages in the non-traded sector result in higher prices on non-traded goods, which mitigates the gain in real wages. In contrast, higher wages in the traded sector have no direct effect on the consumer price level, as long as the price is given at the world market. In fact, if higher traded sector wages reduce aggregate output, the ensuing negative income effect will reduce prices in the non-traded sector. In this case consumer prices fall, adding to the rise in real wages. Under a price level target, the sectors differ with respect to the extent employment and profits are affected by a change in the exchange rate.[3] As will be shown below, the monetary regime has different impact on the traded and non-traded sectors, thus also affecting the relative price of traded versus non-traded goods.

In the analysis, I take as given that the monetary target is fulfilled in equilibrium. Furthermore, I assume that the wage setters know that this will be the case. As for an exchange rate target, one possible interpretation is that there a common currency (as within the EMU), another possible interpretation is that the government in question has established sufficient credibility for sticking to a fixed exchange rate. (The case where the monetary target is non-credible is omitted for reasons of space; cf. however Horn and Persson, 1988, or Holden, 1991). A credible price target may for example be associated with a country where

[3] In actual economies the distinction between traded and non-traded goods is blurred. Furthermore, over time an increasing number of goods have been subject to international trade. However, it is still the case that various sectors differ considerably concerning
(i) to what extent a wage rise affects the consumer price level, and (ii) whether sectoral demand depends mostly on aggregate domestic demand, or on cost competitiveness (and thus also the exchange rate).

the central bank has established credibility for realising its price target. Thus, I abstract from the important issue of how to establish credibility of monetary policy.

The model that I use is a static equilibrium model, with no shocks. This implies that the model cannot be used to discuss the stability properties of the various monetary regimes (on this, see e.g. Rødseth, 1996, or Leitemo and Røisland, 1999, Røisland and Torvik, 1999, Svensson, 1998, Berger and Schjelderup, 1998). Furthermore, it is not possible to follow how the economy evolves over time under the different regimes. One implication of this is that there is no distinction between different forms of price level target regimes, as strict and flexible inflation targeting (see Svensson, 1998).

The present paper is not the first to study the relationship between monetary policy and equilibrium unemployment; see Cubitt (1992, 1995), Bleaney (1996), Skott (1997) and Cukierman and Lippi (1997). These papers investigate the interaction between the central bank and the wage setters, with one implication being that the equilibrium level of employment is endogenous. However, these papers restrict attention to closed economies, where the exchange rate plays no role. Jensen (1997) studies the effects of monetary policy co-operation on inflation and employment. My paper is, however, closer to two papers by Wibaut (1998a,b); in particular (1998b) which compares fixed and floating exchange rate regimes in an economy with monopoly unions in the traded and non-traded sectors.[4] Lawler (1998) compares an optimal managed float with a fixed exchange rate in an economy with a single monopolistic trade union.

At the more technical level, my paper also resembles Rasmussen (1992,1996). In his 1992 paper, Rasmussen focus on the asymmetry between traded and non-traded sectors; in the

[4] I was made aware of these papers after having presented my paper at the EEA Conference in Berlin, 1998.

1996 paper, the main idea is that the price normalisation rule affects the real economy in an economy with large wage setters. In neither of these papers, Rasmussen compares different monetary regimes.

The paper is organised as follows. The model is presented in section II, while section III explores the equilibrium of the model, as well as providing results of numerical simulations. In section IV, the model is extended to an infinite horizon. This extension involves the additional realism that the nominal interest rate is the policy instrument of the central bank. Section V concludes.

II. The model

The economy under consideration consists of two sectors, with traded and non-traded goods. In each sector there is a large exogenous number, n, firms and one union organising all workers in the sector. There is a uniform wage in each sector, which is set in a central bargain between the union and the employers' federation in the sector. Within each sector, firms are identical, producing a homogeneous good, with labour as the only input. The output price of the traded good is given at the world market, $P^T = SP^*$, where S is the nominal exchange rate, and P* is the exogenous price at the world market. Households are either workers (who belong to either of the sector specific trade unions) or shareholders (who receive all profits of the firms). Throughout the paper, all agents are assumed to have perfect information.

The sequence of moves in the model is the following. First, wages are set simultaneously in each sector. Second, the central bank sets the exchange rate so as to ensure that the monetary target is fulfilled. Third, production and consumption take place.

Households

There is large number, M, households in the economy, of which M^j are members of the union in sector j, j = T, N, and $M - M^T - M^N$ are shareholders. All households have identical preferences that are separable in consumption and leisure, and where the subutility function associated with consumption is of the CES-type. The utility function of household h is

$$(1)\ V_h = \left[\gamma^{1/\rho}(C_h{}^N)^{(\rho-1)/\rho} + (1-\gamma)^{1/\rho}(C_h{}^T)^{(\rho-1)/\rho}\right]^{\rho/(\rho-1)} + v(H_h)\,,$$

$$0<\gamma < 1,\ \rho>0,\ \rho\neq 1,\ h=1,2,..\ M$$

where C_h^N and C_h^T are consumption of non-traded and traded goods respectively, ρ is the elasticity of substitution, and $v(H_h)$ is the subutility function associated with leisure, H_h. Workers supply labour inelastically, so without loss of generality we can set $v(H_h) = 0$ for employed workers and $v(H_h) = v_0 > 0$ for unemployed workers. Cobb-Douglas utility can be seen as a special case of (1), where ρ = 1:

$$(1')\qquad V_h = \frac{1}{a}(C_h{}^N)^{\gamma}(C_h{}^T)^{\gamma} + v(H_h), \qquad a = \gamma^{\gamma}(1-\gamma)^{1-\gamma},\quad 0<\gamma < 1,\ h=1,2,..\ M$$

The budget constraint of household h is $P^N C_h^N + P^T C_h^T = I_h$, where I_h is the nominal income of household h. Utility maximisation yields the demand functions

$$(2)\qquad (a)\qquad C_h{}^N = \gamma\left(\frac{P^N}{P}\right)^{-\rho} I_h \qquad\qquad (b)\qquad C_h{}^T = (1-\gamma)\left(\frac{P^T}{P}\right)^{-\rho} I_h\,,$$

where P^j is the price of goods from sector j, j = T,N.

Aggregate consumption demand is found by aggregating over all households; this is simple because households have identical, homotetic utility functions, so that the income distribution does not affect demand. Aggregate nominal income $\Sigma_h I_h =$ PY, where

(3) $Y = (P^N Y^N + P^T Y^T)/P$

is the real aggregate output in the economy, Y^j is output in sector j, j = T,N, and

(4) $P = (\gamma (P^N)^{1-\rho} + (1-\gamma)(P^T)^{1-\rho})^{1/(1-\rho)}$,

is the consumer price index that corresponds to the CES utility function (1). If ρ = 1 (the Cobb-Douglas case), the price index is

(4') $P = (P^N)^{\gamma}(P^T)^{1-\gamma}$.

Aggregate domestic demand for traded goods, and aggregate demand for non-traded goods are

(5) (a) $C^N = \gamma\left(\frac{P^N}{P}\right)^{-\rho} Y$ (b) $C^T = (1-\gamma)\left(\frac{P^T}{P}\right)^{-\rho} Y$

Firms

The production function of a firm in the traded (T) or non-traded (N) sector is

(6) $Y^j = (1/\beta)\,(L^j)^{\beta}$, $0 < \beta < 1$, j = T, N,

where L^j is employment (to simplify notation I do not distinguish between aggregate and firm-level variables; taken literally there is only "one" firm in each sector which nevertheless acts as a price taker). The real profits of a firm in sector j are

(7) $\pi^j = (P^j Y^j - W^j L^j)/P,$ $j = T,N,$

where W^j is the nominal wage in the sector.

Profit maximisation at exogenous price and wage levels, using the production function (6), results in the labour demand and supply functions

(8) $L^j = (P^j/W^j)^{1/(1-\beta)},$ $j = T, N,$

(9) $Y^j = (P^j/W^j)^{\beta/(1-\beta)}\beta^{-1},$ $j = T,N.$

Substituting out for (8) and (9) in (7), the real profits of a firm are

(10) $\pi^j = (1-\beta)\beta^{-1} (P^j)^{1/(1-\beta)} (W^j)^{-\beta/(1-\beta)}/P.$

Unions

Unions are assumed to utilitarian in the sense that they maximise the sum of their members' utilities. The indirect utility of an employed worker in sector j is (using (1) and (2))

(11) $u^j = (W^j - T^j)/P,$

where T^j is the fee paid by union members to the unemployment insurance fund in the sector. The unemployment insurance fund in each sector is assumed to be fully financed by fees paid by workers in the sector, so that $T^j L^j = B^j(M^j - L^j)$, where B^j is the nominal unemployment benefit in sector j.[5] The indirect utility function of an unemployed worker in sector j is

$$(12) \qquad u_b^j = B^j/P + v_0.$$

The sum of utilities of union members is (using (11) and (12))

$$(13) \qquad U^j = L^j u^j + (M^j - L^j)u_b^j = L^j W^j/P + (M^j - L^j)\, v_0 = (W^j/P - v_0)\, L^j + M^j v_0.$$

Monetary policy

I consider two alternative regimes, a price target $P = P^G$ and an exchange rate target $S = S^G$. Both targets are assumed to be perfectly credible. The central bank sets the exchange rate so that the monetary target always is fulfilled, and all agents in the model know that this will be the case. The alternative monetary regimes involve different response functions for the central bank, that is, for various outcomes of the wage setting, the exchange rate set by the central bank will differ.

Wage setting

The wage setting takes place simultaneously in both sectors, so that the outcome of the wage setting in one sector cannot affect the wage setting in the other sector. As there is no uncertainty, the wage setters in one sector can perfectly predict the outcome in the other

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[5] As is apparent from equation (13) below, the level of the unemployment benefit does not matter when benefits are fully financed by the workers in the sector, and utility functions are linear.

sector. Formally, there is a Nash equilibrium in a static game between the wage setters in each sector, as represented by the Nash maximand.

In case of a dispute in the bargaining, the workers go on strike, so that the firm earns zero profits. Workers on strike have no strike pay, and derive no utility from leisure while they strike, so their utility is zero. The M^j - L^j unemployed workers are not affected by the strike, so they have utility v_0. The union part of the Nash maximand is thus

$$(14) \qquad U^j - U_0^j = (W^j/P - v_0)\, L^j, \qquad j, = T,N.$$

The outcome in the wage setting is given by the Nash bargaining solution, that is, W^j is set so as to maximise the Nash product

$$(15) \qquad H^j = (U^j - U_0^j)\, \pi^j, \qquad J = T, N.$$

Substituting out using (7), (8), and (14), the Nash product reads (letting lower case letters denote natural logarithm)

$$(16) \qquad h^j = \ln(W^j/P - v_0) - (1/(1-\beta))\, w^j + (1/(1-\beta))\, p^j$$
$$+ \ln((1-\beta)/\beta) + (1/(1-\beta))p^j - (\beta/(1-\beta))\, w^j - p, \qquad j = T, N.$$

III. Equilibrium

Equilibrium of the model is a situation where households choose consumption so as to maximise their utility; firms set employment so as to maximise their profits; the central bank sets the exchange rate to achieve the monetary target; the sectoral wage is set in a Nash bargain in each sector; and the price of non-traded goods is given by the market clearing condition

(17) $$C^N = Y^N.$$

From the budget condition of the households, it follows that there is balanced trade, $Y^T = C^T$, in equilibrium.

The crucial issue of the model is how the monetary regime affects the wage setting. To investigate this relationship, it is necessary to explore how the economy responds to the outcome of the wage setting under the two different monetary regimes. In particular, it is important to investigate how the various prices (traded, non-traded and consumer prices) are affected by a marginal wage rise under each regime. From the definition of the consumer price level (4), total differentiation yields (in log form)

(18) $$dp = \gamma^i\, dp^N + (1-\gamma^i)\, dp^T,$$

where

(19) $$\gamma^i \equiv \left(\frac{P^N Y^N}{PY}\right)^i = \gamma\left(\frac{P^N}{P}\right)^{1-\rho}, \qquad i = S, P,$$

is the equilibrium share of non-traded goods of total nominal output under monetary regime i. (The latter equality can be derived from (5a), using that $C^N = Y^N$ in steady state.)

Under an exchange rate target, the price of traded goods is constant, so that there is a simple relationship between changes in prices on non-traded goods and changes in consumer prices

(20) $dp = \gamma^j \, dp^N$.

Under a price target, the central bank must set the exchange rate so that changes in the prices of traded and non-traded goods balance each other, that is, dp = 0, which entails that

(21) $dp^N = -((1-\gamma^j)/\gamma^j) \, dp^T$.

Wage setting in the traded sector

The wage level in the traded sector, W^T is set so as to maximise the Nash product (16). Under an exchange rate target, the exchange rate, and thus also the price of traded goods, is constant, while the consumer price level is endogenous. The first order condition is

(22) $$\frac{dh^T}{dw^T}\Big|_{s=s^G} = \frac{W^T/P}{W^T/P - v_0} - \frac{1}{1-\beta} - \frac{\beta}{1-\beta} - \frac{dp}{dw^T} = 0 \ .$$

The Nash bargaining solution implies that the wage level is set so that the marginal gain of higher wages for the union (the first two terms in (22)) is balanced by the marginal loss for the employers (the last two terms in (22)). (22) can be rearranged to

(23) $$\frac{W^T/P}{W^T/P - v_0} = \frac{1+\beta}{1-\beta} + \frac{dp}{dw^T} \ .$$

The last term in (23), the effect on the consumer price level of a marginal rise in traded sector wages, can be derived from the market clearing condition (17) in the non-traded sector. Substituting out for (5a), (3) and (9), (17) reads (in log form)[6]

$$(24)\ \frac{\beta}{1-\beta}(p^N - w^N) - \ln\beta = \ln\gamma - \rho(p^N - p) + \ln(((e^{p^T})^{1/(1-\beta)}(e^{w^T})^{-\beta/(1-\beta)}\beta^{-1} + ((e^{p^N})^{1/(1-\beta)}(e^{w^N})^{-\beta/(1-\beta)})\beta^{-1} / e^{p})$$

Total differentiation of (24) with respect to the endogenous variables w^T, p^N and p, recalling that p^T is exogenous under an exchange rate target, yields

$$(25)\quad \frac{\beta}{1-\beta}dp^N = -\rho(dp^N - dp) + \gamma^S\left(\frac{1}{1-\beta}dp^N\right) (1-\gamma^S)\left(-\frac{\beta}{1-\beta}dw^T\right) - dp$$

Substituting out for dp in (25), using (20), and rearranging, we obtain

$$(26)\quad \frac{dp^N}{dw^T} = \frac{-\beta}{\beta + \rho(1-\beta)} < 0\,.$$

Thus, using (20),

$$(27)\quad \frac{dp}{dw^T} = \frac{-\gamma^S\beta}{\beta + \rho(1-\beta)} < 0\,.$$

[6] To derive (24), observe that (using (3) and (9))

$$\ln Y = \ln((P^T Y^T + P^N Y^N)/P) = \ln(((e^{p^T})^{1/(1-\beta)}(e^{w^T})^{-\beta/(1-\beta)}\beta^{-1} + ((e^{p^N})^{1/(1-\beta)}(e^{w^N})^{-\beta/(1-\beta)}\beta^{-1}) / e^{p})$$

Higher nominal wages in the traded sector lead to lower consumer prices via the following mechanism. Higher wages in the traded sector reduce traded sector output, so that aggregate output and income are reduced. When households' income go down, they reduce their demand for non-traded goods, inducing a reduction in the price on non-traded goods, and thus also a reduction in consumer prices.

The dampening effect on consumer prices of a wage rise in the trade sector is favourable to the wage setters in the traded sector, which will lead them to agree on a higher real wage than they would have done if the consumer price level were exogenous. The outcome of the wage negotiations is found by substituting out for (27) in (23), and rearranging, which yields

$$(28) \qquad \frac{W^T}{P} = \frac{k_S{}^T}{k_S{}^T - 1} v_0 \qquad \textit{where} \quad k_S{}^T = \frac{1+\beta}{1-\beta} - \frac{\gamma^S \beta}{\beta + \rho(1-\beta)} \ .$$

Given that $k_S{}^T$ is greater than unity, there exists a unique positive outcome W^T/P to the wage negotiations. $k_S{}^T$ is above unity if $2/(1-\beta) > \gamma^S/(\beta+\rho(1-\beta))$, which is fulfilled for reasonable parameter values. Here and below, I restrict attention to parameter values for which a positive solution exists. (The case where $k_S{}^T$ is below unity corresponds to the case where the Nash product is increasing for all w^T, because even though the profit level converges to zero as w^T goes to infinity, the payoff of the union goes to infinity sufficiently fast to outweigh the decreasing profit level.) Here and below I also assume that the bargaining outcome is an interior solution, i.e. that there is positive unemployment. This requires that the number of union members M^j is sufficiently large.

Under a price target, the outcome of the wage bargain is found by maximising (16) with respect to w^T, holding the consumer price fixed, but taking into consideration that the exchange rate, and thus also the price on traded goods, is endogenous. As above, the first order condition can be rearranged to

(29) $$\frac{W^T / P}{W^T / P - v_0} = \frac{1+\beta}{1-\beta} + \frac{2}{1-\beta}\frac{dp^T}{dw^T} .$$

The last term in (29), the effect on the price of traded goods of a marginal rise in traded sector wages, is derived using the same approach as above. Total differentiation of (24) with respect to the endogenous variables w^T, p^N and p^T, recalling that p is exogenous under a price target, yields

(30) $$\frac{\beta}{1-\beta}dp^N = -\rho dp^N + \gamma^p\left(\frac{1}{1-\beta}dp^N\right)$$
$$(1-\gamma^p)\left(\frac{1}{1-\beta}dp^T - \frac{\beta}{1-\beta}dw^T\right)$$

Substituting out for dp^N using (21), and rearranging, gives us

(31) $$\frac{dp^T}{dw^T} = \frac{\gamma^P \beta}{\beta + \rho(1-\beta)} > 0 .$$

Higher nominal wages in the traded sector lead to higher prices on traded goods, via the following mechanism. Higher wages in the traded sector reduce traded sector output, so that aggregate output and income is reduced. When households' income go down, they reduce their demand for non-traded goods, inducing a reduction in the price on non-traded goods, with a corresponding dampening effect on consumer prices. To maintain the price target, the central bank devalues the currency, so that traded sector prices increase measured in domestic currency.

The increase in traded sector prices is favourable to the wage setters in the traded sector, as it mitigates the negative effect on employment and profits. This will lead them to agree on a higher real wage than they would have done if the exchange rate were exogenous. The outcome of the wage negotiations is found by substituting out for (31) in (29), which yields

(32) $$\frac{W^T}{P} = \frac{k_P{}^T}{k_P{}^T - 1} v_0 \qquad where \quad k_P{}^T = \frac{1+\beta}{1-\beta} - \frac{2}{1-\beta}\frac{\gamma^P \beta}{\beta + \rho(1-\beta)} \ .$$

Again, if $k_P{}^T$ takes a value above unity (this requires $\gamma^P < \beta + \rho(1-\beta)$, which I assume to be the case), there exists a unique outcome W^T/P to the wage negotiations.

The effect on the wage outcome of the choice of monetary regime is investigated by comparing $k_S{}^T$ and $k_P{}^T$. A direct comparison is made difficult by the fact that the share of non-traded output of total nominal output, γ^i, depends on the monetary regime. This problem in circumvented in the Cobb-Douglas case, where $\gamma^S = \gamma^P = \gamma$, so that $k_S{}^T > k_P{}^T$, as $2/(1-\beta) > 1$. Inspection of (28) and (32) shows that W^T/P is decreasing in $k_i{}^T$, thus $k_S{}^T > k_P{}^T$ implies that $(W^T/P)_S < (W^T/P)_P$. The result is summarised in Proposition 1:

Proposition 1: The consumer real wage in the traded sector, W^T/P, is given by (28) under an exchange rate target, and (32) under a price target. In the Cobb-Douglas case, $\rho = 1$, the consumer real wage is lower under an exchange rate target than under a price target, $(W^T/P)_S < (W^T/P)_P$.

The numerical simulations presented in Table 1 below strongly suggest that the consumer real wage in the traded sector is lower under an exchange rate target than under a price target also in the more general CES case, where $\rho \neq 1$.

Wage setting in the non-traded sector.

The wage in the non-traded sector, W^N, is set so as to maximise the Nash product (16). Under an exchange rate target, the exchange rate constant, while both the price on non-traded goods and the consumer price level are endogenous. The first order condition can be rearranged to

(33) $$\frac{W^N/P}{W^N/P - v_0} = \frac{1+\beta}{1-\beta} - \frac{2}{1-\beta}\frac{dp^N}{dw^N} + \frac{dp}{dw^N} .$$

To find the effect on non-traded and consumer prices of a marginal rise in non-traded sector wages, we use the same approach as for the traded sector. Total differentiation of (24) with respect to w^N, p^N and p, yields

(34) $$\frac{\beta}{1-\beta}(dp^N - dw^N) = -\rho(dp^N - dp) + \gamma^S\left(\frac{1}{1-\beta}dp^N - \frac{\beta}{1-\beta}dw^N\right) - dp$$

Substituting out for dp in (34), using (20), and rearranging, we obtain

(35) $$\frac{dp^N}{dw^N} = \frac{\beta}{\beta + \rho(1-\beta)} > 0 .$$

Thus, using (20),

(36) $$\frac{dp}{dw^N} = \frac{\gamma^S \beta}{\beta + \rho(1-\beta)} > 0 .$$

Higher nominal wages in the non-traded sector lead to both higher prices on non-traded goods and higher consumer prices, due to the negative effect on the supply. The increase in the price is dampened by the negative income effect in demand of the reduction in output. The increase in the price on non-traded goods is favourable to the wage setters, as it reduces the negative effect on employment and profits of a wage rise. On the other hand, the rise in consumer prices has a negative effect on the real wage as well as on real profits. The former effect dominates, however, so that the overall effect of p^N and p being endogenous is that the wage setters agree on a higher real wage than they would have done if these prices were exogenous.

The outcome of the wage negotiations is found by substituting out for (35) and (36) in (33), which yields

$$(37) \qquad \frac{W^N}{P} = \frac{k_S{}^N}{k_S{}^N - 1} v_0 \qquad \textit{where} \quad k_S{}^N = \frac{1+\beta}{1-\beta} - \left(\frac{2}{1-\beta} - \gamma^S \right) \frac{\beta}{\beta + \rho(1-\beta)} \ .$$

Given that $k_S{}^N$ is greater than unity (which requires that $2\rho + \gamma^S > 2$) , there exists a unique positive outcome W^N/P to the wage negotiations.

Under a price target, the outcome of the wage bargain is found by maximising (16) with respect to w^N, holding the consumer price fixed, but taking into consideration that the price on non-traded goods is endogenous. The first order condition can be rearranged to

$$(38) \qquad \frac{W^N / P}{W^N / P - v_0} = \frac{1+\beta}{1-\beta} + \frac{2}{1-\beta} \frac{dp^N}{dw^N} \ .$$

The last term of (38), the effect on the price on non-traded goods of a marginal rise in non-traded wages, is derived as above. Total differentiation of (24) with respect to the endogenous variables w^N, p^N and p^T, recalling that p is exogenous under a price target, yields

$$\frac{\beta}{1-\beta}(dp^N - dw^N) = -\rho dp^N + \gamma^p\left(\frac{1}{1-\beta}dp^N - \frac{\beta}{1-\beta}dw^N\right) \tag{39}$$
$$(1-\gamma^p)\left(\frac{1}{1-\beta}dp^T\right)$$

Substituting out for dp^T using (21), and rearranging, gives us

$$\frac{dp^N}{dw^N} = \frac{(1-\gamma^P)\beta}{\beta + \rho(1-\beta)} > 0\,. \tag{40}$$

Higher nominal wages in the traded sector lead to higher prices on traded goods, due to the negative effect on supply. Consumer prices are kept down by an appreciation of the currency so that traded sector prices go down.

The increase in non-traded prices arising from a wage rise in the non-traded sector is favourable to the wage setters in the non-traded sector, which will lead them to agree on a higher real wage than they would have done if the exchange rate were exogenous.

The outcome of the wage negotiations is found by substituting out for (40) in (38), and rearranging, which yields

$$\frac{W^N}{P} = \frac{k_P{}^N}{k_P{}^N - 1}v_0 \qquad where \quad k_P{}^N = \frac{1+\beta}{1-\beta} - \frac{2}{1-\beta}\frac{(1-\gamma^P)\beta}{\beta + \rho(1-\beta)}\,. \tag{41}$$

Again, given that k_P^N takes a value above unity (which requires $\beta + \rho(1-\beta) > 1-\gamma^P$), there exists a unique outcome W^N/P to the wage negotiations.

The effect on the wage outcome of the choice of monetary regime is investigated by comparing k_S^N and k_P^N. In the Cobb-Douglas case, where $\gamma^S = \gamma^P = \gamma$, inspection shows that $k_S^N < k_P^N$, (as $2/(1-\beta)-\gamma < (2/(1-\beta))(1-\gamma)$), thus $(W^N/P)_S > (W^N/P)_P$. The result is summarised in Proposition 2:

Proposition 2: The consumer real wage in the non-traded sector, W^N/P, is given by (37) under an exchange rate target, and (41) under a price target. In the Cobb-Douglas case, $\rho = 1$, the consumer real wage is higher under an exchange rate target than under a price target, $(W^N/P)_S > (W^N/P)_P$.

Numerical solutions to the model

In this subsection I explore further the difference between the two monetary regimes by use of numerical simulations of the model. Some illuminating cases are presented in Table 1.[7] Because of the highly stylised nature of the model, the magnitudes of the differences cannot be taken seriously, yet the simulations provide a rough indication of the effects that are at work. Comparing columns pair-wise, a number of features are apparent.

- The results of Propositions 1 and 2 that the real consumer wage in the traded sector is higher under a price target, while the real consumer wage in the non-traded sector is higher under an exchange rate target, show up in the CES-cases too.

Table 1: Numerical simulations of the model.

	Cobb-D. $\gamma = 0.5$	Cobb-D. $\gamma = 0.5$	ρ=2 $\gamma = 0.5$	ρ=2 $\gamma = 0.5$	$\rho = 2$ $\gamma = 0.75$	$\rho = 2$ $\gamma = 0.75$	$\rho = 4$ $\gamma = 0.5$	$\rho = 4$ $\gamma = 0.5$
Var.\Reg.	Price	Exch.	Price	Exch.	Price	Exch.	Price	Exch.
W^N/P	0.75	2	0.7	0.91	0.66	0.88	0.67	0.73
W^T/P	0.75	0.64	0.7	0.63	0.77	0.64	0.67	0.63
γ^j, i = P,S	0.5	0.5	0.5	0.46	0.71	0.66	0.5	0.46
L	4.74	1.31	5.83	4.83	5.52	3.73	6.75	6.48
Y	5.33	1.90	6.12	5.31	5.69	4.34	6.75	6.54
Y^N	2.67	0.70	3.06	2.20	3.84	2.52	3.38	2.94
Y^T	2.67	1.50	3.06	3.16	1.90	2.01	3.38	3.60
$V=Y - Lv_0$	2.96	1.25	3.21	2.90	2.93	2.48	3.38	3.30
U^N	0.59	0.48	0.58	0.72	0.65	0.82	0.56	0.64
U^T	0.59	0.14	0.58	0.40	0.38	0.21	0.56	0.48
π^N	0.89	0.32	1.02	0.81	1.35	0.96	1.13	1.01
π^T	0.89	0.32	1.02	0.97	0.55	0.49	1.13	1.17

Notes: In all simulations, $\beta = 2/3$ and $v_0 = 0.5$. In the figures for household and union utility, V and U^j, the constant term $M^j v_0$ is left out.

- In the Cobb-Douglas case, a price target is superior on all accounts; household utility is higher, output (and thus also employment), union utility and profits are higher in both sectors. Note that as output is strictly decreasing in the producer real wage W^j/P^j, the producer real wage is lower under a price target in both sectors.
- In the CES-simulations, a price target is superior for most variables. In particular, a price target involves higher household utility and higher aggregate output and employment. However, an exchange rate target yields higher output and employment in the traded sector; the traded sector constitutes a larger share of aggregate output (i.e. $\gamma^S < \gamma^P$), and

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[7] I have been unable to prove uniqueness of the equilibrium of the model. However, based on exploration of subsets of the model, I strongly expect there to be a unique equilibrium for "reasonable" parameter values. Simulations with different initial values for the endogenous variables corroborate this, as these simulations, if they converge, always converge to the same equilibrium.

union utility in the non-traded sector is larger. In some cases, traded sector profits are higher under an exchange rate target.

- Simulations for other values for ρ and γ (not included) result in the same broad results, except that in rare cases (e.g. $\gamma = 0.25$; $\rho = 6$), household utility and aggregate output are higher under an exchange rate target.

Centralised wage setting

In this subsection I briefly explore the consequences of wage setting being completely centralised in the sense that the relative wage between the sectors is exogenous. This can be given two alternative interpretations. First, there can be co-ordination in the sector-specific wage setting, so that they always reach the same wage outcome (or constant relative wage). Second, one sector is the "wage leading", in the sense that wage setting takes place first in this sector, and that the wage outcome of the other sector is the same as in the wage-leading sector, so that the relative wage is constant. Irrespective of interpretation, it turns out that the choice of monetary regime does not affect the outcome of the wage setting. This can be seen from total differentiation of (24) under either monetary regime, holding $dw^T = dw^N = dw > 0$, as it turns out that the wage terms cancel out. Thus, a proportional change in the wage in both sectors does not affect the price of non-traded goods (the interpretation is that the negative effect on supply of non-traded goods cancels out with the negative effect on demand). Consequently, a proportional change in the wage in both sectors does not affect any of the prices in either of the regimes, thus the same wage outcome will be reached in both monetary regimes.

IV. The infinite horizon case

Using a static model involves a number of limitations to the nature of the effects that can be analysed. An important feature of a static model is that when wage setters consider the effect of a deviation from equilibrium in the wage negotiations, the deviation is, in effect, considered permanent. In other words, a marginal rise in wages has a permanent negative effect on output. An implication of this is that there is no room for effects on the interest rate, as even a permanent rise in the wage level cannot affect the interest rate at permanent basis. Thus, in the static model there is no room for explicit analysis of the effect of the main instrument of the central bank, the short run nominal interest rate. In the present section, the model is extended to the infinite horizon case, to avoid this shortcoming.

The model considers an infinite number of periods, where each period corresponds to the static model above: production technology, household utility functions, and union utility functions are all the same as before. However, wages, prices, production and consumption are only set for one period at the time. Households now have the opportunity to save or borrow so as to transfer consumption between periods. In any single period, the trade balance can differ from zero, so that the country as a whole borrows or saves at the international financial market, to an exogenous nominal interest rate in foreign currency, denoted $i^* > 0$. Yet the intertemporal budget restriction of the households imply that trade is balanced over time.

In the infinite horizon version of the model, the instrument of the central bank is the nominal interest rate. The relationship between the exchange rate and the nominal interest rate is assumed to obey the uncovered interest parity condition, that is, the expected change in the exchange rate is equal to the nominal interest rate differential.

There will be a steady state equilibrium of the infinite horizon model that corresponds to the equilibrium of the static model, where trade surplus is zero, the exchange rate and the price level are constant (the world market price of traded goods, P^*, is assumed to be constant over time), and where the home nominal interest rate is equal to the foreign one. However, if in one period a deviation from steady state equilibrium takes place in the wage setting, prices, consumption and output are affected. The central bank may adjust the interest rate so as to ensure that the monetary target is fulfilled, and in this case the nominal exchange rate is also affected.

To derive the outcome of the wage negotiations in a steady state equilibrium, it is necessary to specify the consequences of a one-period deviation from steady state. This is in general a highly complex issue. If there is a deviation from steady state equilibrium in the wage setting, e.g. marginally higher wages in the non-traded sector, leading to lower output and income, the households will distribute the income loss over all subsequent periods. The effect on households' wealth implies that the economy does not return to the same steady state equilibrium as it was in prior to the deviation. To simplify the analysis, I neglect this effect. Thus, I assume that when wage setters contemplate the consequences of a deviation from steady state equilibrium in the wage setting in one period, they expect the economy to return to its original steady state equilibrium in the subsequent period. This assumption implies that the wage negotiations can be modelled just as in the static case, as the wage setters neglect the effects on subsequent periods that would arise via the effect on households' wealth.

I assume that if a deviation from steady state equilibrium takes place, aggregate consumption expenditure is based on households' estimate of their permanent income, $Y^P{}_t$, and the real interest rate, according to

(42) $$\frac{B_t}{P_t} = Y_t^P (1+r_{t+1})^{-\sigma} \alpha^{-\sigma}, \quad where \quad Y^P{}_t = Y_t^{\delta} (Y^i)^{1-\delta},\ \sigma > 0,\ 0 < \delta < 1, \alpha = \frac{1}{1+i*},$$

where $B = P^N C^N + P^T C^T$ denotes per period nominal consumption expenditure, Y_t is current year aggregate output, Y^i is steady state aggregate output under monetary regime i, r_{t+1} is the real interest rate, given by $(1+r_{t+1}) = (1+i_{t+1})P_t/P_{t+1}$, and δ is the elasticity of current consumption expenditure with respect to current income. σ can be interpreted as the intertemporal elasticity of consumption. Note that in steady state equilibrium, $Y_t^P = Y_t$, $P_t = P_{t+1}$ and $i_t = i^*$, so that $(1+r_{t+1}) = 1/\alpha$ and $B_t/P_t = Y_t$, implying that trade surplus is zero.

If a deviation from steady state equilibrium takes place in the wage negotiations, supply of traded and non-traded goods are still given by (9). However, the market clearing condition (17) gives output and prices in the non-traded sector. Substituting out for (3), (9) and (42), and letting lower case letters denote natural logarithm (except for the interest rate, where I use the approximation that $\ln(1+i) \approx i$), (17) implies that

(43) $$(\beta/(1-\beta))(p^N - w^N) = \ln(\gamma) - \rho(p^N - p) + \delta y + (1-\delta)y^i - \sigma(i - p_{t+1} + p),$$

For later use, it is worthwhile to investigate the consequences of total differentiation of (43) (y^i and p_{t+1} are kept constant equal to their steady state equilibrium values):

(44) $$\frac{\beta}{1-\beta}(dp^N - dw^N) = -\rho(dp^N - dp) + \delta\gamma^i\left(\frac{1}{1-\beta}dp^N - \frac{\beta}{1-\beta}\mathrm{dw}^N\right)$$
$$\delta(1-\gamma^i)\left(\frac{1}{1-\beta}dp^T - \frac{\beta}{1-\beta}dw^T\right) - \delta\mathrm{dp} - \sigma(\mathrm{di} + \mathrm{dp})$$

(44) can be rearranged to

(45) $$(\beta + \rho(1-\beta) - \delta\gamma^{\mathrm{i}})dp^N - \beta(1-\delta\gamma^{\mathrm{i}})dw^N = \delta(1-\gamma^{\mathrm{i}})dp^T - \beta\delta(1-\gamma^{\mathrm{i}})dw^T$$
$$+ (1-\beta)(\rho - \delta - \sigma)\mathrm{dp} - \sigma(1-\beta)\mathrm{di}$$

(45) shows the relationship between changes in prices and wages that must hold if the non-traded goods market is to be cleared.

Monetary policy

The relationship between the nominal interest rate and the nominal exchange rate is given by the uncovered interest parity condition, which in log form reads

$$(46) \qquad s_t - E[s_{t+1}|t] = i^* - i_{t+1},$$

where $E[s_{t+1}|t]$ is the expected nominal exchange rate in period t+1, as viewed from period t. Under an exchange rate target, the market expects the target to be reached in the subsequent period, so that $E[s_{t+1}|t] = s^G$. To ensure that the exchange rate target is reached in period t, the central bank must always set the nominal interest rate equal to the nominal interest rate on foreign currency, $i_{t+1} = i^*$. Thus a deviation in the wage setting will not affect the interest rate set by the central bank.

Under a price target, a deviation in the wage setting will trigger a change in the interest rate, so as to ensure that the price target is nevertheless fulfilled. If, say, nominal non-traded wages one year is above its steady state value, inducing an increase in non-traded prices, the central bank must counteract this by raising the interest rate, which also leads to an appreciation of the nominal exchange rate. As the deviation is only for the current period, the nominal exchange rate is expected to be back at its equilibrium value in the next period. The effect on the nominal exchange of a marginal change in the nominal interest rate di_{t+1} follows directly from the uncovered interest parity condition (46)

$$(47) \qquad ds_t = - di_{t+1}.$$

Exchange rate target

To find the effect on the consumer price level of a marginal rise in traded sector wages, we make use of (45), where we set $dp^T = dw^N = di = 0$, and $dp = \gamma^j dp^N$, and rearrange, to find

$$\text{(48)} \qquad \frac{dp}{dw^T} = \frac{-\gamma^S \beta\delta(1-\gamma^S)}{\beta + \rho(1-\beta) - \delta\beta\gamma^S - (1-\beta)(\rho-\sigma)\gamma^S} < 0 \,.$$

Higher wages in the traded sector reduce traded sector output, so that aggregate output and income is reduced. When households' income go down, they reduce their demand for non-traded goods, inducing a reduction in the price on non-traded goods, and thus also a reduction in consumer prices.

The effect on non-traded and consumer prices of a marginal rise in non-traded sector wages is derived in the same manner. From (45), where we set $dp^T = dw^T = di = 0$, and $dp = \gamma^j dp^N$, and rearrange, to find

$$\text{(49)} \qquad \frac{dp^N}{dw^N} = \frac{\beta(1-\delta\gamma^S)}{\beta + \rho(1-\beta) - \delta\beta\gamma^S - (1-\beta)(\rho-\sigma)\gamma^S} > 0 \,,$$

and

$$\text{(50)} \qquad \frac{dp}{dw^N} = \frac{\gamma^S \beta(1-\delta\gamma^S)}{\beta + \rho(1-\beta) - \delta\beta\gamma^S - (1-\beta)(\rho-\sigma)\gamma^S} > 0 \,.$$

Higher nominal wages in the non-traded sector lead to both higher prices on non-traded goods and higher consumer prices. These effects arise as a consequence of the negative impact on the supply of non-traded goods of an increase in non-traded wages. The increase in non-traded prices is however somewhat dampened by the fact that reduced non-traded output reduces aggregate output and income. When households' income go down, they reduce their demand for non-traded goods, which dampens the rise in non-traded prices. The effect on consumer prices follows directly from the effect on non-traded prices.

Price target

The effect on the price on traded goods of a marginal rise in traded sector wages is also derived from (45). We set dp = $dw^N = 0$, in addition to $dp^N = -((1-\gamma^i)/\gamma^i)\, dp^T = ((1-\gamma^i)/\gamma^i)$ di, (from (21) and (47)). By rearranging, we obtain

$$(51) \qquad \frac{dp^T}{dw^T} = \frac{\gamma^P \beta\delta(1-\gamma^P)}{\beta + \rho(1-\beta) - \beta\gamma^P - (1-\beta)(\rho-\sigma)\gamma^P} > 0 .$$

Higher nominal wages in the traded sector lead to higher prices on traded goods, because lower non-traded prices due to the negative income effect on non-traded demand allows a depreciation of the currency, so that traded sector prices increase measured in domestic currency.

The effect on non-traded prices of a marginal rise in non-traded sector wages is derived as above: in (45), we set dp = $dw^T = 0$, in addition to $dp^N = -((1-\gamma^i)/\gamma^i)\, dp^T = ((1-\gamma^i)/\gamma^i)$ di, (from (21) and (47)), to obtain

$$(52) \qquad \frac{dp^N}{dw^N} = \frac{\beta(1-\delta\gamma^P)}{\beta + \rho(1-\beta) - \beta\gamma^P - (1-\beta)(\rho-\sigma)\gamma^P} > 0 ,$$

and

(53) $$\frac{dp}{dw^N} = \frac{\gamma\beta(1-\delta\gamma^P)}{\beta+\rho(1-\beta)-\beta\gamma^P-(1-\beta)(\rho-\sigma)\gamma^P} > 0 .$$

Higher nominal wages in the non-traded sector lead to both higher prices on non-traded goods and higher consumer prices, due to the negative impact on the supply of non-traded goods.

Wage setting in the infinite horizon version

The analysis of the wage setting is just as in the static model, the only difference is that the effect of a marginal wage rise on the various prices differ between the static and the infinite horizon versions. Substituting out for (48)- (53) in (23), (29), (33) and (38) as appropriate gives us the following results (assuming that the parameter values are such that all k_i^j are greater than unity, which is fulfilled if ρ is sufficiently large):

Proposition 3: The bargaining outcome is sector j under monetary regime i is

(j = T, N; i = S, P):

(54) $$\frac{W^j}{P} = \frac{k_i^{\,j}}{k_i^{\,j}-1} v_0 \quad ,$$

where

(a) $$k_S^{\,T} = \frac{1+\beta}{1-\beta} - \frac{\gamma^S\beta\delta(1-\gamma^S)}{\beta+\rho(1-\beta)-\delta\beta\gamma^S-(1-\beta)(\rho-\sigma)\gamma^S} \ ;$$

(b) $$k_P^{\,T} = \frac{1+\beta}{1-\beta} - \frac{2}{1-\beta}\frac{\gamma^P\beta\delta(1-\gamma^P)}{\beta+\rho(1-\beta)-\beta\gamma^P-(1-\beta)(\rho-\sigma)\gamma^P} \ ;$$

(c) $$k_S^{\,N} = \frac{1+\beta}{1-\beta} - \left(\frac{2}{1-\beta} - \gamma^S\right)\frac{\beta(1-\delta\gamma^S)}{\beta+\rho(1-\beta)-\delta\beta\gamma^S-(1-\beta)(\rho-\sigma)\gamma^S} \ ;$$

(d) $$k_P^{\,N} = \frac{1+\beta}{1-\beta} - \frac{2}{1-\beta}(1-\gamma^P)\frac{\beta(1-\delta\gamma^P)}{\beta+\rho(1-\beta)-\beta\gamma^P-(1-\beta)(\rho-\sigma)\gamma^P}\ .$$

In the Cobb-Douglas case, where $\gamma^S = \gamma^P = \gamma$, inspection of (a) and (b) shows that $k_S^T > k_P^T$, thus $(W^T/P)_S < (W^T/P)_P$. However, even in the Cobb-Douglas case, we cannot rank k_S^N and k_P^N and thus not $(W^N/P)_S$ and $(W^N/P)_P$.

Numerical simulations of the infinite horizon version

Numerical simulations of the infinite horizon model are presented in Table 2. The general picture is much the same as in the static model, although a price target is even more superior than in the static case. An exchange rate target involves higher wages in the non-traded sector, and slightly lower wages in the traded sector, than does a price target. Otherwise, a price target regime is superior on all accounts.

Table 2: Numerical simulations of the infinite horizon model

	$\rho = 2$ $\gamma = 0.5$	$\rho = 2$ $\gamma = 0.5$	$\rho = 2$ $\gamma = 0.75$	$\rho = 2$ $\gamma = 0.75$	$\rho = 4$ $\gamma = 0.5$	$\rho = 4$ $\gamma = 0.5$
Var.\Reg.	Price	Exch.	Price	Exch.	Price	Exch.
W^N/P	0.72	1.14	0.87	1.37	0.68	0.79
W^T/P	0.65	0.63	0.65	0.63	0.64	0.63
γ^i, i = P,S	0.49	0.43	0.66	0.61	0.48	0.44
L	6.32	3.78	3.72	1.76	6.98	5.92
Y	6.45	4.40	4.35	2.48	6.90	6.13
Y^N	3.05	1.60	2.55	1.21	3.31	2.60
Y^T	3.40	2.89	1.97	1.53	3.59	3.55
$V=Y - Lv_0$	3.29	2.51	2.49	1.60	3.41	3.17
U^N	0.64	0.70	0.81	0.64	0.59	0.66
U^T	0.50	0.34	0.22	0.13	0.52	0.46
π^N	1.05	0.62	0.96	0.50	1.11	0.90
π^T	1.10	0.84	0.49	0.32	1.19	1.14

Notes: In all simulations, $\beta = 2/3$, $v_0 = 0.5$, $\sigma = 0.02$, $\delta = 0.5$. In the figures for household and union utility, V and U^j, the constant term $M^j v_0$ is left out.

Centralised wage setting

In this subsection I briefly return to the alternative assumption that the relative wage between the sectors is exogenous. In contrast to the static model, it turns out that the choice of monetary regime does affect the wage setting. To fix ideas, assume that the traded sector is wage leading, in the sense that wage setting takes place first in this sector, and that the wage outcome of the non-traded sector is the same as in the traded sector.

To find the effect on the consumer price level of a marginal rise in wages in both sectors under an exchange rate target, we make use of (45), where we set $dp^T = di = 0$, $dw^T = dw^N = dw$, and $dp = \gamma^j dp^N$, and rearrange, to find

$$\text{(55)} \qquad \frac{dp}{dw} = \frac{\gamma^S \beta(1-\delta^S)}{\beta + \rho(1-\beta) - \delta\beta\gamma^S - (1-\beta)(\rho-\sigma)\gamma^S} > 0\,.$$

Higher wages in the both sectors involve higher prices in the non-traded sector as well as higher consumer prices. The reason is that the negative effect on non-traded supply is stronger than the negative effect on non-traded demand, as the demand effect is not thought to be permanent.

Under a price target, we must derive the effect on traded prices of a marginal rise in wages in both sectors. In (45), we set $dw^T = dw^N = dw$; $dp = dw^N = 0$, in addition to $dp^N = -((1-\gamma^j)/\gamma^j)\, dp^T = ((1-\gamma^j)/\gamma^j)\, di$. By rearranging, we obtain

$$\text{(56)} \qquad \frac{dp^T}{dw} = \frac{-\gamma^P \beta(1-\delta)}{\beta + \rho(1-\beta) - \beta\gamma^P - (1-\beta)(\rho-\sigma)\gamma^P} < 0\,.$$

Higher nominal wages in both sectors lead to lower prices on traded goods, because the increase in non-traded prices requires an appreciation of the currency to realise the price target.

Following the same procedure as above (substituting out for (55) in (23) and (56) in (29)), we obtain

Proposition 4: When traded sector is wage leading, in the sense that the bargaining outcome in the traded sector is given by the Nash bargaining solution under the restriction that the relative wage between the sectors, W^N/W^T = constant, the bargaining outcome is (i = S, P):

(57) $$\frac{W^T}{P} = \frac{k_i^{\ T}}{k_i^{\ T} - 1} v_0 \quad ,$$

where

(a) $$k_S^{\ T} = \frac{1+\beta}{1-\beta} + \frac{\gamma^S \beta(1-\delta)}{\beta + \rho(1-\beta) - \delta\beta\gamma^S - (1-\beta)(\rho-\sigma)\gamma^S} \ .$$

(b) $$k_P^{\ T} = \frac{1+\beta}{1-\beta} + \frac{2}{1-\beta}\frac{\gamma^P \beta(1-\delta)}{\beta + \rho(1-\beta) - \beta\gamma^P - (1-\beta)(\rho-\sigma)\gamma^P} \ .$$

In the Cobb-Douglas case, $\gamma^S = \gamma^P = \gamma$, which implies that $k_P^{\ T} > k_S^{\ T}$, that is, consumer real wages are higher under an exchange rate target.

Thus, when traded sector is the wage leading, the ranking of regimes is reversed. A price target is likely to result in lower wages; in the Cobb-Douglas case we know this for certain. The reason is that the effect on consumer prices/the exchange rate (depending on monetary regime) of a deviation in the wage setting is in the opposite direction when the deviation is in both sectors than when the wage rise only takes place in the traded sector. Under sectoral wage setting, a price target involves higher traded sector wages because wage setters in the traded sector gain from a depreciation of the exchange rate. However, when the traded sector is wage leading, a price target involves lower traded sector wages because traded sector wage setters want to avoid an appreciation of the exchange rate.

A similar analysis of the case where the non-traded sector is wage leading (which is straightforward and not included in order to save space) shows that in this case the earlier results are not reversed, a price target is likely to result in lower wages. (In the Cobb-Douglas case this can be shown for certain.) Thus, irrespective of which of the sectors is wage leading, a price target involves lower wages.

V. Concluding remarks

In the economics literature on monetary regimes, the natural rate hypothesis is usually taken as given; there are unique levels of output and employment (unemployment) that are unaffected by the monetary policy. The main argument of the present paper is that under non-atomistic wage setting, neutrality of money (in the sense that the price or exchange rate level, or the rate of inflation, have no effect on real variables) is not that same as neutrality of the monetary regime. In the present model money is neutral: it can easily be verified that in the static model, the real equilibrium is unaffected by the price or exchange rate level; in the infinite horizon model, the real equilibrium is unaffected by a non-zero, expected rate of inflation or depreciation. Yet the choice of monetary regime affects the equilibrium rate of unemployment. The reason is that the outcome of a wage negotiation depends on the slopes of the trade-offs between consumption real wages and employment, and between consumption real wages and profits. Under wage negotiations for large groups of workers, the slopes of these trade-offs depend on the monetary regime.

In the present model, traded sector wages are likely to be higher under a price target than under an exchange rate target. The reason is that an increase in traded sector wages has a dampening effect on non-traded prices (via a negative income effect in the demand), and under a price target the dampening effect on non-traded prices provides room for a depreciation of the currency. The depreciation mitigates the negative effects on employment and profits of a wage rise, leading wage setters to agree on a higher wages. On the other hand, wages in the non-traded sector are likely to be higher under an exchange rate target than under a price target. Under an exchange rate target a wage rise in the non-traded sector is fully reflected in non-traded prices as well as in the consumer prices. Although unions dislike the increase in the consumer prices, this is outweighed by the increase in non-traded prices, which mitigates the negative effects on employment and profits of a wage rise.

An important consequence of the model is that the monetary regime affects sectoral structure of the economy. The traded sector is likely to constitute a greater part of the total economy under an exchange rate target than under a price target, because under an exchange rate target low traded sector wages stimulate production in the traded sector, while high non-traded wages dampen production in the non-traded sector. The relative price of traded versus non-traded goods is also affected by the monetary regime: higher non-traded wages under an exchange rate target also implies that non-traded prices are higher, relative to the price of traded goods, even in steady state equilibrium where foreign trade is balanced. This is in contrast to the common view (e.g. Svensson, 1997) that in the long run monetary policy cannot affect real variables, nor can it affect the relative price of traded versus non-traded goods.

The results depend on the wage setting being non-atomistic. If wage setting is sufficiently decentralised so that the aggregate variables are exogenous to the individual wage setter, then the regimes are identical in the present model. The assumption of the present paper, that wage setting is completely centralised within the traded and non-traded sectors is clearly not realistic. However, it serves important analytical and pedagogical purposes.

Furthermore, in many European countries, some wage setters are big enough to have a non-negligible impact on aggregate variables. There are powerful trade unions concentrated in industries that belong to the traded sector, and others in industries that belong to the non-traded sector. This is all that is required for effects to arise that are similar to those studied in the present paper.

An interesting extension of the model would be to endogenise the capital stock. Although a proper analysis is outside the scope of the present paper, it seems likely that some of the results of the paper might be exacerbated. A high real wage in one sector implies that the return to capital is low, leading to less investment in this sector. It seems likely that under an exchange rate target, capital would flow out of the high-wage non-traded sector and in to the low-wage traded sector, and thus further reducing non-traded production while traded production is increased. Under a price target capital would flow in the opposite directions.

The results of the numerical simulations are favourable to a price target regime, as in almost all cases this regime results in higher aggregate output and higher household utility. Now one should be very careful in drawing policy conclusions from numerical simulations of a stylised model as in the present paper. However, it appears that the main reason for this result is that an exchange rate target provides insufficient incentive to wage restraint in the non-traded sector. A possible policy implication is that countries with powerful unions in the non-traded sector should adopt a price target rather than an exchange rate target.

There are also other mechanisms, not analysed in the present paper, which might involve an effect of the monetary regime on the equilibrium rate of unemployment. First, inflation per se might enter the preference function of the agents in the model. As argued by Cubitt (1992, 1995), Skott (1997), and Cukierman and Lippi (1997), if there are costs associated with inflation so that society dislikes inflation, these costs presumably also lead unions to dislike inflation. Within the model of this paper, union concern for inflation would not affect wage setting under a credible price target, because unions expect the target to be reached. However, under an exchange rate target, a union in the non-traded sector would know that a large wage increase would lead to higher inflation, and this might have a dampening effect on wages. Thus if unions are concerned about inflation, this would modify the comparison of regimes in favour of an exchange rate regime.

Second, there is considerable empirical evidence suggesting that the equilibrium rate of unemployment depends on the degree of co-ordination in the wage setting (e.g. Calmfors and Driffill, 1988, and Layard et al, 1991). The degree of co-ordination in the wage setting is clearly an endogenous variable itself, cf Holden and Raaum (1991) and Holden (1991). The monetary regime is one variable that might affect whether and to what extent co-ordination is likely to take place (cf. Rødseth, 1997).

Third, the wage setting and equilibrium rate of unemployment may also depend on whether the monetary target is set in levels, a price or exchange rate level (as in the present paper), or in changes (an inflation rate). In the latter case, the central bank does not attempt to reverse previous errors from the inflation target. The distinction between level and change target may affect the equilibrium rate of unemployment, in particular if the wage setting is non-atomistic, cf. Rødseth (1997).

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