A Union Bashing Model of Inflation Targeting*

Frode Meland†

Abstract

This paper shows that in an open two-sector economy, centralization of wage setting may be important in determining the employment (and welfare) effects of different monetary targets. By disciplining unions in the sectors open to international trade, exchange rate targeting yields higher employment than inflation targeting when wage setting is more centralized in the open sector than in the shielded sector. When wage setting centralization is higher in the shielded sector, we show that general price level inflation targeting, while better than exchange rate targeting, is inferior to an inflation target that focuses more heavily on shielded sector prices.

Keywords: Inflation targeting, unemployment, monetary policy, unions, shielded and open sectors.

JEL classification: E52, E58, F41, J51, L16.

1 Introduction

According to recent literature on monetary policy and large wage- and price-setters, the choice of policy target may have long-term real effects, contrary to conventional wisdom. Iversen and Soskice (1999), Bratsiotis and Martin (1999), Coricelli et al. (2003, 2004) and Soskice and Iversen (2000) all find that a more conservative central bank/ more strict inflation targeting may

*I would like to thank Steinar Holden, Kjell Erik Lommerud, Franz Traxler, Knut-Frode Dagestad, Erlend Hodneland, Bjørn Sandvik, Odd Rune Straume, Steinar Vagstad and seminar participants both at the University of Bergen and the CEPR conference 'Globalization and labour markets' in Bergen 2003 for valuable comments and advice.

†Stein Rokkan Centre for Social Studies and Department of Economics, University of Bergen, Fosswinckelsgate 6, 5007 Bergen, Norway. E-mail: frode.meland@econ.uib.no.

contribute to lower unemployment.[1] In a purely unionized setting, the reason for this result is basically that if unions increase their wages, strict monetary policies dampen price adjustments, and thus contribute to increased negative labor demand effects.[2] This paper discusses monetary policy within a two-sector model. Through the effect on the exchange rate, different policies may affect sectors open to direct international competition and those that are not, in quite dissimilar ways. With this focus, the paper has much in common with Holden (2003) and Vartiainen (2002). Holden (2003) argues that aggregate employment will 'in most cases' be higher under inflation targeting than given fixed exchange rates. However, Holden does not discuss differences in union influence across sectors (nor does Vartiainen). We argue that such asymmetries, notably differences in the centralization of wage setting, can be very important for the monetary policy's impact on total employment. Indeed, union influence does vary considerably not only across countries, but also across sectors within countries. Figure 1 shows bargaining (de-)centralization levels for the private and public sector in 19 OECD countries in 1990:[3,4]

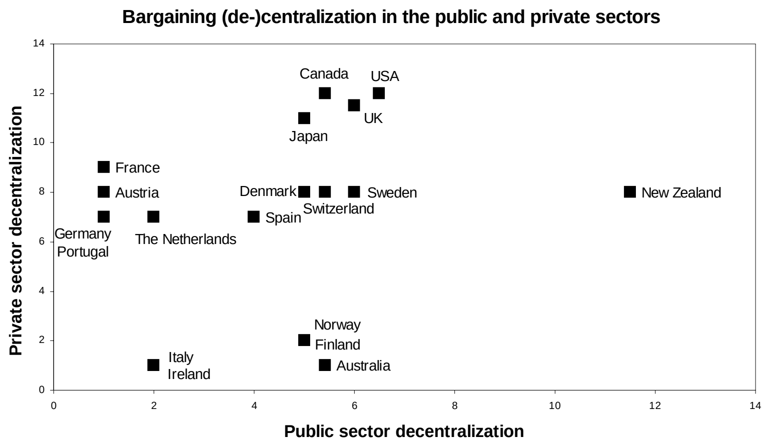

Figure 1

[1] Earlier literature, by focusing on inflation-averse unions,obtained the opposite result. For a survey of both types of approaches, see Cukierman (2004).

[2] This argument is generally not valid if there is only one large wage setter. For further discussion, see Soskice and Iversen (2000).

[3] Sources: Traxler (1999) (public sector) and Traxler *et al.* (2001) (private sector). Numbers on the axis are the scores from Table III.1 in Traxler *et al.* (2001), which are superimposed on the similar categories in Table 3 of Traxler (1999).

[4] As the figure shows, evidence suggests that in the majority of cases, wage setting in the public sector is more centralized than in the private sector. Traxler *et al.* (2001) contains data on private sector bargaining centralization levels up to 1998. Using these later data would only change matters for Australia, Italy and New Zealand, all of whom are reported to have more de-centralized bargaining structures in the private sector.

In this paper, we find that exchange rate targeting yields higher total employment when wage setting is more centralized in the open sector than the shielded sector. Inflation targeting yields higher total employment in the opposite case. Furthermore, in the case where inflation targeting yields the highest employment level, we show that basing the inflation target more heavily on prices in the shielded sector, may yield even higher levels of employment.[5]

In a small, open economy with fixed exchange rates, a wage increase in the open sector spills over into a large reduction in equilibrium employment, since there is comparatively little room for increased prices in the open sector. Compared to open sector unions, shielded sector unions, not facing foreign competition, can act more aggressively. Inflation targeting, however, unlocks this pattern, making unions in the two sectors face more equal terms: If wages increase in the shielded sector, prices tend to rise. However, this is fought off by the Central Bank, increasing the interest rate which leads to an exchange rate appreciation. Focusing on the effect of the latter, this lowers income in the open sector, leading to lower product and labor demand (also) in the shielded sector.[6] Thus unions in the shielded sector are more disciplined under inflation targeting than under exchange rate targeting. The reverse holds for open sector unions, since the Central Bank in that case effectively rewards wage increases with an interest rate drop.[7] This intuition applies also to Holden (2003) and Vartiainen (2002). Now, the more wage setting is centralized, the larger are the 'feedback' effects from the Central Bank, and the more do unions respond do these incentives. Consequently, if wage setting is more centralized in the sector open to international competition than in the shielded sector, exchange rate targeting (disciplining open sector unions) induces higher employment than inflation targeting and vice versa.[8]

The results discussed above also have another implication. By choosing an inflation target more heavily based on shielded sector prices, the 'neg-

[5] Inducing increased total employment also increases welfare.

[6] Interest rate increases may also lead to lower investment and consumption of durable goods, which may further contribute to the labor demand reduction.

[7] Higher wages in the open sector yield small direct increases in open sector prices, but implies lower demand for shielded sector products since total revenue in the domestic open sector decreases. This implies lower prices in the shielded sector, which leads to a decrease in interest rates set by the Central Bank and a depreciation of the exchange rate. This reduces the negative impact on employment of the wage increase in the open sector. Thus unions in the open sector are less disciplined under inflation targeting.

[8] Other aspects not considered in the basic model of this paper may influence which monetary target provides the higher total employment level for sufficiently similar centralization levels across sectors. However, in all extensions considered, an increase in centralization in one sector, makes a policy targeting this sector more attractive.

ative feedback' from the Central Bank for shielded sector unions is further increased, leading to wage restraint among these unions (the corresponding 'positive feedback' for open sector unions is necessarily also increased). We show this to imply higher total employment if wage setting is more centralized in the shielded sector than in the open sector. Thus when general price level inflation targeting yields higher employment than exchange rate targeting, a shielded sector inflation target may perform even better in this respect.

The following section presents the model and obtains the equilibrium employment levels under both exchange rate targeting and inflation targeting. Section 3 compares sector and country level employment under these two targets, while Section 4 discusses other monetary targets. The model's imbedded assumptions are discussed in Section 5, and Section 6 concludes.

2 The model

An economy has two sectors, each producing one distinct good. Sectors are indexed by $s \in \{1,2\}$ and goods by $g \in \{1,2\}$. Sector 1, which produces good 1, is shielded from foreign competition in the sense that no perfect substitute can be imported. However, there exists an imperfect substitute (good 2) produced in sector 2 and abroad. The country is assumed to be small relative to the world with respect to the market for good 2. The world price of this product, p_2^*, is thus assumed fixed.

Consumer preferences are described by a twin Cobb-Douglas utility function of the following form:

$$U(x_1, x_2, y) = (\sqrt{x_1 x_2})^{\alpha}(y)^{1-\alpha}, \alpha \in (0,1), \tag{1}$$

where y is leisure and x_g is the amount of good g consumed by the individual in question. There are N individuals populating the economy, k of which are stockholders (assumed to have exogenously determined leisure) and $n = \frac{N-k}{2}$ is the number of workers in each sector.[9]

We assume labor migration between sectors to be negligible within the short-term scope of the model (to be explained below), and wages are determined by unions prior to production. We choose to assume full (total) union coverage. There are $m_s \geq 1$ (sector-specific) unions in sector s, and these are all sector specific. Unions within a sector are equally large and workers within a single firm are always covered by the same union (which may also cover workers in other firms). Assuming $f_s \geq m_s$ firms in sector s, this means

[9] The income of stockholder i is assumed to be a fraction ϕ^i of total profits in the economy. $\sum_{i=1}^{k} \phi^i = 1$.

that each union in sector s has $\frac{n}{m_s}$ members, working in $\frac{f_s}{m_s}$ firms, and both these numbers are integers. The number of firms in each sector is assumed fixed, and all firms are price takers operating under decreasing returns with labor as the only input. They maximize

$$\Pi_s^j = p_s(L_s^j)^\gamma - w_s^j L_s^j,\ \gamma \in (0,1), \tag{2}$$

where subscripts refer to sectors, and superscripts refer to firms, $j \in \{1,..,f_s\}$. L_s^j is the total labor input utilized by firm j, p_s is the price of the sector s good, and w_s^j is the wage faced by firm j in sector s. Each firm in sector s has access to a fixed stock of workers, which is the equal share of the total workforce to firms; $\frac{n}{f_s}$. However, the firms are only required to pay these workers for the amount of work they do.[10]

With p_2^* assumed fixed, the domestic economy being small and allowing for costless trade, the domestic price for the sector 2 good is simply $p_2 = \frac{p_2^*}{E}$, where E is the nominal exchange rate. When the Central Bank increases its interest rates, it is commonly asserted that consumption and investment drop while the nominal exchange rate appreciates. In this static model, there is no investment or intertemporal saving. Thus we assume that the Central Bank, by setting the interest rate, influences the nominal exchange rate only.[11] For simplicity, we assume that by appropriately adjusting the interest rate, the Central Bank may induce any desired level of the nominal exchange rate, and thus E is modelled as the (only) Central Bank policy instrument. This assumption is the same as in Holden (2003) and Vartiainen (2002).

The sequence of events is as follows: First, the monetary policy objective is determined. On the second stage, unions simultaneously choose wages, and on the third stage, the Central Bank determines the exchange rate.[12] Finally, production occurs and prices are determined. We solve, of course, by backwards induction.

[10] Thus there is strictly speaking no 'unemployment' in this model. However, it is clear that a drop in employment per worker in our model could equally well be interpreted as an increase in unemployment (see for instance Holden (2003)).

[11] This could be thought of as a short term approximation to the behavior of a more complex economy, as exchange rate movements tend to come about much faster than changes in investment or saving.

[12] It is reasonably assumed that wage-setting is a more long-term commitment than the setting of interest rates by the Central Bank.

2.1 Third stage equilibrium

The relative prices ensuring that domestic supply equals domestic demand for the shielded sector good, are given by (see Appendix A):

$$\frac{p_1}{p_2} = K := \left(\frac{\sum_{j=1}^{f_2}(\frac{1}{w_2^j})^{\frac{\gamma}{1-\gamma}}}{\sum_{j=1}^{f_1}(\frac{1}{w_1^j})^{\frac{\gamma}{1-\gamma}}}\right)^{(1-\gamma)}. \tag{3}$$

In the open sector, domestic supply need not equal domestic demand since there is also a foreign market for this good. However, the above relative prices will also imply that supply and demand are equal in the open sector. Thus trade will be balanced in equilibrium.[13]

2.2 Union wage setting

We assume that unions maximize the utility of a representative member. To calculate the expected utility of workers in the two sectors, we need to find both the equilibrium leisure and consumption as functions of wages. However, maximizing utility is the same as maximizing a Cobb-Douglas composite of real income and leisure when work is rationed.[14] Thus, for any individual with income M, $U = (\sqrt{x_1 x_2})^{\alpha}(y)^{1-\alpha} = (\frac{M}{P})^{\alpha}(T-l)^{1-\alpha}$,where T is the total number of available hours for work and leisure, l is the individual's labor supply and $P = 2\sqrt{p_1 p_2}$ is the ideal consumer price index (see Appendix A).

We assume that every union sets the same wage for all the firms they cover. The utility of a member of union $u \in \{1, ..., m_s\}$ in sector s is then given by:[15]

$$U_s^u = (\frac{w_s^u l_s^u}{P})^{\alpha}(T - l_s^u)^{1-\alpha}. \tag{4}$$

[13] The above equation shows that if wage setting was *exogenous* to the monetary rule, an exchange rate adjustment (a change in p_2) would only lead to a proportional adjustment of p_1. This is the well known and time-honored 'neutrality of money' result. However, as pointed out by Soskice and Iversen (2000), the presence of non-atomistic agents may cause the breakdown of money neutrality. This can be traced back to Gabszewicz and Vial (1972) who first showed that general equilibrium models with non-atomistic agents may not be fully specified without *choosing* a numeraire. In the present type of model, the monetary target fills the role of numeraire. This both allows us to solve the model without inconsistencies *and* explains why monetary policy has real effects.

[14] Work will be rationed whenever workers would be willing to work more than demanded by the employers at the prevailing wage. This is discussed in Appendix A and C.

[15] Since every firm employing workers covered by union u has the same costs, face the same prices and produce using the same technology, labor demand is also the same for all firms covered by the same union. Consequently, l_s^u is the same for all workers covered by union u. $l_s^u = f_s \frac{L_s^j}{n}$.

The first-order condition for union utility maximization is

$$\frac{\alpha}{1-\alpha}(\frac{1-\pi_s^u}{\lambda_s^u}+1)=\frac{l_s^u}{T-l_s^u}, \tag{5}$$

where $\lambda_s^u := \frac{w_s^u}{l_s^u}\frac{\partial l_s^u}{\partial w_s^u}$ and $\pi_s^u := \frac{w_s^u}{P}\frac{\partial P}{\partial w_s^u}$. Thus the fraction of employment to leisure, $\frac{l_s^u}{T-l_s^u}$, aimed for by union u is a function of the general price and employment demand elasticities to wages (π_s^u and λ_s^u, respectively). $\frac{l_s^u}{T-l_s^u}$ can be thought of as an employment index.

Through the monetary targets, the Central Bank will set a nominal exchange rate, in turn determining the open sector price, p_2. *How* p_2 is changed to account for different wage schedules depends crucially on the monetary target. To ease the exposition, it is now advantageous to compute the above elasticities, π_s^u and λ_s^u, in terms of the elasticity of p_2 (effectively the Central Bank policy instrument) to wages. Since every union *within a sector* is exactly equal, they would all face the same elasticities of demand and prices with respect to own wages if faced with the same 'outside' wages. Symmetric wage game equilibria then exist, and we therefore present the elasticities in the symmetric cases where wages are equal across unions in each sector; $w_s^u = w_s$, $\forall u \in \{1, .., m_s\}$ (see appendix B). With superscripts dropped,

$$\lambda_1 = \frac{1}{1-\gamma}(\kappa_1+\frac{w_1}{p_2}\frac{\partial p_2}{\partial w_1}-1), \tag{6}$$

$$\lambda_2 = \frac{1}{1-\gamma}(\frac{w_2}{p_2}\frac{\partial p_2}{\partial w_2}-1) \tag{7}$$

and

$$\pi_s=\frac{1}{2}[\kappa_s+2\frac{w_s}{p_2}\frac{\partial p_2}{\partial w_s}], \tag{8}$$

where

$$\kappa_1 = \frac{\gamma}{m_1}, \tag{9}$$

$$\kappa_2 = -\frac{\gamma}{m_2}. \tag{10}$$

We now turn to discuss the various monetary objectives in greater depth.

2.3 Fixed exchange rates

In this case, the Central Bank intervenes only to keep the exchange rate at a pre-determined level. p_2 is thus assumed fixed and non-determined by internal factors ($\frac{w_s^u}{p_2}\frac{\partial p_2}{\partial w_s^u} = 0$). In terms of the above elasticities, we have $\pi_s = \frac{1}{2}\kappa_s$, $\lambda_1 = \frac{1}{1-\gamma}(\kappa_1 - 1)$ and $\lambda_2 = -\frac{1}{1-\gamma}$. Under a fixed exchange rate regime, the first-order conditions for the unions in sector 1 and 2, respectively, are (having imposed a symmetric solution)

$$\frac{\alpha}{1-\alpha}(\frac{1}{2}\gamma\frac{2m_1 - 1 - \gamma}{m_1 - \gamma}) = \frac{l_1}{T - l_1}, \tag{11}$$

$$\frac{\alpha}{1-\alpha}(\frac{1}{2}\gamma\frac{2m_2 - 1 + \gamma}{m_2}) = \frac{l_2}{T - l_2}. \tag{12}$$

The Nash equilibrium wage outcome is not readily available from the above expressions. However, we do not need to find the equilibrium wages. Any non-negative employment level can be induced by the union with an appropriately chosen wage level, and the above expressions provide us with the employment levels in equilibrium.

Before going into the above result in more detail, we also determine employment in the inflation targeting regime.

2.4 Inflation targeting

In our static model, inflation targeting takes the simplified form of targeting a price level. We choose to assume that the price level targeted by the Central Bank is the ideal price index; $P_{CB} = 2p_2\sqrt{K}$, implying $p_2 = \frac{P_{CB}}{2\sqrt{K}}$. The latter formulae shows how the Central Bank influences sector 2 prices under inflation targeting. Given this response, $\frac{\partial p_2}{\partial w_s^u}\frac{w_s^u}{p_2} = -\frac{1}{2}\kappa_s$. π_s is of course zero, since the Central Bank does not allow for the general price level to change. Now, again imposing a symmetric equilibrium, we have $\lambda_1 = \frac{1}{1-\gamma}(\frac{1}{2}\frac{\gamma}{m_1} - 1)$ and $\lambda_2 = \frac{1}{1-\gamma}(\frac{1}{2}\frac{\gamma}{m_2} - 1)$. Thus, under inflation targeting, equilibrium employment in sector s is implicitly given by

$$\frac{\alpha}{1-\alpha}(\gamma\frac{2m_s - 1}{2m_s - \gamma}) = \frac{l_s}{T - l_s}. \tag{13}$$

We now proceed to determine the relative employment levels under the inflation targeting and fixed exchange rate regimes.

3 Fixed exchange rates versus inflation targeting

From the above results, we find:

Proposition 1 *Unions in the shielded sector are more disciplined – yielding higher employment in this sector – under inflation targeting than under a fixed exchange rate regime. The opposite is true for unions in the open sector.*

Proof. $l_1^I > l_1^E \Leftrightarrow \frac{l_1^I}{T-l_1^I} > \frac{l_1^E}{T-l_1^E} \Leftrightarrow \frac{1}{2}\alpha\gamma^2\frac{1-\gamma}{(1-\alpha)(m_1-\gamma)(2m_1-\gamma)} > 0$, and $l_2^E > l_2^I \Leftrightarrow \frac{l_2^I}{T-l_2^I} > \frac{l_2^E}{T-l_2^E} \Leftrightarrow \frac{1}{2}\alpha\gamma^2\frac{1-\gamma}{(1-\alpha)m_2(2m_2-\gamma)} > 0$. These inequalities hold under the assumptions of the model. ■

This result is basically the same as in Holden (2003) and Vartiainen (2002), generalized in terms of allowing for different levels of centralization in wage setting. To understand the result, it is important to realize that a wage increase by a union can have a direct impact on both the price level in the relevant sector and the labor demand faced by the union. Typically, when (marginal) costs go up, prices may increase and production drops. These two effects are interrelated, as a larger price increase would imply that production drops less, all else equal. However, the union will always prefer a situation where production, and hence, labor demand, drops by a small amount and prices instead increase more. The basic reason is that the workers of a union do not bear the full costs of the price increase (even when there is only one union in the sector). In contrast, a labor demand drop does not imply the same kind of spillover to other workers and stockholders in the economy. This explains why open sector unions are more disciplined under a fixed exchange rate, since then, prices in the open sector are effectively fixed. The opposite holds for shielded sector unions, noting that prices in sector 1 are less flexible (though not fixed) under inflation targeting (see the Introduction).[16]

The next result illustrates the importance of wage setting centralization levels in this model:

Proposition 2 *Employment is under both inflation targeting and exchange rate targeting higher in the sector where wage setting is least centralized.*

Proof. Under the fixed exchange rate regime, relative employment indices in the two sectors are given by

$$\eta := \frac{\frac{l_1}{T-l_1}}{\frac{l_2}{T-l_2}} = \frac{\frac{2m_1-1-\gamma}{m_1-\gamma}}{\frac{2m_2-1+\gamma}{m_2}} = \frac{2m_1-1-\gamma}{(m_1-\gamma)(2m_2-1+\gamma)}m_2. \tag{14}$$

$\eta > (<)1$ for $m_2 < (>)m_1 - \gamma$. Since $\gamma < 1$, this proves the proposition in the exchange rate case (m_1 and m_2 are integers; $\frac{l}{T-l}$ is strictly increasing in

[16]Under exchange rate targeting, a wage rise in sector 1 (2) raises (lowers) the general price level, which works against the change in labor demand elasticities. However, these indirect/second order effects never dominate the direct effects on labor demand.

l). For the inflation targeting regime

$$\eta = \frac{(2m_1 - 1)(2m_2 - \gamma)}{(2m_2 - 1)(2m_1 - \gamma)}.$$

$\eta > (<) 1$ for $m_2 < (>) m_1$. ■

As explained in the Introduction, inflation targeting yields a type symmetry between sectors, since unions in both sectors face some increase in sector prices (the general price level stays fixed, however) and some reduction in employment as a result of a wage increase. Because of the symmetric nature of the model, bargaining centralization levels are the only factors that can influence relative employment levels.[17] Higher levels of centralization means that a wage rise influences more workers, thus reducing the negative labor demand effect.[18] This implies less wage restraint and a lower equilibrium employment level. The relative level of centralization is thus the determinant of relative employment under inflation targeting.

It may be more surprising that also in the exchange rate case, the relative level of centralization determines relative employment levels. After all, as discussed in the Introduction, when all else is equal, sector 1 unions have less of an incentive for wage restraint than their counterparts in sector 2. The explanation is that while employment is higher in sector 2 than in sector 1 under exchange rate targeting and given the same level of bargaining centralization in both sectors, sector 2 unions react more aggressively to a higher level of bargaining centralization than sector 1 unions.[19] Thus the relative centralization level has a larger effect on wage setting than in the

[17] As is evident from the earlier expressions, differences in the number of firms between sectors do not change relative employment levels. This is due to the fact that the elasticity of labor demand to wages is not dependent upon the number of firms in each sector, which again can be traced back to the isoelastic production functions. Thus, as explained in Section 5, while introducing differences in γ across sectors may influence results, changing the number of firms does not.

[18] While never dominating this direct effect, the indirect effect through the exchange rate is also larger: For sector 1 unions, a wage rise pushes prices more, leading to a larger appreciation of the exchange rate, and accordingly, a larger (offsetting) decrease in demand from sector 2 workers and stockholders. For sector 2 unions, a wage rise decreases sector 2 rents more, and demand for sector 1 products falls accordingly. This implies even lower sector 1 prices, which induces a larger exchange rate depreciation. The larger depreciation offsets the direct effect of a lower labor demand drop.

[19] Both type unions increase wage claims as a response to lower elasticity of labor demand. However, there is now an effect on the *general* price level. Increasing sector 1 wages increases the general price level, while increasing sector 2 wages decreases the general price level. This effect makes sector 1 unions *less* aggressive when the degree of centralization increases, while sector 2 unions behave *more* aggressively.

inflation targeting case, and this offsets the asymmetric impact exchange rate targeting has on the two sectors.[20]

What then happens to *total* employment in the economy? Relative employment in the two monetary regimes discussed so far is given by:

$$\Lambda := \frac{nl_1^I + nl_2^I}{nl_1^E + nl_2^E} = \frac{\frac{\frac{\alpha}{1-\alpha}\gamma\frac{2m_1-1}{2m_1-\gamma}T}{1+\frac{\alpha}{1-\alpha}\gamma\frac{2m_1-1}{2m_1-\gamma}} + \frac{\frac{\alpha}{1-\alpha}\gamma\frac{2m_2-1}{2m_2-\gamma}T}{1+\frac{\alpha}{1-\alpha}\gamma\frac{2m_2-1}{2m_2-\gamma}}}{\frac{\frac{\alpha}{1-\alpha}\frac{1}{2}\gamma\frac{2m_1-1-\gamma}{m_1-\gamma}T}{1+\frac{\alpha}{1-\alpha}\frac{1}{2}\gamma\frac{2m_1-1-\gamma}{m_1-\gamma}} + \frac{\frac{\alpha}{1-\alpha}\frac{1}{2}\gamma\frac{2m_2-1+\gamma}{m_2}T}{1+\frac{\alpha}{1-\alpha}\frac{1}{2}\gamma\frac{2m_2-1+\gamma}{m_2}}}. \tag{15}$$

It can be shown that Λ has the following properties:[21]

$$\Lambda > 1 \text{ for } m_2 \geq m_1 \tag{16}$$

$$\Lambda < 1 \text{ for } m_2 < m_1 \tag{17}$$

Proposition 3 *Inflation (Exchange rate) targeting will induce higher total employment than exchange rate (inflation) targeting if wage setting is more centralized in the shielded (open) sector.*

Sector 2 unions are disciplined by exchange rate targeting because labor demand elasticities are high. Under inflation targeting, there is a 'positive feedback' from the monetary authorities, since a wage increase in sector 2 decreases demand for sector 1 products, decreasing prices in sector 1 – which is then compensated for by a price increase in sector 2. The important point is that this effect is *larger* the more centralized wage setting is (larger unions determine wages in more firms, inducing a stronger price increase). Thus with more centralized wage setting in sector 2, it becomes more important to choose exchange rate targeting over inflation targeting. In sector 1, inflation targeting induces a 'negative feedback': If wages in sector 1 are increased, prices in this sector increase and consequently, prices in sector 2 decrease (as a result of Central Bank intervention), reducing demand for sector 1 goods from sector 2 workers and stockholders. As with sector 2 unions, this effect is stronger the fewer unions there are. Under exchange rate targeting, there is no such 'feedback'. Thus with more centralized wage setting in sector 1, it

[20] These results may seem at odds with the familiar Calmfors-Driffill hump shape, but this is not necessarily so. Since we are only discussing sector-specific unions, unions in a sector – no matter how large they are – never take into direct consideration how their wage setting affects workers (or stockholders) in the other sector. However, if we for instance introduced a single union covering all workers in the economy, we find (not shown) that employment would be at the same level as in the completely decentralized case (infinite number of unions in both sectors).

[21] Solving for $\Lambda = 1$ yields $m_1 - m_2 = \frac{\gamma}{2}$. However, due to the whole number restriction, $m_1 - m_2$ can never equal $\frac{\gamma}{2}$ and $m_2 < m_1$ is equivalent to $m_2 \leq m_1 - 1$.

becomes relatively more important to choose inflation targeting. All in all, the above considerations produce Proposition 3.

Both Holden (2003) and Vartiainen (2002) use models where, effectively, $m_1 = m_2 = 1$. Total employment is not discussed in Vartiainen (2002), but Holden (2003) finds that "Numerical simulations suggest that in most cases overall welfare and aggregate employment are higher under a price target than under an exchange rate target". This result is only replicated in the present model for $m_2 \geq m_1$, illustrating the potential importance of focusing on labor market asymmetries. Appendix E discusses welfare in this model. Numerical simulations strongly suggest that welfare always follows employment in this model – that is whenever total employment is increased by the choice of monetary target, welfare is also increased, and vice versa.

4 Other monetary targets

If inflation targeting yields higher total employment than exchange rate targeting, it does so by disciplining unions in the shielded sector. One may therefore argue that an inflation target focusing more on shielded sector prices, may lead to an even more advantageous effect on total employment. This is indeed the case: Fixing prices in the shielded sector (the extreme case), disciplines unions in this sector in the exact same way as exchange rate targeting disciplines sector 2 unions. Furthermore, the spillovers to the other sector are also similar, which can be easily shown. Thus:[22,23]

Proposition 4 *If the level of centralization in wage setting is higher in the shielded sector than in the open sector, shielded sector inflation targeting produces higher employment than either exchange rate targeting or general price level inflation targeting.*

From the preceding analysis, it is clear that the monetary policy that disciplines union wage setting the most (over all), also produces higher employment (and welfare). Accordingly, this is indeed a "union bashing" model, where the effects of monetary policy on aggregate outcomes are associated only with wage discipline. Theoretically, policy could be arranged in such a

[22] Welfare again increases if employment increases.

[23] Implementing a shielded sector inflation targeting regime rather than a regime where the target is based on a general consumption index, means potentially saving costs on monitoring fewer prices, but adding costs of separating shielded and open sector goods. The latter consideration may be important, but the gist of this discussion is not that one has to monitor all shielded sector prices to get an effect, but rather that focusing *more* on these prices gives an *additional* effect on employment.

way that wage increases are explicitly fought off by the central bank (wage-targeting), thereby inducing higher employment. However, the present model disregards any other issues more commonly discussed in relation to monetary targets (for instance output and exchange rate volatility). For this reason, we restrict attention to targets that are presumed to be more suitable as the basis of actual monetary policy, both for economic and political reasons.[24,25] One such possibility is production targets. In Appendix D, calculations for a range of nominal production targets are provided. These calculations show that no such target is able to outperform the better of the above targets when it comes to inducing high levels of employment. To understand this, consider a given wage increase by a union. As previously discussed, the wage increase could increase prices and/or decrease labor demand facing the relevant union. Thus the value of production, which is essentially a product of these two, could be less dependent upon wages than prices alone would be. Consequently, targeting prices is a more precise way of tackling high wages (by making labor demand more elastic) than targeting the value of production. This is summarized in the following proposition:[26]

Proposition 5 *Nominal production targets induce lower total employment than, at least, the better of the previously discussed (price) targets.*

Proof. See appendix D. ■

5 Assumptions

The above results come from a highly stylized model. How general can we assume that these results are? In this section, we discuss – mainly in reference

[24] A possible example of a more direct 'union bashing' rule is $E = f(\overrightarrow{w})$, where $\overrightarrow{w}$ is a vector of all union wages, w_i, and $\frac{\partial f}{\partial w_i} < 0$. In this case, an increase in wages from any union, will increase the exchange rate, hurting labor in both sectors. However, this would also amount to an 'instrument rule', rather than a 'targeting rule' As noted by Svensson (2002, 2003), an instrument rule may be economically undesirable since it deprives the Central Bank of any possibility to respond flexibly to shocks in the economy.

[25] A wage-targeting policy may prove highly provocative to unions and their members, and as such, be politically unfeasible.

[26] Although not shown, any employment target would also be expected to have negative strategic effects on union wage setting (relative to the fixed exchange rate and inflation targets). As discussed in some detail above, unions moderate their wage claims if prices respond less and employment more to a wage increase. In whatever way it is implemented, an employment target would be expected to provide a lower level of flexibility in employment, at least in one sector. In this case, unions would become more aggressive. The effect on total employment would of course depend on the Central Bank's ability to implement the target level of employment. We do not, however, continue this line of thought here.

to Proposition 3 – some of the assumptions made in the paper.

First of all, the consumption sub-utility function is a simple symmetric Cobb-Douglas type. The Cobb-Douglas assumption turns out to be the most innocent of the assumptions made. Simulations with a standard symmetric CES consumption sub-utility function, suggest that the employment effect of choosing a monetary target focusing on prices in the most centralized sector, is higher the less substitutable products are. For very close substitutes, the difference disappears.[27] A discussion of strong complements in this set-up, can however not be made, since, with too much complementarity (and too few unions), labor demand becomes inelastic, and the implied second order condition is breached.

The sectors are also otherwise treated as symmetric in the basic set-up. I have checked three extensions. First, it is possible to show theoretically that if there are a large difference in the number of workers in the two sectors, the previous results may not hold. With a lot of workers in a sector (relative to the other), even with more unions in that sector, the representative worker is working less than in the other sector. Thus these workers have a lower marginal utility of leisure. This means that if disciplined, the unions, maximizing the utility of a representative worker, will fight for and obtain a comparatively large increase in employment. Thus, from an employment point of view, it may be better to choose a monetary target that focuses on the sector with a lot of workers (low marginal utility of leisure) rather than the sector where wage setting centralization is highest. However, if the wage setting centralization levels become sufficiently different, it again becomes most important to discipline the most centralized sector. Although not done, these results should also apply to an asymmetric CES-function of the type used in Holden (2003) or Vartiainen (2002): Larger weight on one consumption good would increase the workload of a representative worker in the sector producing that good, making it less favorable to target this sector.[28,29]

Another asymmetry considered, is different technology parameters (γ) in the two sectors. Again, the result is as above; differences in technology

[27] The reason is that for closer substitutes, the wage competition between unions in the two sectors becomes fierce (for perfect substitutes it would be as fierce as the competition within a sector), and consequently any policy disciplining unions in one sector, also disciplines unions in the other sector.

[28] This suggest an additional and different explanation for the same type of result as found by Holden (2003) (page 261 (6)).

[29] The fact that Holden (2003) finds no effect of a different number of workers in each sector, seems to rely on the use of a utility function that is separable in leisure, making the union maximand totally independent upon the number of workers.

may dominate small differences in the centralization of wage setting. If one sector has better production technology, it produces more with given labor, and consequently, the representative worker has more leisure. As above, disciplining unions in this sector may lead to higher total employment even though wage setting centralization is lower in this sector. However, again, this is less likely the higher is the relative wage setting centralization level.

Finally, the basic model has 100% coverage levels in both sectors. Changing this assumption turns out to be particularly difficult. However, some limited numerical results have been obtained, and again, it seems that for sufficient differences in centralization levels, the results given in this paper are still valid.[30]

6 Implications and further remarks

Our results suggest that a small inflation targeting country with a large and relatively strongly unionized shielded sector, may face the possibility of increased unemployment if it enters into a monetary union. In such a union, the exchange rates vis-à-vis the trading partners within the union are fixed. The monetary union may very well be an inflation fighter, but it will take inflation in all countries within the union into account. Consequently, for a small country, this monetary policy may much more closely resemble that of a fixed exchange rate regime than an inflation targeting regime. The reduced discipline such a move will imply in relation to shielded sector wage setting, may prove to be important if unemployment is already a cause of concern. In fear of grossly overstating the potential policy impact of a stylized paper like this one, it is interesting to note that if the table in the Introduction is indicative, and with the public sector being an important part of the shielded sector, the UK government could be rightly cautious in their approach toward the EMU.

On a technical note, it is also worth observing that the disciplining effect on the *shielded* sector unions in both the case of country-wide and shielded sector inflation targeting, comes about because the monetary authorities credibly commit to *hurt* workers and stock-holders in the *open* sector. Moving from a country-wide to a shielded sector inflation target involves hurting the open sector *even more* for any wage increase in the shielded sector. The unions in the open sector are, however, only negatively affected by this policy

[30] However, the very limited evidence suggest that coverage levels do not affect total employment levels in the same way as the centralization level (one might think that high coverage and centralization work in the same direction), and it *may* be more important to discipline unions in the sector with the *lowest* coverage level.

change if the unions in the shielded sector continue to set high wages. This is not the case in equilibrium since these unions are disciplined by spillovers from the open sector. Consequently, the open sector unions would actually prefer the narrower price target because it gives them a chance to increase wages without suffering an equally large drop in employment (compared to what was the case under country-wide inflation targeting). It is then natural to ask how union incentives for cooperation, both within and across sectors, change with the monetary regime.[31] This is left for further work.

References

[1] Bratsiotis, G. and C. Martin (1999): "Stabilisation, policy targets and unemployment in imperfectly competitive economies", *Scandinavian Journal of Economics* 101(2), 241-256.

[2] Calmfors, L. (2001): "Wages and wage-bargaining institutions in the EMU - a survey of the issues", *Empirica* 28, 325-51.

[3] Calmfors, L. and J. Driffill (1988): "Bargaining structure, corporatism and macroeconomic performance", *Economic Policy* 6, 13-62.

[4] Coricelli, F., Cukierman, A. and A. Dalmazzo (2004): "Monetary institutions, monopolistic competition, unionized labor markets and economic performance", Working paper. Available at www.tau.ac.il/~alexcuk/pdf/ccd-1-04.pdf.

[5] Coricelli, F., Cukierman, A. and A. Dalmazzo (2003): "Economic performance and stabilization policy in a monetary union with imperfect labor and goods' markets", Forthcoming in Widgren (ed.) *Issues of Monetary Integration in Europe*, MIT Press.

[31] Holden (2005) shows that the possibly undesirable employment effects of entering a monetary union may be offset by increased incentives among unions to cooperate at a national level. In an excellent overview of possible impacts of EMU membership on employment and wages in potential entrant economies, Calmfors (2001) extends this argument: Membership in a monetary union may make decentralized wage bargaining more attractive, which could also lead to a lower level of unemployment. These arguments rely on the notion that both decentralized and fully centralized wage bargaining is better for employment than intermediate structures – a result which does not necessarily prevail in the present model because there are always intersectoral spillovers. It would be interesting to try to mesh the two approaches to evaluate the importance of cross-sectoral differences in unionism for the expected impact of monetary union membership on the degree of centralization in wage setting.

[6] Cukierman, A. (2004): "Monetary institutions, monetary union and unionized labor markets - some recent developments", in Beetsma, Favero, Missale, Muscatelli, Natale and Tirelli (eds.) *Monetary Policy, Fiscal Policies and Labour Markets: Key Aspects of Macroeconomic Policymaking in EMU*, Cambridge University Press.

[7] Gabszewicz, J. J. and J. P. Vial (1972): "Oligopoly "à la Cournot" in general equilibrium analysis", *Journal of Economic Theory* 4, 381-400.

[8] Holden, S. (2003): "Wage setting under different monetary regimes", *Economica* 70, 251-266.

[9] Holden, S. (2005): "Monetary regimes and the co-ordination of wage setting", *European Economic Review* 49, 833-43.

[10] Iversen, T. and D. Soskice (1999): "Monetary integration, partisanship, and macroeconomic policy", Paper presented at the 95th American Political Association Meeting, Sept. 2-5, 1999.

[11] Soskice, D. and T. Iversen (2000): "The nonneutrality of monetary policy with large price or wage setters", *Quarterly Journal of Economics* 115(1), 265-284.

[12] Svensson, L.E.O. (2002): "Inflation targeting: Should it be modeled as an instrument rule or a targeting rule?", *European Economic Review* 46, 771-780

[13] Svensson, L.E.O. (2003): "What is wrong with Taylor rules? Using judgement in monetary policy through targeting rules", *Journal of Economic Literature* 41, 426-477.

[14] Traxler, F. (1999): "The state in industrial relations: A cross-national analysis of developments and socioeconomic effects", *European Journal of Political Research* 36, 55-85.

[15] Traxler, F., Blaschke, S. and B. Kittel (2001): *National labour relations in internationalized markets*, Oxford University Press.

[16] Vartiainen, J. (2002): "Relative prices in monetary union and floating", *Scandinavian Journal of Economics* 104, 277-287.

Appendices

A Third stage equilibrium

In this appendix, we start out by discussing the supply side of the economy, taking wages as a given. After also having determined domestic demand, we find the relative prices in the shielded sector.

A.1 Supply

The firms decide the amount to supply on the basis of the goods' prices and wage levels only. No firms employ workers from more than one union, and wages are equal for all workers within the firm. Profit maximizing behavior implies choosing the following employment level in firm j producing the sector s good:

$$L_s^j = (\frac{\gamma p_s}{w_s^j})^{\frac{1}{1-\gamma}}. \tag{18}$$

It is assumed that workers are willing to work the necessary amount at the prevailing wage. This may not necessarily be the case, but as will be shown in Appendix C, the assumption turns out to hold in equilibrium.

Production by firm j is then given by $x_s^j = (\frac{\gamma p_s}{w_s^j})^{\frac{\gamma}{1-\gamma}}$, and aggregating to obtain total supply from sector s, we get

$$X_s^S = \sum_{j=1}^{f_s} (\frac{\gamma p_s}{w_s^j})^{\frac{\gamma}{1-\gamma}}, \tag{19}$$

where superscript 'S' denotes supply.

A.2 Demand

The domestic demand for the two products is given by the total demand of the N price taking, utility maximizing individuals that populate the economy. The demand by a *worker* employed in firm j in sector s is the solution to

$$\max_{x_1,x_2,y} (\sqrt{x_1 x_2})^{\alpha} (y)^{1-\alpha} \text{ s.t. } w_s^j (T-y) = p_1 x_1 + p_2 x_2, \tag{20}$$

where $m_s^j = w_s^j (T-y)$ is the income of the individual. T is the total time available to an employee for work and leisure.

The income levels of the workers stem from their wage income. This is in turn determined by the wage level and the amount of work required by the employer. If the employer needs less work than the individual is ready to supply at the prevailing wage, the individual cannot offer to work at a lower wage, so work would then be rationed. It is easily shown that work is rationed whenever $T - y = l \leq \alpha T$. In these cases, demand for good $g \in \{1, 2\}$ by a worker employed in firm j in sector s is $x_g = \frac{w_s^j l_s^j}{2p_g}$. As will be shown (Appendix C), union wages will always be high enough to induce an employment level lower than αT.

Aggregate demand also depends on the demand of the k firm owners. We have assumed that each *stockholder* i gets a fraction ϕ^i of total profits in the economy, $\sum_{i=1}^{k} \phi^i = 1$. Since we have assumed firms to be price takers, these stockholders simply maximize utility subject to their income being their share of total profits in the economy. Following the assumption that the stockholders' leisure is exogenously given, utility maximization requires $x_g^i = \frac{\phi^i(\Pi_1+\Pi_2)}{2p_g}$, $g \in \{1, 2\}$,where Π_s is the *total* profits accrued by firms in sector s.

With the present type of utility function for all individuals, the ideal price index is readily accessible. The utility gained from consumption is given by (short of a monotonic transformation) $\sqrt{x_1 x_2} = \frac{M}{2\sqrt{p_1 p_2}} = \frac{M}{P}$, for any individual with income M. Thus $P = 2\sqrt{p_1 p_2}$ is the ideal price index.

Adding up demand by workers and stockholders (in both sectors), it is also easily shown that total demand (for the sector 1 product) only depends on prices and the *total* income in the economy:

$$X_1^D = \frac{\frac{n_1}{f_1} \sum_{j=1}^{f_1} w_1^j l_1^j + \frac{n_2}{f_2} \sum_{j=1}^{f_2} w_2^j l_2^j + \Pi_1 + \Pi_2}{2p_1}, \tag{21}$$

where superscript 'D' denotes demand. Thus the distribution of profits across stockholders and the distribution of wage income across workers do not matter for demand. This is a convenient result stemming from Cobb-Douglas utility in consumption.[32]

A.3 Third stage equilibrium in prices

We have assumed that the sector 2 good can be produced both at home and abroad. Accordingly, home production need not be equal to home demand.[33] However, in the case of the shielded good, prices are determined by equating

[32] The same would be true for a CES-type utility function.

[33] However, in equilibrium, trade will be balanced.

domestic demand and supply. We know (and it is easily calculated) that the value of production, $p_s X_s^S$ equals labor costs and profits. Since total demand only depends on *total* labor costs and profits in the economy (as discussed above), equating supply, X_1^S, with demand, X_1^D, implies

$$X_1^S = \frac{p_1 X_1^S + p_2 X_2^S}{2p_1} = \frac{1}{2}[X_1^S + \frac{p_2 X_2^S}{p_1}]. \tag{22}$$

Thus supply creates its own demand through labor income and profits. This gives rise to the possibility of an *upward sloping demand curve*.[34] However, since a rise in supply leads to a 50% rise in demand, an increase in supply never leads to a relatively larger increase in demand, ensuring that any equilibrium calculated from (22) is stable.

Rearranging the above equation, we get

$$1 = \frac{1}{2}[1 + \frac{p_2}{p_1}\frac{X_2^S}{X_1^S}]. \tag{23}$$

We observe that the relative prices in equilibrium can be derived solely from the relative supply in the two sectors. Now, using our previous results, it is also easy to show that *relative supply* depends only on *relative* prices:

$$\frac{X_2^S}{X_1^S} = \frac{\sum_{j=1}^{f_2}(\frac{\gamma p_2}{w_2^j})^{\frac{\gamma}{1-\gamma}}}{\sum_{j=1}^{f_1}(\frac{\gamma p_1}{w_1^j})^{\frac{\gamma}{1-\gamma}}} = \frac{\sum_{j=1}^{f_2}(\frac{1}{w_2^j})^{\frac{\gamma}{1-\gamma}}}{\sum_{j=1}^{f_1}(\frac{1}{w_1^j})^{\frac{\gamma}{1-\gamma}}}(\frac{p_2}{p_1})^{\frac{\gamma}{1-\gamma}}. \tag{24}$$

Thus if the relative prices only depend on relative supply, and relative supply only depends on relative prices, then (23) and (24) determine an equilibrium in relative prices where the ratio of the two prices is constant. The reason why an exogenous 10% increase in the sector 2 prices are followed by exactly a 10% increase in the sector 1 prices can then be attributed to the fact that both sectors have access to the same technology. If the parameter γ differed across sectors, this rather special result would not prevail. However, it makes for a tidier analysis. Section 5 discusses this issue further.

[34] When the price of the good increases, the demand response is governed by four effects: The substitution effect and the familiar income effect both contribute to lower demand. However, in a general equilibrium set-up there are two additional effects: First of all, a higher price in sector 1 induces higher production and employment in that sector, increasing the wage bill of workers. This endogenous wage bill effect contributes positively to demand. At the same time, the price increase benefits stockholders through an accompanying endogenous profit effect, also leading to higher demand. These effects may well dominate the two other effects, leading to an upward sloping demand curve.

The equilibrium is then easily calculated from (23) and (24):[35]

$$\frac{p_1}{p_2} \triangleq K = \left(\frac{\sum_{j=1}^{f_2}(\frac{1}{w_2^j})^{\frac{\gamma}{1-\gamma}}}{\sum_{j=1}^{f_1}(\frac{1}{w_1^j})^{\frac{\gamma}{1-\gamma}}}\right)^{(1-\gamma)}. \tag{25}$$

B Elasticities

In this appendix, we calculate the elasticities, π_s and λ_s.

From A1, imposing the pricing game equilibrium of A3, the labor demand faced by a member of the union u is (remember that each firm has a labor stock of $\frac{n}{f_s}$ and that l_s^u represents the labor demand facing a *single worker* who is a member of union u)

$$l_1^u = \frac{f_1}{n}\left(\frac{\gamma p_1}{w_1^u}\right)^{\frac{1}{1-\gamma}} = \frac{f_1}{n}\left(\frac{\gamma K p_2}{w_1^u}\right)^{\frac{1}{1-\gamma}}, \tag{26}$$

$$l_2^u = \frac{f_2}{n}\left(\frac{\gamma p_2}{w_2^u}\right)^{\frac{1}{1-\gamma}}. \tag{27}$$

From these, the labor demand elasticities faced by each union can be calculated:

$$\lambda_1^u = \frac{\partial l_1^u}{\partial w_1^u}\frac{w_1^u}{l_1^u} = \frac{1}{1-\gamma}\left(\frac{w_1^u}{K}\frac{\partial K}{\partial w_1^u} + \frac{w_1^u}{p_2}\frac{\partial p_2}{\partial w_1^u} - 1\right), \tag{28}$$

$$\lambda_2^u = \frac{\partial l_2^u}{\partial w_2^u}\frac{w_2^u}{l_2^u} = \frac{1}{1-\gamma}\left(\frac{w_2^u}{p_2}\frac{\partial p_2}{\partial w_2^u} - 1\right). \tag{29}$$

$\frac{w_s^u}{K}\frac{\partial K}{\partial w_s^u}$, $s = 1, 2$ can be calculated using the definition of K in (25). Since all firms covered by union u faces the same wages, K can be rewritten (summarizing over unions):

$$K = \left(\frac{\frac{f_2}{m_2}\sum_{v=1}^{m_2}(\frac{1}{w_2^v})^{\frac{\gamma}{1-\gamma}}}{\frac{f_1}{m_1}\sum_{v=1}^{m_1}(\frac{1}{w_1^v})^{\frac{\gamma}{1-\gamma}}}\right)^{(1-\gamma)}.$$

[35] If we had chosen instead a (CES-) utility function of the form: $U(x_1, x_2, y) = \{[(x_1)^\rho + (x_2)^\rho]^{\frac{1}{\rho}}\}^\alpha\{y\}^{1-\alpha}, \rho \in (\leftarrow, 1]/\{0\}$, the relative pricing game equilibrium would have become $\frac{p_1}{p_2} = K^{\frac{1-\rho}{1-\gamma\rho}}$. However, due to reasons of tractability, we have chosen to work with the simpler twin Cobb-Douglas utility function. Section 5 discusses some results for the above CES case.

This yields

$$\kappa_1^u \triangleq \frac{\partial K}{\partial w_1^u}\frac{w_1^u}{K} = \frac{\gamma}{(w_1^u)^{\frac{\gamma}{1-\gamma}} \sum_{v=1}^{m_1} (\frac{1}{w_1^v})^{\frac{\gamma}{1-\gamma}}}, \tag{30}$$

$$\kappa_2^u \triangleq \frac{\partial K}{\partial w_2^u}\frac{w_2^u}{K} = -\frac{\gamma}{(w_2^u)^{\frac{\gamma}{1-\gamma}} \sum_{v=1}^{m_2} (\frac{1}{w_2^v})^{\frac{\gamma}{1-\gamma}}}. \tag{31}$$

Note that when a union changes its wage claims, this affects all firms that employ members of that union ($\frac{f_s}{m_s}$ firms).

The general price level elasticities can also be calculated. With $P = 2\sqrt{p_1 p_2}$, we have

$$\pi_s^u = \frac{w_s^u}{P}\frac{\partial P}{\partial w_s^u} = \frac{1}{2}(\frac{w_s^u}{p_1}\frac{\partial p_1}{\partial w_s^u} + \frac{w_s^u}{p_2}\frac{\partial p_2}{\partial w_s^u}). \tag{32}$$

Now, again imposing the third stage equilibrium, $p_1 = Kp_2$, we have

$$\begin{aligned} \pi_s^u &= \frac{1}{2}((\frac{w_s^u}{K}\frac{\partial K}{\partial w_s^u} + \frac{w_s^u}{p_2}\frac{\partial p_2}{\partial w_s^u}) + \frac{w_s^u}{p_2}\frac{\partial p_2}{\partial w_s^u}) \\ &= \frac{1}{2}[\kappa_s^u + 2\frac{w_s^u}{p_2}\frac{\partial p_2}{\partial w_s^u}]. \end{aligned} \tag{33}$$

Every union *within a sector* is exactly equal in all respects. Given that two unions face the same outside wages from its 'rival' unions, they face the same elasticities of demand and prices to own wages. Then there exist sector-wise symmetric wage game equilibria, and we therefore frequently use the elasticities in the symmetric cases (dropping superscripts), where

$$\kappa_1 = \frac{\gamma}{m_1}, \tag{34}$$

$$\kappa_2 = -\frac{\gamma}{m_2}. \tag{35}$$

C Rationing of work

In the previous analysis, we assumed that workers were not allowed to work as much as they wanted to at the prevailing wage. This implies that $l_s \leq \alpha T$, or equivalently, $\frac{l_s}{T-l_s} \leq \frac{\alpha}{1-\alpha}$. Here, we show this to be valid in the cases discussed in the paper:

For the fixed exchange rate regime, the above inequalities are reduced to

$$\frac{1}{2}\gamma\frac{2m_1 - 1 - \gamma}{m_1 - \gamma} \leq 1, \tag{36}$$

$$\frac{1}{2}\gamma\frac{2m_2 - 1 + \gamma}{m_2} \leq 1. \tag{37}$$

Both these inequalities hold for $\gamma \leq 1$.[36]

For the case of inflation targeting, we similarly need

$$\gamma \frac{2m_s - 1}{2m_s - \gamma} \leq 1,$$

which again holds trivially for $\gamma \leq 1$.

D Production targets

In this appendix, we discuss the possibility of providing the Central Bank with a production target. We assume that monetary policy is aimed at keeping a weighted sum of the *nominal* production values in the two sectors at a specific target level. We assign weights, β and $1-\beta$, $\beta \in [0,1]$, to the value of production in sectors 1 and 2, respectively. Letting V denote the target level, we then have

$$\beta p_1 \sum_{j=1}^{f_1} (\frac{\gamma p_1}{w_1^j})^{\frac{\gamma}{1-\gamma}} + (1-\beta)\, p_2 \sum_{j=1}^{f_2} (\frac{\gamma p_2}{w_2^j})^{\frac{\gamma}{1-\gamma}} = V. \tag{38}$$

Even though the Central Bank aims at keeping the weighted value of production fixed, the relative prices will still be determined by $p_1 = Kp_2$. Substituting into the above expressions yields

$$p_2^{\frac{1}{1-\gamma}} [\beta K^{\frac{1}{1-\gamma}} \sum_{j=1}^{f_1} (\frac{\gamma}{w_1^j})^{\frac{\gamma}{1-\gamma}} + (1-\beta) \sum_{j=1}^{f_2} (\frac{\gamma}{w_2^j})^{\frac{\gamma}{1-\gamma}}] = V. \tag{39}$$

Using the definition of K, the above expression simplifies to

$$p_2^{\frac{1}{1-\gamma}} \sum_{j=1}^{f_2} (\frac{\gamma}{w_2^j})^{\frac{\gamma}{1-\gamma}} = V. \tag{40}$$

Thus, in this model, *any* value-of-production target will amount to targeting the value of production in the open sector. The reason is that a wage increase in sector 1 will reduce production with the exact same fraction as it increases prices. Thus the value of production in this sector stays the same, and the Central Bank effectively pays no attention to sector 1. In the open sector, however, a wage increase will, without Central Bank intervention, only lead

[36] This then also holds for a shielded sector inflation target.

to a decrease in production. To keep the target, the Central Bank will then compensate by inducing an exchange rate depreciation.[37]

Following the above discussion, $\frac{dp_2}{dw_1^u}\frac{w_1^u}{p_2} = 0$ for all nominal production targets. Using (40) and imposing symmetry, we obtain $\frac{dp_2}{dw_2^u}\frac{w_2^u}{p_2} = \frac{\gamma}{m_2}$. Equilibrium employment in sector s is then implicitly given by

$$\frac{\alpha}{1-\alpha}\left(\frac{1}{2}\gamma\frac{2m_s - 1 - \gamma}{m_s - \gamma}\right) = \frac{l_s}{T - l_s}. \tag{41}$$

It is worth noting that employment in sector 1 is as it would have been under a fixed exchange rate. This follows trivially since $\frac{dp_2}{dw_1^u}\frac{w_1^u}{p_2} = 0$. Furthermore, employment in the competitive sector is strictly higher under exchange rate targeting. With a given value of production target, a wage increase in sector 2 will increase prices. This would not have happened under a credible exchange rate target, and following the previous discussion, it is the opposite of what is needed in order to induce high employment.

It is important to realize, however, that the invariability of these results with respect to the type of value-of-production target, depends crucially on the Cobb-Douglas preferences and the fact that each individual's spending on each good is a constant share of his or her income. Without this assumption, it would matter which sector's value of production is targeted. In any case, however, a price target yields a sharper focus on wages (which are the variables that matter) than does a production target.

E Welfare

Since the model incorporates both workers and stockholders, total welfare depends upon how we weigh these two groups against each other. In the following, we will work with an additive welfare function:

$$\begin{aligned} W &= n\left(\frac{w_1 l_1}{P}\right)^{\alpha}(T - l_1)^{1-\alpha} + n\left(\frac{w_2 l_2}{P}\right)^{\alpha}(T - l_2)^{1-\alpha} \\ &\quad + \sum_{i=1}^{k}\left(\phi_i \frac{\Pi_1 + \Pi_2}{P}\right)^{\alpha}((T - l_k))^{1-\alpha}, \end{aligned} \tag{42}$$

where the two first parts is total individual utility in sectors 1 and 2, while the last part is the total utility of stockholders.

[37] As long as the value of production in the non-shielded sector remains the same, there is no spillover into the shielded sector, as the value of production exactly equals the payoff to labor and capital (Appendix A).

When we choose such a welfare function, the relative distribution of workers/ stockholders in the economy and the relative distribution of wealth across stockholders will strongly co-determine the welfare impacts of different policies. If there are only a few stockholders, their marginal utility of money is close to zero, and they can consequently be dropped from the analysis. To find the likely welfare effects of different monetary regimes, we discuss both this special case and its theoretical opposite where only the sum of stockholders' utilities count for welfare. Our results strongly suggest that the ranking of welfare across the different regimes follows employment; welfare is higher under the regime that induces the higher level of employment. This should come as no surprise in the case where only stockholders' utility-levels count, as monetary policies increase employment if and only if it manages to discipline union wage setting. That individual utility-levels also rice when employment increases, reflects the fact that a union do not take into account how their wage setting affects workers represented by other unions. Consequently wages are too high and employment too low.

E.1 Workers' utility

Total worker utility under inflation targeting (superscript I) relative to exchange rate targeting (superscript E) is given by

$$\Omega_1 = \frac{n(\frac{w_1^I l_1^I}{P^I})^\alpha (T - l_1^I)^{1-\alpha} + n(\frac{w_2^I l_2^I}{P^I})^\alpha (T - l_2^I)^{1-\alpha}}{n(\frac{w_1^E l_1^E}{P^E})^\alpha (T - l_1^E)^{1-\alpha} + n(\frac{w_2^E l_2^E}{P^E})^\alpha (T - l_2^E)^{1-\alpha}}. \quad (43)$$

We now want to express Ω_1 in terms of employment only, so that we can substitute for the equilibrium values found in the main paper.

Wages are related to employment according to

$$\frac{f_s}{n}(\frac{\gamma p_s}{w_s})^{\frac{1}{1-\gamma}} = l_s. \quad (44)$$

Solving for w_s, we get

$$w_s = \gamma p_s (\frac{f_s}{n})^{1-\gamma} l_s^{\gamma-1}. \quad (45)$$

Also,

$$\frac{w_s l_s}{P} = \frac{\gamma p_s (\frac{f_s}{n})^{1-\gamma} l_s^\gamma}{2\sqrt{p_1 p_2}} = \frac{\gamma (\frac{f_s}{n})^{1-\gamma} l_s^\gamma}{2} \sqrt{\frac{p_s^2}{p_1 p_2}}. \quad (46)$$

Relative prices are (in a symmetric equilibrium) given by:

$$\frac{p_1}{p_2} = (\frac{f_2}{f_1})^{1-\gamma}(\frac{w_1}{w_2})^{\gamma} = (\frac{f_2}{f_1})^{1-\gamma}(\frac{\gamma p_1(\frac{f_1}{n})^{1-\gamma}l_1^{\gamma-1}}{\gamma p_2(\frac{f_2}{n})^{1-\gamma}l_2^{\gamma-1}})^{\gamma} \Leftrightarrow$$

$$\frac{p_1}{p_2} = (\frac{f_2}{f_1})^{(1-\gamma)}(\frac{l_2}{l_1})^{\gamma}. \tag{47}$$

Expressing $\frac{w_1 l_1}{P}$ and $\frac{w_2 l_2}{P}$ in terms of l_1 and l_2, we then get

$$\begin{aligned}\frac{w_1 l_1}{P} &= \frac{\gamma(\frac{f_1}{n})^{1-\gamma}l_1^{\gamma}}{2}\sqrt{\frac{p_1}{p_2}} \\ &= \frac{1}{2}\sqrt{(f_1 f_2)^{1-\gamma}(l_1 l_2)^{\gamma}}\gamma(\frac{1}{n})^{1-\gamma}\end{aligned} \tag{48}$$

and

$$\frac{w_2 l_2}{P} = \frac{1}{2}\sqrt{(f_1 f_2)^{1-\gamma}(l_1 l_2)^{\gamma}}\gamma(\frac{1}{n})^{1-\gamma} = \frac{w_1 l_1}{P}. \tag{49}$$

Substituting this in Ω_1 yields

$$\begin{aligned}\Omega_1 &= \frac{(\frac{1}{2}\sqrt{(f_1 f_2)^{1-\gamma}(l_1^I l_2^I)^{\gamma}}\gamma(\frac{1}{n})^{1-\gamma})^{\alpha}}{(\frac{1}{2}\sqrt{(f_1 f_2)^{1-\gamma}(l_1^E l_2^E)^{\gamma}}\gamma(\frac{1}{n})^{1-\gamma})^{\alpha}}\frac{(T-l_1^I)^{1-\alpha}+(T-l_2^I)^{1-\alpha}}{(T-l_1^E)^{1-\alpha}+(T-l_2^E)_2^{1-\alpha}} \\ &= (\frac{l_1^I l_2^I}{l_1^E l_2^E})^{\alpha\frac{\gamma}{2}}\frac{(T-l_1^I)^{1-\alpha}+(T-l_2^I)^{1-\alpha}}{(T-l_1^E)^{1-\alpha}+(T-l_2^E)^{1-\alpha}}.\end{aligned} \tag{50}$$

Thus Ω_1 depends on employment in the above way. Finding l_s is straight forward:

1. Inflation targeting:

$$\frac{\alpha}{1-\alpha}(\gamma\frac{2m_s-1}{2m_s-\gamma}) = \frac{l_s^I}{T-l_s^I} \Leftrightarrow \tag{51}$$

$$l_s^I = \alpha\gamma T\frac{2m_s-1}{2m_s-\gamma-2\alpha m_s(1-\gamma)} \tag{52}$$

2. Exchange rate targeting:

$$\frac{\alpha}{1-\alpha}(\frac{1}{2}\gamma\frac{2m_1-1-\gamma}{m_1-\gamma}) = \frac{l_1^E}{T-l_1^E} \Leftrightarrow \tag{53}$$

$$l_1^E = \alpha\gamma T\frac{-2m_1+1+\gamma}{\alpha(1-\gamma)(2m_1-\gamma)-2(m_1-\gamma)} \tag{54}$$

$$\frac{\alpha}{1-\alpha}(\frac{1}{2}\gamma\frac{2m_2-1+\gamma}{m_2}) = \frac{l_2^E}{T-l_2^E} \Leftrightarrow \tag{55}$$

$$l_2^E = \alpha\gamma T\frac{2m_2-1+\gamma}{-\alpha(1-\gamma)(\gamma+2m_2)+2m_2}. \tag{56}$$

Substituting the above values for employment yields

$$\begin{aligned}
\Omega_1 &= \left(\frac{l_1^I l_2^I}{l_1^E l_2^E}\right)^{\alpha\frac{\gamma}{2}} \frac{(T-l_1^I)^{1-\alpha}+(T-l_2^I)^{1-\alpha}}{(T-l_1^E)^{1-\alpha}+(T-l_2^E)^{1-\alpha}} \\
&= \left(\frac{AB}{CD}\right)^{\alpha\frac{\gamma}{2}} \frac{(1-\alpha\gamma A)^{1-\alpha}+(1-\alpha\gamma B)^{1-\alpha}}{(1-\alpha\gamma C)^{1-\alpha}+(1-\alpha\gamma D)^{1-\alpha}},
\end{aligned} \tag{57}$$

where

$$\begin{aligned}
A &= \frac{2m_1-1}{2m_1-\gamma-2\alpha m_1(1-\gamma)} \\
B &= \frac{2m_2-1}{2m_2-\gamma-2\alpha m_2(1-\gamma)} \\
C &= \frac{-2m_1+1+\gamma}{\alpha(1-\gamma)(2m_1-\gamma)-2(m_1-\gamma)} \\
D &= \frac{2m_2-1+\gamma}{-\alpha(1-\gamma)(\gamma+2m_2)+2m_2}
\end{aligned}$$

I have not been able to determine when Ω_1 exceeds or falls below unity analytically. However, numerical simulations strongly suggest that welfare follows employment in this model; that is Ω_1 is larger than 1 for $m_2 \geq m_1$ and similarly less than 1 for $m_2 < m_1$. MATLAB has been used to check this numerically, and the relevant m.-files are available from www.econ.uib.no/pub/frode/BU.zip.

E.2 Stockholders' utility

It turned out to be impossible to obtain an analytical solution to the problem of welfare maximization in the above case. For the case of total stockholders' utility, this is no longer the case.

Regardless of the distribution of wealth across stockholders, maximizing total stockholder utility amounts to maximizing real profits. Real profits are given by

$$\frac{\Pi_1+\Pi_2}{P} = \frac{f_1(p_1L_1^\gamma - w_1L_1)+f_2(p_2L_2^\gamma - w_2L_2)}{P}. \tag{58}$$

Using $\frac{p_1}{p_2} = (\frac{f_2}{f_1})^{1-\gamma}(\frac{l_2}{l_1})^\gamma$, we get

$$\begin{aligned}
\frac{p_1L_1^\gamma}{P} &= \frac{(\frac{f_2}{f_1})^{\frac{1-\gamma}{2}}(\frac{l_2}{l_1})^{\frac{\gamma}{2}}}{2}(nl_1)^\gamma \\
&= \frac{(\frac{f_2}{f_1})^{\frac{1-\gamma}{2}}(l_1l_2)^{\frac{\gamma}{2}}}{2}n^\gamma.
\end{aligned} \tag{59}$$

Similarly,

$$\frac{p_2 L_2^\gamma}{P} = \frac{(\frac{f_1}{f_2})^{\frac{1-\gamma}{2}}(l_1 l_2)^{\frac{\gamma}{2}}}{2} n^\gamma. \tag{60}$$

Using (48) and (49), we then get:

$$\begin{aligned}\frac{\Pi}{P} &= f_1 \frac{(\frac{f_2}{f_1})^{\frac{1-\gamma}{2}}(l_1 l_2)^{\frac{\gamma}{2}}}{2} n^\gamma + f_2 \frac{(\frac{f_1}{f_2})^{\frac{1-\gamma}{2}}(l_1 l_2)^{\frac{\gamma}{2}}}{2} n^\gamma - (f_1+f_2)\frac{1}{2}\sqrt{(f_1 f_2)^{1-\gamma}(l_1 l_2)^\gamma}\gamma(\frac{1}{n})^{1-\gamma} \\ &= \frac{1}{2}(l_1 l_2)^{\frac{\gamma}{2}}(f_1 f_2)^{\frac{1-\gamma}{2}} n^\gamma (f_1^\gamma + f_2^\gamma - \frac{\gamma}{n}(f_1+f_2)). \end{aligned} \tag{61}$$

Thus welfare is maximized in the regime yielding the higher level of $l_1 l_2$. Ω_2 can thus represent relative welfare in this case:

$$\Omega_2 = \frac{l_1^I l_2^I}{l_1^E l_2^E} = \frac{\frac{2m_1-1}{2m_1-\gamma-2\alpha m_1(1-\gamma)} \frac{2m_2-1}{2m_2-\gamma-2\alpha m_2(1-\gamma)}}{\frac{-2m_1+1+\gamma}{\alpha(1-\gamma)(2m_1-\gamma)-2(m_1-\gamma)} \frac{2m_2-1+\gamma}{-\alpha(1-\gamma)(\gamma+2m_2)+2m_2}}. \tag{62}$$

Now, it is relatively easy to show that $\Omega_2 = 1$ for $m_2 = m_1 - \frac{\gamma}{2}$ and that for integer numbers, $\Omega_2 > 1$ for $m_2 \geq m_1$ and $\Omega_2 < 1$ for $m_2 \leq m_1 - 1$. This proves that welfare is higher under the monetary regime that yields higher total employment.