A Union Bashing Model of Inflation Targeting

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Foreword

This publication comes out of the *Strategic Program for Research on Globalization and Internationalization: welfare, work, legitimacy and globalization*, at the Stein Rokkan Centre for Social Studies at Bergen University Research Foundation. This program is designed as a University of Bergen research network, and its primary area of activity is the study of changes in *welfare and labor market institutions* as they are played out in the debate on globalization and internationalization
(see http://129.177.180.14/globalisering/programnotat.pdf).

Issues of distribution, regulation and fairness are central to the program, which incorporates research in sociology, political science, economics, history and philosophy. One basic premise for program research is that focusing on welfare and labor market institutions can provide important insights into other areas of society and that it can also shed light on other globalization issues, such as the status of the nation state and conditions for democratic governance.

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A Union Bashing Model of Inflation Targeting[*]

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Abstract

This paper shows that in an open economy, general price level inflation targeting may provide large wage setters with little incentive for wage restraint. This contradicts recent developments within the inflation targeting literature, and the discrepency is due to the asymmetric impact exchange rate changes have on sectors shielded from, and sectors open to, international trade. By disciplining unions in the non-shielded sectors, exchange rate targeting yields higher employment than inflation targeting when unions in the open sector are strong relative to their shielded sector counterparts. In the opposite case, when unions are stronger in the shielded sector, we show that general price level inflation targeting is inferior to an inflation target that focuses only on shielded sector prices.

Keywords: Inflation targeting, unemployment, monetary policy, unions, shielded and non-shielded 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 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. Accordingly, strict monetary policies induce low unemployment by disciplining unions.[2] This paper builds much on the same premises as these earlier studies, but 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. The resulting asymmetric impact on shielded and non-shielded sectors is the focus of this paper.

Another important backdrop of the present paper, is the fact that union influence varies considerably not only across countries, but also across sectors within countries. Table 1 shows collective bargaining coverage for the private and public sector in selected European countries in 2001 (%):

Table 1

Country	Private sector	Public sector
Austria	98	0
Denmark	71	100
Germany West	[a]70	nd
Germany East	[a]55	nd
Hungary	31	31
Netherlands	86	100
Norway	[b]63	[b]100
Portugal	[c]89	81
Slovakia	34	59
Slovenia	100	100
Sweden	>90	100
Great Britain	22	73

Source: Eiro (2003), nd = no data; a,b,c = in years 2000, 1998, 1999

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[1] Earlier literature, by focusing on inflation-averse unions, obtained the opposite result. See Skott (1997), Jensen (1997), Cukierman and Lippi (1999), Guzzo and Velasco (1999, 2002), Lippi (2002) and Jerger (2002). For a survey of both types of approaches, see Cukierman (2002). See also Lippi (2003).

[2] This argument is generally not valid if there is only one large wage setter – then this union may only take relative wages into consideration, and the classical dichotomy between monetary policies and real variables, hold. However, with multiple wage setters, relative prices do not enter the maximand in the same way, and the changing of absolute prices matters. For further discussion, see Soskice and Iversen (2000) and Section 8 of this paper.

The general gist of this table, that substantial sectoral differences exist, is also confirmed if sectors are divided by industry (EIRO, 2003).[3] With such differences in union presence across sectors, and noting that monetary policy may affect unions in different sectors asymmetrically, the question arises of what this all has to say for the attractiveness of monetary policies. We argue that, although it is unreasonable to design monetary policy solely to discipline unions, insofar as this is an important consideration, inflation targeting may be an inferior target given the observed inter-sectoral asymmetries. While pinpointing the general price level, inflation targeting leaves shielded and non-shielded sector prices adjustable. In a small, open economy, prices would typically be less adjustable (to domestic wages) in non-shielded sectors than in shielded sectors under exchange rate targeting, since import prices are then non-affected by domestic developments. Conversely, under an inflation target focusing only on the shielded sector, the prices in this sector would be less adjustable. These two other types of monetary targets may therefore induce more union wage-discipline in the non-shielded and shielded sectors, respectively, than does general price level inflation targeting. In the present model, we show that if unions are stronger in either of the two sectors, disciplining these unions through the appropriate choice of monetary target, increases equilibrium employment beyond the level under general price level inflation targeting.

Holden (2003a) and Vartiainen (2002) use a similar two-sector set-up to ours, though without labor market asymmetries. The authors discuss fixed exchange rates and general price level inflation targeting, and their focus is mainly on wages and prices. This paper replicates their main result: If there is a shift from an exchange rate target to an inflation target (country-wide), real wages in the sector shielded from foreign competition are decreased, while the opposite is true in the non-shielded sector.[4] While this result is basically robust to the differing labor market structures introduced in the present paper, the same is not true for the monetary policy-objective's effect on *total* employment. The paper by Vartiainen does not address this question, but Holden argues (using numerical simulations) that aggregate employment will 'in most cases' be higher under inflation targeting than given fixed exchange rates. We show the reverse to be true whenever wage setting is more centralized in the non-shielded sector than in the shielded sector. The reason is that the shift from exchange rate targeting to inflation targeting yields lower discipline on non-shielded sector unions and more on

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[3]For data on union density, see for instance Booth *et al.* (2001) p. 26.

[4]In the present paper, we obtain the 'complementary' effect: Equilibrium employment increases in the shielded sector and decreases in the non-shielded sector.

shielded sector unions, a move which may lead to higher unemployment if unions are stronger (here; fewer) in the shielded sector relative to the non-shielded sector.

Mankiw and Reis (2003) is another interesting paper where the authors discuss alternative measures for the prices targeted by the central bank. The focus in that paper is *stabilization* (of economic activity), and one of the main results is that the more flexible prices are in a sector, the less they should be weighted in the price index used to target inflation.[5] To the extent that less flexible prices correspond to more monopoly power in that sector, our results can be interpreted as augmenting the stability argument, since focusing on the 'less competitive' sector may also yield higher equilibrium employment.

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.[6,7]

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. The choice of a monopoly union model is made to make analytical headway. With monopoly unions, union

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[5] Aoki (2001) obtains a similar result. See also Erceg, Henderson and Levin (2000).

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

[7] The main results of the paper carry through to the situation where the number of workers in each sector are not equal, but for analytical convenience we assume equal division of workers between sectors.

strength – which according to the remarks made in the introduction, is expected to be important to the results – cannot be measured through union bargaining power. Again, for tidy symmetric results, we choose to assume full (total) union coverage and work with the number of unions in the two sectors (the degree of centralization in wage setting) as the premier (inverse) measure of union strength. There are $m_s \geq 1$ unions in sector s, and these are all sector specific. In addition, unions within a sector are equally large and workers within a single firm is 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 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 work force to firms; $\frac{n}{f_s}$. However, the firms are only required to pay these workers for the amount of work they do.[8]

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

$$p_2 = \frac{p_2^*}{E}, \tag{3}$$

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. 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. For simplicity, we assume that

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[8]Thus there is strictly speaking no 'unemployment' in this model. This set-up is used purely for analytical convenience, as we do not want to focus on insider-outsider problems in this paper. 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 (2003a)).

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 (2003a) and Vartiainen (2002).[9]

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 sets the interest rate, which determines the exchange rate.[10] Finally, production occurs and prices are determined. We solve, of course, by backwards induction. The following section presents the fourth stage equilibrium in prices. Section 4 addresses the behavior of unions, also determining some essential elasticities needed in the following analysis. We then turn to discussing different monetary policies, starting with a fixed exchange rate in Section 5. Inflation targeting is discussed in Section 6, while a shielded sector inflation/price target is discussed in Section 7. Section 8 discusses the role of the numeraire, and Section 9 concludes.

3 Third stage equilibrium

We defer the calculations of the third stage equilibrium in prices to Appendix A. The relative prices ensuring that domestic supply equals domestic demand for the shielded sector good, are given by:

$$\frac{p_1}{p_2} = K := \left(\frac{\sum_{j=1}^{f_2}\left(\frac{1}{w_2^j}\right)^{\frac{\gamma}{1-\gamma}}}{\sum_{j=1}^{f_1}\left(\frac{1}{w_1^j}\right)^{\frac{\gamma}{1-\gamma}}}\right)^{(1-\gamma)}. \tag{4}$$

In the non-shielded 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 non-shielded sector. Thus trade will be balanced in equilibrium.

As discussed, we will assume that the monetary authority can change the nominal exchange rate, and thus adjust p_2. 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. Technically,

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[9]Mankiw and Reis (2003) also discuss price targeting in a single period model, but without specifying the route through which monetary control is implemented.

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

the right hand side of (4) may change due to a change in monetary regime. The breakdown of money neutrality is further addressed in Section 8.

4 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.[11] Thus, for any individual with income M,

$$U = (\sqrt{x_1 x_2})^\alpha (y)^{1-\alpha} = (\frac{M}{P})^\alpha (T - l)^{1-\alpha}, \tag{5}$$

where T is the total number of available hours for work and leisure, l is the individual's labor supply and P 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:

$$U_s^u = (\frac{w_s^u l_s^u}{P})^\alpha (T - l_s^u)^{1-\alpha}. \tag{6}$$

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.[12]

The first-order condition for union utility maximization is

$$\frac{\alpha}{1-\alpha}(\frac{1 - \pi_s^u}{\lambda_s^u} + 1) = \frac{l_s^u}{T - l_s^u}, \tag{7}$$

where

$$\lambda_s^u \quad : \quad = \frac{w_s^u}{l_s^u} \frac{\partial l_s^u}{\partial w_s^u}, \tag{8}$$

$$\pi_s^u \quad : \quad = \frac{w_s^u}{P} \frac{\partial P}{\partial w_s^u}. \tag{9}$$

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[11] 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.

[12] l_s^u equals $f_s \frac{L_s^j}{n}$ for all firms j covered by union 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 deciding the non-shielded 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 A). With superscripts dropped,

$$\lambda_1 = \frac{1}{1-\gamma}(\kappa_1 + \frac{w_1}{p_2}\frac{\partial p_2}{\partial w_1} - 1), \tag{10}$$

$$\lambda_2 = \frac{1}{1-\gamma}(\frac{w_2}{p_2}\frac{\partial p_2}{\partial w_2} - 1) \tag{11}$$

and

$$\pi_s = \frac{1}{2}[\kappa_s + 2\frac{w_s}{p_2}\frac{\partial p_2}{\partial w_s}], \tag{12}$$

where

$$\kappa_1 = \frac{\gamma}{m_1}, \tag{13}$$

$$\kappa_2 = -\frac{\gamma}{m_2}. \tag{14}$$

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

5 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, more importantly, non-determined by internal factors. Consequently $\frac{w_s^u}{p_2}\frac{\partial p_2}{\partial w_s^u} = 0$ for all unions. Thus, in terms of the above elasticities, we have

$$\pi_s = \frac{1}{2}\kappa_s, \tag{15}$$

$$\lambda_1 = \frac{1}{1-\gamma}(\kappa_1 - 1), \tag{16}$$

and

$$\lambda_2 = -\frac{1}{1-\gamma}. \tag{17}$$

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)

$$\frac{\alpha}{1-\alpha}\left(\frac{1}{2}\gamma\frac{2m_1 - 1 - \gamma}{m_1 - \gamma}\right) = \frac{l_1}{T - l_1}, \tag{18}$$

$$\frac{\alpha}{1-\alpha}\left(\frac{1}{2}\gamma\frac{2m_2 - 1 + \gamma}{m_2}\right) = \frac{l_2}{T - l_2}. \tag{19}$$

The Nash equilibrium wage outcome is not readily available from the above expressions. However, we do not need to find the equilibrium wages. The above expressions provide us with the employment level aimed for by the unions. Any non-negative employment level can be induced by the union with an appropriately chosen wage level (there is imperfect substitutability between the goods produced in the two sectors). The employment indices determined above thus provide us with the flip-side of the coin; the employment level in equilibrium. Before going into the above result in more detail, we also determine employment in the inflation targeting regime.

6 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 (see Appendix A). This is given by $P_{CB} = 2p_2\sqrt{K}$. Thus, the price of the sector 2 good responds to wages according to the following formulae:

$$p_2 = \frac{P_{CB}}{2\sqrt{K}}. \tag{20}$$

This response is induced by the Central Bank, adjusting the exchange rate to keep the general price level at the specified target level.

Given this response, we can easily calculate the missing elasticities from Section 4:

$$\frac{\partial p_2}{\partial w_s^u}\frac{w_s^u}{p_2} = -\frac{1}{2}\kappa_s. \tag{21}$$

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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

$$\frac{\alpha}{1-\alpha}(\gamma\frac{2m_s-1}{2m_s-\gamma}) = \frac{l_s}{T-l_s}. \tag{22}$$

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

6.1   Fixed exchange rates versus inflation targeting

From the above results, we find:

Proposition 1 *Employment per worker 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 in the two sectors is given by

$$\eta := \frac{\frac{l_1}{T-l_1}}{\frac{l_2}{T-l_2}} = \frac{\frac{2m_1-1-\gamma}{m_1-\gamma}}{\frac{2m_2-1+\gamma}{m_2}} = \frac{2m_1-1-\gamma}{(m_1-\gamma)(2m_2-1+\gamma)}m_2. \tag{23}$$

$\eta > (<)1$ 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). For the inflation targeting regime

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

$\eta > (<)1$ for $m_2 < (>)m_1$. ∎

This result may seem at odds with the familiar Calmfors-Driffill hump shape[13], 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.[14] Thus the effect that would discipline unions under

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[13]Calmfors and Driffill (1985). See also Driffill and van der Ploeg (1993, 1997).

[14]However, unions do *indirectly* care about workers in the other sector, since a possibly significant part of the negative labor demand effect of a wage increase, consists of a decrease in purchases made by other workers.

higher levels of centralization in a Calmfors-Driffill-type model – the internalization of inter-sectoral price spillovers – is not present in this model. In line with the discussion in the introduction, we would argue that the exclusion of such effects would be far from unreasonable. Indeed Knell (2002) argues that the ongoing process of deregulation and globalization may have contributed to a situation where centralized wage-bargaining systems are no longer advantageous (relative to intermediate structures).[15] 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), thus illustrating that a Calmfors-Driffill hump-shape could materialize if such inter-sectoral effects were introduced.

Finally, it should be noted that if there is an equal number of unions in the two sectors, employment per worker is strictly higher in the non-shielded sector relative to the shielded sector under a fixed exchange rate regime and exactly equal to the employment in the shielded sector under price targeting.

The next question we ask is what happens to employment if we go from a fixed exchange rate regime to a regime with inflation targeting. It is easily shown that employment (both per worker and sector wide) in the shielded sector increases, while employment in the non-shielded sector is reduced:

Proposition 2 *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 non-shielded sector.*

Proof.

$$l_1^I > l_1^E \Leftrightarrow$$
$$\gamma(1 - \gamma) > 0, \tag{24}$$
$$l_2^E > l_2^I \Leftrightarrow$$
$$\frac{1}{2}\gamma \frac{1 - \gamma}{m_2(2m_2 - \gamma)} > 0, \tag{25}$$

where superscripts I and E denote inflation targeting and exchange rate targeting respectively. Both (24) and (25) hold under the assumptions of the model. ∎

To understand this 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 members. Typically, when

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[15]See also Molle (2002).

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(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. Consequently, in the present model – and we would anticipate in much more general settings – any policy rendering prices rigid in a sector leads to lower wages and higher employment in this sector.[16]

With this in mind, it is easy to understand why unions in the non-shielded sector are more disciplined under the fixed exchange rate regime than under inflation targeting: Under fixed exchange rates, the sector 2 price level is effectively fixed. Thus the drop in labor demand associated with a wage increase is very high, and unions choose low wages and obtain high employment. Under inflation targeting, however, a wage increase by a sector 2 union is allowed to spill over into a higher price in this sector through the following equilibrium effects: A wage increase reduces profits and can be shown also to reduce labor income in sector 2. This reduces the demand for *both* non-shielded and shielded sector goods. The reduction in demand in the *shielded* sector would lead to a lower price in this sector. However, the price/inflation targeting Central Bank will not allow such a price decrease, since this would decrease the general price level. To compensate, the Central Bank decreases interest rates and induces an exchange rate depreciation. This, in turn, increases prices in the non-shielded sector. The end result of a wage increase by the non-shielded sector unions is thus a price increase in sector 2. More importantly, the increase in the sector 2 prices contributes to a lower drop in labor demand in sector 2. Following the above discussion, this will then make the sector 2 unions less willing to keep wages low, and accordingly employment is lower under inflation targeting than under a fixed exchange rate regime.

The opposite result holds for the shielded sector unions. Under a fixed exchange rate regime, a wage increase in the shielded sector leads to a relatively large increase in prices in this sector.[17] Under inflation targeting, the above price increase is fought off by the Central Bank aiming to keep the

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[16]Although not explained in detail by the authors, this intuition would apply equally to the discussion in Holden (2003a) and Vartiainen (2002).

[17]The underlying effects are as follows: The wage increase decreases supply, given prices. As before, though, demand also decreases. However, the decrease in supply is larger than the decrease in demand, leading to higher prices and lower demand for labor.

price level down. This is done by inducing an exchange rate appreciation, leading to lower prices in the non-shielded sector. However, this spills over into the shielded sector through lower demand (reduced profits and labor income in sector 2). The reduced demand works contrary to the supply-driven increase in prices in the shielded sector, and it contributes to a more severe reduction in labor demand. Consequently, unions in the shielded sector are more disciplined under inflation targeting than under a fixed exchange rate regime.

The results of this section are not really new. As discussed in the introduction, Holden (2003a) and Vartiainen (2002) address the same questions and obtain similar results. There is no hiding that the present paper is in some respects simpler than the two other papers.[18] However, this paper offers a different set-up along the union strength dimension: In both Holden (2003a) and Vartiainen (2002), there is (effectively) a single union in both sectors. In our model, we do not impose any a priori assumptions on the number of unions or the distribution of these unions across sectors. As we have seen, the above results do not depend on this assumption. In this respect, we have provided a generalization of these two other papers. However, the assumption also proves critical in assessing the impact of the different policy targets on *total* employment.

6.2 Total employment

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

$$\Lambda := \frac{nl_1^I + nl_2^I}{nl_1^E + nl_2^E} = \frac{\frac{\frac{\alpha}{1-\alpha}\gamma\frac{2m_1-1}{2m_1-\gamma}T}{1+\frac{\alpha}{1-\alpha}\gamma\frac{2m_1-1}{2m_1-\gamma}} + \frac{\frac{\alpha}{1-\alpha}\gamma\frac{2m_2-1}{2m_2-\gamma}T}{1+\frac{\alpha}{1-\alpha}\gamma\frac{2m_2-1}{2m_2-\gamma}}}{\frac{\frac{\alpha}{1-\alpha}\frac{1}{2}\gamma\frac{2m_1-1-\gamma}{m_1-\gamma}T}{1+\frac{\alpha}{1-\alpha}\frac{1}{2}\gamma\frac{2m_1-1-\gamma}{m_1-\gamma}} + \frac{\frac{\alpha}{1-\alpha}\frac{1}{2}\gamma\frac{2m_2-1+\gamma}{m_2}T}{1+\frac{\alpha}{1-\alpha}\frac{1}{2}\gamma\frac{2m_2-1+\gamma}{m_2}}}. \tag{26}$$

It can be shown that Λ has the following properties:[19]

$$\Lambda > 1 \text{ for } m_2 \geq m_1 \tag{27}$$

$$\Lambda < 1 \text{ for } m_2 < m_1 \tag{28}$$

As it turns out, when $m_2 \geq m_1$, total employment is higher in the inflation targeting regime, while the opposite is true for $m_2 < m_1$. Inflation targeting

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[18]Especially; demand is Cobb Douglas, while the authors work with CES-utility in the two other papers – albeit in Holden's case by simulations.

[19]Solving for $\Lambda = 1$, gives $m_1 - m_2 = \frac{\gamma}{2}$. 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 $m_2 \leq m_1 - 1$.

disciplines shielded sector unions, and the disciplining effect has a larger potential to increase employment in the sector where there are larger (i.e. more powerful) unions. Thus the employment effect in the shielded sector more than balances the negative employment effect in the non-shielded sector when there are relatively more unions in the non-shielded sector. We state this result as a proposition:

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

Total employment is not discussed in Vartiainen (2002), but Holden (2003a) 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 this model for $m_2 \geq m_1$, illustrating the potential importance of focusing on labor market asymmetries.[20] Welfare in this model is discussed in Meland (2004). 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.

7   A shielded sector price target

In this section, we explore the possibility that the central bank may choose an inflation target that focuses more on shielded sector prices. More precisely, we assume that the Central Bank is given the task to target inflation in the shielded sector only. Again, in our static model, this is equivalent to a shielded sector price target.[21]

We assume that $p_1 = P_1$ is the target level which eventually will be induced by the Central Bank. In this case $p_2 = \frac{P_1}{K}$. We then have $\frac{\partial p_2}{\partial w_s^u} \frac{w_s^u}{p_2} = -\kappa_s$ and $\lambda_1 = -\frac{1}{1-\gamma}$, $\lambda_2 = -\frac{1}{1-\gamma}(\kappa_2 + 1)$ and $\pi_s = -\frac{1}{2}\kappa_s$. In a symmetric

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[20] Holden (2003a) and Vartiainen (2002) discuss interesting scenarios pertaining to different supply technology and demand functions, which we will not touch upon.

[21] It is worth noting that implementing a shielded sector inflation targeting regime would be no more difficult for the monetary authorities than implementing an inflation targeting regime based on the general price level. Actually, it could be simpler, as knowledge of only a fraction of the prices is needed.

equilibrium,

$$\frac{\alpha}{1-\alpha}(\frac{1}{2}\gamma\frac{2m_1-1+\gamma}{m_1}) = \frac{l_1}{T-l_1}, \tag{29}$$

$$\frac{\alpha}{1-\alpha}(\frac{1}{2}\gamma\frac{2m_2-1-\gamma}{m_2-\gamma}) = \frac{l_2}{T-l_2}. \tag{30}$$

Strictly speaking, we could have anticipated this result from the start. Paying close attention to the expressions, we see that they are exactly the same as for the fixed exchange rate regime, only with the two sectors switched. Shielded sector price/inflation targeting works in the shielded sector exactly the same way as the fixed exchange rate worked in the non-shielded sector: It fixes prices in that sector. The results for the shielded sector price target and fixed exchange rates are therefore exactly symmetric. The discussion under fixed exchange rates can now be reapplied, only replacing sector 1 with sector 2 and vice versa.

As a direct consequence, depending on the number of workers and unions in each sector, either fixed exchange rate targeting or shielded sector price targeting produces higher employment than the general inflation targeting regime. The only exception is the symmetric case, $m_1 = m_2$. To see this, note that we found that for $m_1 \leq m_2$, employment is higher in the inflation targeting regime than in the fixed exchange rate regime. Accordingly, targeting the general price level rather than the shielded price level will yield higher employment if $m_2 \leq m_1$. The only case where inflation targeting will dominate both exchange rate targeting and a shielded sector price target in terms of employment, is for $m_1 = m_2$.[22]

Again, we summarize the above results as a Proposition:

Proposition 4 :

1. *Only for countries where the levels of centralization in wage setting are relatively equal across sectors, will inflation targeting yield higher equilibrium employment than both fixed exchange rates and a regime targeting inflation in the shielded sector only.*

2. *If the level of centralization in wage setting is higher (lower) in the shielded sector than in the non-shielded sector, shielded sector inflation targeting (exchange rate targeting) produces higher employment than either of the two other monetary targets.*

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[22]Welfare again follows suit.

Of course, the present model is highly stylized. Looking beyond the constraints of the model, however, what we should learn from this is that *relative* union strength may be important for the employment effects of different monetary policies, and that the stronger unions are in a sector, the more important it may be to restrict price movements in this sector.

7.1 Other monetary targets

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. With this focus, could not policy be arranged in such a way that wage increases are explicitly fought off by the central bank (wage-targeting), thereby creating higher employment? The answer to this question is in the affirmative. 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.[23],[24] One such target that has been discussed 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. The basic reason behind this result is that nominal production targets do worse than price/inflation levels in 'punishing' high wages by unions. 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 effects, could be less dependent upon wages than prices alone

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[23] 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' (Svensson (2002, 2003)). Targeting the general price level or the exchange rate only specifies the goal, which in a richer set-up, leaves the Central Bank with the option of choosing the way to respond in order to achieve the target. An instrument rule, on the other hand, portray exactly how the interest rates (e.g. the exchange rate) should respond to the previously set wages. As noted by Svensson, an instrument rule may therefore be economically undesirable as it deprives the Central Bank of any possibility to respond flexibly to shocks in the economy.

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

would be. Consequently, targeting prices is a more precise way of tackling high wages than targeting the value of production. This is summarized in the following proposition:[25]

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

Proof. See appendix D. ∎

8 The numeraire

Gabszewicz and Vial (1972) first showed that in general equilibrium models with non-atomistic agents and where Nash solution concepts are utilized, the models will not be fully *specified* without *choosing* a numeraire. This numeraire must then be founded in economic realities, as the choice of numeraire *matters* when it comes to real variables in these models. Technically, it is impossible to solve such a model without a preassigned numeraire, which is only to say that the non-atomistic agents care about the choice of numeraire. They do so because this choice determines their influence over the relative prices in the economy.[26]

In models combining game theory and general equilibrium, we then have to search for an economic basis on which to choose the numeraire. In models like the one presented here, the Central Bank objective – or target – provides us with such a real-world basis. If the Central Bank is an inflation fighter, the inflation target (if credible) is seen as fixed by the agents in the economy. Agents with considerable market power could, additionally, take into account how they influence prices in the economy given the fixed inflation target. Similarly, any other Central Bank target, for instance fixed exchange

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[25]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.

[26]It is easily checked that monetary policy do not have an effect on outcomes in the totally decentralized case when union power is neglible ($m_s \rightarrow \infty$). The same result would apply to the totally centralized case with only one union covering all workers (not shown). Thus the classical dichotomy between monetary policy and real variables, remain in these cases – in the decentralized case because there are no agents with market power and in the centralized case because the single union takes all relevant externalities into consideration.

rates, may provide such a real world basis for the choice of numeraire. This explains *exactly* how money neutrality breaks down in such models: Different Central Bank policy targets provide for different numeraires, and non-atomistic agents will respond to the change in numeraire, inducing different real outcomes.[27]

9   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. Although the model used in this paper focused on different levels of centralization in wage setting across sectors, the general idea that it may provide superior employment levels to discipline unions in the sector where they are strong, does not confine attention to the concept of centralization. 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 *non-shielded* sector (if wages in the shielded sector are high). Moving from a country-wide to a shielded sector inflation target involves hurting the non-shielded sector *even more* for any wage increase in the shielded sector. The unions in the non-

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[27] The monetary target may also be thought of as the 'nominal anchor'. The existence of a stable nominal anchor has been stressed as an important prerequisite for healthy economic development (Bernanke *et al.* (1999)). In models of general equilibrium with Nash-playing agents, a tie-down of monetary policy is *necessary* to obtain an equilibrium. Without such a 'nominal anchor', no equilibrium can be found, with unpredictable consequences for expectation formation and economic outcomes.

shielded sector are, however, only negatively affected by this policy 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 non-shielded sector. Consequently, the non-shielded 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.[28] This is left for further work.

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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:

$$L_s^j = \left(\frac{\gamma p_s}{w_s^j}\right)^{\frac{1}{1-\gamma}}. \tag{31}$$

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 $x_s^j = \left(\frac{\gamma p_s}{w_s^j}\right)^{\frac{\gamma}{1-\gamma}}$, and aggregating to obtain total supply from sector s, we get

$$X_s^S = \sum_{j=1}^{f_s} \left(\frac{\gamma p_s}{w_s^j}\right)^{\frac{\gamma}{1-\gamma}}, \tag{32}$$

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

$$\max_{x_1,x_2,y} (\sqrt{x_1 x_2})^\alpha (y)^{1-\alpha} \text{ s.t. } w_s^j(T - y) = p_1 x_1 + p_2 x_2, \tag{33}$$

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:

$$X_1^D = \frac{\frac{n_1}{f_1} \sum_{j=1}^{f_1} w_1^j l_1^j + \frac{n_2}{f_2} \sum_{j=1}^{f_2} w_2^j l_2^j + \Pi_1 + \Pi_2}{2p_1}, \tag{34}$$

where superscript 'D' denotes demand and l_s^j is the employment level of a worker in firm j in sector s. 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.[29]

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.[30]

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

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

However, in the case of the shielded good, prices are determined by equating 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

$$X_1^S = \frac{p_1 X_1^S + p_2 X_2^S}{2p_1} = \frac{1}{2}[X_1^S + \frac{p_2 X_2^S}{p_1}]. \tag{35}$$

Thus supply creates its own demand through labor income and profits. This gives rise to the possibility of an *upward sloping demand curve*.[31] 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 (35) is stable.

Rearranging the above equation, we get

$$1 = \frac{1}{2}[1 + \frac{p_2}{p_1}\frac{X_2^S}{X_1^S}]. \tag{36}$$

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:

$$\frac{X_2^S}{X_1^S} = \frac{\sum_{j=1}^{f_2}(\frac{\gamma p_2}{w_2^j})^{\frac{\gamma}{1-\gamma}}}{\sum_{j=1}^{f_1}(\frac{\gamma p_1}{w_1^j})^{\frac{\gamma}{1-\gamma}}} = \frac{\sum_{j=1}^{f_2}(\frac{1}{w_2^j})^{\frac{\gamma}{1-\gamma}}}{\sum_{j=1}^{f_1}(\frac{1}{w_1^j})^{\frac{\gamma}{1-\gamma}}}(\frac{p_2}{p_1})^{\frac{\gamma}{1-\gamma}}. \tag{37}$$

Thus if the relative prices only depend on relative supply, and relative supply only depends on relative prices, then (36) and (37) 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.

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[31]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 (36) and (37):[32]

$$\frac{p_1}{p_2} \triangleq K = \left(\frac{\sum_{j=1}^{f_2}\left(\frac{1}{w_2^j}\right)^{\frac{\gamma}{1-\gamma}}}{\sum_{j=1}^{f_1}\left(\frac{1}{w_1^j}\right)^{\frac{\gamma}{1-\gamma}}}\right)^{(1-\gamma)}. \tag{38}$$

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)

$$l_1^u = \frac{f_1}{n}\left(\frac{\gamma p_1}{w_1^u}\right)^{\frac{1}{1-\gamma}} = \frac{f_1}{n}\left(\frac{\gamma K p_2}{w_1^u}\right)^{\frac{1}{1-\gamma}}, \tag{39}$$

$$l_2^u = \frac{f_2}{n}\left(\frac{\gamma p_2}{w_2^u}\right)^{\frac{1}{1-\gamma}}. \tag{40}$$

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

$$\lambda_1^u = \frac{\partial l_1^u}{\partial w_1^u}\frac{w_1^u}{l_1^u} = \frac{1}{1-\gamma}\left(\frac{w_1^u}{K}\frac{\partial K}{\partial w_1^u} + \frac{w_1^u}{p_2}\frac{\partial p_2}{\partial w_1^u} - 1\right), \tag{41}$$

$$\lambda_2^u = \frac{\partial l_2^u}{\partial w_2^u}\frac{w_2^u}{l_2^u} = \frac{1}{1-\gamma}\left(\frac{w_2^u}{p_2}\frac{\partial p_2}{\partial w_2^u} - 1\right). \tag{42}$$

$\frac{w_s^u}{K}\frac{\partial K}{\partial w_s^u}$, $s = 1, 2$ can be calculated using the definition of K in (38). Since all firms covered by union u faces the same wages, K can be rewritten (summarizing over unions):

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

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[32] 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.

This yields

$$\kappa_1^u \triangleq \frac{\partial K}{\partial w_1^u}\frac{w_1^u}{K} = \frac{\gamma}{(w_1^u)^{\frac{\gamma}{1-\gamma}}\sum_{v=1}^{m_1}(\frac{1}{w_1^v})^{\frac{\gamma}{1-\gamma}}}, \tag{43}$$

$$\kappa_2^u \triangleq \frac{\partial K}{\partial w_2^u}\frac{w_2^u}{K} = -\frac{\gamma}{(w_2^u)^{\frac{\gamma}{1-\gamma}}\sum_{v=1}^{m_2}(\frac{1}{w_2^v})^{\frac{\gamma}{1-\gamma}}}. \tag{44}$$

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

$$\pi_s^u = \frac{w_s^u}{P}\frac{\partial P}{\partial w_s^u} = \frac{1}{2}(\frac{w_s^u}{p_1}\frac{\partial p_1}{\partial w_s^u} + \frac{w_s^u}{p_2}\frac{\partial p_2}{\partial w_s^u}). \tag{45}$$

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

$$\begin{aligned}\pi_s^u &= \frac{1}{2}((\frac{w_s^u}{K}\frac{\partial K}{\partial w_s^u} + \frac{w_s^u}{p_2}\frac{\partial p_2}{\partial w_s^u}) + \frac{w_s^u}{p_2}\frac{\partial p_2}{\partial w_s^u}) \\ &= \frac{1}{2}[\kappa_s^u + 2\frac{w_s^u}{p_2}\frac{\partial p_2}{\partial w_s^u}]. \end{aligned} \tag{46}$$

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

$$\kappa_1 = \frac{\gamma}{m_1}, \tag{47}$$

$$\kappa_2 = -\frac{\gamma}{m_2}. \tag{48}$$

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

$$\frac{1}{2}\gamma\frac{2m_1 - 1 - \gamma}{m_1 - \gamma} \leq 1, \tag{49}$$

$$\frac{1}{2}\gamma\frac{2m_2 - 1 + \gamma}{m_2} \leq 1. \tag{50}$$

Both these inequalities hold for $\gamma \leq 1$.[33]

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

$$\beta p_1 \sum_{j=1}^{f_1} \left(\frac{\gamma p_1}{w_1^j}\right)^{\frac{\gamma}{1-\gamma}} + (1 - \beta) p_2 \sum_{j=1}^{f_2} \left(\frac{\gamma p_2}{w_2^j}\right)^{\frac{\gamma}{1-\gamma}} = V. \tag{51}$$

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

$$p_2^{\frac{1}{1-\gamma}} [\beta K^{\frac{1}{1-\gamma}} \sum_{j=1}^{f_1} \left(\frac{\gamma}{w_1^j}\right)^{\frac{\gamma}{1-\gamma}} + (1 - \beta) \sum_{j=1}^{f_2} \left(\frac{\gamma}{w_2^j}\right)^{\frac{\gamma}{1-\gamma}}] = V. \tag{52}$$

Using the definition of K, the above expression simplifies to

$$p_2^{\frac{1}{1-\gamma}} \sum_{j=1}^{f_2} \left(\frac{\gamma}{w_2^j}\right)^{\frac{\gamma}{1-\gamma}} = V. \tag{53}$$

Thus, in this model, *any* value-of-production target will amount to targeting the value of production in the non-shielded 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 non-shielded sector, however, a wage increase will, without Central

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

Bank intervention, only lead to a decrease in production. To keep the target, the Central Bank will then compensate by inducing an exchange rate depreciation.[34]

Following the above discussion, $\frac{dp_2}{dw_1^u} \frac{w_1^u}{p_2} = 0$ for all nominal production targets. Using (53) 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

$$\frac{\alpha}{1-\alpha}\left(\frac{1}{2}\gamma\frac{2m_s - 1 - \gamma}{m_s - \gamma}\right) = \frac{l_s}{T - l_s}. \tag{54}$$

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 discussion in Section 7.1, 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.

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[34] 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).

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