Open sector wage leadership

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March 16, 2012

Abstract

TBW.

Keywords: TBA

JEL classification codes: TBA

1 Open Sector Wage Leadership

Since the 1930s, the economy in the Scandinavian countries has been characterized by high economic growth and a regulated, egalitarian wage structure. The regulations followed from an ideology of solidaristic wage setting, and the equalization policy was designed not to hurt exports.

Under the slogan "equal pay for equal work", the Scandinavian countries have strived for small wage differences between different sectors. The origin of solidaristic wage policies can be found in the 1930s, where firms in internationally competing industrial sectors were afraid that wage claims in shielded sectors, as construction, could become too high and ultimately hurt the export sectors. Their concern was taken into account. As it turned out, in addition to the appealing fairness of solidaristic wage setting, the heighday of these politics – the 1950s and 1960s – were times with rapid growth.

In this paper we will look at the welfare implication of open sector wage leadership. We also investigate what effect compressed union wages has on employment. The approach we have used also gives us the opportunity to look at what implications open sector wage leadership has on the effect of globalization.

The policy in the Nordic countries that has lead to wage equalization has many names, amongst them are the Nordic model, the Scandinavian model and solidaristic wage setting. We approach the implications of this policy from a technical angle and focus on the wage policy alone. In doing this, we ignore a number of factors that were included in the policy package,

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and it would be imprecise to use any of these names. What we focus on is open sector wage leadership, and we name our model the Front Trade model, where unions in open sectors set wages first, and shielded sector unions are expected to follow suit and not increase wages by more than the open sector unions.

Because of the remarkable combination of growth and regulations, the field has drawn some attention. Central to the discussion is the hump shape hypothesis by Calmfors and Drifill (1988) that indicates that centralized bargaining leads to more moderate wage growth than partly centralized wage barging will. According to Moene and Wallerstein (1997) united wage negotiation reduces the possibility of ex post wage increases that can make it less favorable to start firms. In the long run, this type of wage bargaining will create higher unemployment. They also find that compressed wages promote growth because less efficient firms will go out of business earlier. On that same note, Agell and Lommerud (1993) suggest that wage equalization will create a selection towards firms in the innovative sector. They indicate that compressed wages therefore can function as a subsidy to promote technological improvements, and thus, growth.

A wide variety of issues concerning the Scandinavian model has been investigated, and the focus has been mainly on growth. Growth generates welfare improvements as there will be more wealth to go around. But income distribution has aggregate welfare implications in its own respect.[1] Our contribution is to fill this gap, and investigate if income equality gives higher consumer welfare than a more uneven wage structure.

When wages are compressed, this will have implications both directly as a change in production costs, and indirectly through readjustments in labor demand. Altering wages will obviously change welfare levels amongst workers in the sector in question, but in addition it will change the distribution of production, and thus consumer goods prices. This second effect will have welfare implications because consumption patterns will change.

The main argument for implementing open sector wage leadership was that wages will be lower in industries that are subject to international competition, therefore, we need a model that can encompass this feature. We use a model where the economy is described as imperfectly competitive in the form of strategic interaction between firms. Strategic interaction will create a model with different wages in the shielded and the open sector because the higher number of competing firms in the latter will ensure that firms there have less market power. This provides us with a scenario that fits with the argument for implementing open sector wage leadership. In addition, it is important for our purpose that the model can demonstrate all consequences of implementing open sector wage leadership, both partial and general equilibrium effects.

Models combining these traits are rare, but research is moving in this direction. Neary (2002a, 2003a) has developed such a framework, namely a General Oligopolistic Equilibrium-

[1] For instance there has been a debate of how income inequality might affect national health (Judge, Mulligan and Benzeval, 1998).

model (GOLE). In this model, each firm has oligopolistic power in their own market, but each market is so small in the economy that each participant in the market assumes no influence on general equilibrium matters.

Our results indicate that there is a positive welfare effect from open sector wage leadership. This is both due to a lower price level, and a price *structure* that is more fortunate for the consumers. In addition, we find that open sector wage leadership produces an equilibrium with lower unemployment. Further, globalization leads to higher welfare in our setup, but open sector wage leadership does not make globalization *more* favorable for unemployment.

In section 2 we present the basic model set-up and discuss the case of open sector wage leadership and a baseline scenario. In both cases, we assume a symmetric setting where either none of the two countries, or both, have open sector wage leadership. Section 3 presents the main findings for the symmetric setting. In Section 4 we extend the analysis to an asymmetric setting. Section 5 offers concluding remarks.

2 Model

We use a variant of the GOLE framework (Neary 2002b, 2003b and 2009) where there are both shielded and non-shielded sectors, as in Kreickemeier and Meland (2011). However, when it comes to labor market structure, we follow Egger and Etzel (2011) and adopt a setting where all industries are unionized and where there is unemployment in equilibrium. There are two countries, home and foreign. Both are similar with respect to demand and the number of firms, but may potentially differ with respect to the Front Trade model. The representative agent in country 1 has utility function

$$U = \int_0^1 \left(aX\left(z\right) - \frac{1}{2} bX\left(z\right)^2 \right) dz, \tag{1}$$

where $X(z)$ is domestic consumption of good z, of which there are a continuum ranging from 0 to 1. The representative agent in country 2 has the same type of utility function, where the parameters a and b are assumed to be the same as in country 1. In the following we will focus on country 1.

We assume that the representative agent maximizes utility given the budget constraint

$$I = \int_0^1 \left(p\left(z\right) X\left(z\right) \right) dz, \tag{2}$$

where $p(z)$ is the price of good z. Maximizing utility yields direct and indirect demand for good z given by

$$X\left(z\right) = \frac{a - \lambda p\left(z\right)}{b}, \tag{3}$$

and

$$p\left(z\right)=\frac{a-bX(z)}{\lambda}, \tag{4}$$

where λ is the marginal utility of income (the Lagrange multiplier associated with the budget constraint). Using (4) in (2) we get

$$\lambda=\frac{a\mu_1-bI}{\mu_2}, \tag{5}$$

where $\mu_1=\int_0^1 p(z)dz$ is the first moment of prices and $\mu_2=\int_0^1(p(z))^2dz$ is the second moment of prices. Crucially, we will assume that all agents in the economy (firms, unions) are so small that they take λ as a given. Then demand is linear as perceived by the agents, which lets us solve for a general equilibrium with oligopolistic firms and unions.

We measure national welfare as the utility of the representative individual. Reinserting (3) in (1) yields $U=\frac{1}{2b}(a^2-\lambda^2\mu_2)$, hence welfare is a falling function of $\lambda^2\mu_2$. We will use the monotonically transformed welfare measure $W=-\lambda^2\mu_2$ in the following.

We divide the economy into two sectors; shielded and non-shielded from international trade. We assume all industries $z\in[0,\alpha]$ ('the open sector') are open to international trade, while the remaining industries ('the shielded sector') is not. Since we have only two countries in our analysis, the same division must hold also for the second country. In all industries in both countries we assume there to be N firms, and all compete in quantities à-la Cournot. We assume zero trade costs, but the competitive environment is different in the two sectors. Because there are more competing firms in the open sectors than in the shielded sectors, each firm possess less market power. We assume that markets are treated as segmented by the firms. As in Egger and Etzel (2011), we assume that there is a fixed supply of labor in both countries, given by L. Also, we will assume that there is always some unemployment. This will happen if L is sufficiently high. Production technology is very simple, with one unit of labor producing one unit of output. Furthermore, we follow Bastos and Kreickemeier (2009), Egger and Etzel (2009) and Kreickemeier and Meland (2011), and assume that there is a single, monopoly closed shop union in each industry, and the unions maximize rents

$$\lambda(w(z)-B)(x(z)+y(z)), \tag{6}$$

where $x(z)$ and $y(z)$ are the home market and export production by the N firms in industry z and B is an unemployment benefit. $y(z)$ is non-zero only for $z\in[0,\alpha]$. We will assume that the unemployment benefit is positively dependent upon both the shielded and open sector wages, the precise form to be determined later. However, since all unions are small relative to the economy as a whole, we will assume - in accordance with the modelling of firms - that none take into account how their own wage influences the unemployment benefit.

Reasonably, we assume that wage setting is a more long-term commitment than the production decision of firms. The sequence of events is then as follows. First, we implement the

Front Trade model or not. In the case baseline model, the shielded and non-shielded sector unions all set wages independently and simultaneously, before firms choose quantities. In the Front Trade model, we assume that the wage in the shielded sectors are simply determined by adopting the open sector wage. Since no open sector union (or shielded sector union) is big enough to take nation-wide effects into consideration, the open sector unions do not directly take this into consideration. However, there is a feedback channel through the unemployment benefit that changes open sector behavior.

We solve, of course, by backwards induction.

2.1 Firm behavior

In the shielded sector, each industry is characterized by N symmetric firms, and the outcome is the symmetric oligopoly Cournot-Nash equilibrium, given by

$$x_i(z) = \frac{a - \lambda w(z)}{(N+1)\, b}, \tag{7}$$

where subscript i indicates an individual firm. $\lambda w(z)$ is called the 'real wage at the margin'.

In the open sectors each firm chooses production levels for the two countries to maximize profits,

$$\begin{aligned} x_i(z), y_i(z) \quad = \quad & \arg \max_{x_i(z), y_i(z)} [(\frac{a - b(x(z) + y^*(z))}{\lambda} - w(z))x_i(z) \\ & +(\frac{a - b(x^*(z) + y(z))}{\lambda^*} - w(z))x_i(z)], \end{aligned} \tag{8}$$

where $x^*(z)$ and $y^*(z)$ are the total production by country 2 firms for country 2 and country 1 (exports), respectively. λ^* is the analog to λ for country 2. A similar maximization problem applies to foreign firms. We assume $y_i(z) = y_j(z)$ and $x_i(z) = x_j(z)$, $\forall i, j$, and similarly for foreign firms, because costs are the same for all firms in a national industry. We then obtain

$$x_i(z) = \frac{a - by^*(z) - \lambda w(z)}{b(N+1)}, \tag{9}$$

$$y_i(z) = \frac{a - bx^*(z) - \lambda^* w(z)}{b(N+1)}. \tag{10}$$

The expressions for $x_i^*(z)$ and $y_i^*(z)$ are similar, and inserting these in (9) and (10), we obtain the Cournot-Nash equilibrium quantities in the open sectors:

$$x_i(z) = \frac{a + \lambda w^*(z)N - \lambda w(z)(N+1)}{b\,(2N+1)},$$

$$y_i(z) = \frac{a + \lambda^* w^*(z)N - (N+1)\lambda^* w(z)}{b\,(2N+1)}.$$

2.2 Union wage setting

As stated earlier, there is a single union determining the wage for all firms in an industry. In the shielded sector, in the baseline model, the unions maximize $\lambda(w(z) - B)Nx_i(z)$, which yields

$$w_s = \frac{a + \lambda B}{2\lambda} \quad for \quad z \in (\alpha, 1]. \tag{11}$$

Subscript s stands for the shielded sector. The foreign wage is then $w_s^* = \frac{a+\lambda^* B^*}{2\lambda^*}$ by analogy.

In the open sector, the unions similarly maximize $\lambda(w(z) - B)N(x_i(z) + y_i(z))$, yielding

$$w(z) = \frac{1}{2}\frac{2a + Nw^*(z)\left(\lambda + \lambda^*\right) + B(N+1)(\lambda + \lambda^*)}{(N+1)\left(\lambda + \lambda^*\right)}.$$

The foreign wage is similar. Naturally, the optimal wages depend on the wage of the union in the other country, and we must look for a Nash equilibrium in wages. However, note that we have assumed that the countries are perfectly symmetric. Then, $B = B^*$ and we can also conclude that $\lambda = \lambda^*$ will be the case. We can therefore search for a symmetric Nash equilibrium where $w(z) = w^*(z)$, and this yields

$$w_t = w_t^* = \frac{a + \lambda B\left(N+1\right)}{\lambda\left(N+2\right)} \quad for \quad z \in [0, \alpha],$$

where subscript t stands for the sector that trades. With the same assumptions as above, we can conclude that $w_s = w_s^*$.

The unemployment benefit plays an important role in wage setting, as seen from the above expressions. We will assume that $B = \beta(w_s + w_t)$. Thus, the unemployment benefit is positively related to wages both in the shielded and open sectors. Reasonably, we assume that β is chosen sufficiently low so that $B < \min\{w_s, w_t\}$. With these assumptions, and also normalizing λ to unity (standard in the GOLE literature), we find the equilibrium wages in the two sectors and the unemployment benefit to be:

$$\begin{aligned} w_s &= a\frac{2 + (1-\beta)N}{4(1-\beta) + N(2-3\beta)}, \\ w_t &= a\frac{2 + \beta N}{4(1-\beta) + (2-3\beta)N}, \\ B &= a\beta\frac{4 + N}{4(1-\beta) + (2-3\beta)N}. \end{aligned} \tag{12}$$

Lemma: $w_s > w_t$. Proof: $w_s - w_t = \frac{a+B}{2} - \frac{a+B(N+1)}{N+2} = \frac{1}{2}\frac{N(a-B)}{(N+2)}$, which is positive since $B < w_s < a$.

This is a result of the lower competition in the shielded sector, making labour demand less elastic, and therefore wage claims higher.

Furthermore, for $B < w_t$, we need

Assumption: $\beta < \frac{1}{2}$.

This assumption ensures that the unemployment benefit is always below the wage income in both sectors. This may seem a bit strange since $B = \beta(w_t + w_s)$, and $w_s > w_t$, but for $\beta \geq \frac{1}{2}$, $B \geq a$, which cannot be the case. For $\beta = \frac{1}{2}$, $w_s = w_t$.

In the Front Trade model, we will assume that the unions in the shielded sector are simply forced to adopt the open sector wage. Our aim is to look at the effects of an induced wage structure, and the GOLE framework is a suited tool for doing this. Even though the model does not allow for any participant in the market to have a concept of general equilibrium effects, we have no problem inducing the policy as an external factor for the sake of comparing the outcome of the two regimes.

Since unions in the open sector are small, they will not directly take into account that the open sector wages will be superimposed on shielded sector firms, but the lower wages in the economy will nonetheless influence open sector wages through a drop in the unemployment benefit. Thus, in this case wages and unemployment benefits are given by

$$\begin{aligned} w_F &= \frac{a}{(1-2\beta)N + 2(1-\beta)}, \\ B_F &= \frac{\beta a}{(1-2\beta)N + 2(1-\beta)}. \end{aligned} \tag{13}$$

In the Front Trade model, quite naturally, $\beta < \frac{1}{2}$ again suffices for $B_F < \min\{w_F\}$. Note that wages and prices are not directly comparable between the Front Trade regime and the baseline regime, since all nominal terms are measured relative to $\frac{1}{\lambda}$, which is normalized to unity in both cases.

3 Welfare and unemployment

In the appendix, we have presented the necessary expressions to evaluate the welfare difference between the Front Trade regime and the baseline regime.

Proposition 1 *Welfare is higher under open sector wage leadership.*

Proof. See Appendix A and B. ■

As we have demonstrated earlier, welfare depends solely on μ_2. Two factors influence this second moment of prices, price variance and the price level, since, from the definition of variance, $\mu_2 = var(p) + \mu_1^2$. For the intuition to be as clear as possible, we discuss the two separately.

μ_1 is an average price level in the economy. Because the wage level is lower in the Front Trade model, we expect the prices to be lower as well. Comparing μ_1 in the two regimes confirms that

this is in fact the case. We find that the price has fallen both in the open and in the shielded sector, and thus, that average price is lower with the Front Trade model. This is then one positive impact of open sector wage leadership.

The above effect would be absent if we had not allowed for unemployment. We would then have constant production, and this would typically imply a constant first moment of prices, see for instance Kreickemeier and Meland (2011). In their model, the constant average price holds for all changes as long as the parameters are constant.[2] The reason is that indirect demand is linear; for aggregate demand to stay constant, any increase in price in one sector must be exactly compensated for by a decrease in price in another sector. When the model has constant price level, the only factor left to have an impact on welfare is variance in prices. The assumed nature of consumer utility is the key to the welfare effect. To date, all GOLE models have declining marginal utility.[3] This implies that for a constant level of consumption, the utility is highest from spreading consumption evenly between all sectors. As the price divide increases between the sectors, the consumer gets further away from an optimal consumption bundle. This explains why lower price variance yields higher welfare.

While not alone in having an effect on welfare, the variance of prices influences welfare in the same way in the present set-up with unemployment. With open sector union wage leadership, wages are equalized between sectors. This also, quite naturally, leads to lower variance of prices, and thus higher welfare.

Proposition 1 does not strongly depend on our assumptions regarding the unemployment benefit. True, part of the welfare gain is triggered by the lower price level, which again is in part a result of the drop in unemployment benefits. We can reduce, but not eliminate, this effect by assuming that the welfare benefit is non-existent, i.e. $\beta = 0$. However, even if the unemployment benefit were to increase as a result of open sector wage membership (as a part of wider policy package), it has to do so by a rather large margin to stop the first moment of prices to go down when the shielded sector wage is reduced to the level of the open sector. In any case, there is also the lower price variance to overcome before open sector union wage leadership can turn out to be detrimental for welfare.

Although our primary welfare measure is the utility of the representative individual, unemployment may well be even more relevant for policy.

Proposition 2 *Unemployment is lower under open sector wage leadership.*

Proof. See appendix C. ■

With the Front Trade model, the wages are determined solely by the industries that face international competition. Wages are therefore lower in the shielded sector, and indeed, lower

[2] In an early stage of this project, we implemented the Front Trade model in their version of GOLE, and found that the change did not affect the price level.

[3] Neary (2002) discuss why this is plausible an practical.

also in the open sector since the unemployment benefit drops. Thus employment is higher under the Front Trade regime.

In this set-up, globalization can be represented by an increase in the number of markets where firms engage in trade. We have

Proposition 3 *Globalization (increased α) leads to higher welfare and lower unemployment.*

Proof. See appendix D ■

In both our regimes, globalization has two positive effects on welfare. First; with more exporting markets, a larger proportion of the market will be subject to outside competition. With globalization, we will find more production and lower goods prices in a larger part of the economy.

Kreickemeier and Meland (2011) investigated the same aspect in GOLE, and unlike us, they found that in some cases, globalization represented by an expanding open sector can influence welfare negatively. In their version, they assume no unemployment, this means that total production is constant by definition. This again implies that higher employment in one sector means lower employment in the other. Therefore, when the open sector produces more, the shielded sector produces less. In their model, if initial production is low in the open sector, the positive effect on welfare from more of these less expensive goods, is outweighed by less production and even higher prices in the shielded sector.[4]

This brings us to our point; because we have allowed for unemployment in our model, not only will the proportion of cheaper goods increase relatively to the more expensive shielded sector good, but unemployed will join the workforce and total production will increase. By picking up on this effect, which we deem realistic, this set-up formalizes an important welfare gain from globalization.

This result applies in both regimes, but the magnitude differs. The positive effect on employment is more prominent in the baseline model. The main trigger for this result is that in the baseline model, the initial employment in the open sector is low, and therefore, a decrease of the size of this sector will not cost many workers their jobs compared to a decrease of the open sector in the Front Trade model. What happens in the open sector is a different story. In fact, when looking at this separately, the number of new jobs created as the open sector grows, is lower in the baseline model. See appendix C. This means that the smaller the open sector, the more positive open sector wage leadership will be for employment. This is interesting considering the policy environment in which the Front Trade model originated. Beside protecting and promoting the export industry, this result indicates that the welfare benefit was even more important when it was implemented, because the open sector was smaller than it is today.

[4]Kreickemeier and Meland have included a trade cost in their set-up, and low production in the shielded sector occurs when trade costs are high. Introducing trade costs in our model will never create a scenario where an expanding open sector can have adverse effects on utility. The reason for this is explained below.

4 Open sector wage leadership in only one country

In this section, we relax the rather unsatisfactory assumptions that either none of the countries or both of them, implement open sector wage leadership. To do this, we will use simulations.

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5 Concluding remarks

In this paper we have evaluated the welfare implications of open sector wage leadership. This is a policy that emerged in Scandinavia in the first half of the 20th century, and was a consequence of the discovery that workers in the heavy industries, which were the ones that traded on the international marked, had lower wages than workers in shielded industries. Simply put, the policy is to implement the lower open sector wage in the shielded industry as well. For this purpose we have used Neary's GOLE model with oligopoly and general equilibrium. Because this model allows for oligopoly, it captures the fact that the industries that engage in trade are subject to more competition, and thus have lower wages compared to the shielded industries. Because it yields a general equilibrium, we can look at how the new wage structure affects the consumers.

In our set-up, the GOLE model consists of two identical countries, each divided in an open and a shielded sector. Wages are set by monopoly unions, and the unemployed workers receive an unemployment benefit. We construct one regime where both countries have implemented open sector leadership, and compare it to a baseline regime where there are no such policies.

We find that open sector wage leadership has some favorable effects. First and foremost, we find that this regime creates a higher welfare level. This is caused by two factors. The average price level decreases, and in addition, the price of good produced in different sectors is distributed in a way that is better for the consumer. Further, we find that unemployment is lower under open sector wage leadership. This effect is caused by the overall lower wage level that will encourage firms to hire more workers.

The economy has evolved since Front Trade was implemented, specially in terms of openness. Therefore, we are interested in how the policy plays out at different stages of globalization. We find that both under open sector wage leadership and in the baseline model, an expanding open sector has a positive welfare effect. This is caused by a lower average price level. In addition, we find that globalization creates a lower unemployment level. This is because the sector with the higher labour demand expands, while the sector with lower labour demand contracts.

A The Models

For the sake of keeping the outline clear, we present the two models separately. The initial difference lies in the different union wages in the shielded sector, but in general equilibrium the wage differences influence all aspects of the models. We start off with the baseline model.

A.1 The Baseline Model

We have already determined the equilibrium wages in the two sectors, (12). By inserting these in the optimal production (7), (9) and (10), we find the equilibrium production by each firm. Because we have assumed identical firms in each market, $\sum_i^N x_i(z) = Nx_i(z)$. The aggregate production in each marked in the shielded sector is

$$\begin{aligned} x_s &= \sum_i^N x_i(z) \quad for \quad z \in [\alpha, 1)] \\ &= aN\frac{(N+2)(1-2\beta)}{(N(2-3\beta)+4(1-\beta))(N+1)b}. \end{aligned} \tag{14}$$

In the open sector we find both aggregate production to be sold at home, and aggregate export:

$$\begin{aligned} x_t &= \sum_i^N x_i(z) \quad for \quad z \in [0, \alpha)] \\ &= 2aN\frac{(1-2\beta)(N+1)}{(N(2-3\beta)+4(1-\beta))(2N+1)b}, \end{aligned} \tag{15}$$

$$\begin{aligned} y_t &= \sum_i^N y_i(z) \quad for \quad z \in [0, \alpha)] \\ &= 2aN\frac{(1-2\beta)(N+1)}{(N(2-3\beta)+4(1-\beta))(2N+1)b}. \end{aligned} \tag{16}$$

We obtain prices of goods in the two sectors by using these expressions for optimal production. Total output sold in the shielded sector is x_s, and total sales in the open sector is $(x_t + y_t^*)$. We insert (14), (15) , and (16), where $y_t^* = y_t$, for X in (4), and obtain the equilibrium prices.

$$p_s = a\frac{(N+2)^2 - \beta\left(3N+N^2+4\right)}{(4(1-\beta)+N(2-3\beta))(N+1)}, \tag{17}$$

$$p_t = a\frac{2(3N+2)-\beta(3N+4)+2\beta N^2}{(4(1-\beta)+(2-3\beta)N)(2N+1)}. \tag{18}$$

With these, we can find the first and second moment of prices. The first moment represents

the average price. The second moment of prices can be interpreted as a indicator of price variance.

The first moment is defined as $\mu_1 = \int_0^1 p(z)dz$. With the two different sectors, this becomes $\mu_1 = \alpha p_t + (1-\alpha)\, p_s$. Inserting the prices (17) and (18) yields

$$\mu_1 = a\frac{N\left(4-3\beta\right)+\left(N^2+4\right)\left(1-\beta\right)-\alpha\left(1-2\beta\right)\frac{N\left(3N+2N^2+2\right)}{(2N+1)}}{\left(N+1\right)\left(4\left(1-\beta\right)+\left(2-3\beta\right)N\right)}.$$

We find that a large open sector will make the first moment of prices decrease, but by definition it can never be negative. Because the price is lower in the open sector, an expansion of this sector will give a lower average price.

The second moment of prices with two sectors is $\mu_2 = \alpha p_t^2 + (1-\alpha)\, p_s^2$. Two factors increase the second moment of prices; higher average price level, and higher price difference in the two sectors for any given price average.

$$\begin{aligned}\mu_2 \quad = \quad & \frac{a^2\left(\left(1-\beta\right)\left(N^2+4\right)+\left(4-3\beta\right)N\right)^2}{\left(4\left(1-\beta\right)+N\left(2-3\beta\right)\right)^2\left(N+1\right)^2} \\ & -\alpha\frac{a^2N\left(3N+2N^2+2\right)\left(1-2\beta\right)\frac{\left(2\left(9N+4N^2+4\right)\left(1-\beta\right)+N\left(7N+2N^2+4\right)\right)}{(2N+1)^2}}{\left(N+1\right)^2\left(4\left(1-\beta\right)+N\left(2-3\beta\right)\right)^2}.\end{aligned} \tag{19}$$

The second moment of prices will also increase when the open sector is smaller. Once again this is because the average price level will increase.

A.2 Open sector wage leadership

The procedure for obtaining production and prices in the Front Trade model corresponds to the procedure for the baseline model. The outset is the same, but now, we use the common union wage (13) in all markets. We insert the wage into the optimal output equations in both sectors (7), (9) and (10). The equilibrium production in the shielded sector is

$$x_s = \sum_i^N x_i(z) \quad for \quad z \in [\alpha, 1)] = aN\frac{\left(1-2\beta\right)\left(N+1\right)}{\left(N\left(1-2\beta\right)+2\left(1-\beta\right)\right)\left(N+1\right)b}. \tag{20}$$

In the open sector, with the Front Trade model, equilibrium output is

$$x_t = \sum_i^N x_i(z) \quad for \quad z \in [0, \alpha)] = aN\frac{\left(1-2\beta\right)\left(N+1\right)}{\left(N\left(1-2\beta\right)+2\left(1-\beta\right)\right)\left(2N+1\right)b} \tag{21}$$

for goods to be sold at home, and likewise,

$$y_t = \sum_i^N y_i(z) \quad for \quad z \in [0, \alpha)] = aN \frac{(1-2\beta)(N+1)}{(N(1-2\beta)+2(1-\beta))(2N+1)b} \tag{22}$$

for exports.

Prices of goods in the two sectors are, as before, found by inserting optimal production into indirect demand (4). We use the Front Trade model levels of production (20), (21), (22) and $y_t^* = y_t$.

$$p_s = a - bx_s = a\frac{2(1-\beta)}{2(1-\beta)+N(1-2\beta)}, \tag{23}$$

$$p_t = a - b(x_t + y_t) = a\frac{1+\frac{2N}{2(1-\beta)+N(1-2\beta)}}{2N+1}. \tag{24}$$

At this point we can look at the first and second moment of prices in the Front Trade model. The first moment is obtained by inserting (23) and (24) into $\mu_1 = \alpha p_t + (1-\alpha) p_s$. We get

$$\mu_1 = a\frac{2(1-\beta) - \alpha\frac{N}{(2N+1)}(1-2\beta)}{2(1-\beta)+N(1-2\beta)}.$$

We find that an increase in α lowers the first moment of prices. This is because α indicates the size of the open sector where prices are lower, and when this sector expands, the average price will decrease.

The second moment of prices, $\mu_2 = \alpha(p_t)^2 + (1-\alpha)(p_s)^2$, with (23) and (24), this becomes

$$\mu_2 = a^2\frac{4(1-\beta)^2 - \alpha(1-2\beta)N\frac{N(7-6\beta)+4(1-\beta)}{(2N+1)^2}}{(2(1-\beta)+N(1-2\beta))^2}. \tag{25}$$

Like before, we find that an expansion of the open sector leads to lower second moment of prices. This is because the average price falls.

B Comparative statics

At this point we look at what effect the Front Trade model has induced. When we compare the baseline model and the Front Trade model, we use subscript F to denote the latter.

B.1 Price level

Comparing the price level in this two sectors in the Front Trade model and the baseline model is easily done by comparing successively (17) and (23), and (18) and (24). We find that the Front

Trade model price is lower in the shielded sector:

$$p_s - p_{sF} = \frac{N^2 a\left(1-2\beta\right)\left(2-\beta+\left(1-\beta\right)N\right)}{\left(N-2\beta N+2-2\beta\right)\left(2N-3\beta N+4-4\beta\right)\left(N+1\right)} > 0.$$

And that the same is the case in the open sector:

$$p_t - p_{tF} = \frac{2\left(1-2\beta\right)\left(N+1\right)N^2 a\beta}{\left(N-2\beta N+2-2\beta\right)\left(2N-3\beta N+4-4\beta\right)\left(2N+1\right)} > 0.$$

B.2 Wage level and unemployment benefit

The wage in both sectors and the unemployment benefit is higher in the baseline model than in the Front Trade model. Comparing the expressions from (12) and (13) gives us

$$w_s - w_F = \frac{\left(1-2\beta\right)\left(N-\beta-N\beta+2\right)Na}{\left(N-2\beta N+2-2\beta\right)\left(2N-3N\beta+4-4\beta\right)} > 0,$$
$$w_t - w_F = \frac{\left(1-2\beta\right)\left(N+1\right)Na\beta}{\left(N-2\beta N+2-2\beta\right)\left(2N-3N\beta+4-4\beta\right)} > 0$$

and

$$B - B_F = a\beta\frac{\left(N+2\right)^2\left(1-2\beta\right)+\beta\left(N+4\right)}{\left(2N-3N\beta+4-4\beta\right)\left(N-2N\beta+2-2\beta\right)} > 0.$$

B.3 Welfare

We use the priorly defined W and W_F to compare the welfare level. We use (19) and (25), and get

$$\begin{aligned}
\left(W_F - W\right) &= \alpha\frac{a^2N^2\left(1-2\beta\right)^2\beta\frac{4(N+1)\left(2(3N+2)(N+2)+\beta N\left(N^2+2\right)+2\beta^2\frac{(N+4)(2N+1)}{(1-2\beta)}\right)}{\left(2N+1\right)^2}}{\left(N-2N\beta+2-2\beta\right)^2\left(2N-4\beta-3N\beta+4\right)^2} \\
&\quad + \left(1-\alpha\right)\left[\frac{a^2\left(1-2\beta\right)\frac{N^2(N(1-\beta)+2-\beta)\left(16(1-\beta)^2+\beta N^2(5-6\beta)\right)}{(N+1)}}{\left(N-2N\beta+2-2\beta\right)^2\left(2N-4\beta-3N\beta+4\right)^2\left(N+1\right)}\right. \\
&\quad \left.+\frac{a^2\left(1-2\beta\right)\frac{N^2(N(1-\beta)+2-\beta)((1-\beta)N(4(6-7\beta)+N(1-2\beta)(N+10)))}{(N+1)}}{\left(N-2N\beta+2-2\beta\right)^2\left(2N-4\beta-3N\beta+4\right)^2\left(N+1\right)}\right] \\
&> 0.
\end{aligned}$$

In this equation, the difference in the second moment of prices in the open sector is represented by the first part, and the difference in the shielded sector is represented by the second part. We find that both in the open and the shielded sector, the second moment of prices is unambiguously lower with the Front Trade regime. Thus, we have proven that the welfare level

is higher under open sector wage leadership.

Comparing the first moment of prices in the two regimes gives us

$$\begin{aligned}\mu_1 - \mu_{1F} &= \alpha \frac{(1-2\beta) N^2 a 2\beta (N+1)^2}{(N-2\beta-2N\beta+2)(2N-3N\beta+4-4\beta)(2N+1)(N+1)} \\ &\quad + (1-\alpha) \frac{(2N+1)(N-N\beta+2-\beta)(1-2\beta) N^2 a}{(N-2\beta-2N\beta+2)(2N-3N\beta+4-4\beta)(2N+1)(N+1)} \\ &> 0.\end{aligned}$$

The aggregate prices is lower in the Front Trade model. The first part represent the open sector, and the second represent the shielded sector. We find that there has been a price decrease in both sectors.

The price variance is lower in the Front Trade model. Using $var(p(z)) = \mu_2 - (\mu_1)^2$, we find that

$$\begin{aligned}&var(p(z)) - var(p_F(z)) = \\ &(1-\alpha)\alpha(1-2\beta)^2 N^3 a^2 \frac{\frac{\left((2-3\beta)+N(5-7\beta)+2N^2(1-2\beta)\right)}{(2N+1)^2} \frac{\left(8(1-\beta)+N(14-17\beta)+N^2(9-13\beta)+2N^3(1-2\beta)\right)}{(N+1)^2}}{(N-2\beta-2N\beta+2)^2 (2N-4\beta-3N\beta+4)^2}.\end{aligned}$$

C Employment

Because we have defined production to be equal to labour demand, total production in equilibrium is $L-u = e = \alpha(x_t + y_t) + (1-\alpha)(x_s)$, where u represent unemployment, and e represent employment. In the baseline model we get

$$e = a \frac{(1-2\beta)\left((N+2) + \alpha \frac{\left(3N+2N^2+2\right)}{(2N+1)}\right)}{(2N-3\beta N+4-4\beta)(N+1)b}. \tag{26}$$

The Front Trade model employment is

$$e_F = \frac{(1-2\beta)\left(1+\frac{\alpha}{(2N+1)}\right)a}{(N-2\beta-2N\beta+2)b}. \tag{27}$$

The Front Trade model promotes higher employment than the baseline model. Comparing employment in the two regimes gives us

$$\begin{aligned} e_F - e &= \frac{\alpha\left(\frac{\beta(N+1)}{(2N+1)}\right)2Na\left(1-2\beta\right)}{b\left(N-2N\beta-2\beta+2\right)\left(2N-3N\beta+4-4\beta\right)} \\ &\quad + \frac{\left(1-\alpha\right)\left(\frac{((2-\beta)+N(1-\beta))}{2(N+1)}\right)2Na\left(1-2\beta\right)}{b\left(N-2N\beta-2\beta+2\right)\left(2N-3N\beta+4-4\beta\right)} \\ &> 0. \end{aligned}$$

The effect in the open and shielded sectors is represented separately. The first part represent the change in the open sector, and the second part represent the change in the shielded sector. Both are positive, and this means that employment has increased in both sectors due to the Front Trade model.

D Globalization

The influence of globalization is found by looking at how the model changes when the open sector expands.

D.1 Welfare and globalization

We will first look at what impact globalization has on welfare in the baseline model. Again, instead of using the full indirect utility function, we use W and (19).

We find that

$$\begin{aligned} \frac{d}{d\alpha}W &= Na^2\frac{\left(3N+2N^2+2\right)}{\left(2N+1\right)\left(N+1\right)}\left(1-2\beta\right)\frac{\left(N+4\right)+\frac{\left(9N+4N^2+4\right)(1-2\beta)}{(2N+1)(N+1)}}{\left(2N-4\beta-3N\beta+4\right)^2} \\ &> 0, \end{aligned}$$

and we can conclude that globalization increases welfare in the baseline model.

Because the same wage appears in both sectors, the effect of globalization is less complex in the Front Trade model. We use (25) and find

$$\frac{d}{d\alpha}W_F = \frac{\left(7N-4\beta-6N\beta+4\right)\left(1-2\beta\right)a^2N}{\left(N-2\beta-2N\beta+2\right)^2\left(2N+1\right)^2} > 0.$$

We get that globalization leads to an increase of utility also in the Front Trade model.

D.2 Employment and globalization

By taking the derivative of total employment with respect to the size of the open sector, α, we find how globalization affects employment. Whether employment increase of not depends on if the number of additional workers in the open sector is higher than the decrease of workers in the shielded sector. We use (26) for the baseline model and get

$$\frac{d}{d\alpha}e = a\frac{\left(3N+2N^2+2\right)(1-2\beta)}{(4\beta-2N+3N\beta-4)(2N+1)(N+1)b} > 0.$$

For the Front Trade model, we use (27), and find

$$\frac{d}{d\alpha}e_F = a\frac{1-2\beta}{(N+2-2\beta(1-N))(2N+1)b} > 0.$$

We see that in both cases, globalization has a positive effect on employment.

When comparing the two, we find that the increase in employment is higher in the baseline model.

$$\frac{d}{d\alpha}(e-e_F) = \frac{aN(1-2\beta)\left((2-3\beta)+N(5-7\beta)+2N^2(1-2\beta)\right)}{(N-2\beta-2N\beta+2)(2N-4\beta-3N\beta+4)(2N+1)(N+1)b} > 0.$$

To get the intuition behind this, we look at the effect in the open sector and in the shielded sector separately.

$$\begin{aligned}\frac{d}{d\alpha}(e-e_F) &= -2\frac{(1-2\beta)(N+1)Na\beta}{(N-2\beta-2N\beta+2)(2N-4\beta-3N\beta+4)(2N+1)b} \\ &\quad +\frac{(N-N\beta+2-\beta)(1-2\beta)Na}{(N-2\beta-2N\beta+2)(2N-4\beta-3N\beta+4)(N+1)b}.\end{aligned}$$

The first part represents the open sector, and the second part represent the shielded sector. We see that the first part is negative, this means that in the open sector, an increase of α has a stronger positive effect on employment in the Front Trade model. The second part is negative, this is because the positive effect from globalization in the shielded sector is stronger in the baseline model. Combined, what happens in the shielded sector dominates what happens in the open sector. Globalization is more favorable in the baseline model because of the very low production in the shielded sector in this regime.

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