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Union Power, Minimum Wage Legislation, Endogenous Labor Supplies and Production*

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Abstract

The objective of this work is to study the impact of the unions' bargaining power on production and wages. We present a model where a competitive final good is produced through two substitutable intermediate goods, one produced by unskilled labor and the other by skilled labor. Potential workers decide at their cost to become skilled or unskilled and, thus, labor supplies are determined endogenously. We find that the reallocation of the labor supplies due to changes in the unskilled (or skilled) unions' bargaining power may have a positive impact on the final goods production. At the same time, total labor earnings increase with the unskilled unions' bargaining power if the final goods production increases too. We also show that the minimum wage legislation has e.ects similar to an increase in the bargaining power of the unskilled unions.

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1 Introduction

The aim of this paper is to analyze the impact of the unions' bargaining power in economies characterized by a labor market that is endogenously segmented into skilled and unskilled workers. We show that, under certain conditions, the presence of unions may be beneficial for the economy in the sense that they may induce higher production.

The effects of unions in the economy have been widely analyzed both from a theoretical and an empirical point of view. Empirical analysis has mainly centered on wage dispersion. In this respect, the results seem to be conclusive. Among others, Freeman (1980, 1993) and Card (1992) for the U.S. case, Lemieux (1998) for the Canadian case, and Bover, Bentolila and Arellano (2000) for the Spanish case, find that union power reduces wage dispersion. Theoretical studies have considered the impact of unions with other variables of the economy, such as capital, unemployment or production. Grout (1984), in a partial equilibrium analysis, finds that unions have a negative impact for the economy when wage agreements are not binding. Likewise, Deveraux and Lockwood (1991), in an overlapping generations general equilibrium approach, show that an increase in the unions' bargaining power raises wages and thus both savings of the young generation and capital. In contrast with the last paper, which depends crucially on the assumption that the depreciation rate is zero, de la Croix and Licandro (1995) find that the effects of unions on capital is ambiguous when uncertainty and irreversibility with regards to physical and human capital and technology is introduced. Regarding the effects on production, Dutt and Sen (1997) show that in a demand constrained economy with imperfect competition, a rise in the unions' bargaining power increases the markup and may increase the real wage and thus output and employment. In a different setting, Palokangas (1996) finds that when the engine of economic growth is with Research and Development activities, then the growth rate increases with the union power since there is a transfer of skilled labor from the final goods production to the R&D sector. Also, Ramos-Parreño and Sánchez-Losada (2002), in a two sector overlapping generations economy with altruism and human capital, show that the relationship between growth and unions' influence depends on the interaction between the technology in the human capital sector and the degree of unionization of the economy. The effect on unemployment has been studied by de la Croix (1993), who, in a setting with wage envy externalities between unions, finds that unemployment increases

with the unions' bargaining power.

In this paper we construct a very stylized economy where a competitive final good is produced through two substitutable intermediate goods, which are produced in a unionized competitive unskilled sector and a unionized competitive skilled sector. Potential workers decide at their cost to become skilled or not and, thus, labor supplies are determined endogenously. In this setting, the relationship between the unskilled and the skilled unions' bargaining power is found to be crucial in specifying the effects on the final goods production of a change in one of the unions' bargaining power. Any change in one of the union's bargaining power has two effects: a scale effect and a reallocation one. An increase in the bargaining power of the union in some sector causes an increase in the wage of this sector, which is transferred to the intermediate goods price. This has a negative effect on the demand for this input of the final goods firm and hence production decreases. This is the scale effect. Moreover, this increase in the unions' bargaining power has a negative effect on the employment rate in this sector. As well, the expected wage in the affected sector decreases, making the other sector more attractive to potential workers because of a change in both the expected wages and the opportunity cost of becoming skilled. This leads to potential workers changing their qualification choice, resulting in a reallocation of the labor supplies which then affects the prices and may induce an increase in the intermediate goods demands and, consequently, an increase in final production. The importance of the reallocation effect with respect to the scale effect depends on the intermediate goods "productivity", the union powers and the costs associated with acquiring skills.

An increase in production as a consequence of an increase in the bargaining power of the unions in the unskilled sector leads to an increase in the total labor earnings. This is not necessarily true when the increase in production is due to an increase in the skilled unions' bargaining power, since the reallocated labor earns a lower wage. This means that if skilled unions cause final goods production to rise, this increase may become entirely firm profits. As far as wage dispersion is concerned, we find that the unionized relative wage (skilled over unskilled) is decreasing with the unskilled union power, as the evidence suggests, and that it is increasing with the skilled union power. At the same time, the unionized expected relative wage (expected skilled wage over expected unskilled wage) is increasing with the unskilled union power and decreasing with the skilled union power.

Government could affect the influence of unions in different ways, such as law changes or higher coverage of unions. An alternative mechanism that has similar consequences to an increase in the bargaining power of unskilled unions is the imposition of a minimum wage in the economy.

Traditionally, minimum wages have been associated with lower aggregate labor demand and therefore lower employment and welfare. Recently, this relationship has been questioned and a positive effect of a minimum wage on employment has been found to appear in some models, as in Jones (1987), Chalkey (1991) or Rebitzer and Taylor (1995). Other studies have centered on the connection between the minimum wage and skilled-unskilled labor. In this respect, Flug and Galor (1986), in an open economy, find that a minimum wage may increase the skilled to unskilled ratio of the economy and, therefore, force the economy to produce skill intensive goods. Cahuc and Michel (1996), in an endogenous growth through human capital accumulation economy, show that an increase in the minimum wage raises both human capital accumulation and the endogenous growth rate, while the minimum wage has negative effects in case of exogenous growth. Cahuc, Saint-Martin and Zylberberg (2001), in an unionized economy, show that the relationship between labor demands and wages depends on the elasticity of substitution between skilled and unskilled labor, and that a positive relation between the minimum wage and unskilled labor employment may occur. The evidence for the effects of minimum wages on employment is not conclusive. Among others, Kaufman (1989) and Couch and Wittenburg (2001) find that a minimum wage has a negative effect on employment, Card and Krueger (1995) and Dolado et al. (1996) find that the effect on aggregate employment is positive, and De Fraja (1999) shows that the effects of changes in the minimum wage on employment are limited.

In our setting, an increase in the minimum wage makes the skilled wage decrease since a decrease in unskilled labor demand implicitly reduces skilled labor productivity. Whereas unskilled labor employment decreases, skilled employment increases. Worthy of note in this situation is that the expected unskilled wage decrease is higher than the expected skilled wage decrease. This change in expected wages attracts potential workers to change their qualification choice, resulting in a higher skilled labor supply and lower unskilled one. As a result, if the qualification cost is not too high and the skilled labor is sufficiently "productive", final goods production increases. These results substantiate

Cahuc and Michel (1996) and Cahuc et al. (2001), since we find that there could be positive effects in an exogenous growth setting, although in our model a positive relation between minimum wage and unskilled labor employment never occurs.

The paper is organized as follows. In the next section we present the production processes, labor supplies decisions and equilibrium for the competitive economy. In section 3 we analyze the effects of the unions' bargaining power in a unionized economy, while in section 4 we focus on the effects of a minimum wage legislation. Finally, section 5 concludes.

2 The Competitive Economy

2.1 Production

There are two types of labor in the economy: unskilled and skilled. Unskilled labor l is employed to produce the intermediate goods y_l, while skilled labor h is employed to produce the intermediate goods y_h. These intermediate goods are used to produce final goods in a perfectly competitive output market. Let p_l and p_h denote the respective sectorial price indices and normalize the final goods price to 1. The production function of a representative final goods firm is

$$Y = [\phi y_l^{\rho} + (1-\phi) y_h^{\rho}]^{1/\rho}, \tag{1}$$

where $\phi \in (0,1)$ and $\rho < 1$, which indicates that inputs are imperfect substitutes.

From the firm's profit maximization, we get

$$\frac{y_h}{y_l} = \left[\frac{p_l}{p_h}\left(\frac{1-\phi}{\phi}\right)\right]^{\frac{1}{1-\rho}} \tag{2}$$

and

$$1 = \left[p_l^{\frac{\rho}{\rho-1}} \phi^{\frac{1}{1-\rho}} + p_h^{\frac{\rho}{\rho-1}} (1-\phi)^{\frac{1}{1-\rho}}\right]^{\frac{\rho-1}{\rho}}, \tag{3}$$

where the first equation specifies the relative demand for intermediate goods, and the second equation is the non profit condition.

Intermediate unskilled and skilled goods are an aggregate of the output from a continuum of the industry firms, i.e., $y_l = \int_0^1 y_i di$ and $y_h = \int_0^1 y_j dj$, where y_i and y_j are the output of an individual intermediate unskilled and skilled goods firm, respectively, with $i, j \in [0, 1]$.

The production function of an intermediate skilled goods firm j is given by $y_j = h_j^{\varepsilon_h} \overline{h}^{\varepsilon_{\overline{h}}}$, where h_j is the skilled labor employed and $\overline{h}$ is an externality due to the skilled labor, which is equal to the average skilled labor employed in the economy (that may represent research discoveries, new technologies,...).[1,2] Given the specific production function considered, it is straightforward to show that ε_h and $\varepsilon_{\overline{h}}$ are the elasticities of revenue of h and $\overline{h}$, respectively, where it is assumed $\varepsilon_h, \varepsilon_{\overline{h}} \in (0, 1)$ and $\varepsilon_h + \varepsilon_{\overline{h}} = 1$. This externality induces constant returns to scale in the economy as a whole, while at the firm's level there are decreasing returns to scale and thus a surplus for the individual firms. This surplus is necessary for the existence of local wage bargaining in a competitive environment. Otherwise, firms have no incentive to enter into negotiations with a union and the monopoly union is the only possible case.[3]

We assume the "right-to-manage", so firms decide on the level of employment of skilled labor to maximize profits, given the wage. Denoting the skilled labor wage by w_h, the optimal level of employment h for any firm satisfies

$$w_h = p_h \varepsilon_h h^{\varepsilon_h - 1} \overline{h}^{\varepsilon_{\overline{h}}}. \tag{4}$$

Note that the labor elasticity of revenue is equal to its share in total revenue, i.e. $\varepsilon_h = w_h h / p_h y_j$.

The production function of an unskilled input firm i is given by $y_i = l^{\varepsilon_l} \overline{l}^{\varepsilon_{\overline{l}}}$, where l is the unskilled labor employed, $\overline{l}$ is an externality accruing from the aggregate unskilled labor,

[1] Hereinafter, we suppress the subindices of each firm, i.e. $h_j = h$. The same applies for the unskilled input firms.

[2] Other production functions only complicate the analysis. The results remain if the labor elasticity of revenue is constant. Also, the introduction of capital does not vary the results if an open economy is considered.

[3] All results of the paper except Proposition 3 are maintained under the assumption of no externalities and decreasing returns to scale in the intermediate goods firms technology. An alternative way of formalizing the economy in such a way that similar results arise is to assume imperfect competition in the intermediate goods market. However, introducing externalities simplifies the exposition of the paper. In any case, in the next sections we explicitly comment how they affect our results.

and ε_l and $\varepsilon_{\bar{l}}$ are the elasticities of revenue of l and $\bar{l}$, respectively, where $\varepsilon_l, \varepsilon_{\bar{l}} \in (0,1)$ and $\varepsilon_l + \varepsilon_{\bar{l}} = 1$. Again, given the unskilled wage w_l, the firms choose the level of employment l satisfying

$$w_l = p_l \varepsilon_l l^{\varepsilon_l - 1} \bar{l}^{\varepsilon_{\bar{l}}}. \tag{5}$$

As before, the labor elasticity of revenue is equal to its share in total revenue, i.e. $\varepsilon_l = w_l l / p_l y_i$.

In order to contemplate situations where skilled labor is more "productive" than unskilled labor it is assumed throughout that $\varepsilon_h > \varepsilon_l$. This implies that the labor share of the total revenue is higher in the skilled sector than in the unskilled one.

2.2 Labor Supplies

The acquisition of skills is costly and the ability to acquire these skills differs among agents. Education is a means of acquiring skills: not everybody must apply the same effort in order to obtain the same level of education. In this setting, both unskilled L and skilled H labor supplies are endogenously determined by the choices made by the potential workers, who are assumed to have perfect foresight. Their decisions must contemplate the gains from becoming skilled against the alternative situation of remaining unskilled.

The reward from remaining unskilled or not acquiring skills is the unskilled expected wage $w_l l/L$, where the employment rate of unskilled labor l/L (i.e., the firms' demand over the unskilled labor supply) represents the probability of finding a job. In order to become a skilled worker, each individual bears a cost, which is assumed to be an opportunity cost and therefore proportional to the expected unskilled wage $c w_l l/L$, where $c > 0$. Each individual also has a personal ability, denoted by a, affecting the cost of acquiring these skills. We assume that this cost is inversely proportional to ability. Then, the reward for being skilled is the expected wage that the skilled worker earns minus the acquisition cost,

$$w_h \frac{h}{H} - \frac{c}{a} w_l \frac{l}{L}, \tag{6}$$

where the employment rate of skilled labor h/H (i.e., the firms' demand over the skilled labor supply) is the probability of finding a job in the skilled sector. The ability value a^* which makes the individual indifferent between acquiring skills or being unskilled is

simply the value that makes both rewards equal, i.e.,

$$a^* = \frac{c\frac{l}{L}}{\frac{w_h}{w_l}\frac{h}{H} - \frac{l}{L}}. \tag{7}$$

Clearly, an increase in the skilled employment rate or in the relative wage (skilled over unskilled wage), and a decrease in the cost of acquiring skills or in the unskilled employment rate, all reduce the minimum level of ability required to acquire skills a^*.

We assume that there is a continuum of potential workers with measure one and that a is uniformly distributed across them. Then, the unskilled labor supply is $L = a^*$ and the skilled labor supply is $H = 1 - a^*$, since lower personal ability implies higher opportunity cost and thus a lower reward for being skilled. Substituting a^* and H in (7) shows that the proportion of workers choosing not to become skilled satisfies

$$w_h\left(\frac{h}{1-L}\right) = w_l\frac{l}{L}(1 + \frac{c}{L}). \tag{8}$$

2.3 Equilibrium

Once the workers have decided either to become skilled or not, they inelastically offer a unit of labor each. Since there are no unions, sectorial wages are decided by the market clearing condition. Note that, as all firms are equal, in equilibrium $h_j = h$, $y_j = y_h$, $l_i = l$ and $y_i = y_l$ must be satisfied. Also, notice that in a competitive equilibrium $h = \overline{h} = 1 - L$ and $l = \overline{l} = L$, since there is no unemployment. Using $\varepsilon_{\overline{l}} = 1 - \varepsilon_l$, $\varepsilon_{\overline{h}} = 1 - \varepsilon_h$ and evaluating in equilibrium, conditions (4) and (5) become

$$p_h = \frac{w_h}{\varepsilon_h}, \tag{9}$$

and

$$p_l = \frac{w_l}{\varepsilon_l}, \tag{10}$$

that means that any change in the wage is compensated by a change in the intermediate goods price.

Likewise, in equilibrium the equations (2) and (8) can be expressed as

$$p_h = p_l\left(\frac{1-\phi}{\phi}\right)\left(\frac{1-L}{L}\right)^{\rho-1}, \tag{11}$$

$$w_h = w_l(1 + \frac{c}{L}). \tag{12}$$

Combining (9), (10) and (11) we obtain

$$\frac{w_h}{\varepsilon_h} = \frac{w_l}{\varepsilon_l}\left(\frac{1-\phi}{\phi}\right)\left(\frac{1-L}{L}\right)^{\rho-1}, \tag{13}$$

which, divided by (12), implicitly yields the unskilled equilibrium labor supply L^*,

$$\left(\frac{1-\phi}{\phi}\right)\left(\frac{\varepsilon_h}{\varepsilon_l}\right) = (1 + \frac{c}{L^*})\left(\frac{1-L^*}{L^*}\right)^{1-\rho}. \tag{14}$$

The right hand side of (14) is a decreasing function of L and thus solely defines the equilibrium unskilled labor supply. Moreover, evaluating equation (1) in equilibrium and using (14), the final goods production Y^* can be expressed as

$$Y^* = (1 - L^*)(1-\phi)^{\frac{1}{\rho}}\left[1 + \frac{\varepsilon_h}{\varepsilon_l}\left(\frac{L^*}{1-L^*}\right)\frac{1}{\left(1 + \frac{c}{L^*}\right)}\right]^{\frac{1}{\rho}}, \tag{15}$$

or

$$Y^* = L^*\phi^{\frac{1}{\rho}}\left[1 + \frac{\varepsilon_l}{\varepsilon_h}\left(\frac{1-L^*}{L^*}\right)\left(1 + \frac{c}{L^*}\right)\right]^{\frac{1}{\rho}}. \tag{16}$$

3 The Unionized Economy

3.1 Bargaining

Workers negotiate wages at the firm level. Both skilled and unskilled workers are represented by different unions. Unions do not cooperate and they focus exclusively on obtaining the highest possible wage, i.e., they disregard the employment consequences of the negotiated wages. This behavior can be justified by the observation that unions tend to be more interested in the welfare of insiders than outsiders.[4]

First, consider the negotiations in a typical skilled intermediate goods firm. As usual, the Nash solution is assumed to arise as the outcome of the bargaining process. The

[4] Cahuc et al. (2001) model a labor market where a sole union represents all workers. However, this union is only concerned about skilled workers.

maximand of the union representing skilled workers in the Nash bargaining process is

$$U_h - U_{0h} = w_h - s_h, \tag{17}$$

where s_h is the income of a skilled worker if the negotiation fails. Following Barth and Zweimüller (1995), s_h is the expected income that a skilled worker can get in the rest of the economy, that is

$$s_h = \frac{h}{H} V_h, \tag{18}$$

where V_h is the average wage rate for skilled workers in all other firms.[5]

The maximand of the firm in the bargaining process is

$$\pi_h - \pi_{0h} = p_h h^{\varepsilon_h} \overline{h}^{\overline{\varepsilon_h}} - w_h h, \tag{19}$$

since the firm's disagreement payoff π_{0h} is zero.

Denoting the bargaining power of the skilled union and the firm by β_h and $(1-\beta_h)$ respectively, with $0 < \beta_h < 1$, the wage w_h resulting from the bargaining process is that which maximises the Nash product

$$(U_h - U_{0h})^{\beta_h} \cdot (\pi_h - \pi_{0h})^{1-\beta_h}$$

subject to (4), which indicates the right-to-manage restriction. This yields

$$w_h = \frac{(1-\beta_h)\,\varepsilon_h}{(\varepsilon_h - \beta_h)} s_h. \tag{20}$$

Note that the employment rate is positive if $\beta_h < \varepsilon_h$, which is assumed throughout.[6] Otherwise, production is equal to zero because as the union is only concerned with the wage, a higher power implies that the wage stated by the union is higher than the labor productivity and therefore no firm would want to hire these workers.

[5] Note that we are assuming that a skilled worker cannot work as unskilled. Since the expected wage is always higher in the skilled sector than in the unskilled, one can reinterpret this situation just considering that skilled workers spend their time looking for a job in the skilled sector.

[6] All results of the paper are then conditioned to this inequality. Even if we consider how changes in the unions bargaining power affect the variables of the model, we always restrict the analysis to these situations.

By symmetry, in equilibrium all firms pay the same wage. Thus, $V_h = w_h$ and then $s_h = \frac{h}{H} w_h$. Substituting this value into (20) the equilibrium skilled employment rate is obtained as

$$\frac{h}{H} = \frac{(\varepsilon_h - \beta_h)}{(1 - \beta_h)\,\varepsilon_h}. \tag{21}$$

Similarly, in a typical unskilled intermediate goods firm, the union representing unskilled labor seeks to maximize $U_l - U_{0l} = w_l - s_l$, where $s_l = \frac{l}{L} V_l$, and the firm $\pi_l - \pi_{0l} = p_l l^{\varepsilon_l} \overline{l}^{\varepsilon_{\overline{l}}} - w_l l$, since, again, its disagreement payoff π_{0l} is zero. From the Nash bargaining process we obtain

$$w_l = \frac{(1 - \beta_l)\,\varepsilon_l}{(\varepsilon_l - \beta_l)} s_l, \tag{22}$$

where β_l represents the bargaining power of the unskilled workers. Using, as before, that $V_l = w_l$ is satisfied in equilibrium, the equilibrium unskilled employment rate is

$$\frac{l}{L} = \frac{(\varepsilon_l - \beta_l)}{(1 - \beta_l)\,\varepsilon_l}. \tag{23}$$

In this case, the employment rate is positive whenever $\beta_l < \varepsilon_l$.

The presence of unions results in both unskilled and skilled employment rates being constant in each sector. This means that any change in the labor supply would be compensated by a proportional change in the employed labor. Therefore, although the union focuses exclusively on the wage, as a result of negotiations this wage is adjusted in order to maintain the employment rate constant. Note that from (21) and (23), there is always unemployment since ε_h and ε_l are smaller than one.

3.2 Equilibrium and Comparative Statics

In this section, labor supplies and the final goods production in the unionized economy are considered.

From (2), using $\varepsilon_{\overline{h}} = 1 - \varepsilon_h$ and evaluating in equilibrium, the following relation has to be satisfied

$$p_h = p_l \left(\frac{1 - \phi}{\phi}\right) \left(\frac{h}{l}\right)^{\rho - 1}. \tag{24}$$

Substituting w_h and w_l from (4) and (5) into (8) and evaluating in equilibrium, we obtain

$$p_h = p_l \left(\frac{1-L}{L}\right) \frac{l}{h} \frac{\varepsilon_l}{\varepsilon_h} \left(1 + \frac{c}{L}\right). \tag{25}$$

Hence, combining (24) and (25), the relative labor demand is given by

$$\left(\frac{h}{l}\right)^{\rho} = \left(\frac{\phi}{1-\phi}\right) \frac{\varepsilon_l}{\varepsilon_h} \left(\frac{1-L}{L}\right) \left(1 + \frac{c}{L}\right). \tag{26}$$

Substituting h and l from (21) and (23) into (26) we have the unskilled labor supply L_u of the unionized economy specified by

$$\left(\frac{1-\phi}{\phi}\right) \left(\frac{\varepsilon_h}{\varepsilon_l}\right)^{1-\rho} \left[\frac{(\varepsilon_h - \beta_h)(1-\beta_l)}{(\varepsilon_l - \beta_l)(1-\beta_h)}\right]^{\rho} = \left(\frac{1-L_u}{L_u}\right)^{1-\rho} \left(1 + \frac{c}{L_u}\right). \tag{27}$$

Since the left hand side of the previous equation increases with β_l and the right hand side decreases with L_u, any increase in β_l must involve a decrease in L_u. Likewise, an increase in β_h implies an increase in L_u. Thus, the next lemma follows.

Lemma 1 An increase in the unskilled (skilled) union power implies a decrease (increase) in the unskilled labor supply, i.e. $dL/d\beta_l < 0$ and $dL/d\beta_h > 0$.

The existence of skilled unions increases the unskilled labor supply by lowering skilled employment even though unskilled unions are present in the economy. The effects of unskilled unions are opposed to those generated by skilled unions, that is, the unskilled labor supply is reduced as the unskilled unions' bargaining power increases. The reason is that an increase in the bargaining power of any union increases the wage and thus reduces the employment rate in this sector. Moreover, the expected wage in the sector concerned is also reduced. Consequently, the proportion of skilled and unskilled labor demands in the economy changes, decreasing the labor supply in that sector. Therefore, any change in union power produces a reallocation of the labor force. This affects both wages and intermediate goods prices and thus the demand for intermediate goods by the final goods firm. Next, we analyze how these changes in the bargaining power of unions affect the final goods production.

Evaluating (1) in equilibrium and using (21), (23) and (26), we obtain the unionized final goods production Y_u as

$$Y_u = \left[\frac{\varepsilon_h - \beta_h}{(1-\beta_h)\,\varepsilon_h}\right](1-L_u)\,(1-\phi)^{\frac{1}{\rho}}\left[1+\frac{\varepsilon_h}{\varepsilon_l}\left(\frac{L_u}{1-L_u}\right)\frac{1}{\left(1+\frac{c}{L_u}\right)}\right]^{\frac{1}{\rho}}, \tag{28}$$

or

$$Y_u = \left[\frac{\varepsilon_l - \beta_l}{(1-\beta_l)\,\varepsilon_l}\right]L_u\phi^{\frac{1}{\rho}}\left[1+\frac{\varepsilon_l}{\varepsilon_h}\left(\frac{1-L_u}{L_u}\right)\left(1+\frac{c}{L_u}\right)\right]^{\frac{1}{\rho}}. \tag{29}$$

For some parameter values, an increase in the bargaining power of unions has positive effects on the final goods production of the economy. These results are made explicit in the next two propositions.[7]

Proposition 2 There exist $\widehat{c}(\rho, \varepsilon_l, \varepsilon_h)$ and $\widehat{\phi}(\rho, \varepsilon_l, \varepsilon_h, c, \beta_l, \beta_h)$ such that an increase in the unskilled union power implies a higher final goods production whenever $c < \widehat{c}$ and $\phi < \widehat{\phi}$.

An increase in unskilled union power has two effects: a scale effect and a reallocation effect. There is a scale effect since final goods firms reduce the demand for the unskilled intermediate goods, because the increase in the unskilled wage produces an increase in its price. As a consequence, production decreases. In addition, there is a change in expected wages which makes individuals change their qualification choice, resulting in a reallocation of the labor supplies (higher skilled labor supply and lower unskilled supply). This reallocation effect leads to a decrease in the price of the skilled intermediate goods and hence the final goods firm increases the demand for the skilled intermediate goods which may induce production to increase. The importance of these effects depends on the intermediate goods "productivity", the unions' bargaining power and the cost parameter. Moreover, raising unemployment may increase final goods production when skilled intermediate goods are relatively more productive than unskilled ones (ϕ smaller than some critical value $\widehat{\phi}$) In such a case, the reallocation effect is stronger on final production than the scale effect; this is because the opportunity cost to qualify supported by the individuals is relatively small and the "effective" marginal product added (included the unemployed individuals) by the new skilled workers is higher than the unskilled marginal product loss.

[7] All the proofs of the paper are relegated to the Appendix.

Note that, by the continuity of the effects of the unions' bargaining power (when $\beta_h = \beta_l = 0$ we are in the competitive scenario), if $\phi < \widehat{\phi}$ then the final goods production is higher in the unionized economy than in the competitive economy. Also note that critical unskilled labor productivity $\widehat{\phi}$ depends both on unskilled and skilled unions' bargaining power, which means that the significance of the reallocation effect depends on the unions relative bargaining power. Moreover, $\widehat{\phi}$ is decreasing in β_h and increasing in β_l. Therefore, a higher skilled union power implies that it is less plausible that an increase in the unskilled unions' bargaining power makes final goods production to increase.

A higher unskilled wage reduces the opportunity cost of becoming skilled by decreasing the unskilled expected wage. In some sense, this means that the restriction of the economy due to the cost of qualification diminishes and a better allocation of labor supplies is attained. This effect is only present when the expected unskilled wage decreases. Externalities do not play a crucial role for this result. However, the presence of externalities, which imply a difference between private productivity and "social" productivity, is important when considering the effects on production of an increase in the skilled unions' bargaining power. In fact, an important aspect of our assumption is that the wage received by the workers does not reflect their productivity in the economy. Thus, under these circumstances, even by restricting the mobility of potential workers (induced by an increase in β_h), the reallocation of the labor force may have positive effects on the final goods production, as the next proposition shows.

Proposition 3 There exist $\widetilde{c}(\rho, \varepsilon_l, \varepsilon_h)$ and $\widetilde{\phi}(\rho, \varepsilon_l, \varepsilon_h, c, \beta_l, \beta_h)$ such that an increase in the skilled union power implies a higher final goods production whenever $c < \widetilde{c}$ and $\phi > \widetilde{\phi}$.

The positive effects on production of an increase in the bargaining power of the unskilled union has other effects on the economy: unskilled unemployment, unskilled expected wage and unskilled labor earnings decrease as w_l increases. However, some workers who previously did not acquire skills change their minds and become part of the skilled labor supply. Thus, the effects on the total labor earnings $TLE = w_l l + w_h h$ are not necessarily negative. The next proposition shows that total labor earnings increase whenever final production increases as a result of an increase in the bargaining power of unskilled unions.

Proposition 4 If $c < \widehat{c}$ and $\phi < \widehat{\phi}$, then an increase in the unskilled union power implies higher total labor earnings.

An increase in the final goods production has positive effects on total labor earnings. Although total labor earnings increase with the unskilled unions' bargaining power, we can say nothing when the increase in production is due to stronger skilled unions, since the reallocated labor earns a lower wage. This means that if skilled unions cause final goods production to rise, this increase may become entirely profits.

Regarding the relative wages, the next propositions show that even though the expected relative wages $W = (w_h h/H)/(w_l l/L)$ increase as the bargaining power of unskilled unions increase, relative wages $\omega = w_h/w_l$ move in the opposite direction.

Proposition 5 The relative wage is decreasing (increasing) with the unskilled (skilled) union power.

Proposition 6 The expected relative wage is increasing (decreasing) with the unskilled (skilled) union power.

Although the relative wage decreases whenever the unskilled union power increases, the expected relative wage increases. This behavior, which may seem "myopic", is exclusively due to the fact that unions concentrate solely on wages.

4 Minimum Wage Legislation

There may be alternative ways for a government to change the influence of unions in the economy. In this section, a specific policy consisting of imposing a minimum wage for the economy is considered. This policy has similar effects to an increase in the unskilled unions' bargaining power. Hence, under certain circumstances minimum wage legislation has positive effects on the final production of the economy.

Consider the case where the government fixes a minimum wage $\overline{w}$ higher than the

unskilled wage of the previous section w_l.[8] Let us also assume that $\overline{w}$ is lower than the skilled wage, otherwise skilled unions would have no effect. In this situation, the effects of the unskilled unions disappear and therefore the analysis can be reduced to that of an economy where just the skilled unions are present. Labor supplies and final goods production will now be a function of the minimum wage imposed by a government in the economy.

Substituting w_l by $\overline{w}$, using $\varepsilon_{\overline{l}} = 1 - \varepsilon_l$ and evaluating in equilibrium, equation (5) becomes

$$p_l = \frac{\overline{w}}{\varepsilon_l}. \tag{30}$$

From (2), using $\varepsilon_{\overline{h}} = 1 - \varepsilon_h$ and evaluating in equilibrium, we have

$$p_h = p_l \left(\frac{1-\phi}{\phi}\right) \left(\frac{h}{l}\right)^{\rho-1}. \tag{31}$$

Substituting w_h and w_l from (4) and (5) into (8), we obtain

$$p_h = p_l \left(\frac{1-L}{L}\right) \frac{l}{h} \frac{\varepsilon_l}{\varepsilon_h} \left(1 + \frac{c}{L}\right). \tag{32}$$

Combining (31) and (32) we obtain the relative labor demands as a function of unskilled labor supply,

$$\frac{h}{l} = \left[\left(\frac{\phi}{1-\phi}\right) \frac{\varepsilon_l}{\varepsilon_h} \left(\frac{1-L}{L}\right) \left(1 + \frac{c}{L}\right)\right]^{\frac{1}{\rho}}. \tag{33}$$

From (30), (31) and (33) the skilled intermediate goods price is obtained as a function of the minimum wage,

$$p_h = \frac{\overline{w}}{\varepsilon_l} \left[\frac{\varepsilon_l}{\varepsilon_h} \left(\frac{1-L}{L}\right) \left(1 + \frac{c}{L}\right)\right]^{\frac{\rho-1}{\rho}} \left(\frac{\phi}{1-\phi}\right)^{\frac{1}{\rho}}. \tag{34}$$

The unskilled labor supply $\overline{L}$ is implicitly obtained from (3), substituting both prices from (30) and (34),

$$1 = \frac{\overline{w}}{\phi^{\frac{1}{\rho}}} \left[\varepsilon_l^{\frac{\rho}{1-\rho}} + \frac{\varepsilon_l^{\frac{1}{1-\rho}}}{\varepsilon_h} \left(\frac{1-\overline{L}}{\overline{L}}\right) \left(1 + \frac{c}{\overline{L}}\right)\right]^{\frac{\rho-1}{\rho}}. \tag{35}$$

[8] In order to find the wage settled by the Nash bargaining solution, we have to include the restriction that the bargained wage must be at least the minimum wage. It is straightforward to show that this restriction is always binding and thus this minimum wage would be the negotiated wage.

It is straightforward to prove the following result.

Lemma 7 An increase in the minimum wage implies:

(a) higher unskilled (lower skilled) intermediate goods price.

(b) lower unskilled (higher skilled) labor supply, and

(c) lower unskilled (higher skilled) labor demand.

The imposition of a minimum wage has similar effects to the introduction of unions in the unskilled sector: it induces unemployment in the unskilled labor market and consequently a reallocation of the labor force. Hence, as in the previous section, the reallocation effect may be high enough so that the imposition of a minimum wage has a positive impact on the final goods production.

Evaluating (1) in equilibrium and using (21), (33) and (35) we obtain the final goods production $\overline{Y}$,

$$\overline{Y} = \left[\frac{\varepsilon_h - \beta_h}{(1-\beta_h)\,\varepsilon_h}\right](1-\overline{L})\,(1-\phi)^{\frac{1}{\rho}}\left[1+\frac{\varepsilon_h}{\varepsilon_l}\left(\frac{\overline{L}}{1-\overline{L}}\right)\frac{1}{\left(1+\frac{c}{\overline{w}\overline{L}}\right)}\right]^{\frac{1}{\rho}}. \tag{36}$$

Noting that this expression coincides with (28), the next proposition is straightforward.

Proposition 8 There exist $\widehat{c}(\rho, \varepsilon_l, \varepsilon_h)$ and $\overline{\phi}(\rho, \varepsilon_l, \varepsilon_h, c, \overline{w})$ such that an increase in the minimum wage implies a higher final goods production whenever $c < \widehat{c}$ and $\phi < \overline{\phi}$.

Note that, by continuity, if $\phi < \overline{\phi}$ then the final goods production is higher in the economy with minimum wage legislation than in the competitive economy. Also note that $\overline{\phi}$ increases with $\overline{w}$ and now $\overline{\phi}$ does not depend on the skilled unions' bargaining power. In this way, since the significance of the reallocation effect does not depend on the unions' influence, the minimum wage has stronger effects than those produced by an increase in the unskilled unions' bargaining power.

Increases in final goods production as a consequence of an increase in the minimum wage have positive effects on the total labor earnings $TLE = \overline{w}l + w_h h$. Thus, the increase in labor earnings in the skilled sector compensates the reduction of the labor earnings in the unskilled sector.

Proposition 9 If $c < \widehat{c}$ and $\phi < \overline{\phi}$, then an increase in the minimum wage implies higher total labor earnings $\overline{w}l + w_h h$.

The effects of a minimum wage legislation in the economy are similar to those of an increase in unskilled bargaining power. There is a scale effect that reduces production and a reallocation effect that increases production. When the last effect dominates the first, an increase in the minimum wage is beneficial for the economy. Although we are in the case when final goods production increases, a higher minimum wage may imply higher unemployment. Thus, we cannot claim that higher final goods production implies higher welfare in the economy, since some agents of the economy may be excluded from these gains.

5 Final Remarks

One of the aspects of the model which is important for our results is the endogeneity of the labor supplies. There is an opportunity cost to becoming skilled that restricts the mobility of potential workers to become part of the skilled labor supply.

The reallocation of labor supplies has been shown to be the key effect in order to obtain a positive relationship between unions' influence and final production. Changing the bargaining power of the unions or the imposition of a minimum wage are tools to adjust labor supplies in the economy in order to correct the inefficient assignment caused by the existence of costs associated with the acquisition of skills. In this respect, it must be emphasized that minimum wage legislation is different from a public policy designed to directly reduce the costs of acquiring skills. Minimum wage legislation reduces the opportunity cost of becoming skilled by reducing the expected wage in the unskilled sector. However, subsidizing potential workers in order to increase the skilled labor supply will not reduce such costs, which need to be supported by agents of the economy.

The results of the paper are enhanced if considering a positive relationship between the total factor productivity $A\left(\overline{h}\right)$ (assumed here to be one) and the average skilled employed labor, i.e. $Y = A(\overline{h})\left[\phi y_l^{\rho} + (1-\phi) y_h^{\rho}\right]^{1/\rho}$ where $A' > 0$ and $A'' < 0$ (according to Coe and Helpman, 1995) In this case, the reallocation effect would be greater only in the cases

where the unskilled labor supply decreases. The total quantity depends on the degree of concavity of the total factor productivity.

The introduction of monopolistic competition would enable an important effect of the minimum wage to be shown. Although monopolistic competition restricts labor mobility and skilled labor is lower than in perfect competition, as emphasizes Tse (2000), the existence of a minimum wage is revealed as an important mechanism to partially break this labor mobility restriction.

Appendix

Proof of Proposition 2

Since $dY_u/d\beta_l = (dY_u/dL) \cdot (dL/d\beta_l)$ and we know, by Lemma 1 that $dL/d\beta_l < 0$, we have to prove that $dY_u/dL < 0$.

From (28)[9], the sign of the derivative of the final goods production with respect to the unskilled labor supply is

$$sign\frac{dY_u}{dL} = sign\left\{L^3\rho\left(\varepsilon_l - \varepsilon_h\right) + L^2\left(\rho\varepsilon_l\left(2c-1\right) + \varepsilon_h\left[1 - c\left(1+\rho\right)\right]\right)\right.$$

$$\left. + Lc\left[\rho\varepsilon_l(c-2) + 2\varepsilon_h\right] - \rho\varepsilon_l c^2 = g(L) + f(L)\right\}.$$

Let

$$f\left(L\right) = L^2\left(\rho\varepsilon_l\left(2c-1\right) + \varepsilon_h\left[1 - c\left(1+\rho\right)\right]\right) + Lc\left[\rho\varepsilon_l(c-2) + 2\varepsilon_h\right] - \rho\varepsilon_l c^2$$

and

$$g(L) = L^3\rho\left(\varepsilon_l - \varepsilon_h\right).$$

Since $sign(dY_u/dL) = sign\left\{g(L) + f(L)\right\}$, where $g\left(L\right) < 0$ for any $L \in (0,1)$, $sign(dY_u/dL) < 0$ will occur whenever $f(L) < 0$.

The solution to $f(L) = 0$ is

$$\widehat{L} = \frac{c\left[\rho\varepsilon_l(2-c) - 2\varepsilon_h\right]}{2\left(\rho\varepsilon_l\left(2c-1\right) + \varepsilon_h\left[1 - c\left(1+\rho\right)\right]\right)} \pm$$

$$\pm\frac{\sqrt{c^2\left[\rho\varepsilon_l(2-c) - 2\varepsilon_h\right]^2 + 4\rho\varepsilon_l c^2\left(\rho\varepsilon_l\left(2c-1\right) + \varepsilon_h\left[1 - c\left(1+\rho\right)\right]\right)}}{2\left(\rho\varepsilon_l\left(2c-1\right) + \varepsilon_h\left[1 - c\left(1+\rho\right)\right]\right)}. \qquad \text{(A.1)}$$

If $\rho\varepsilon_l\left(2c-1\right) + \varepsilon_h\left[1 - c\left(1+\rho\right)\right] > 0$, then there is a unique positive real solution, that with positive sign. This happens when

$$c < \widehat{c}\left(\rho, \varepsilon_l, \varepsilon_h\right) = \frac{\varepsilon_h - \rho\varepsilon_l}{\varepsilon_h\left(1+\rho\right) - 2\rho\varepsilon_l} = \frac{\varepsilon_h - \rho\varepsilon_l}{\varepsilon_h - \rho\varepsilon_l + \rho\left(\varepsilon_h - \varepsilon_l\right)}.$$

[9] We use (28) instead of (29) since there is no β_l in (28).

It has been shown that $sign(dY_u/dL) < 0 \ \forall L \in (0, \widehat{L})$. Hence, if $L_u < \widehat{L}$ the proposition holds. As $d[(1 + \frac{c}{L})\left(\frac{1-L}{L}\right)^{1-\rho}]/dL < 0$, from (27) it is immediately shown that $L_u < \widehat{L}$ is satisfied when

$$(1 + \frac{c}{\widehat{L}})\left(\frac{1-\widehat{L}}{\widehat{L}}\right)^{1-\rho} < \left(\frac{1-\phi}{\phi}\right)\left(\frac{\varepsilon_h}{\varepsilon_l}\right)^{1-\rho}\left[\frac{(\varepsilon_h - \beta_h)(1-\beta_l)}{(\varepsilon_l - \beta_l)(1-\beta_h)}\right]^{\rho}$$

and thus

$$\phi < \widehat{\phi}(\rho, \varepsilon_l, \varepsilon_h, c, \beta_l, \beta_h) = 1/\left(1 + (1 + \frac{c}{\widehat{L}})\left(\frac{1-\widehat{L}}{\widehat{L}}\right)^{1-\rho}\left(\frac{\varepsilon_l}{\varepsilon_h}\right)^{1-\rho}\left[\frac{(\varepsilon_l - \beta_l)(1-\beta_h)}{(\varepsilon_h - \beta_h)(1-\beta_l)}\right]^{\rho}\right).$$

Proof of Proposition 3

Since $dY_u/d\beta_h = (dY_u/dL) \cdot (dL/d\beta_h)$ and we know that $dL/d\beta_h > 0$, we have to prove that $dY_u/dL > 0$.

From (29)[10], the sign of the derivative of the final goods production with respect to the unskilled labor supply is:

$$sign\frac{dY_u}{dL} = sign\left\{L^2\rho(\varepsilon_h - \varepsilon_l) - L\varepsilon_l(1-c)(1-\rho) - c\varepsilon_l(2-\rho)\right\}.$$

Direct computations show that $sign\,(dY_u/dL) = 0$ when

$$\widetilde{L} = \frac{\varepsilon_l(1-c)(1-\rho) + \sqrt{\varepsilon_l^2(1-c)^2(1-\rho)^2 + 4\rho(\varepsilon_h - \varepsilon_l)c\varepsilon_l(2-\rho)}}{2\rho(\varepsilon_h - \varepsilon_l)}. \tag{A.2}$$

Moreover, $sign\,(dY_u/dL) > 0$ for any $L > \widetilde{L}$.

In order that $\widetilde{L} \in (0,1)$, a sufficient condition is that $c < \widetilde{c}(\rho, \varepsilon_l, \varepsilon_h) = (\rho\varepsilon_h - \varepsilon_l)/\varepsilon_l$, since this condition ensures that $(dY_u/dL)|_{L=1} > 0$. Now, we are done if we show that $\widetilde{L} < L_u$.

As $d[(1 + \frac{c}{L})\left(\frac{1-L}{L}\right)^{1-\rho}]/dL < 0$, from (27) we know that $\widetilde{L} < L_u$ whenever

$$(1 + \frac{c}{\widetilde{L}})\left(\frac{1-\widetilde{L}}{\widetilde{L}}\right)^{1-\rho} > \left(\frac{1-\phi}{\phi}\right)\left(\frac{\varepsilon_h}{\varepsilon_l}\right)^{1-\rho}\left[\frac{(\varepsilon_h - \beta_h)(1-\beta_l)}{(\varepsilon_l - \beta_l)(1-\beta_h)}\right]^{\rho},$$

[10] We use (29) instead of (28) since there is no β_h in (29).

which happens if

$$\phi > \widetilde{\phi}\left(\rho, \varepsilon_l, \varepsilon_h, c, \beta_l, \beta_h\right) = 1/\left(1 + \left(1 + \frac{c}{\widetilde{L}}\right)\left(\frac{1-\widetilde{L}}{\widetilde{L}}\right)^{1-\rho}\left(\frac{\varepsilon_l}{\varepsilon_h}\right)^{1-\rho}\left[\frac{\left(\varepsilon_l - \beta_l\right)\left(1-\beta_h\right)}{\left(\varepsilon_h - \beta_h\right)\left(1-\beta_l\right)}\right]^{\rho}\right).$$

Proof of Proposition 4

Since Y_u is produced competitively, using (9) and (10), we know that

$$Y_u = p_l l + p_h h = \frac{w_l}{\varepsilon_l} l + \frac{w_h}{\varepsilon_h} h. \tag{A.3}$$

Assuming that $dY_u/d\beta_l = \left(dY_u/dL\right) \cdot \left(dL/d\beta_l\right) > 0$, we know that $dL/d\beta_l < 0$, which implies that $w_l l/L$ has to decrease, otherwise L would not decrease. Thus, $w_l l$ must also decrease when β_l increases, which implies that, from (A.3), $w_h h$ must increase with β_l even though w_h decreases.

Using (A.3), the total labor earnings $TLE = w_l l + w_h h$ becomes

$$TLE = \varepsilon_l Y_u + \left[1 - \frac{\varepsilon_l}{\varepsilon_h}\right] w_h h, \tag{A.4}$$

from where the derivative of TLE with respect to β_l is

$$\frac{dTLE}{d\beta_l} = \varepsilon_l \frac{dY_u}{d\beta_l} + \left[1 - \frac{\varepsilon_l}{\varepsilon_h}\right] \frac{d\left(w_h h\right)}{d\beta_l}, \tag{A.5}$$

which is positive since $\varepsilon_l < \varepsilon_h$.

Proof of Proposition 5

Combining (9), (10) and (24), and denoting the unionized relative wage as ω, we have

$$\frac{h}{l} = \left(\omega \frac{\varepsilon_l}{\varepsilon_h} \frac{\phi}{1-\phi}\right)^{\frac{1}{\rho-1}}, \tag{A.6}$$

which combined with (26) gives

$$\omega = \left(\frac{\varepsilon_h}{\varepsilon_l} \frac{1-\phi}{\phi}\right)^{\frac{1}{\rho}} \left[\left(\frac{1-\widetilde{L}}{\widetilde{L}}\right)\left(1 + \frac{c}{\widetilde{L}}\right)\right]^{\frac{\rho-1}{\rho}}. \tag{A.7}$$

Since $d\left[\left(\frac{1-L}{L}\right)\left(1 + \frac{c}{L}\right)\right]/dL < 0$, the proposition follows from Lemma 1.

Proof of Proposition 6

Denoting the unionized expected relative wage by W and using (8), we have

$$W = \left(1 + \frac{c}{L_u}\right), \tag{A.8}$$

and, hence, the relative expected wage decreases with L. The proposition follows by Lemma 1.

Proof of Proposition 8

Using Lemma 7, the proof is the same as Proposition 2 but now, from (35), since

$$d\left[\left(\frac{1-L}{L}\right)\left(1 + \frac{c}{L}\right)\right]/dL < 0,$$

we know that if $\widehat{L} > \overline{L}$ then

$$(1 + \frac{c}{\widehat{L}})\left(\frac{1-\widehat{L}}{\widehat{L}}\right) < \left[\frac{\overline{w}^{\frac{\rho}{1-\rho}}}{\phi^{\frac{1}{1-\rho}}} - \varepsilon_l^{\frac{\rho}{1-\rho}}\right]\left(\frac{\varepsilon_h}{\varepsilon_l^{\frac{1}{1-\rho}}}\right).$$

This happens whenever

$$\phi < \overline{\phi}(\rho, \varepsilon_l, \varepsilon_h, c, \overline{w}) = \overline{w}^{\rho}/\left[\varepsilon_l^{\frac{\rho}{1-\rho}} + \frac{\varepsilon_l^{\frac{1}{1-\rho}}}{\varepsilon_h}(1 + \frac{c}{\widehat{L}})\left(\frac{1-\widehat{L}}{\widehat{L}}\right)\right]^{1-\rho}.$$

Proof of Proposition 9

The proof is the same as Proposition 4 but replacing β_l with $\overline{w}$.

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