A MODEL OF DEUNIONIZATION DRIVEN BY SKILL BIASED TECHNICAL CHANGE

FERNANDO DE HOLANDA BARBOSA FILHO*

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Abstract

In this study I analyze how skill biased technical change(SBTC), union bargain power and institutions affect deunionization.

The results show that SBTC, union "effective" bargain power and legal and institutional changes can explain deunionization. SBTC explains deunionization because the increase in productivity towards the skilled workers increases their competitive wage above the union wage. Regarding, the union "effective" bargain power, an increase in union demands to extract more rents from firms, incentives firms to react strongly and avoid union existence to increase their profits. Legal and political institutional changes against unions cause deunionization because it increases the union formation costs.

Simulations based on the model support the findings described above.

Resumo

Este trabalho analisa como o avanço tecnológico viesado (ATV), o poder de barganha dos sindicatos e as instituições afetam a dessindicalização.

Os resultados mostram que o ATV, o poder de barganha efetivo e mudanças institucionais podem explicar a queda dos sindicatos.

*Fernando de Holanda Barbosa Filho is a researcher at IBRE (Brazilian Institute of Economics). This research is part of his Ph.D. thesis at NYU. The author thanks his advisor Gianluca Violante, Alberto Bisin, Fernando de Holanda Barbosa and Ana Luiza Barbosa for helpful comments. All

O ATV explica esta queda porque o aumento de produtividade dos agentes mais capacitados eleva o seu salário competitivo acima do salário do sindicato. Uma maior extração de renda, através do poder de barganha efetivo, incentiva a firma a mudar suas decisões de emprego para elevar seus lucros. Mudanças institucionais afetam os sindicatos através de um aumento nos seus custos de formação. Simulações do modelo dão suporte a estas conclusões.

Palavras-Chave: Dessindicalização, Poder de Barganha, Avanço Tecnológico Viesado.

Key Words: Deunionization, Union Bargain Power, Skill Biased Technical Change.

JEL: E24, J30, J51.

1 Introduction

Over the past two decades, the US and UK economies observed a fierce decrease in the rate of unionized workers related to the total of workers in the economy. In the late 70's, the rate of unionized workers was 30% in the U.S. while in 2000 it was only 14% (Farber and Western, 2000). Regarding the UK, this rate was above 55% and drops to below 30% in the same period (Machin, 2000, 2002).

The literature has been using three different hypotheses to explain this reduction of unionization.

The first one states that the fall of unionization is due to a change in the economy's composition towards the increase in the services sectors, where unions were not strong, and away from the industrial sectors, where unions were traditionally stronger (Dickens and Leonard, 1985). Farber and Krueger (1992) estimated that compositional effects can account for at most one quarter of this decline.

A second hypothesis relates this deunionization to changes in the legal and political system, moving away from unions. Key facts related to this are the 1981 air-traffic controller strike and the Reagan's labor board appointments in 1983 (Farber and Western, 2001) for the US and the Thatcher government in the UK.

The third one justifies the deunionization due to the action of market forces, which increase the tensions among the workers inside the unions and beyond its breaking point.

In this same period of analysis (the last two decades), there was an increase in the wage inequality in both countries. The ratio of the 90th to 10th percentile of male weekly wages was 2.7 and 2.4, in 1980, rising to 3.5 and 3.1 in 1990, in both US and UK, respectively.

Skill biased technical change(SBTC) is a well-accepted explanation for this increase in wage inequality. Katz and Murphy (1992) claim that SBTC combined with a smaller growth in the skilled workers' supply is the main cause in the increase in wage inequality. As unions are well recognized as wage compression agents, the drop in the unions can also account for some of the increase in this inequality during the period.

Acemoglu, Aghion and Violante (2001) analyze unions as rent-seeking agents imposing a contract on the firm or as efficiency-enhancing unions, where the union induces training to the workers, or provides insurance to themselves. Their study makes use of the skill biased technical change as the driving force that generates deunionization because it increases the outside option of skilled workers.

This paper contributes to the existing literature for the following reasons: 1) Presents a stochastic general equilibrium model that incorporates an endogenous union formation and union membership decision. 2) Joins two different hypotheses presented in the literature to explain deunionization: changes in the legal and political system and market forces through skill biased technical change. 3) Presents a new market force explanation: firms' reaction to union "effective" bargain power.

It is shown that the presence of SBTC, unions high "effective" bargain power and institutional changes against unions may cause deunionization. The former because the increase towards the skilled workers productivity increases their outside option above the wage paid by the union. The second due to the firms reactions against unions in order to increase their profits. And the latter because this changes increase union formation costs.

This paper is organized as follows: the next section presents the model. It starts describing the economy: the preferences, the endowment and the technology. Then I present the timing of the actions, describe the bargaining game between the firms and the union, solve the model and define the equilibrium. Section 3 shows some comparative statics of how skill bias technical change, union "effective" bargain power and legal and political institutional changes affect the union membership. Section 4 shows the algorithm used to solve the problem and also presents some simulations. Finally, section 5 sums up with the concluding remarks.

2 The Model

The present model incorporates a decreasing returns to scale (DRS) sector that interacts in a large economy. In this DRS sector, firms choose their level of employment competitively, taking the wages as given. The workers are divided in two distinct groups with different productivity: skilled and unskilled workers. Both groups supply labor inelastically.

A union exists when the total rents that it extracts from the firm is higher than a stochastic unionization cost c. This cost c can be interpreted as an institutional cost that unions face when they are being organized. Moreover, the workers may decide to join the union or not through the comparison between the outside option of the workers and the union wage. If their outside option is higher they do not join the union, otherwise they do.

2.1 Preferences, Endowment and Technology

Workers have a utility function given by $U(c)$ that has the usual properties: $U'(c) > 0$, $U''(c) < 0$ and the Inada conditions hold.

The economy is endowed with a continuum of workers N divided in two groups: skilled (N_s) and unskilled (N_u). Both groups supply 1 unit of labor inelastically. The skilled workers have a higher productivity than the unskilled.

The model represents a DRS sector that interacts in a larger economy. There is no storage technology. Therefore, the households have instantaneous utility given by: $U(c) = U(w)$.

The firms have a decreasing returns to scale technology given by a production function $F(n_s, n_u)$, where n_s represents the number of skilled workers used in production and n_u the number of unskilled workers. This production function has $F' > 0$ and $F" < 0$ in both arguments. I also assume that both workers are essential to production.

We assume that unions are coalitions of workers that bargain together for a unique wage. Basically, unions are rent extractors. They extract rents from the firms to the workers.

The unionization cost c is a random variable and is distributed by $G(c)$, where: $G_C(c) = \Pr(C \leq c)$. Each firm will face a different c, therefore we use the notation c_i to indicate the unionization cost faced by firm i for each worker that it employs. The total cost(C_i) faced by firm i is the following: $C_i = c_i.\left(n_s + n_u\right)$.

This unionization cost represents the institutional costs to organize a union[1]. Therefore, any institutional change designed to affect unions negatively reflects an increase in C.

2.2 Timing

The model has the following time: 1) Firms decide to enter the sector. 2) The unionization cost c_i is observed. 3) The hiring decision takes place. 4) Workers decide to form a union or not. 5) The bargain between the union and firm occurs. 6) Production and consumption take place.

We solve the model using backwards induction. It is assumed that the agents have perfect forecast. Our first analysis regards the bargaining between the firms and the unions. Once we know the wages negotiated by the unions, the agents decide their membership status in the union through the comparison of the competitive wages and the union wage.

The firms decide their level of employment with the knowledge that it can affect the union wage. Therefore, it incorporates this information in its maximization problem.

2.3 The bargain between the union and firm

The union can be formed if the rent extracted from the firm is higher than its random creation cost, C_i. Therefore, in order to analyze whether the rents are higher than the costs, one needs to describe the bargaining process and the possible outcomes.

There are two agents in this bargain: firms and unions. The latter represents the workers interests and aims to extract rents that increase the workers wages. The model presents a Nash bargain where the agents split-the difference of their "output ". In this kind of bargaining, the outside options are important because it affects the negotiations as threat points.

The outside option of the firm is to produce an output that gives a profit equal to $\gamma\pi\left(w_s, w_u\right)$, where $\gamma < 1$, i.e., once an agreement is not reached, the firm will suffer a loss $\left(1-\gamma\right)\pi\left(w_s, w_u\right)$. The outside option of the union is the wage amount that its members would receive if they were not members

[1] For example, organize elections, legal costs and so on.

of the union, i.e., the sum of the competitive wages paid in non-unionized firms.

Once negotiations break down, there are no further negotiations, and both agents leave with their outside options.

Definition 1: A union is a coalition of workers that bargains for the same wage $\widehat{w}$.

The bargain between the firms and the unions is a Nash bargain where the unions have a bargain power β and γ is the fraction of the profit that the firm can obtain in case of a failure in the negotiations.

$$\beta\left[F(n_s,n_u)-\widehat{w}\left(n_s+n_u\right)-\gamma\pi\left(w_s,w_u\right)\right]=(1-\beta)[\widehat{w}(n_s+n_u)-(n_s w_s+n_u w_u)] \tag{1}$$

If negotiations fail, the workers can impose a $(1-\gamma)$ loss on the firm. It can be viewed as a lack of effort to the workers or any externality that they can impose on the firm. Rearranging equation 1:

$$\widehat{w}=\frac{1}{(n_s+n_u)}\{[\beta(1-\gamma)\pi\left(n_s,n_u\right)]+n_s w_s+n_u w_u\} \tag{2}$$

The bargained wage (2) is the total competitive wage paid by a firm to its workers plus the rents extracted from the firms divided between the workers. The rent extracted is: $R=\beta(1-\gamma)\pi\left(n_s,n_u\right)$.

Equation 2 shows us that the higher the bargain power of the union, the higher the bargained wage. And the higher the punishment imposed on the firm (the lower γ), the higher the bargained wages. Therefore, we can call $\beta(1-\gamma)$ as the "effective union bargain power".

2.3.1 Bargain only with the unskilled worker

When the union bargains only for the unskilled workers, the bargained wage is:

$$\widehat{w}_u=w_u+\frac{1}{n_u}[\beta_u(1-\gamma_u)\pi\left(w_s,w_u\right)] \tag{3}$$

As can be seen in (3), the unskilled worker will always benefit joining the union because he receives a higher wage ($\widehat{w}$ or $\widehat{w}_u$) than the competitive one(w_u).

To have that, the bargained wage when all the workers join the union is bigger than the one when only unskilled workers decide to join the union. Therefore, the following condition has to be satisfied:

$$w_s \geq w_u + \frac{1}{n_s}[\frac{\beta_u(1-\gamma_u)}{n_u} - \frac{\beta(1-\gamma)}{n_s+n_u}] \quad (4)$$

When the bargained wage with both skilled and unskilled workers in the union is smaller than the one bargained by unskilled workers only, the unskilled workers will prefer to bargain alone[2].

2.4 Workers decision

The workers choose to join the union or not. They join the union whenever it gives them higher wages[3]. Therefore, the skilled and unskilled workers, face the following problem when deciding to be a union member or not:

$$\widehat{w} \geq w_s \quad (5)$$

$$\widehat{w} \geq w_u \quad (6)$$

The right hand side of equation (5) is higher than the one in equation (6), given that $w_s > w_u$. Therefore, there is a higher chance for the skilled worker not to join the union than for the unskilled.

2.5 Firms Optimum Employment Decision

As in this model the firms have perfect forecast of the union wage, they can take advantage of that in their objective function. Therefore, they replace the union wage in their profit function:

$$\widehat{\pi}(\widehat{w}) = F(n_s, n_u) - (n_s + n_u)\,\widehat{w} = [1-\beta(1-\gamma)][F(n_s, n_u) - n_s w_s - n_u w_u] \quad (7)$$

$$\widehat{\pi}(\widehat{w}) = \widehat{\pi}\,(w_s, w_u) = [1-\beta(1-\gamma)]\pi\,(w_s, w_u) \quad (8)$$

[2] Once we assume that $\beta_u < \beta$ and that $\gamma_u > \gamma$, the wage bargained with both type of workers will be higher than the one bargained only by unskilled workers.

[3] In the present model, the only benefit that unions offer is a higher wage.

As can be seen, this is the neoclassical profit function($\pi(w_s, w_u)$) scaled down by $[1 - \beta(1-\gamma)]$. This implies that when the firms maximize this function, their choice of employment will be the same one as the firms that do not interact with unions. But their profits are reduced.

As firms may operate under the presence of unions, they must choose their level of employment taking into account that firms' profits may be reduced. Therefore, depending on the union formation cost faced by the firm(c_i), it may choose different levels of employment. Thus, the choice of labor may depend on c_i, i.e., the firms will choose level of employment $(n_s(c_i), n_u(c_i))$.

2.5.1 The Problem

We can divide the employment decision in three different regions.

In region 1, no union can be formed because the cost is too high. In this region the employment decision is $\{n_s(c_i), n_u(c_i)\} = \{n_s^*, n_u^*\}$.

The second region is a region where the firm has an employment choice $\{\widehat{n}_s(c_i), \widehat{n}_u(c_i)\} \neq \{n_s^*, n_u^*\}$ that exclude unions because the costs are higher than the rents and gives a higher profit than $[1-\beta(1-\gamma)]\pi(w_s, w_u, n_s^*, n_u^*)$.

The third is the one where the firm maximizes its profit by choosing $\{n_s(c_i), n_u(c_i)\} = \{n_s^*, n_u^*\}$,because the unionization cost c_i is too low.

As can be noted, the choice of employment depends on the unionization cost c_i that is a random variable. Therefore, the employment choice$\{n_s, n_u\}$ is a function of c, $\{n_s(c_i), n_u(c_i)\}$.

In order to use the reasoning described above, let's define $\underline{c}$ and $\overline{c}$. The value $\overline{c}$ is the value of c_i such that $\beta(1-\gamma)\pi(w_s, w_u, n_s^*, n_u^*) = (n_s^* + n_u^*)c_i$. Therefore I have that:

$$\overline{c} = \frac{\beta(1-\gamma)\pi(w_s, w_u, n_s^*, n_u^*)}{(n_s^* + n_u^*)} \tag{9}$$

The value $\underline{c}$ is the one for which we have: $[1-\beta(1-\gamma)]\pi(w_s, w_u, n_s^*, n_u^*) = \pi(w_s, w_u, \widehat{n}_s(c_i), \widehat{n}_u(c_i))$ and at the same time we have that $\widehat{n}_s(c_i), \widehat{n}_u(c_i)$ maximize $\beta(1-\gamma)\pi(w_s, w_u, \widehat{n}_s(c_i), \widehat{n}_u(c_i)) = (\widehat{n}_s(c_i) + \widehat{n}_u(c_i))\, c_i$[4]. From this last equality we obtain $\underline{c}$:

[4]If $\widehat{n}_s(c), \widehat{n}_u(c)$ do not maximize $\beta(1-\gamma)\pi(w_s, w_u, \widehat{n}_s(c), \widehat{n}_u(c)) = (\widehat{n}_s(c) + \widehat{n}_u(c))\, c$, I have multiple combinations of $\widehat{n}_s(c), \widehat{n}_u(c)$ that make $[1-\beta(1-\gamma)]\pi(w_s, w_u, n_s^*, n_u^*) = \pi(w_s, w_u, \widehat{n}_s(c), \widehat{n}_u(c))$.

And more, the firm choice of $\widehat{n}_s(c) + \varepsilon, \widehat{n}_u(c) + \varepsilon$ would not necessarily maximize the firms profit, given c_i.

$$\underline{c} = \frac{\beta(1-\gamma)\pi(w_s, w_u, \widehat{n}_s(\underline{c}), \widehat{n}_u(\underline{c}))}{(\widehat{n}_s(\underline{c}) + \widehat{n}_u(\underline{c}))} \tag{10}$$

The problem of the firm is to choose $n_s(c), n_u(c)$ to $\max\{\pi(w), \pi(\widehat{w})\}$. We define $\pi(w)$ and $\pi(\widehat{w})$ in the following way:

$$\pi(w) = \max_{n_s(c), n_u(c)} \qquad \pi(w_s, w_u, n_s(c), n_u(c))$$

$$s.t. \quad \beta(1-\gamma)\pi(w_s, w_u, n_s(c), n_u(c)) \leq (n_s(c) + n_u(c))\, c$$

$$\pi(\widehat{w}) = \max_{n_s(c), n_u(c)} \qquad [1-\beta(1-\gamma)]\pi(w_s, w_u, n_s(c), n_u(c))$$

When firms are in region 1, they employ $n_s(c_i) = n_s^*$, $n_u(c_i) = n_u^*$ and make profits equal to $\pi(w_s, w_u, n_s^*, n_u^*)$. This happens because when $c_i > \overline{c}$ the constraint in $\pi(w)$ is not binding. Therefore, firms act in the same way as a competitive firm does[5].

In region 2, where $c_i \in (\underline{c}, \overline{c})$, the constraint in $\pi(w)$ is binding. Here, the employment choice depends directly on the value of c_i because the total rents that can be extracted by the union may be higher than its formation cost for some employment choice. For example, if a firm employs $(n_s(c_i), n_u(c_i)) = (n_s^*, n_u^*)$ we have that $R = \beta(1-\gamma)\pi(w_s, w_u, n_s^*, n_u^*) > (n_s^* + n_u^*)\, c_i$. Therefore, it is possible for the union to exist and extract rents from the firm. On the other hand, the best employment choice for the firm is to pick an $(\widehat{n}_s(c) + \varepsilon, \widehat{n}_u(c) + \varepsilon)$ that gives a profit level $\pi(w_s, w_u, \widehat{n}_s(c) + \varepsilon, \widehat{n}_u(c) + \varepsilon) > [1-\beta(1-\gamma)]\pi(w_s, w_u, n_s^*, n_u^*)$. And at the same time we have that $\beta(1-\gamma)\pi(w_s, w_u, \widehat{n}_s(c) + \varepsilon, \widehat{n}_u(c) + \varepsilon) < (\widehat{n}_s(c) + \widehat{n}_u(c) + 2\varepsilon)\, c_i$. In this region the firm chooses an employment that gives the higher possible profit. A consequence of this choice is that it excludes the possibility of union existence.

As can be seen in the latter case, the bigger is $\beta(1-\gamma)$, the union "effective" bargain power, the larger the loci of points that the firm can choose to avoid the unions and increase its profits. This is very intuitive because the more the union "hurts "the firm, the more the firm react.

[5] The competitive firms solve the following problem: $\max_{n_s, n_u} \pi(w_s, w_u) = F(n_s, n_u) - n_s w_s - n_u w_u$.

The standard solution of the above equation is the following:$w_s = F_1(n_s, n_u)$ and $w_u = F_2(n_s, n_u)$.

In region 3 we have that $c_i < \underline{c}$. Here, the firm maximizes its profits in the union's presence, because if it chooses $(n_s(\underline{c}), n_u(\underline{c}))$ that maximizes $\pi(w)$, the value obtained will be equal to $[1-\beta(1-\gamma)]\pi(w_s, w_u, n_s^*, n_u^*)$ by the definition of $\underline{c}$. Any value $c_i < \underline{c}$ that gives a solution to $\pi(w)$, $(n_s(\underline{c}), n_u(\underline{c}))$ will give a profit $\pi(w_s, w_u, \widehat{n}_s(c)+\varepsilon, \widehat{n}_u(c)+\varepsilon) < [1-\beta(1-\gamma)]\pi(w_s, w_u, n_s^*, n_u^*)$. The firm maximizes its profit by choosing the pair $(n_s(\underline{c}), n_u(\underline{c})) = (n_s^*, n_u^*)$ and obtain profits $[1-\beta(1-\gamma)]\pi(w_s, w_u, n_s^*, n_u^*)$.

2.6 Entry Decision

As this DRS sector is interacting in a larger economy, we have the following free entry condition:

$$\kappa = E_t[\pi(w_s, w_u)] \tag{11}$$

where κ is the entry cost of a new factory in the sector and E is the expectation taken over the possible realizations of the unionization cost.

Thus, the free entry condition(11) states that the expected profit in this DRS sector must equal to the cost that the entrant has to pay. It means that firms enter this sector while the expected return is higher than the entrance cost, κ. The right hand side of the above equation falls with the increase of m, the number of firms. The reduction in n_s, n_u per firm, caused by an increase in the number of firms, increases wages and then reduces the firm's profits.

2.7 Equilibrium

Definition 2: Given the stochastic process $G_C(c) = \Pr(C \leq c)$, an equilibrium in this economy is a price system $(\widehat{w}, w_s, w_u)$ and an allocation $(n_s(c), n_u(c), m)$ such that:

1) Firms maximize their profit choosing $(n_s(c), n_u(c))$ and workers act optimally deciding to be a member of the union or not.

2) Markets clear: $N_s = \sum_{i=1}^{m} n_s(c_i)$ and $N_u = \sum_{i=1}^{m} n_u(c_i)$.

3) m is the number of firms in the sector, i.e., the number of firms that satisfy the free entry condition, $\kappa = E_t[\pi(w_s, w_u)]$.

3 Comparative Statics

In this section, I study how skill biased technical change, union effective bargain power and institutional changes affects unions.

3.1 Skill Biased Technical Change

Skill biased technical change is an introduction of new technologies that increases the productivity gap between skilled and unskilled workers. Thus, when this new technology is introduced it gives wages advantages to the skilled workers. In the union context, this technology development gives productivity advantages to the skilled workers, who may wish not to join the unions due to the possibility of a better payment outside the union.

In order to see how this effect can happen, we will adopt the following nonseparable production function: $F\left(n_s, n_u\right) = An_s^{\alpha} n_u^{1-\alpha-\theta}$.

In this production function, an increase in A represents an increase in the total productivity and it affects both workers productivity in a similar way. However, one of the aspects of the skill biased technical change is the asymmetric effect that it has over the productivities of individuals with different skills. Skill biased technical change in this framework will be an increase in α.

How a change in technology affects the workers decision towards the unions? Using this production function, we obtain w_s, w_u and $\widehat{w}$. This gives us the following:

$$w_s = \alpha A n_s^{\alpha-1} n_u^{1-\alpha-\theta} \tag{12}$$

$$w_u = (1-\alpha-\theta) A n_s^{\alpha} n_u^{-\alpha-\theta} \tag{13}$$

$$\widehat{w} = \frac{1}{(n_s+n_u)}\{\beta(1-\gamma)[An_s^{\alpha} n_u^{1-\alpha-\theta} - n_s w_s - w_u n_u] + n_s w_s + n_u w_u\} \tag{14}$$

In order to analyze who joins the union, let's observe the net benefit of joining it. Let Z_i be the net benefit of worker $i = s, u$, where s denotes skilled and u denotes unskilled workers. The skilled net benefit:

$$Z_s = An_s^{\alpha} n_u^{1-\alpha-\theta}[\beta(1-\gamma)\theta - \alpha\frac{n_u}{n_s} + (1-\alpha-\theta)] \tag{15}$$

When $Z_s = 0$, we are able to obtain the α value that makes the skilled worker indifferent between being a member of the union or not[6].

$$\alpha^* = \frac{\phi_s(c)N_s}{\phi_s(c)N_s + \phi_u(c)N_u}\left[\beta(1-\gamma)\theta + (1-\theta)\right] \tag{16}$$

Now that we know the threshold value α^* let's study the behavior of Z_s for the different values of α.

$$\frac{dZ_s}{d\alpha} < 0 \Leftrightarrow 1 + \log\left(\frac{\phi_s(c)N_s}{\phi_u(c)N_u}\right)(\alpha - \alpha^*) > 0 \tag{17}$$

Therefore, once we have that 17 is satisfied, Z_s is positive before α^* and negative after[7].

Proceeding in a similar way with the unskilled worker we obtain Z_u.

$$Z_u = An_s^{\alpha}n_u^{1-\alpha-\theta}[\beta(1-\gamma)\theta + \alpha - (1-\alpha-\theta)\frac{n_s}{n_u}] \tag{18}$$

When $Z_u = 0$, we are able to obtain the α value that makes the unskilled worker indifferent between being in the union or not.

$$Z_u = 0 \Longrightarrow \alpha^{**} = \frac{1}{\phi_s(c)N_s + \phi_u(c)N_u}[\phi_s(c)N_s\,(1-\theta) - \phi_u(c)N_u\beta(1-\gamma)\theta] \tag{19}$$

Following the same steps for the unskilled worker we have:

$$\frac{dZ_u}{d\alpha} > 0 \Longleftrightarrow 1 + \log\left(\frac{\phi_s(c)N_s}{\phi_u(c)N_u}\right)(\alpha - \alpha^{**}) > 0 \tag{20}$$

Thus, once I know that (20) is satisfied, we have that as α increases, the net benefit of joining the union increases for the unskilled worker. This is due to the fact that as α increases, the competitive unskilled wage decreases.

Proposition 1 *Once the unionization cost is smaller than the rent extracted from the firm, the union is formed. Then there are 2 threshold values for α: α^* and α^{**}. Then, in order to have a union formed by skilled and unskilled workers, we need that $\alpha \in [\alpha^{**}, \alpha^*]$. When $\alpha > \alpha^*$, the union is formed only by unskilled workers.*

[6] The number of workers employed by firms that choose $n_i(c) = n_i^*$equals $n_i^* = \phi_i(c)N_i$.

[7] The number of workers employed by firms that choose $n_i(c) = n_i^*$equals to $n_i^* = \phi_i(c)N_i$.

3.2 Union effective Bargain Power

The share of the firms profits that unions extract during the bargain process is equal to $\beta(1-\gamma)$. Thus, it can be viewed as the "effective" union bargain power, while $[1-\beta(1-\gamma)]$ is the share of the profits that the firms obtain in the bargaining.

The effective bargain power affects unions in two different ways. The first effect is in the union formation, because $\beta(1-\gamma)$ affects $\underline{c}$ and through it the number of firms that are unionized, that is.

$$\frac{d\underline{c}}{d\beta(1-\gamma)} = [1-2\beta(1-\gamma)]\,\pi(w_s, w_u, n_s^*, n_u^*) \tag{21}$$

Equation (21) shows us that when $\beta(1-\gamma) > \frac{1}{2}$, an increase in $\beta(1-\gamma)$ decreases $\underline{c}$. On the other hand, when $\beta(1-\gamma) < \frac{1}{2}$, an increase in $\beta(1-\gamma)$ increases $\underline{c}$. Therefore, an increase in $\beta(1-\gamma)$ reduces unionization when the effective bargain power of the union is bigger than the firms. While an increase in $\beta(1-\gamma)$ increases $\underline{c}$ when the firm has a bigger effective bargain power[8].

The second effect is on the workers decision to be a union member or not. As the workers divide the total rents extracted among themselves, higher rents imply higher union wages. We can see this below:

The bargain power(β) and the "punishment" that the union can impose on firms $(1-\gamma)$ have a positive effect on the net benefit of joining a union for both workers[9].

With this in hands is easy to see that the "effective" union bargain power has the same positive impact.

$$\frac{dZ_i}{d\beta(1-\gamma)} > 0 \qquad i = s, u \tag{22}$$

3.3 Legal and Political Changes

In this model, legal and political changes with respect to unions are captured by the parameter C, that gives the highest possible unionization cost in the

[8] As unions only exist in firms where $c_i < \underline{c}$, a decrease in $\underline{c}$ decreases unionization and an increase in $\underline{c}$ increases unionization.

[9] However, the firms reaction against unions are stronger because a high $\beta(1-\gamma)$ causes a fierce reduction in its profits. Therefore, a high $\beta(1-\gamma)$ incentive skilled workers to join the union but affects union formation negatively.

distribution $G_C(c)$. It means that when we have a change in the legal and political institutions that make the "environment" more hostile to unions, the value of C goes up. The opposite happens if the change benefits unions.

Therefore, a change in legal and political institutions against unions may cause deunionization because an increase in C reduces the probability that $c_i < \underline{c}$, therefore reducing the number of unions.

4 Algorithm and Some Simulations

Due to the analytical difficulties of solving the problem described above, the use of computational methods is required. The algorithm used to solve it is described below.

Firstly, I assume that the wages values for the skilled and unskilled workers are given by w_{s0} and w_{u0}. Then, I solve the competitive firms problem and obtain the profits $\pi(n_s^*, n_u^*)$, which are used to form the three different regions previously described.

Then, I draw the unionization cost c_1 designed for the first firm in order to find in which of the three regions this firm is in.

Based on this firm's problem, I observe whether the total labor demand is equal to the total labor supply. If I have an excess demand for labor, the wage must increase. If I have an excess supply of labor, the wage decreases. Therefore the wages change until the labor market for skilled and unskilled workers clears.

If the profit obtained is greater than the entry cost, another firm entries and receives its unionization cost c_2. Then, I solve the problem of the two firms and change wages until the skilled and unskilled labor markets clear. After that, I verify if the expected profit is higher than the entry cost. If it is higher, another firm will enter and the procedure continues in the same way, until the point in which that entry cost is higher than the expected profits.

It is important to note that the values that the unionization cost c_i take in the region 2, where the firm can increase its profit by changing the labor employment in order to avoid the union existence, are important in this process, because they will determine the profit of that firm.

4.1 Functional Forms

I adopt the same production function used in the previous section: $F(n_s, n_u) = An_s^{\alpha} n_u^{1-\alpha-\theta}$. With this production function, I have that both types of workers are essential to production, as required before. The degree of diminishing returns to the plant level is represented by θ.

The relative productivity between skilled and unskilled workers is represented by α. As α increases, the skilled worker increases its productivity gap to the unskilled.

It is also necessary to choose a distribution for the stochastic process that generates the unionization cost c_i. The uniform distribution is the one used. More specifically we use a uniform distribution in the interval zero, capital c, i.e., $U \,\tilde{}\, [0, C]$.

4.2 Calibration and Simulations

In order to perform the simulations, I need to set values to the parameters A, C, β, γ, α and θ.

The parameter θ that represents the degree of diminishing returns is set to be equal to 0.15.

The parameter A, that represents total factor productivity, is set equal to 80. This choice was made based on the total factor productivity obtained from the BLS website for the late 70's, that is around 80.

The total number of skilled and unskilled workers is the same and sets equal to 400, $N_s = N_u = 400$.

We assume that the unionization costs are drawn from a uniform distribution between zero and C. In order to study the impact of changes in the legal and political institutions on unionization, we choose 2 different values for C. First I set $C = 1.1$. This value of C gives us a rate of unionized workers around 35% of the total number of workers. Then, I make $C = 2$ in order to see the impact of a change in legal and political institutions against unions.

Instead of setting different values of β and γ, I set three different values of $\beta(1-\gamma)$, that is the fraction of firms profit that the union can extract. The parameter $\beta(1-\gamma)$ is set equal to $\frac{1}{3}$, $\frac{1}{2}$, and $\frac{2}{3}$. These three different values are used to analyze how the unions rent extraction can affect the unionization rate.

The variable that measures skill biased technical change is α. I start the study using $\alpha = 0.425$, that gives equal relative productivity between skilled and unskilled workers, and change it until $\alpha = 0.5$.

The entry cost κ is set in order to have a number of firms equal to 20 ($m = 20$) for all the values of alpha. We run the program 100 times to obtain some "consistence" because the results depend on the draws c_i that come from an i.i.d. uniform distribution. Doing this, we have a total of 2000 draws of c. To avoid "extra" stochastic effects of the draws in the results, we use the same 2000 unionization cost values(c) to the different values of α. The displayed results are the average of the wages($w_s, w_u, \widehat{w}, \widehat{w}_u$) and unionization rates(UR) obtained during the 100 times that the program ran. The simulations results are displayed in the tables below.

Table 1: Simulations results for $\beta(1-\gamma) = \frac{1}{3}$ and $C = 1.1$.

	w_s	w_u	$\widehat{w}$	$\widehat{w}_u$	UR
$\alpha = 0.425$	26.793	26.793	28.372	-	36.20%
$\alpha = 0.44$	27.637	25.954	28.375	-	36.20%
$\alpha = 0.45$	28.199	25.391	28.380	-	36.20%
$\alpha = 0.4625$	28.901	24.690	28.393	27.876	17.94%
$\alpha = 0.47$	29.322	24.270	28.403	27.463	17.90%
$\alpha = 0.48$	29.880	23.711	28.419	26.915	17.84%
$\alpha = 0.49$	30.440	23.151	28.438	26.367	17.84%
$\alpha = 0.50$	30.999	22.592	28.461	25.820	17.82%

As can be observed, the skilled worker competitive wage (w_s) has a positive relation with α while the unskilled's one (w_u) has a negative relation. This result is the standard one, because an increase in α increases the marginal productivity of the skilled worker and decreases the unskilled's one.

The union wage bargained when both workers are in the union($\widehat{w}$) is very stable, varying very little in all tables. On the other hand, if the skilled workers are not part of the union, we have that the union wage $\widehat{w}_u$, has a negative relation with α. This is due to the fact that the wage bargained $\widehat{w}_u$ equals the unskilled competitive wage plus the division of the rents extracted from the firm. Therefore, it captures all the variation in the unskilled competitive wage. Moreover, the union wage earned by the unskilled if the skilled workers do not join the union is lower than the wage bargained by a union formed by both types of workers[10].

[10] This difference can be even higher if we drop the assumption that the bargain power of the union is the same with and without the skilled workers as members, $\beta = \beta_u$, and that the punishment by the union is also the same, $\gamma = \gamma_u$.

The rate of unionized workers remains pretty stable with any change of alpha until the threshold value α^*. After this value, the rate of unionized workers drops heavily, because the skilled workers leave the unions. This result indicates the kind of phenomena that were previously expected: skill biased technical change causes deunionization because the skilled workers do not benefit joining unions when $\alpha > \alpha^*$.

Table 2: Unionization Rates for different $\beta(1-\gamma)$ and C.

C	1.1	1.1	1.1	2
$\beta(1-\gamma)$	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{2}{3}$	$\frac{1}{3}$
$\alpha = 0.425$	36.20%	37.07%	22.75%	17.28%-
$\alpha = 0.44$	36.20%	37.07%	22.75%	17.28%
$\alpha = 0.45$	36.20%	37.07%	22.75%	17.28%
$\alpha = 0.4625$	17.94%	32.59%	22.74%	17.28%
$\alpha = 0.47$	17.90%	18.93%	22.74%	8.54%
$\alpha = 0.48$	17.84%	18.20%	22.73%	8.51%
$\alpha = 0.49$	17.84%	18.16%	11.12%	8.49%
$\alpha = 0.50$	17.82%	18.09%	11.07%	8.46%

Comparing the results under the assumption of 3 different rent extractions values($\beta(1-\gamma)$), equals to $\frac{1}{3}$, $\frac{1}{2}$ and $\frac{2}{3}$, allow some interesting conclusions. First, the higher the amount of rents that can be extracted, the stronger is the firm's reaction. It can be seen through the difference between unionization rates with values: $\frac{1}{3}$ and $\frac{2}{3}$. In this exercise, this difference is around 14% for low $\alpha' s$ and drops to around 6% for high $\alpha' s$. Therefore, a lower rent extraction by the union helps to increase the rate of unionized workers.

On the other hand, with a higher rent extraction the unions are more able to "resist" to deunionization caused by the skill biased technical change. It can be seen in the fact that when we have $\beta(1-\gamma) = \frac{1}{3}$, just after $\alpha = 0.45$ the skilled workers left the union; when we have that $\beta(1-\gamma) = \frac{2}{3}$ the skilled workers leave the union only when α is above 0.48. This fact was shown in the comparative statics section where we had that: $\frac{dZ_s}{d\beta} > 0$ and $\frac{dZ_s}{d(1-\gamma)} > 0$[11].Therefore, we can conclude that when the rent extraction is very high the unions are able to keep the skilled workers in the union even in the presence of a huge productivity gap between skilled and unskilled workers.

Comparing the first and last columns in table 2 allow us to see the impact if changes in legal and political institutions against unions, that in this

[11]As here we are studying the changes in unionization rate when $\beta(1-\gamma)$ changes, we can see that: $\frac{dZ_s}{d\beta(1-\gamma)} > 0$.

framework implies an increase in the value C. As can be observed comparing the unionization rates(UR) in both tables the increase in C from $C = 1.1$ to $C = 2$ causes a fierce decrease in the rate of unionized workers.

It drops from around 37% to only around 17% for low $\alpha's$ and from almost 18% to only roughly 8.50% for high $\alpha's$[12]. Then, is this framework changes in the legal and political system affects unionization.

The fact that the bargained wage $\widehat{w}$ is very stable and the results that also show a stable unionization rate when α varies depend heavily on the assumption that the number of skilled and unskilled workers are the same, $N_s = N_u$. Therefore, it is important to make some remarks. The unionization rate (UR) and the union wage($\widehat{w}$) are steady across $\alpha's$ only because the above assumption. If the number of unskilled workers were bigger than the number of skilled workers, both would decrease with increases in alpha[13]. This would imply that as α increases, the rate of unionized workers(UR) would drop gradually and also the union wage ($\widehat{w}$). Therefore, some sensitivity analysis with respect to N_s and N_u are to be pursued as possible future extensions.

5 Conclusion

This study describes a Stochastic General Equilibrium Model, where a DRS sector interacts in a larger economy and can be affected by unions. Firms react to the possible presence of unions by changing their employment decisions in order to maximize their profits that are negatively affected by unions. Unions are formed when firms best response is to employ the neoclassical amount of labor. Therefore, unions extract rents from the firms and divide them among their members paying a unique wage. The unions are formed only when the random cost of forming a union is smaller than the rents that can be extracted.

Once the unions are formed, we analyze how SBTC affects unionization rate. We find out that the skilled workers choose not to join the union

[12] Low $\alpha's$ are the α values before skill biased technical change affects the skilled workers decision towards unions. And high $\alpha's$ are for α values in which the skilled workers are not in the unions anymore.

[13] The fact that the union wage would drop with α can be observed in $\frac{d\widehat{w}}{d\alpha} = \frac{A(\phi_u(c)N_u)^{1-\theta}}{2(\phi_s(c)N_s+\phi_u(c)N_u)}\left(\frac{\phi_s(c)N_s}{\phi_u(c)N_u}\right)^{\alpha}\log\left(\frac{\phi_s(c)N_s}{\phi_u(c)N_u}\right)$, that is smaller than zero if $\phi_u(c)\,N_u > \phi_s(c)\,N_s$. Where $n_i^* = \phi_i(c)\,N_i$ is the number of workers i that are members of unions.

depending on the magnitude of the increase in their productivity. Regarding the unskilled workers, they will always join the union once a union is formed. If the skilled workers do not join the union, the unskilled workers will receive a wage smaller than the one they would receive if the skilled workers were union members. But this wage is still higher than the unskilled competitive one. Therefore, when skilled workers decide not to be union members, there is an increase in the wage inequality.

I also conclude that the unionization rate is affected by union "effective" bargain power. The rate of unionized workers is higher when union "effective" bargain power is lower. This happens because this lowers rent extraction by unions and thus firms response against unions is not so strong. On the other hand, with a lower "effective" bargain power unions are more "exposed" to SBTC, that can drive skilled workers away from unions easily.

Finally, we show that a change in institutional and political institutions that make the environment more hostile against unions, reduces the rate of unionization. This happens because this institutional changes make unions formation more expensive, reducing their chance to exist.

Therefore, three forces can help to explain the drop in unionization in this paper. The first one is the reaction of skilled workers in the presence of SBTC. The second one is the firms' response against unions. The firms' response is stronger when the unions try to extract higher rents, what causes a low rate of unionized workers because of lower union formation. The third one is a change in the legal and political institutions against unions because it increases the union formation costs, decreasing the number of unions.

As pointed out before, some sensitivity analysis of the simulations seems as a natural and necessary extension of the present work. Also a dynamic model is a future and challenging extension of the present model. It would enrich the analysis about the relationship between SBTC, rent extraction, institutional changes and deunionization.

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