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RESUMEN
Dada una economía con producción, definimos un juego de sindicatos considerando el comportamiento estratégico de éstos en la oferta de factores de producción que están bajo su control. Nos referimos a los equilibrios de Nash de este juego como Equilibrio de Sindicatos. Analizamos, en primer lugar, situaciones en las que el desempleo de factores puede ser sustentado como un Equilibrio de Sindicatos, con la conclusión de que el nivel de desempleo de los factores, en el Equilibrio de Sindicatos, depende de condiciones de naturaleza tecnológica. Apuntamos, por tanto, a una fuente de desempleo que difiere de las que han sido sugeridas por la literatura. A continuación probamos un resultado límite que muestra que a medida que el poder de negociación (de manipulación de ofertas) de los sindicatos disminuye, la cantidad de desempleo de factores también lo hace, llegando, en el límite, a ofertarse todo de todos los factores. En este caso límite el Equilibrio de Sindicatos es una asignación walrasiana.

Palabras clave: Juego de Sindicatos, desempleo, equilibrio walrasiano, manipulabilidad.

ABSTRACT
Given a production economy, we define a trade union game by considering strategic behavior on factor supplies. We refer to the Nash equilibria of this game as trade union equilibria. First we analyze situations under which unemployment of factors are supported as trade union equilibria. The degree of unemployment depends on technological conditions. In this line, we suggest a source of unemployment which differs from the usual sources provided in the related literature. Then, we state a limit result which shows that when the market power of trade unions decreases the corresponding sequence of trade union equilibria converges to the walrasian equilibrium, that is, to full employment of factors.

Keywords: Trade Union Games, unemployment, walrasian equilibrium, manipulability.
JEL Classification: D51, C72

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Union Games: Technological Unemployment*

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Abstract. Given a production economy, we define a trade union game by considering strategic behavior on factor supplies. We refer to the Nash equilibria of this game as trade union equilibria. First we analyze situations under which unemployment of factors are supported as trade union equilibria. The degree of unemployment depends on technological conditions. In this line, we suggest a source of unemployment which differs from the usual sources provided in the related literature. Then, we state a limit result which shows that when the market power of trade unions decreases the corresponding sequence of trade union equilibria converges to the walrasian equilibrium, that is, to full employment of factors. We also provide some examples which illustrate the main results.

Journal of Economic Literature Classification: D51, C72

Key words: Trade union games, unemployment, walrasian equilibrium, manipulability.

1 Introduction

Manipulability of the walrasian mechanism has been thoroughly studied in the literature, specially for pure exchange economies. Different approaches to manipulability have been considered, dealing with both cooperative and non cooperative solutions. Actually, it is well known that by considering misrepresentation either of endowments or preferences or, more generally, demands, agents may have an incentive to deviate from a competitive behavior and manipulate prices in their own benefit (see, for example, Hurwicz (1972) Roberts and Postlewaite (1976), Postlewaite (1979), Otani and Sicilian (1982, 1990), Safra (1985), Yi (1991), Jackson and Manelli (1997), Hervés, Moreno and Páscoa (1999)).

In production economies manipulability of the walrasian mechanism has a particular significance in the light of the theory of imperfect competition. One may hope to extract from manipulability results and examples some answers to the reasons for non full employment of factors and, in particular, some contributions to the long standing debate on the sources of unemployment of labor.

For a long time economists have been concerned with the issue of unemployment, trying to find reasons for such a situation. In a theoretical sense, the reason why there is unemployment is that the labor market does not clear. The question can be rephrased so that we can ask why the labor market does not clear or what prevents the labor market from clearing. In fact, the literature dealing with this point poses the following question: What are the forces and conditions in the labor market that prevent real wages to fall down? Although there is no simple answer for this question, the long standing debate regarding unemployment has focused around several reasons commonly given as to why the labor market does not clear. These reasons have been captured essentially by the following theories: efficiency wages theory, sticky wages, minimum wages laws, training costs and imperfect information. To be more precise:

> Firms may not find profitable to decrease wages to market clearing levels because wages are related to marginal productivities through the effort of workers (see Solow (1979) and Shapiro and Stiglitz (1984)).
>
> Firms may find not possible to decrease wages because of different arrangements in the bargaining process due to long term relations with workers. Depending on this relationship, workers and firms may arrange wage schemes that guarantee minimum utility levels (see Leontieff (1946), Barro (1977),

Hall (1980 and 1982)), or some kind of insurance to protect workers from fluctuations in the economic activity (see Azariadis (1975), Baily (1974) and Gordon (1974)). It could also be the case that not all workers are represented in the bargaining process; in this case only those workers with a long term relationship with the firm would decide, together with the firm, the level of employment of temporary workers (see Oswald (1993), Gottfries (1992), Blanchard and Summers (1986) and Gregory (1986)).

Institutions could play a role transforming into long term unemployment what should have otherwise been a reaction to a short term shock (see Bean (1994), Siebert (1997), Ljungvist and Sargent (1998), Ball (1999) and Blanchard and Wolfers (1999)).

Differences in the technical skills required to fill a vacancy with respect to those endowed in a worker asking for a job (see Pissarides (1985), Howit (1988), Mortensen (1986), Hosio (1990), and Mortensen and Pissarides (1999)).

Finally, one may also think that agents do correspond to those in a walrasian economy. In this case all unemployment we observe is due to temporary changes of job and it is simply a matter of time to adjust to market clearing conditions.

The aim of this paper is to provide a different source for unemployment situations to those proposed in the literature taking into account strategic behavior (that is, deviations from the competitive or price-taking behavior) and manipulation of prices. For this, we consider a production economy where the endowments of factors are controlled by different trade unions. These trade unions behave strategically on the supplies of inputs. Then, a non-cooperative solution is introduced which we refer to as trade union equilibrium. Thus, we analyze situations under which unemployment of factors are supported as trade union equilibria.

More precisely, in this paper we consider a model of production economy in which the number of factors is finite and can be used only to produce a consumption commodity using a technology that exhibits constant returns to scale. Total initial endowments of factors are controlled by a finite number of different trade unions. These trade unions behave strategically by supplying an amount of inputs which may differ from the real initial endowments of factors with the objective of maximizing the total income of factors under their control. Then, each strategy profile defines a new economy which is equal to the real one except for the initial amount of inputs which is given by the corresponding strategy profile. Thus, in a first stage, unions declare the amount of inputs to be supplied in the production process, and in a second stage the walrasian mechanism generates the price vector for the economy created by the unions. In this line, we associate to a production economy a walrasian endowment game which we refer to as trade union game whose Nash equilibria are called trade union equilibria.

We show that the conditions under which trade union equilibria lead to non full employment of factors are of technological nature. For this kind of unemployment to exist it is required a certain degree of complementarity of factors in the production function. If there is no such complementarity, the walrasian equilibrium with perfect disclosure of total endowments will dominate the solution of our model. Actually, non full employment of factors could arise as a consequence of the awareness of the owners of a factor about the impact that a full supply of the factor can have on prices. Indeed, technology and the awareness of unions about the impact on prices of undercutting factor supplies are the two key ingredients of this paper.

Following the approach above, we point out that the unemployment situations depend on the ownership of factors, on the fact that factors have a specific technical complementarity and on the market power that the different trade unions might exert to manipulate the factors prices under their control. Then, we conclude that the unemployment situations depend crucially on technological conditions and the manipulation of prices of factors. Therefore, we suggest a source of unemployment which differs from the usual sources provided in the literature.

In particular, trade unions do not declare the total initial endowments of inputs when they have an incentive to deviate from a competitive behavior, that is, when they have incentive to manipulate prices. Actually, it is known that manipulation of prices and strategic considerations are important in small economies where economic agents may have strong incentives to adopt a non competitive behavior.

On the other hand, there are results which point out that the individual incentive to deviate from a price taking behavior in finite pure exchange economies diminishes as the economy become large. In fact, Roberts and Postlewaite (1976) pioneering work pointed out that the individual incentive to manipulate equilibrium prices vanishes as the number of agents in the economy increases infinitely. Subsequently, Otani and Sicilian (1982, 1990) analyzed whether true walrasian allocation in exchange economies with a large number of agents can be claimed to be sufficiently robust against strategic manipulations of agents' demand maps. Later, Makowski, Ostroy and Segal (1995) identified conditions on the richness of the domain of preferences that allow to characterize efficient and incentive compatible mechanisms as perfectly competitive. Jackson and Manelli (1997) identified conditions on the beliefs of agents under which all market-clearing prices and allocations of the reported economy approximate the competitive equilibria of the true economy. More recently, Lahmandi-Ayed (2001) considers the concept of oligopoly equilibrium, due to Codognato and Gabszewicz (1991,1993) and Gabszewicz and Michel (1997), and shows that the symmetric oligopoly equilibria in pure strategies lead to the competitive equilibrium as the economy is replicated, under uniqueness of the Walras price equilibrium for any strategy profile.

The conclusion that may be inferred from this literature, dealing with limit results for pure exchange economies, is that when the number of competitors is large enough the ability to manipulate prices can be considered negligible. Following this kind of approach, we obtain a limit result for the production economy that we consider in our model. Precisely, we show that when the market power of trade unions decreases the corresponding sequence of trade union equilibria converges to the walrasian equilibrium, that is, to full employment of factors. For this, we consider a sequence of economies by replicating the initial different trade unions that share the total initial amounts of the inputs. Considering again the strategic behavior of trade unions on the supply of inputs we define a trade union game associated to each economy in which the trade unions are replicated. Our limit result points out the intuitive idea that when a trade union becomes "smaller" the market power diminishes. Actually, the benefit that a trade union can get by behaving strategically goes to zero as the size of the trade union decreases.

The remainder of this paper is organized as follows. In Section 2, we state the model of a simple production economy. In Section 3, we define a trade union game associated to the production economy and we define the notion of trade union equilibrium. In Section 4, we show the main results. In Section 5, we present several examples which illustrate the results stated in this paper.

2 A Walrasian Production Economy

Consider a production economy $\mathcal{E}$ with a finite number n inputs, or factors used to produce a single commodity considered as numeraire.

Production of the consumption good takes place by means of a technology represented by the production function $f : \mathbb{R}^n_+ \to \mathbb{R}_+$ with constant returns to scale.

We assume that f is twice continuously differentiable and $f(0) = 0$ (i.e., positive amount of output requires positive amount of some of the inputs).

There are a finite number m of consumers in the economy $\mathcal{E}$. Each consumer i is characterized by an initial endowment of factors ω^i and a preference relation $\succeq_i$ over the consumption of the unique commodity which is produced in this economy and is the numeraire. We assume that preferences are continuous and strictly monotone.

Let $\overline{z} = (\overline{z}_1, \ldots, \overline{z}_n)$ be total endowments of the n factors in the economy $\mathcal{E}$, where $\overline{z}_k = \sum_{i=1}^{m} \omega_k^i$. We assume that $\overline{z} \gg 0$. These amounts of inputs have a use only as production factors (i.e., consumers do not wish to consume them).

The production economy $\mathcal{E}$ is given by

$$\mathcal{E} = \left(\omega^i, \succeq_i, i = 1, \ldots, m; f : \mathbb{R}_+^n \rightarrow \mathbb{R}_+\right).$$

Note that in a Walrasian or competitive equilibrium factors are supplied inelastically, that is, there is full employment of every factor; and, therefore, competitive equilibrium prices are determined by the productive sector.

Then, a competitive equilibrium in the economy $\mathcal{E}$ is completely defined by a price system $p^* = (p_1^*, \ldots, p_n^*)$ of factors which is given by

$$p_k^* = \frac{\partial f}{\partial z_k}(\overline{z}) = f_k(\overline{z});$$

that is, in a competitive equilibrium each factor is paid its marginal productivity evaluated at the total endowments of inputs $\overline{z}$. Note that the competitive equilibrium prices depends on the total amount of factors $\overline{z}$ and not on the precise distribution of such inputs among consumers.

3 Trade Union Equilibria

Consider the production economy $\mathcal{E} = \left(\omega^i, \succeq_i, i = 1, \ldots, m; f : \mathbb{R}_+^n \rightarrow \mathbb{R}_+\right)$, described in the previous Section, with n factors used to produce a single commodity considered as numeraire. In this Section, we associate a game to the production economy $\mathcal{E}$ and we define the non-cooperative solution of trade union equilibrium.

Consider that there are H different trade unions and consumers supply inelastically factors to them. We say that the union h controls the factor j if this union has at its disposal, either totally or partially, the initial endowment of factor j, that is, union h has a positive available amount of factor j. Let $F_h \neq \emptyset$ denote the set of factors controlled by the trade union h and let H_j denote the set of unions which control the factor j, i.e., the set of unions which own a positive amount of factor j. Note that $j \in F_h$ if and only if $h \in H_j$.

Given a trade union h and a factor $j \in F_h$ let $\overline{z}_j^h$ denote the amount of input j owned by the union h. Since every consumer supplies inelastically her endowment of factors to some union, we have that $\sum\limits_{h \in H_j} \overline{z}_j^h = \overline{z}_j$ for every input $j = 1, \ldots, n$; and then $\bigcup\limits_{h=1}^{H} F_h = \{1, \ldots, n\}$. On the other hand, note that since the cardinality of the sets H_j can be greater than one, we consider the possibility that a factor can be controlled by more than one union. Hence, every factor is controlled by at least one trade union and each trade union may control one or more factors of production.

Remark. If $\{F_h | h \in \{1, \ldots, H\}\}$ is a partition of $\{1, \ldots, n\}$ (and then $H \leq n$), we have the particular case in which $F_h \bigcap F_{h'} = \emptyset$, that is, every factor is controlled by only one trade union, and every trade union may control more than one factor of production. If in addition $H = n$, we have the situation where every union controls only one factor which is also a particular case within our setting.

Consider that the objective of trade unions is to maximize the total payments to their factors. Then, trade unions may have an incentive to behave strategically and manipulate factor prices in their benefit. In other words, union may have a strategic incentive to announce not the total amount of factors under their control but only a fraction and manipulate prices trying to increase the total income share of their available factors.

The strategic behavior of the different trade unions leads to define the following game $\mathcal{G}$:

The players are the H different unions. The strategy set S_h for each union h is given by:

$$S_h = \left\{\theta_k^h, \text{ with } k \in F_h \text{ and } 0 \leq \theta_k^h \leq \overline{z}_k^h\right\}$$

When trade unions declare a strategy profile $\theta = (\theta_k^h, k \in F_h, h \in \{1, \ldots, H\})$, they create a new economy $\mathcal{E}_{z(\theta)}$ which coincides with the real economy $\mathcal{E}$ except for the total amount of inputs that is given by $z(\theta) = (z_j(\theta))_{1=1}^n$, where $z_j(\theta) = \sum\limits_{h \in H_j} \theta_j^h$, instead of $\overline{z} = (\overline{z}_1, \ldots, \overline{z}_n)$.

Let $p(z(\theta))$ denote the competitive equilibrium prices for the economy $\mathcal{E}_{z(\theta)}$, that is, $p_k(z(\theta)) = f_k(z(\theta))$ for every factor k; where f_k is the marginal product of factor k. Then, the payoff functions for trade unions are defined by their total income as follows:

$$\Pi_h(\theta) = \sum_{k \in F_h} p_k(z(\theta))\theta_k^h.$$

In this way, given the production economy $\mathcal{E}$, we have considered a trade union game $\mathcal{G}$ which is defined by the strategy sets S_h and the payoff functions $\Pi_h,\ h \in \{1, \ldots, H\}$.

Definition 3.1 *A Trade Union Equilibrium is a Nash Equilibrium for game $\mathcal{G}$.*

Therefore, a trade union equilibrium is an amount of the factors under the control of each union such that no trade union has incentive to change the supply of the inputs in order to get a greater payoff.

4 Main Results

Given a production economy $\mathcal{E}$ we have defined an associated trade union game $\mathcal{G} = (S_h, \Pi_h, h = 1, \ldots, H)$.

Note that the strategy sets S_h are compact and that the payoff function of each union is continuous. Therefore, applying Glicksberg's existence theorem (see, for example, Fudenberg and Tirole (1995)), we obtain the existence of trade union equilibria in mixed strategies for the game $\mathcal{G}$. However, we are interested in results addressing equilibria in pure strategies.

We use the following notation. Let θ be a strategy profile. We denote by θ_{F_h} the strategy profile restricted to F_h whereas θ_{-F_h} denotes the strategy profile restricted to the unions $h' \neq h$. We write $\theta = (\theta_{F_h}, z_{-F_h})$, where $\theta_{F_h} = (\theta_j^h, j \in F_h)$ represents the amounts of factors which are supplied by the union h via the strategy profile θ and θ_{-F_h} includes the corresponding amounts of factors which are supplied by the other different unions.

The next result states sufficient conditions for existence of pure strategy trade union equilibria.

Theorem 4.1 *Assume that, for every trade union h and every θ_{-F_h}, the function $\Pi_h(\theta_{-F_h}, \cdot)$ is quasi-concave. Then, the set of trade union equilibria is non empty.*

Proof. The strategy set S_h is non empty, convex and compact for every h. Since the functions $\Pi_h(\theta_{-F_h}, \cdot)$ are continuous and quasi-concave, the best response correspondences of the different unions take closed and convex values. It remains to apply Kakutani's fixed point theorem to the correspondence whose fixed points coincide with the set of trade union equilibria.

Q.E.D.

Remark. Let us write $F_h = \{j_1, \ldots j_{n(h)}\}$ and Let $D_r^h(\cdot)$ denote the bordered Hessian determinants of $\Pi_h(\theta_{-F_h}, \cdot)$ for $r = 1, \ldots card(F_h)$, where $card(F_h) = n(h)$ is the number of factors controlled by the union h, defined as follows:

$$D_r^h(\cdot) = \begin{vmatrix} 0 & \frac{\partial \Pi_h(\theta_{-F_h}, \cdot)}{\partial \theta_{j_1}^h} & \cdots & \frac{\partial \Pi_h(\theta_{-F_h}, \cdot)}{\partial \theta_{j_r}^h} \\ \frac{\partial \Pi_h(\theta_{-F_h}, \cdot)}{\partial \theta_{j_1}^h} & \frac{\partial^2 \Pi_h(\theta_{-F_h}, \cdot)}{\partial \theta_{j_1}^{h2}} & \cdots & \frac{\partial^2 \Pi_h(\theta_{-F_h}, \cdot)}{\partial \theta_{j_1}^h \partial \theta_{j_r}^h} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{\partial \Pi_h(\theta_{-F_h}, \cdot)}{\partial \theta_{j_r}^h} & \frac{\partial^2 \Pi_h(\theta_{-F_h}, \cdot)}{\partial \theta_{j_r}^h \partial \theta_{j_r}^1} & \cdots & \frac{\partial^2 \Pi_h(\theta_{-F_h}, \cdot)}{\partial \theta_{j_r}^{h2}} \end{vmatrix}$$

Recall that a necessary condition for $\Pi_h(\theta_{-F_h}, \cdot)$ to be quasi-concave is that $(-1)D_r^h(x) \geq 0$ for $r = 1, \ldots, n(h)$ and all $x \in \mathbb{R}_+^{n(h)}$; and a sufficient condition for $\Pi_h(\theta_{-F_h}, \cdot)$ to be quasi-concave is that $(-1)D_r^h(x) > 0$ for $r = 1, \ldots, n(h)$ and all $x \in \mathbb{R}_+^{n(h)}$.

Since the partial derivatives above are given in terms of the partial derivatives of the production function, we conclude that the quasi-concavity of the payoff functions is implied by the corresponding properties of the technology.

Note also that since the sum of quasi-concave function, in general, is not quasi-concave, the quasi-concavity of the function $p_j(z(\theta_{-F_h}, \theta_{F_h}))\theta_j^h$ on θ_{-F_h} for every $j \in F_h$ does not guarantee the quasi-concavity of the payoff function $\Pi_h(\theta_{-F_h}, \cdot)$. However, if $p_j(z(\theta_{-F_h}, \theta_{F_h}))\theta_j^h$ is concave on θ_{-F_h} for every $j \in F_h$, then the payoff function $\Pi_h(\theta_{-F_h}, \cdot)$ is also concave and, therefore, is quasi-concave.

Let us consider the particular case in which each union controls only one factor and each factor is controlled by only one union. In this case we can write a strategy profile as $\theta = (\theta_1, \dots, \theta_n)$ and $z(\theta) = \theta$. Thus, the payoff functions are given by $\Pi_h(\theta) = p_h(\theta)\theta_h$, with $h = 1, \dots, n$. We obtain that if $\dfrac{\partial^2 p_h(\theta)}{\partial \theta_h^2}\, \theta_h < 2\, \dfrac{\partial p_h(\theta)}{\partial \theta_h}$, then $\Pi_h(\theta_{-h}, \cdot)$ is a concave function and, therefore, is quasi-concave.

Taking into account this remark we conclude that the quasi-concavity of the payoff functions can be implied from the pointed out conditions, which actually are conditions required on the technology.

Next we provide necessary conditions for a profile θ to be a trade union equilibrium in terms of the elasticities of demand of factors. For it, let $\sigma_{i,j}$ denote the elasticity of p_i with respect to z_j, that is, $\sigma_{i,j}(\theta) = \dfrac{\partial p_i(z(\theta))}{\partial z_j}\, \dfrac{z_j(\theta)}{p_i(z(\theta))}$. Given a strategy profile $\theta = (\theta_k^h, k \in F_h, h \in \{1, \dots, H\})$ let $s_j^h(\theta) = \dfrac{p_j(z(\theta))\ \theta_j^h}{f(z(\theta))}$, that is $s_j^h(z)$ is the income share of factor j that union h receives when the factor supplies are given by the strategy profile θ. Finally, let $s_j(\theta)$ denote the total income share of factor j when the strategy profile is θ. Note that $s_j(\theta) = \dfrac{p_j(z(\theta))\ z_j(\theta)}{f(z(\theta))} = \sum_{h \in H_j} s_j^h(\theta)$,

Proposition 4.1 *Let θ^* be a trade union equilibrium such that $0 < \theta_j^{*h} < \overline{z}_j^h$ for every h and j (which implies $0 \ll z(\theta^*) \ll \overline{z}$). Then, for every trade union h we have that $\sum_{j \in F_h} \dfrac{s_j^h(\theta^*)}{s_k(\theta^*)}\, \sigma_{j,k}(\theta^*) = -1$ for every factor $k \in F_h$.*

Proof. The objective of every trade union h maximizes the payoff function

$$\Pi_h(\theta) = \sum_{k \in F_h} p_k(z(\theta_{F_h}, \theta_{-F_h}))\theta_k^h.$$

Then, the best response curve $\theta_{F_h}^*(\theta_{-F_h}) = \{\theta_k^{*h},\ k \in F_h\}$ for trade union h is implicitly given by

$$\sum_{j \in F_h} \frac{\partial p_j(z(\theta_{F_h}^*, \theta_{-F_h}))}{\partial z_k}\ \theta_j^{*h} + p_k(z(\theta_{F_h}^*, \theta_{-F_h})) = 0, \quad \text{for every } k \in F_h.$$

Equivalently $\sum_{j \in F_h} s_j^h(z(\theta_{F_h}^*, \theta_{-F_h}))\sigma_{j,k}(z(\theta_{F_h}^*, \theta_{-F_h})) = -s_k(z(\theta_{F_h}^*, \theta_{-F_h}))$ for every factor k controlled by the trade union h when $\theta_k^{*h} < \overline{z}_k^h$.

Therefore, the equalities $\sum_{j \in F_h} s_j(\theta^*)\, \sigma_{j,k}(\theta^*) = -s_k(\theta^*)$ for every union h and every factor $k \in F_h$ are necessary conditions for all the interior trade union equilibria.

Q.E.D.

Note that the result above state necessary conditions for trade union equilibria where all factors are used but with unemployment of every factor.

Non full employment of factors can be supported as trade union equilibria when unions have an incentive to deviate from a competitive behavior and manipulate prices in their own benefit. Thus, following this approach, the degree of unemployment of factors depends crucially on the market power that unions may have to manipulate prices (with the aim to increase their income share of the factors under their control), which in turn depends on technological conditions.

It is well known that strategic considerations are important in small economies in the sense that economic agents can have strong incentives to manipulate prices by behaving strategically. On the other hand, a variety of limit results for pure exchange economies show that the individual incentive to behave strategically diminishes when the economy become large (see, for instance, Roberts and Postlewaite (1976), Otani and Sicilian (1982, 1990), Jackson and Manelli (1997), Codognato and Gabszewicz (1991, 1993), Gabszewicz and Michel (1997)).

Now our aim is to obtain a limit result for the production economy considered in this paper, which makes precise the intuitive idea that when the market power of trade unions becomes "smaller" the incentive to behave strategically diminishes and, therefore, in the limit full employment of factors is attained.

For it, consider a sequence of economies by replicating the initial H different trade unions. For each natural number r let $r\mathcal{E}$ be the economy with rH trade unions, indexed by (h, j). Each trade union (h, j) controls the factors belonging to F_h and is endowed with the same amount $\overline{z}_k^h$ of every factor $k \in F_h$. Then, in the economy $r\mathcal{E}$ there are r trade unions of type h endowed with the total initial amounts of the inputs controlled by union h in the economy $\mathcal{E}$. The production function in the economy $r\mathcal{E}$ depends on the aggregate amount of the n factors and is f, i.e., the same production function as in the initial economy $\mathcal{E}$.

Note that the competitive equilibrium prices for the economy $r\mathcal{E}$ are given by

$$p_k = \frac{\partial f}{\partial z_k}(r\overline{z}) = f_k(r\overline{z}) = f_k(\overline{z})$$

where the last equality follows from the homogeneity of degree zero of f_k (which is implied by the constant returns of scale). Therefore, the competitive equilibrium prices for any replicated economy $r\mathcal{E}$ are identical and coincide with the competitive equilibrium prices for the initial economy $\mathcal{E}$.

In each economy $r\mathcal{E}$, trades unions can behave strategically by announcing amounts of factors under their control, which differ from the real ones. That is, if $k \in F_h$, a trade union (h, j) can declare an amount of factor k which is less or equal than $\overline{z}_k^h$.

Considering this strategic behavior of trade unions on the supply of inputs, we define the game $r\mathcal{G}$ associated to the economy $r\mathcal{E}$ as follows:

The players are the rH trade unions. The strategy set S_h for each union (h, j) is given by:

$$S_{(h,j)}^r = S_h^r = \left\{\theta_k^r, \text{ with } k \in F_h \text{ and } \theta_k^r \leq \overline{z}_k^h)\right\}$$

Let us denote by $\theta_k^r(h, j)$, the amount of factor $k \in F_h$ supplied by the trade union (h, j) in the economy $r\mathcal{E}$. When trade unions declare a strategy profile $\theta^r = (\theta_k^r(h, j),\ h = 1, \ldots, H;\ j = 1, \ldots, r)$, they create a new economy $\mathcal{E}_{\theta^r}$ which, with regard to walrasian equilibrium prices, coincides with the economy $r\mathcal{E}$ except for the total amounts of the n different inputs that are given by $z(\theta^r) = (z_1(\theta^r), \ldots, z_n(\theta^r))$, where $z_k(\theta^r) = \sum_{j=1}^{r} \sum_{h \in H_k} \theta_k^r(h, j)$, instead of $r\overline{z} = (r\overline{z}_1, \ldots, r\overline{z}_n)$. Let $p(z(\theta^r)) = (p_1(z(\theta^r)), \ldots, p_n(z(\theta^r)))$ denote the competitive equilibrium prices of factors for the economy $\mathcal{E}_{\theta^r}$, that is, $p_k(z(\theta^r)) = f_k(z(\theta^r))$ for every factor k; where f_k is the marginal product of factor k in the economy $r\mathcal{E}$. Then, the payoff functions for trade unions are defined by their total income as follows:

$$\Pi_{(h,j)}^r(\theta^r) = \sum_{k \in F_h} p_k(z(\theta^r))\theta_k^r(h, j).$$

In this way, for each production economy $r\mathcal{E}$, we have considered a trade union game $r\mathcal{G}$ which is defined by the strategy sets $S_{(h,j)}^r$, and the payoff functions $\Pi_{(h,j)}^r$ with $h = 1, \ldots, H$ and $j =, 1 \ldots, r$.

Definition 4.1 *A trade Union Equilibrium for the economy $r\mathcal{E}$ is a Nash Equilibrium for game $r\mathcal{G}$.*

We say that a trade union equilibrium θ^r in the economy $r\mathcal{E}$ is symmetric if $\theta^r(h, j) = \theta^r(h, j') = \theta^r(h)$ for every $j, j' \in \{1, \ldots, r\}$ and for every type h of trade unions.

That is, a symmetric trade union equilibrium is a trade union equilibrium in which unions of the same type supply the same amount of factors under their control.

We remark that, alternatively, the game $r\mathcal{G}$ can be described in the following way which is equivalent regarding equilibria:

There are H different types of trade unions and r unions of each type. The r unions of type h have to decide the supply of factors belonging to F_h, that is, the supply of the factors controlled by this type of trade union. Thus, every union (h,j), $j = 1,\ldots,r$ proposes an amount $y_k^r(h,j) \leq \overline{z}_k$ for every $k \in F_h$. Then, it is supplied the average of the proposed amounts, that is, the amount supplied of a factor $k \in F_h$ is given by $y_k = \dfrac{1}{r}\sum_{j=1}^{r}\sum_{h\in H_k} y_k^r(h,j)$. In this case, the factor prices are given by the corresponding marginal products in the economy $\mathcal{E}$, that is, $p_z(y) = \dfrac{\partial f}{\partial z_k}(y)$. Following this approach the payoff functions may be defined by $\Pi^r_{(h,j)}(y^r) = \sum_{k\in F_h} p_k(y)\dfrac{y_k^r(h,j)}{r}$.

Next result points out the intuitive idea that when a trade union becomes "smaller" the market power diminishes. Actually, the benefit that a trade union can get by behaving strategically goes to zero as the size of the trade union decreases.

Theorem 4.2 *For every r let θ^r be a trade union equilibrium for the economy $r\mathcal{E}$. Then, the sequence $\eta(\theta^r) = (\eta_1(\theta^r),\ldots,\eta_n(\theta^r))$, given by $\eta_k(\theta^r) = \dfrac{1}{r}\sum_{j=1}^{r}\sum_{h\in H_k}\theta_k^r(h,j)$, converges to $\overline{z}$ as r increases.*

Proof. Suppose that $\eta(\theta^r)$ does not converge to $\overline{z}$. Then, there exist a type h of trade union, a factor $k \in F_h$ and $\varepsilon > 0$ such that, for every r_0 there exists $r \geq r_0$ and a trade union j_r of type h such that $\theta_k^r(h,j_r) < \overline{z}_k^h - \varepsilon$. Then, we have that $\theta_k^r(h,j_r) < \overline{z}_k^h - \varepsilon$ for infinitely many r. For each r, let us consider the strategy profile α^r which coincides with θ^r except for the trade union (h,j_r) that chooses a supply $\overline{z}_k^h$ of factor k instead of $\theta_k^r(h,j_r)$. Then, $\dfrac{z(\alpha^r)}{r} - \dfrac{z(\theta^r)}{r}$ converges to zero when r goes to ∞. On the other hand, since f exhibits constant returns to scale, we have that $p_k(z(\theta^r)) = p_k(z(\theta^r)/r)$ and $p_k(z(\alpha^r)) = p_k(z(\alpha^r)/r)$. This implies that the prices of factors depend continuously on the average of the total supplies. By this continuity property of equilibrium prices, we obtain that for every $\delta > 0$, there exists $r(\delta)$

such that $\|p(z(\theta^r)) - p(z(\alpha^r))\| \leq \delta$ for every $r \geq r(\delta)$. Since $\theta_k^r(h, j_r) < \overline{z}_k^h - \varepsilon$, we conclude that for r large enough $\Pi^r_{(h,j_r)}(\alpha^r) > \Pi^r_{(h,j_r)}(\theta^r)$ which is in contradiction with the fact that θ^r is a trade union equilibrium for each r.

Q.E.D.

5 Some Examples of Trade Union Games

5.1 A Simple Game

Let $\mathcal{E}$ be a production economy with $n = 2$ inputs, namely, $z_1 = K$ (capital) and $z_2 = L$ (labor) used to produce a single consumption commodity. In this economy there are a total endowment $\overline{K}$ of capital and a total endowment $\overline{L}$ of labor, supplied inelastically to two different trade unions $H = \{1, 2\}$. That is, we consider a production economy, where there are only capital and labor as production factors. All capital $\overline{K}$ belongs to a union called capitalist union (i.e. , $F_1 = \{1\}$) while all labor $\overline{L}$ belongs to a different union here called labor union (i.e., $F_2 = \{2\}$).

The single commodity is produced according to the following constant returns to scale technology:

$$F(K, L) = \left(\varepsilon K^{-1} + (1-\varepsilon)L^{-1}\right)^{-1}, \ \varepsilon \in (0, 1).$$

Both trade unions behave strategically by supplying an amount of the factor under their control. Thus, the strategy sets for capitalist and labor unions are given respectively by

$$\begin{aligned} S_1 &= \{K, \text{ with } 0 \leq K \leq \overline{K}\} \\ S_2 &= \{L, \text{ with } 0 \leq L \leq \overline{L}\} \end{aligned}$$

Competition in markets for capital and labor services guarantee that the price for each factor equates its marginal product. Hence, we have that the corresponding wage w and rental rate r are given by the next functions:

$$\begin{aligned} w(K, L) &= (1-\varepsilon)L^{-2} \left(\varepsilon K^{-1} + (1-\varepsilon)L^{-1}\right)^{-2} \\ r(K, L) &= \varepsilon K^{-2} \left(\varepsilon K^{-1} + (1-\varepsilon)L^{-1}\right)^{-2} \end{aligned}$$

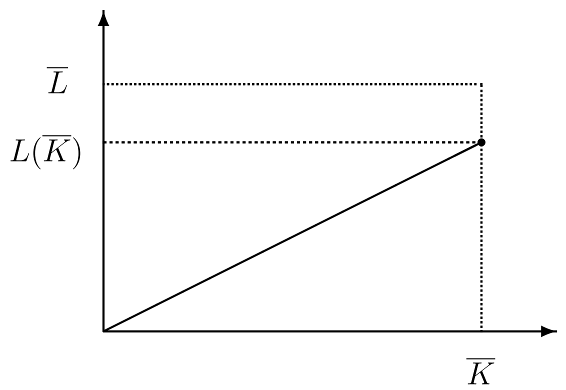
where K and L are the supplied amount of capital and labor via the strategy profile (K, L).

The objective function of unions is to maximize total income. Therefore, capital union best response function $K(L)$ is obtained by maximizing $\Pi_1(K,L) = r(K,L)K$, whereas labor union best response function $L(K)$ is obtained by maximizing $\Pi_2(K,L) = w(K,L)L$. Actually, best response functions are defined by the following relations:

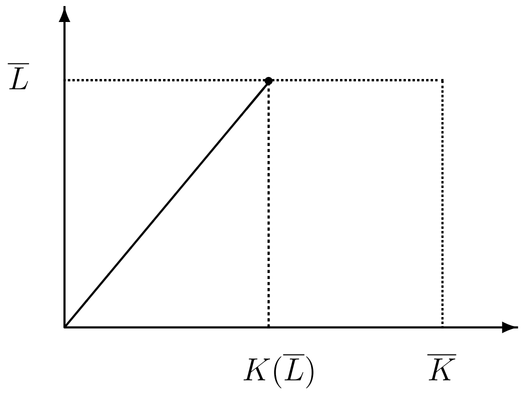
$$\begin{aligned} K(L) &= \left(\frac{\varepsilon}{1-\varepsilon}\right) L \ \text{ if } L > 0 \\ L(K) &= \left(\frac{1-\varepsilon}{\varepsilon}\right) K \ \text{ if } K > 0 \end{aligned}$$

Then, in this example there exists a continuum of Pareto ranked Nash equilibria in pure strategies, (K, L) given by $(1-\varepsilon)K = \varepsilon L$. Therefore if $(1-\varepsilon)\overline{K} < \varepsilon\overline{L}$, every Nash Equilibria results in unemployment of labor. On the other hand, if $(1-\varepsilon)\overline{K} > \varepsilon\overline{L}$ every Nash Equilibrium results in capital unemployment.

In the next figures we have a representation of a collection of Nash equilibria.



Case (i)
Labor unemployment



Case (ii)
Capital unemployment

We now analyze the above condition for unemployment of factors. Trade unions have as an objective to increase their total income; since this increase can only be done by reducing the supply of the factor under their control, this implies less production. Therefore, to increase total income for the unemployed factor implies increasing its share in total income. To see this more clearly let us write

$$s_k(K,L) = \frac{r(K,L)K}{r(K,L)K + w(K,L)L}, \quad s_l(K,L) = \frac{w(K,L)L}{r(K,L)K + w(K,L)L}.$$

The elasticity of substitution between capital and labor $\eta_{K,L}$ can be written in terms of the income share, s_k and s_l, and the elasticity of factor demands $\sigma_{r,K}$, $\sigma_{w,L}$ as follows:

$$\eta_{K,L} = (1 - s_k)\sigma_{r,K} = (1 - s_l)\sigma_{w,L}.$$

Hence, at any Nash Equilibrium income shares must be equal for both unions. This is due, basically, to the structure of trade unions and to the elasticity of substitution between capital and labor which is constant and given by $\dfrac{1}{1-\rho}$.

Assume now that $s_k(\overline{K},\overline{L}) > s_l(\overline{K},\overline{L})$. This means that under competitive equilibrium (which implies full employment of factors) the share of capital in total income is larger than the share of labor and, therefore, it cannot be supported as a Nash Equilibrium and in order to increase the share of labor income it is necessary to create unemployment of labor. Analogously, if under competitive equilibrium the share of labor in total income is larger than the capital share, some unemployment of capital is necessary to get Nash Equilibria. In fact, in this example, a competitive equilibrium can be obtained as a Nash equilibrium if and only if $s_k(\overline{K}, \overline{L}) = s_l(\overline{K}, \overline{L})$.

Finally, we remark that for every given ε, Nash Equilibria are Pareto ranked. Then, it is reasonable, although it is not guaranteed by the Walrasian mechanism, to think that in case we observe unemployment of a factor there should be full employment of the other factor. Actually, given any ε, there is a Nash equilibrium which Pareto dominates all the other Nash equilibria and underlies full employment of either capital or labor.

5.2 A Generic Trade Union Game

In this section we provide an example of trade union games with a C.E.S. production function which illustrates the results stated in the previous section and allows us to explore particular situations of economic interest.

Consider a production economy where a single consumption commodity is produced according to the following constant returns to scale technology:

$$F(K_1, K_2, \ldots, K_n, L) = (\varepsilon(K_1 + K_2 + \ldots + K_n)^\rho + (1 - \varepsilon)L^\rho)^{1/\rho}$$

where $\varepsilon \in (0, 1)$, $\rho < 0$ and $n \geq 1 - \rho$.

This technology uses $n+1$ inputs, with the first n factors being perfect substitutes of capital whereas the last factor is labor. In this economy consumers are endowed with a total amount $\overline{K}_1, \ldots, \overline{K}_n$ of the first n factors and a total endowment $\overline{L}$ of labor. Assume that $\overline{K}_i = \overline{k}$ for every $i = 1, \ldots, n$. Since consumer derive utility consuming the single produced good, these endowments of factors are supplied inelastically to $n + 1$ different trade unions. Then there are $H = n + 1$ trade unions each of them controlling one and only one factor. Alternatively, it may be interpreted that there are only capital and labor as production factors, and all capital $\overline{K} = \sum_{i=1}^{n} \overline{K}_i = n\overline{k}$ is equally distributed among n different trade unions.

All trade unions behave strategically by supplying an amount of the factor under their control. Thus, the strategy sets for capital union i and labor union are given respectively by

$$
\begin{aligned}
S_i &= \{K_i, \text{ with } 0 \leq K_i \leq \overline{k}\} \\
S_2 &= \{L, \text{ with } 0 \leq L \leq \overline{L}\}
\end{aligned}
$$

Given a strategy profile $(K_1, \ldots, K_n, L)$ we denote $K = \sum_{i=1}^{n} K_i$. Competition in markets for capital and labor services guarantee that the price for each factor equates its marginal product. Hence, we have that the corresponding wage w and rental rate r are given by the next functions:

$$
\begin{aligned}
w(K, L) &= (1-\varepsilon)L^{\rho-1}\left(\varepsilon K^{\rho} + (1-\varepsilon)L^{\rho}\right)^{\frac{1}{\rho}-1} \\
r(K, L) &= \varepsilon K^{\rho-1}\left(\varepsilon K^{\rho} + (1-\varepsilon)L^{\rho}\right)^{\frac{1}{\rho}-1}
\end{aligned}
$$

The objective function of unions is to maximize total factor revenue. Therefore, capital union i best response function $K_i(K_{-i}, L)$ is obtained by maximizing $\Pi_i(K_1, \ldots, K_n, L) = r(K, L)K_i$, whereas labor union best response function $L(K)$ is obtained by maximizing $\Pi_{n+1}(K, L) = w(K, L)L$. Actually, best response functions for the n capital unions are:

$$
K_i(K_{-i}, L) = \overline{k} \text{ for every } i = 1, \ldots, n
$$

and the best response function for labor union is:

$$
L(K) = \left(-\frac{\rho\varepsilon}{1-\varepsilon}\right)^{\frac{1}{\rho}} K \text{ if } K > 0
$$

Notice that, since $1-\rho < n$, every capital union supplies all capital regardless the strategy choice of other unions. That is, $\overline{k}$ is a dominant strategy for trade union $i = 1, \ldots, n$. Therefore, we have a unique symmetric Nash equilibrium in pure strategies given by $(\overline{k}, \ldots, \overline{k}, \min\{\overline{L}, L(\overline{K})\})$. We conclude that when $(1-\varepsilon)\overline{K}^{|\rho|} < |\rho|\varepsilon\overline{L}$ the Nash equilibrium results in unemployment of labor.

Finally, we remark that the larger is $|\rho|$ the lower is the elasticity of substitution between the aggregate of capital K and labor, which in turn, implies higher degree of complementarity between them. In fact, the larger is $|\rho|$, the more unemployment of labor will be observed at the Nash equilibrium. The limit case where the technology is Leontieff is of particular interest because the condition of unit elasticity of the factor demand does not hold at any point and will be studied in the next section.

5.3 Trade Union Games with Fixed Factor Proportions

Consider a production economy where a single consumption commodity is produced using capital and labor according to the following technology:

$$F(K,L) = \begin{cases} \min\{\varepsilon K, L\} & \text{if } \varepsilon K \geq m \text{ and } L \geq m \\ 0 & \text{otherwise} \end{cases}$$

where ε is a positive real number.

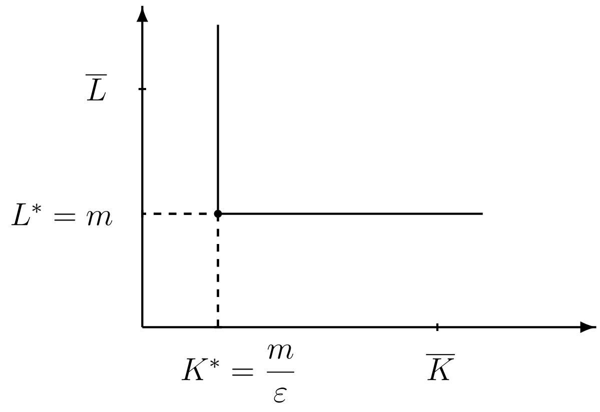
The total endowment $\overline{K}$ of capital is controlled by the capital union and the total endowment $\overline{L}$ is controlled by the labor union. We assume that $\min\{\varepsilon\overline{K}, \overline{L}\} > m$, which guarantees that production is possible.

Both unions behave strategically announcing supplies of factors. Let (K, L) be a strategy profile. If $\varepsilon K = L$ the walrasian output is determined by $F(K, L)$ although walrasian prices are no longer unique. In order to state a well defined game we consider that when $\varepsilon K = L$ both unions share total revenue. Then, the payoff functions for capital and labor unions are defined by:

$$\Pi_1(K,L) = \begin{cases} 0 & \text{if } \varepsilon K > L \\ aF(K,L) & \text{if } \varepsilon K = L \\ F(K,L) & \text{if } \varepsilon K < L \end{cases}$$

$$\Pi_2(K,L) = \begin{cases} F(K,L) & \text{if } \varepsilon K > L \\ (1-a)F(K,L) & \text{if } \varepsilon K = L \\ 0 & \text{if } \varepsilon K < L \end{cases}$$

Observe that, when $\varepsilon K = L$, the share of the total income is given by the parameter $a \in (0, 1)$. Note that $(0, 0)$ is a trivial trade union equilibrium. Actually every profile (K, L) such that $F(K, L) = 0$ is a trade union equilibrium. However, it is easy to see that there is only one trade union equilibrium with production, independently of the value of a, that is, when walrasian prices are not determined any share of the income underlies the same trade union equilibrium. This equilibrium is (K^*, L^*), where $\varepsilon K^* = L^* = m$. To see that $\left(\frac{m}{\varepsilon}, m\right)$ is the unique trade union equilibrium with production, notice that positive income for both unions are distributed only along the line $L = \varepsilon K$, but given any such point, both unions have incentives to deviate supplying slightly less of their factor, and get all the income. The next picture illustrate this equilibrium.



Regarding this example, a natural question that arises is the following one: how can we get the maximum production level as result of a trade union equilibrium?

Note that the previous payoff functions present discontinuities which come from the discontinuity and multiplicity of the walrasian equilibrium price correspondence. In order to avoid this difficulty, let us consider that the payoff functions are defined as follows:

$$\overline{\Pi}_1(K, L) = aF(K, L)$$

$$\overline{\Pi}_2(K, L) = (1 - a)F(K, L)$$

where a is any positive number between zero and one.

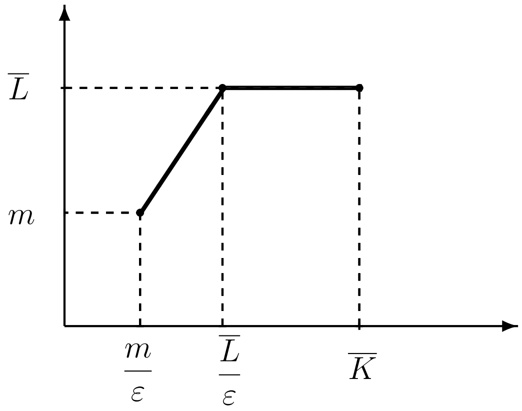
In this case, it is easy to see that any strategy profile which leads to no production is a trade union equilibrium. That is, if (K, L) is a strategy profile such that $\min\{\varepsilon K, L\} \leq m$, then, (K, L) is a trade union equilibrium. On the other hand, we have also a set of union equilibrium with production. Moreover, $(\overline{K}, \overline{L})$ is a trade union equilibrium. In other words, full employment of factors can be reached as a Nash equilibrium for this game where the payoff functions are continuous.

In order to define all the trade union equilibria with production, we distinguish several situations:

If $\overline{L} < \varepsilon\overline{K}$, then the set of union equilibria with production is the following one:

$$\{(K,L) \mid L = \varepsilon K,\ F(K,L) > 0\} \bigcup \left\{(K, \overline{L} \mid \overline{L} \leq \varepsilon K\right\}$$

Next picture illustrate this situation.

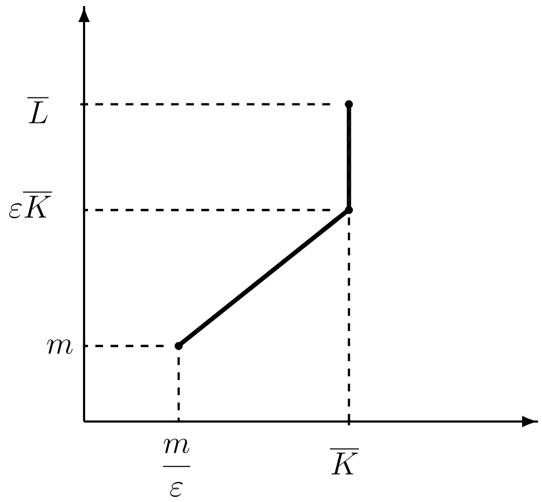


Case (i) $\overline{L} < \varepsilon\overline{K}$

If $\overline{L} > \varepsilon\overline{K}$, then the set of union equilibria with production is the following one:

$$\{(K,L) \mid L = \varepsilon K,\ F(K,L) > 0\} \bigcup \left\{(\overline{K}, L) \mid L \geq \varepsilon\overline{K}\right\}$$

Next picture illustrate this second situation.



Case (ii) $\overline{L} > \varepsilon\overline{K}$

Finally, note that when $\overline{L} = \varepsilon \overline{K}$, we can conclude that $(\overline{K}, \overline{L})$ not only is a trade union equilibrium but also Pareto dominates all the other union equilibria.

6 Concluding Remarks

In this paper, we have defined union games associated to production economies within a general equilibrium framework. The objective of each trade union is to maximize the total amount of revenues of factors under its control. Then, union behave strategically on the supply of inputs in order to manipulate prices in their own benefit.

We remark that the structure of unions we have stated is general enough to allow us to consider interesting situations as particular cases.

We have analyzed trade union equilibria regarding non full employment of factors. The results obtained along the paper point out a source of unemployment, which depends on technological condition and union structure, and therefore differs from those usually considered in the literature.

An important caveat of our model we want to stress is the fact for each economy with non full employment of factors, generated by a Union Game, there exists an economy with no unemployment and exactly the same prices and the same utilization of inputs. This might be important for simulation purposes. We can calibrate an economy using National Accounts and the insights of competitive general equilibrium, incorporating unemployment of factors in the parameters of the production function.

Since the players are unions and not consumers, a problem which is not addressed in our analysis is the distribution of income from factors to the consumers. It seems, however, reasonable to assume a proportional distribution with respect to the initial endowment of factors. The process of Union formation and their stability is out of the scope of this paper, but it is in our agenda for future research.

References

Ball, L.: Aggergate Demand and Long-Term Unemployment. Brookings Papers on Economic Activity 2, 189-251 (1999).

Bean, C. R.: European Unemployment: A Survey Journal of Economic Literature 2, 573-619 (1994)

Barro, R. J.: Long-Term Contracting, Sticky Prices, and Monetary Policy. Journal of Monetary Economics, 3, 305-316 (1977).

Blanchard, O. J., Summmers, L. H.: Hysteresis and European Unemployment Problems. NBER Macroeconomics Annual 1, 15-78 (1986).

Blanchard, O. J., Wolfers, J.: The Role of Shocks and Institutions in the Rise of European Unemployment. NBER Working Paper n^o 7282 (August) (1999).

Bullow, J., Summers, L. H.: A Theory of Dual Labor Markets with Applications to Industrial Policy, Discrimination, and Keynesian Unemployment. Journal of Labor Economics 4, 376-414 (1986).

Codognato, G, Gabszewicz, J.J.: Cournot-Walras Equilibria in Pure Exchange Economies. CORE Discussion Paper No. 9110, 1991.

Codognato,G., Gabszewicz, J.J.: Cournot-Walras Equilibria in Markets with a Continuum of Traders. Economic Theory 3, 453-464 (1993).

Gabszewicz, J.J., Michel, P.: Oligopoly Equilibria in Exchange Economies, *in* "Trade, Technology and Economics. Essays in honour of Richard G. Lipsey" (B. Curtis Eaton and Richard G. Harris, Eds.), pp. 217-241, Cheltenham, Edward Elgar, 1997.

Gottfries, N.: Insiders, Outsiders, and Nominal Wage Contacts. Journal of Political Economy 100, 252-270 (1992).

Gregory, R.G.: Wages, Policy and Unemployment in Australia. Economica 53, 543-574 (1986).

Hall, R. E.: Employment Fluctuations and Wage Rigidity. Brookings Papers on Economic Activity 1, 91-123 (1980).

Hall, Robert E. 1982. The Importance of Lifetime Jobs in the US Economy American Economic Review 72 (September): 716-724

Hervés, C., Moreno, E., Páscoa, M.: Manipulation-Proof Equilibrium in Atomless Economies with Commodity Differentiation. Economic Theory 14, 545-563 (1999).

Hosios, Arthur J. 1990. On the Efficiency of Matching and Related Models of Search and Unemployment Review of Economic Studies 57 (April): 279-298

Howitt, Peter. 1988. Business Cycles with Costly Search and Recruiting Quarterly Journal of Economics 103 (February): 147-165

Hurwicz, L.: On Informationally Decentralized Sistems. In McGuire, C.B., Radner, R. (eds) Decision and Organization: a volume in honor of Jacob Marshack. Amsterdam: North-Holland, 1972.

Jackson, M.O., Manelli, A.M.: Approximately Competitive Equilibria in Large Finite Economies. Journal of Economic Theory 77, 354-376 (1997).

Katz, Lawrence F. 1986. Efficiency Wage Theories: A Partial Evaluation NBER Macroeconomics Annual 1: 235-276

Leontieff, W.: The Pure Theory of Guaranteed Annual Wage Contract. Journal of Political Economy 54, 76-79, (1946).

Lahmandi-Ayed, R.: Oligopoly Equilibria in Exchange Economies: a Limit Theorem. Economic Theory 17(3), 665-674 (2001).

Ljungvist, L., Sargent, T. J.: The European Unemployment Dilemma. Journal of Political Economy 108, 514-550 (1998).

Makowski, L., Ostroy, J.M., Segal, U.: Perfect Competition as the Blueprint for Efficiency and Incentive Compatibility. Working Paper, University of California, 1995.

Mortensen, D. T.: Job Search and Labor Market Analisys. In Oerly Ashenfelter and Richard Layar eds. Handbook of Labor Economics, Vol 2, 848-919. Amsterdam. Elsevier (1986).

Mortensen, D. T., Pissarides, C. A.: Job Reallocation, Employment Fluctuations and Unemployment. In John B. Taylor and Michael Woodford, eds. Handbook of Macroeconomics, 1171-1228. Amsterdam. Elsevier (1999).

Oswald, A. J.: Efficient Contracts are on The Labor Demand Curve: Theory and Facts. Labor Economics 1, 85-113 (1993).

Otani, Y., Sicilian, J.: Equilibrium Allocations of Walrasian Preference Games. Journal of Economic Theory 27, 47-68 (1982) .

Otani, Y., Sicilian, J.: Limit Properties of Equilibrium Allocations of Walrasian Strategic Games. Journal of Economic Theory 51, 295-312 (1990).

Pissarides, C. A.: Short Run Dynamics on Unemployment, Vacancies, and Real Wages. American Economic Review 75, 676-690 (1985).

Postlewaite, A.: Manipulation via Endowments. Review of Economic Studies 46, 255-262, (1979).

Roberts, D.J., Postlewaite, A.: The incentives for price-taking behavior in large exchange economies. Econometrica 44, 115-127, (1976).

Safra, Z.: Existence of Equilibrium for Walrasian Endowment Games. Journal of Economic Theory 37, 366-378 (1985).

Shapiro, C., Stiglitz, J. E.: Equilibrium Unemployment as a Worker Discipline Device. American Economic Review 74, 433-444 (1984).

Siebert, H.: Labor Market Rigidities: At the Root of Unemployment in Europe. Journal of Economic Perspectives 11, 37-54 (1997).

Solow, R. M.: Another Possible Source of Wage Stickness. Journal of Macroeconomics 1, 79-82 (1979).

Yellen, J. L.: Efficiency Wage Models of Unemployment. American Economic Review 74, 200-205 (1984).

Yi, G.: Manipulation via Withholding. Review of Economic Studies 58, 817-820 (1991).