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Unemployment Insurance and Labor Reallocation

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Résumé

Dans ce papier, nous développons un modèle d'appariement pour évaluer les effets des allocations chômage et de leur financement sur la réallocation du facteur travail entre des secteurs (industries) hétérogènes. L'hétérogénéité provient des différences dans les taux de turnover et dans les niveaux de productivité. Le modèle est ensuite étalonné sur la Turquie qui est en passe d'introduire un système d'assurance chômage mais le champ d'application des résultats est beaucoup plus général. Notre analyse montre qu'avec un système de cotisation basé sur la seule masse salariale, une hausse des allocations chômage augmentent la subvention implicite aux secteurs les plus volatiles, ce qui induit une réallocation des travailleurs vers ces secteurs. A contrario, l'introduction d'un système d'*experience-rating* permet de réduire cette subvention et de stabiliser l'emploi en réduisant la taille des secteurs les plus volatiles. Finalement, il est montré que l'*experience-rating* a des effets non triviaux sur la production totale.

Abstract

In this paper, an equilibrium search-and-matching model of a segmented labor market has been developed to assess the effects of unemployment insurance and its financing on labor allocation across heterogeneous economic sectors (industries). Heterogeneity stems from different rates of labor turnover and levels of productivity. The model has been applied to Turkey, which is currently introducing an unemployment insurance system. The results can be extended to a wide range of countries however. Our analysis leads us to argue that with a payroll taxation system, more generous unemployment payments increase the implicit subsidy to volatile sectors, which in turn leads a flow of workers to these sectors. Conversely, a switch from a payroll tax system to an experience-rated system makes it possible to reduce the implicit lay-off subsidy. This in turn stabilizes employment by reducing the size of the volatile sectors. Furthermore, it has been proved that experience rating has a non-trivial effect on total output.

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1 Introduction

The impact of unemployment insurance (henceforth UI) on the frequency and severity of unemployment periods has been extensively documented. The UI system can affect unemployment by influencing the employment decisions of workers and employers. Volumes of theoretical and empirical literature have recently emerged on the effects that UI has on the search strategies of workers and the hiring and lay-off decisions of employers[1]. Most of the previous contributions have been based on the job-search theory and have focused on the transition of unemployed workers to employment and the related moral hazard problems. Although the findings of the different studies have not been uniform, in general, higher unemployment payments are associated to longer unemployment spells. Another strand of the research has concentrated on the transition from employment to unemployment induced by UI. The evidence that a large number of the unemployed workers in the US are rehired by their last employer has led some economists to focus on the employers' lay-off decisions. Since the unemployment costs of the workers is only partially borne by the firms thanks to UI, incentives for temporary lay-offs and unemployment rates are higher.

A related feature of these employer-side interpretations has attracted the interest of some economists, though to a much lesser extent. The UI-induced lay-off decisions are not symmetric for all sectors. Sectors with relatively stable demand have lower lay-off incentives than the volatile sectors. Hence, the sectors with low labor turnover subsidize the high labor turnover sectors. The subsidy is created by the difference between the unemployment insur-

[1] For an extensive survey see Holmlund (1998).

ance payroll taxes levied on the hiring of a worker and the unemployment insurance benefits that the worker is expected to receive. This subsidy can be at the industry level as well as the firm level. If the difference is negative, *i.e.*, the taxes paid are less than the benefits received, the employment in the firm (industry) is subsidized by the other firms (industries), whose contribution to the UI system is higher than the benefits their workers receive. Consequently, with constant tax rates, some industries that are characterized by high labor turnover rates receive a constant subsidy from those with lower rates.

A natural outcome is the reallocation of labor across industries. Employment in the subsidized sectors is higher than it should be when there is no UI. The UI affects labor allocation by two channels, which are not completely independent from each other: first, by the magnitude of the unemployment payments, and second, by the financing system of the UI. The higher the UI benefits, the higher the subsidy level. The financing method of the UI also plays a crucial role in determining the subsidy, which depends on the share of the unemployment costs paid by the firms. Instead of constant tax rates, an experience-rated system, which ties the tax burden to the firm's own lay-off history, can be used to finance the UI. In most OECD countries, unemployment benefits are financed by payroll taxes paid by employers and employees or by government contributions. Experience rating is an original feature of the US unemployment compensation scheme and is remarkably absent from all other OECD countries. It has received close scrutiny in the literature since the seminal works pioneered by Feldstein (1976) and Brechling (1977). If experience rating is perfect, employers undertake all of the costs of the unemployment benefits and there is no subsidy. Thus far, the only country applying an experience-rated system is the US. However, experience rating is not perfect in the US; the firms do not undertake the entire lay-off costs.

There are a number of contributions, including Topel and Welch (1980), Deere (1991), Anderson and Meyer (1993) among others, that have focused on cross subsidies across different industries in the US. The first two authors have also analyzed the labor allocation effects of UI. It is remarkable that this phenomenon has only attracted interest in the US – the only country using an experience-rated system. It would seem that the allocative effects of UI might be more significant for other countries using payroll taxation to finance UI systems. All of these papers provide empirical estimates of the phenomenon. For example, both Deere (1991) and Anderson and Meyer (1993) find that construction, mining and manufacturing are mainly subsidized industries in most US states, while transportation, public utilities, finance, insurance and real estate are the losers of UI. Furthermore, Deere states that:

> "... a 10%increase in the implicit subsidy to a layoff increases the employment share in construction by about 1.7% and decreases the employment share in services by almost 1%."

However, with the exception of Topel and Welch (1980), these earlier studies do not provide a theoretical explanation for the problem. Instead, they build their estimations based on the intuitive explanation given above. As a matter of fact, Topel and Welch consider a limited case in the context of implicit contract theory, where the workers are tied to a specific firm and unemployment is only temporary. Once unemployed, instead of searching for another job, workers wait to be recalled by their former employers. Thus, the level of employment is determined solely by the decisions of the employers and workers' searching strategies are ignored. Nonetheless, temporary layoffs appear to be much less common in Europe and other OECD countries than in the US (Atkinson and Micklewright, 1991 and OECD, 2002), their analysis is, therefore, likely to be irrelevant for other countries. Another limitation of their model is the purely seasonal character of product demand, which can be completely foreseen. Thus, the firms choose the optimal amount of labor knowing the product demand in advance. In other words, uncertainty vanishes – the product demand being revealed before the firms choose their optimal hiring strategies. Firms with higher fluctuation hoard labor during high-demand periods, and when demand is low, they temporarily lay off a fraction of their attached workers. In reality, however, the majority of the demand shocks are not seasonal and cannot be perfectly foreseen.

In this paper, we provide a theoretical framework and some simulations for assessing the impact of UI on the allocation of labor across industries, which are characterized by different rates of labor turnover. We build an equilibrium search-and-matching model of a segmented labor market where the size of each sector is endogenously determined. Job creation and destruction decisions are also endogenous. The search is directed since the workers are aware of their opportunities in each sector. In equilibrium, the size of each sector is determined by a trade-off rule ensuring that the expected returns to unemployment are equal across all sectors. Changes in the UI system affect the value of being unemployed as well as the job creation and destruction decisions. Therefore, these changes lead to a reallocation of labor.

One of the main advantages of our model is that it considers both sides of the labor market. As it is based on an equilibrium framework, the decisions of both workers and employers are taken into account, and the relationship between the firm and the worker is not assumed to continue after their separation. Furthermore, different from Topel and Welch, the demand shocks are not seasonal.

Several numerical exercises have been performed to assess the impact of the UI system on the reallocation of labor. The model has been applied to Turkey, which is in the process of introducing an unemployment insurance system. The model's results, however, can be extended to a wide range of countries. The model has been calibrated to reproduce the main characteristics of the several major sectors of the Turkish Economy. Four heterogenous sectors, which differ in their labor turnover rates and productivity levels, have been chosen. The differences in the turnover rate will determine the inter-sectoral subsidies, and hence the labor reallocation across sectors. As for the productivity differentials, although they do not matter in determining labor reallocation, they play a crucial role in determining the total output of the economy, which can be used as an efficiency criterion. In other words, our goal is to analyze the impact of UI, not only on the labor market structure and related variables like the unemployment rate, but also on output and efficiency.

The first simulation is meant to evaluate the effects of enhancing unemployment benefits. In line with earlier studies, our findings lead us to argue that with a lump-sum payroll taxation system, a rise in unemployment benefits increases the subsidy to the volatile sectors, thus increasing their size.

Furthermore, unemployment rates are increased, which is a classical result in the UI literature. In addition, the overall quality of the matches has improved, a result that is also advocated by Marimon and Zilibotti (1999), Acemoglu and Shimer (1999) and Acemoglu (2001) in different frameworks. Second, we turn to the financing issues of UI by considering a mix of lump-sum payroll taxation and an experience-rated taxation. An increase in the experience-rated taxes implies lower payroll taxes. As expected, when experience rating becomes more strictly applied, implicit subsidies, and consequently, the share of the volatile sectors decrease. It also turns out that experience rating unambiguously decreases the unemployment rates. Finally, the effects of experience rating on the total output are analyzed. Our results do not advocate any clear-cut effect. Indeed, according to the sectors considered and depending on the impact that experience rating has on unemployment, experience rating is shown to have a non-trivial effect on total production.

The remainder of the paper is organized as follows. The next section describes the equilibrium unemployment framework we will use. Section 3 briefly highlights the Turkish UI characteristics and a set of empirical evidence. Numerical exercises are also provided in Section 3 to assess UI policy effects. Finally, our conclusions are presented in Section 4.

2 The Model

We will consider a n sector continuous time search-and-matching model in the fashion of Mortensen and Pissarides (1994, 1999a, b) with a particular emphasis on UI. Throughout the paper, we will index the variable related to sector i by the subscript i. We will first present the baseline characteristics and then detail the equilibrium conditions. Finally, we will focus on unemployment compensation financing.

2.1 Production and Unemployment

We will study an economy with $n+2$ goods and n sectors. Labor is used to produce n non-storable intermediate goods, which in turn are used to produce a final consumption good. Each sector is specialized in the production of an intermediate good, which is sold at price p_i. Consumers only value the consumption of the final good, regardless of the intermediate goods. The price of the final good is normalized to unity. The production function is CES and denoted by:

$$Y = \left(\sum_{i=1}^{n} \alpha_i Y_i^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where Y, Y_i represent the production of the final good and the production of sector i, respectively. σ is the elasticity of substitution between the n intermediate goods, and α_i denotes the weight of the sector in total output. From the first order conditions[2], prices are given by:

$$p_i = \alpha_i Y_i^{-\frac{1}{\sigma}} Y^{\frac{1}{\sigma}}. \tag{2}$$

There is a continuum of identical and infinitely lived workers with measure normalized to one: $\sum_{i=1}^{n} N_i = 1$, where N_i represents the labor force in sector i. The number of unemployed workers in each sector satisfies:

$$U_i = N_i - L_i, \tag{3}$$

where U_i and L_i represent the number of unemployed workers and the number of employed workers in sector i, respectively. Individuals have identical

[2]Detailed price equations are reported in Appendix (1).

preferences that are represented by a linear utility function. The choice of a linear utility function is used for simplicity's sake. Indeed, introducing risk aversion into a model with endogenous job destruction adds a dimension of complexity (L'Haridon, Malherbet and Perez-Duarte, 2002) we would rather avoid here. Since the focus of the paper is not on the optimal design of UI, this assumption is deemed not too restrictive. Each worker supplies one unit of labor and can be either employed and producing or unemployed and searching. The mass of firms is endogenous. Each firm has only one job slot, which is either filled and producing or vacant and searching. We assume that there is no on-the-job search and that the unemployed workers are aware of their opportunities in each sector, hence their search is directed[3]. Accordingly, unemployed workers choose only one sector in which to look for a job. Firms and workers are brought together in sector i via an imperfect matching technology. This process is captured by a customary matching function, which links the total number of contacts to the number of protagonists actively searching on each side of the market. This function satisfies the standard properties: it is increasing, continuously differentiable, homogenous of degree one and yields no hiring if the mass of the unemployed workers or the mass of vacant jobs is nil. The instantaneous flow of new matches in sector i is, therefore, defined by the following matching function $M(V_i, U_i)$, where V_i represents the number of vacancies. The linear homogeneity of the matching function

[3]These assumptions are crucial as the size of the sectors will be determined by the search decisions of the unemployed workers. Although a model that considers on-the-job search could be more instructive, for simplicity's sake, we have chosen to ignore this possibility. On the contrary, the directed search assumption seems to be more realistic than the undirected search, as already mentioned by several authors (for example, see Acemoglu (2001)).

enables us to write the transition rate for vacancies as $M(V_i, U_i)/V_i = m(\theta_i)$, where $\theta_i = V_i/U_i$ is the labor market tightness. Similarly, the flow out of unemployment is obtained by $M(V_i, U_i)/U_i = \theta_i m(\theta_i)$. The properties of the matching function imply that $m(\theta_i)$ and $\theta_i m(\theta_i)$ are respectively decreasing and increasing functions of labor market tightness.

Productive activity is the purpose of job-worker matches. Each job is endowed with an irreversible technology requiring one unit of labor to produce ε units of output where ε is a random, job-specific, productivity parameter drawn from a general distribution function F with support in the range [ε_l, ε_{u_i}]. The product of a match changes from time to time without warning. Idiosyncratic shocks hit jobs at the Poisson rate λ_i. Accordingly, a new value of ε, which is independent of initial productivity and irreversible, is drawn from the general distribution F. Taking into account an endogenous threshold denoted by ε_{di}, the firm can choose to either continue production at the new productivity level or terminate the job and separate from the worker. Thus, the job destruction rate in sector i follows a Poisson process with parameter $\lambda_i F(\varepsilon_{di})$. Denoting the unemployment rate in sector i by $u_i = U_i/N_i$, the law of motion of the unemployment rate reads as:

$$\dot{u_i} = \lambda_i F(\varepsilon d_i)(1 - u_i) - \theta_i m(\theta_i) u_i. \tag{4}$$

The steady-state unemployment rate is obtained by equating flows out of unemployment to the number of destroyed jobs, and is given by:

$$u_i = \frac{\lambda_i F(\varepsilon d_i)}{\lambda_i F(\varepsilon d_i) + \theta_i m(\theta_i)}. \tag{5}$$

A Beveridge curve is obtained, showing that sector $i's$ unemployment rate is a function of the reservation productivity as well as labor market tightness.

2.2 Firms and Workers

A vacant job costs h_i per unit of time and is filled at rate $m(\theta_i)$. The asset value of holding a vacancy in sector i, denoted by Π_{vi}, satisfies:

$$r\Pi_{vi} = -h_i + m(\theta_i)\left[\Pi_{0i}(\varepsilon_{u_i}) - \Pi_{vi}\right], \tag{6}$$

where r is the exogenous interest rate and $\Pi_{0i}(\varepsilon_{u_i})$ is the asset value of a new job. As long as there are positive rents from vacant jobs, there will be new suppliers of vacant jobs. Therefore, free entry to the vacancies ensures that all profit opportunities from new jobs are exploited in equilibrium. This implies that $r\Pi_{vi} = 0$. Once a contract is signed, new jobs start off at the maximum productivity level ε_{u_i}. This latter assumption is not restrictive and avoids further complexity, although the model can be extended for stochastic job matching (Pissarides, 2000). Experience rating introduces a discrepancy between a new and a continuing job. Wages are the outcome of a Nash bargaining between the firm and the worker, and therefore, may differ depending on whether they are considered to be at the negotiation or renegotiation stage. More accurately, at the very beginning of a match, the firm is not responsible for any separation costs since the contract has not yet been signed. However, once the firm and the worker have signed the contract a dismissal tax must be paid in case of a separation. Differences in job asset values result from the asymmetry between the negotiated contracts and the renegotiated contracts.

The asset value of a new job in sector i reads as:

$$\begin{aligned} r\Pi_{0i}(\varepsilon_{u_i}) &= p_i\varepsilon_{u_i} - w_{0i}(\varepsilon_{u_i}) - \tau \\ &\quad + \lambda_i \left[\int_{\varepsilon_l}^{\varepsilon_{u_i}} Max\left[\Pi_{ei}(\zeta), \Pi_{vi} - \tau_{ei}\right] dF(\zeta) - \Pi_{0i}(\varepsilon_{u_i}) \right], \end{aligned} \tag{7}$$

where w_{0i} is the wage bargained at the beginning of the match, τ the lump-sum payroll tax and τ_{ei} the experience-rated tax the firm must pay in case of **a** separation.

The asset value of a continuing job, $\Pi_{ei}(\varepsilon)$, satisfies:

$$\begin{aligned} r\Pi_{ei}(\varepsilon) &= p_i\varepsilon - w_i(\varepsilon) - \tau \\ &\quad + \lambda_i \left[\int_{\varepsilon_l}^{\varepsilon_{u_i}} Max\left[\Pi_{ei}(\zeta), \Pi_{vi} - \tau_{ei}\right] dF(\zeta) - \Pi_{ei}(\varepsilon) \right], \end{aligned} \tag{8}$$

where $w_i(\varepsilon)$ is the outcome of the wage bargaining for the current idiosyncratic level of productivity ε. Operating a continuing job yields the firm with an instantaneous profit that is worth the value of production minus the wage and the lump-sum payroll tax. Productivity changes from time to time without warning at the Poisson rate λ_i, in which case, the firm compares the option value of dissolving the match to the value of continuing it. In the event of such an idiosyncratic shock, a new value of job specific productivity ε is drawn from the general distribution F. The match is terminated if the new value of ε is below an endogenous threshold ε_{di}. In that case, the firm bears the separation costs. For all remaining cases, the relationship between the firm and the worker is continued.

The expected value, V_{ui}, of the discounted stream of income of an unemployed worker in sector i is denoted by:

$$rV_{ui} = b + \theta_i m(\theta_i)\left[V_{0i}(\varepsilon_{u_i}) - V_{ui}\right], \tag{9}$$

where b is the unemployment benefits and $V_{0i}(\varepsilon_{u_i})$ is the expected value of the stream of income for a newly hired worker. An unemployed worker gets an instantaneous income b and expects to return to employment with a transition rate $\theta_i m(\theta_i)$.

As previously noted, a distinction must be made between the expected utility stream of a newly hired worker and that of a previously hired worker. The expected present utility, $V_{0i}(\varepsilon_{u_i})$, of the stream of income of a newly hired worker *satisfies* the following equation:

$$rV_{0i}(\varepsilon_{u_i}) = w_{0i}(\varepsilon_{u_i}) + \lambda_i \left[\int_{\varepsilon_l}^{\varepsilon_{u_i}} Max \left[V_{ei}(\zeta), \overline{V_{ui}} \right] dF(\zeta) - V_{0i}(\varepsilon_{u_i}) \right], \quad (10)$$

where V_{ei} is the expected utility stream of a worker with seniority and $\overline{V_{ui}}$ is the maximum expected utility stream of being unemployed in any sector.

Finally, the expected utility stream of a worker with seniority, $V_{ei}(\varepsilon)$, satisfies:

$$rV_{ei}(\varepsilon) = w_i(\varepsilon) + \lambda_i \left[\int_{\varepsilon_l}^{\varepsilon_{u_i}} Max \left[V_{ei}(\zeta), \overline{V_{ui}} \right] dF(\zeta) - V_{ei}(\varepsilon) \right]. \quad (11)$$

To clarify our argument on the reallocation of labor across different sectors, it is necessary to detail $\overline{V_{ui}}$. Unemployed workers are allowed to move from one sector to another. The workers' decisions stem from the comparison between the value of being unemployed in the current sector relative to the value of being unemployed in a different sector. In the case of unemployment, workers will choose the sector in which they will be best off. More accurately, $\overline{V_{ui}}$ is the maximum income stream of an unemployed worker previously hired in sector i. The formal condition is given by:

$$\overline{V_{ui}} = Max \left[V_{u1}, ..., \ V_{un} \right].$$

For simplicity's sake, two assumptions can be made. First, we will assume that moving from one sector to another is costless.[4] Second, we will assume that all unemployed workers are entitled to UI benefits regardless of their past employment experience. Together, these two assumptions explain why we have chosen a fixed level of unemployment benefits b for all the sectors.

2.3 Job Creation and Job Destruction

Matches yield a surplus, which is equal to the sum of the expected present value of the workers' and the employers' future income on the job minus the expected present value of their income in case of separation. In order to derive the equilibrium conditions of the model, it is convenient to refer to the surplus associated to a new match, such as $S_{0i}(\varepsilon_{u_i})$, and a continuing match, such as $S_i(\varepsilon)$, respectively. Experience rating introduces a discrepancy between the surplus associated to a new job and a continuing job, as explained in the last section.

Hence, an employer who accepts to be matched with a worker obtains $\Pi_{0i}(\varepsilon_{u_i})$, and otherwise gets Π_{vi}. Symmetrically, a newly matched worker gets $V_{0i}(\varepsilon_{u_i})$ or remains unemployed, therefore getting V_{ui}. Accordingly, the surplus of a new job satisfies:

$$S_{0i}(\varepsilon_{u_i}) = \Pi_{0i}(\varepsilon_{u_i}) - \Pi_{vi} + V_{0i}(\varepsilon_{u_i}) - V_{ui}. \tag{12}$$

Obviously, things change once a contract is signed. In that case, the firm must pay a separation cost that is worth τ_{ei}. For every continuing job with

[4] Assuming perfect mobility of unemployed workers may seem questionable. Workers can search in a specific sector according to their skills, location etc. Thus, changing sectors can be costly for at least some of the workers. However, in order to take into accont the limits on workers' mobility, adding these costs to our model changes our results only quantitatively, hence we have chosen to ignore them.

current productivity ε, an employer gets $\Pi_{ei}(\varepsilon)$ and obtains $\Pi_{vi} - \tau_{ei}$ in the case of a separation. Aside from the change in the idiosyncratic component of the productivity, the workers' threat point in the negotiation remains the same since there is no redundancy payment. Thus, the surplus of a continuing job with productivity ε is:

$$S_i(\varepsilon) = \Pi_{ei}(\varepsilon) - \Pi_{vi} + \tau_{ei} + V_{ei}(\varepsilon) - V_{ui}. \tag{13}$$

Wages are continuously renegotiated and are the outcome of a Nash sharing rule, which provides a share $\beta \in [0,1]$ of the surplus to the worker. β could be interpreted as the worker's bargaining power. The bargain sets the wage so as to split the surplus into a fixed proportion at each instant. Since experience rating improves the workers' threat point in a continuing job, the bargain yields two different wages for a new and a continuing job, denoted by $w_{0i}(\varepsilon_{u_i})$ and $w_i(\varepsilon)$, such that $\Pi_{0i}(\varepsilon_{u_i}) - \Pi_{vi} = (1-\beta)S_{0i}(\varepsilon_{u_i})$ and $V_{0i}(\varepsilon_{u_i}) - V_{ui} = \beta S_{oi}(\varepsilon_{u_i})$ in a new job and $\Pi_{ei}(\varepsilon) - \Pi_{vi} + \tau_{ei} = (1-\beta)S_i(\varepsilon)$ and $V_{ei}(\varepsilon) - V_{ui} = \beta S_i(\varepsilon)$ in a continuing job. It is worth noting that the value of the surplus is independent of the wage since it does not depend on the sharing rule. Therefore, wage equations are not required to define equilibrium. Equations (12) and (13) need to be expanded[5] in order to obtain the detailed expression of the surplus associated with a new and a continuing match. We will start by defining the job destruction condition, and will then turn to the job creation condition.

According to Appendix (2), the surplus associated with a continuing

[5]The formal derivation of the surplus is given in Appendix (2).

match satisfies the following equation:

$$(r+\lambda_i)S_i(\varepsilon) = p_i\varepsilon - \tau - b - \frac{\theta_i\beta h_i}{(1-\beta)} + r\tau_{ei} + \frac{\lambda_i p_i}{r+\lambda_i}\int_{\varepsilon_{di}}^{\varepsilon_{u_i}}(\zeta - \varepsilon_{di})dF(\zeta). \quad (14)$$

The severance between an employer and worker occurs as soon as the surplus associated to a match becomes nil. In other words, once the rent to be shared is zero, there is no reason to continue the match. The formal condition reads as $S_i(\varepsilon_{di}) = 0$, where ε_{di} is the productivity threshold, *i.e.,* the minimum value of the productivity required to pursue the relationship between an employer and a worker. Using this latter condition with the surplus equation (14), the job destruction condition is finally obtained by:

$$p_i\varepsilon_{di} = b + \frac{\theta_i\beta h_i}{(1-\beta)} + \tau - r\tau_{ei} - \frac{\lambda_i p_i}{r+\lambda_i}\int_{\varepsilon_{di}}^{\varepsilon_{u_i}}(\zeta - \varepsilon_{di})dF(\zeta) \qquad (15)$$

This condition precisely defines the reservation threshold. The right-hand side shows that the reservation productivity depends on the opportunity cost of employment $b + \theta_i\beta h_i/(1-\beta) + \tau$, which is the sum of the unemployment benefits, the expected value of the search and the lump-sum tax. Labor hoarding sources are twofold and can either be institutional or voluntary. Institutional labor hoarding is denoted by $r\tau_{ei}$ and refers to the capitalized value of the separation costs. Obviously, an increase in the separation costs tends to lower the reservation productivity, and therefore, less jobs are destroyed. The last term of equation (15) refers to the voluntary labor hoarding, or more accurately, the option value of maintaining an existing match. Both sources are common to matching models that handle job protection.

For simplicity's sake, it is useful to rewrite the expression associated with the surplus of a continuing job. By combining equations (14) and (15), we obtain:

$$S_i(\varepsilon) = \frac{p_i(\varepsilon - \varepsilon_{di})}{r + \lambda_i}. \tag{16}$$

Now, we will focus on the derivation of the job creation condition. Combining equations (7), (8), (10), (11) with the surplus equations (12) and (13), a simple expression that defines the surplus of a new job can be obtained as:

$$S_{0i}(\varepsilon_{u_i}) = S_i(\varepsilon_{u_i}) - \tau_{ei}. \tag{17}$$

Next, by combining the free-entry condition with the expected value of a vacant job (6) using the sharing rules, the expected cost of a vacant job is obtained as a function of the surplus of a new job:

$$\frac{h_i}{m(\theta_i)} = (1 - \beta) S_{0i}(\varepsilon_{u_i}).$$

Finally, combining the surplus equations (16) and (17) with the previous equation, the job creation condition in sector i is determined as:

$$\frac{h_i}{m(\theta_i)} = (1 - \beta) \left[\frac{p_i(\varepsilon_{u_i} - \varepsilon_{di})}{r + \lambda_i} - \tau_{ei} \right]. \tag{18}$$

This equation shows that the expected cost of a vacant job must be equal to the expected profit of a new job. It also defines a decreasing relation between labor market tightness θ_i and the reservation productivity ε_{di}. The average cost of a vacant job increases with labor market tightness θ_i, because the greater the labor market tightness, the longer it takes to fill a vacancy. The right-hand side of the equation stands for the expected profit of a starting job. The average employment spell is a decreasing function of the reservation productivity. Hence, the expected profit associated with a new job is a decreasing function of the reservation productivity, and firms tend to open less vacancies when ε_{di} increases.

Job destruction (15) and job creation (18) are two key equations of the model. To solve the model for all unknowns, we now need to take into account the balanced-budget rule for the unemployment compensation system.

2.4 Unemployment Compensation Financing

Unemployment benefits are financed by the taxes paid by firms. The sources of the taxes are twofold. First, firms pay a lump-sum tax for each occupied job; second, in case of a separation, firms must pay a portion of the fiscal costs they induce by their firing decisions. This modelling makes it possible to create a mix of two systems, which are used to finance UI. In fact, there are three possible cases. First, if τ_{ei} is worth zero, the unemployment insurance system is completely financed by payroll taxes. The fiscal cost of the new unemployed worker is, therefore, totally covered by the unemployment compensation system. This case reflects a prominent feature of most OECD countries where unemployment benefits are financed by payroll taxes, which are paid by the employers and employees or by government contributions (Holmlund, 1998). Second, if τ is worth zero, unemployment benefits are exclusively financed by taxes levied on firms' lay-offs. This latter case, although unrealistic, corresponds to the logic behind the US unemployment system, or more accurately, to a perfectly experience-rated system. In fact, the US system is imperfectly experience rated in the sense that firms do not pay the full benefit cost of an additional lay-off. Third, in our framework, imperfect experience rating refers to all remaining situations between the two polar cases mentioned above. The unemployment compensation system is, therefore, financed by a mix of the two instruments, with the weights depending on the degree of experience rating.

In order to satisfy a balanced budget, total tax revenues must be equal to total unemployment insurance expenditures. Thus, the balanced-budget rule reads as:

$$\tau \sum_{i=1}^{n}(1-u_i)N_i + \sum_{i=1}^{n} \lambda_i F(\varepsilon_{di})(1-u_i)N_i\tau_{ei} = \sum_{i=1}^{n} u_i N_i b. \tag{19}$$

The left-hand side of equation (19) is the total revenue, and the right-hand side is the total UI payments. By rearranging equation (19), the lump-sum tax is obtained as a function of labor market tightness and the reservation productivity. This tax formula satisfies:

$$\tau = \frac{\sum_{i=1}^{n} u_i N_i b - \sum_{i=1}^{n} \lambda_i F(\varepsilon_{di})(1-u_i)N_i\tau_{ei}}{\sum_{i=1}^{n}(1-u_i)N_i}. \tag{20}$$

The lump-sum tax is a decreasing function of the experience-rated tax τ_{ei}. Accordingly, the mutualized part of the fiscal cost, and thus the inter-sectorial subsidies, decrease with the experience-rating level.

In case of separation, the tax incurred by the firm is determined according to a fiscal-cost criterion. The fiscal cost of an unemployed worker, C_i, is given by the following asset equation:

$$rC_i = b + \theta_i m(\theta_i)\left[0 - C_i\right]. \tag{21}$$

An unemployed worker gets an instantaneous revenue b, and with probability $\theta_i m(\theta_i)$, returns to employment. In this case, the fiscal cost becomes nil. The tax rate τ_{ei} reflects the share of the fiscal cost borne by the firm, such that: $\tau_{ei} = e_i C_i$ where e_i is the degree of experience rating. This equality, in conjunction with equation (21) makes it possible to express the experience-rated tax as:

$$\tau_{ei} = \frac{e_i b}{r + \theta_i m(\theta_i)}. \tag{22}$$

It is worth noting that the experience-rated tax is a decreasing function of labor market tightness. It is well known that higher market tightness increases the exit rate from unemployment, which decreases the unemployment rate. Consequently, the budget needed to finance unemployment benefits is reduced and the tax is lowered.

2.5 Equilibrium

The definition of the equilibrium requires the model to be solved for all unknowns in the steady state. An equilibrium is defined by $(p_i, \varepsilon_{d_i}, \theta_i, \tau, \tau_{e_i}, N_i)$ for $i \in [1, n]$. It solves equations (2), (15), (18), (20), (22) and also satisfies the trade-off conditions given by the following rule: $rV_{u_i} = rV_{u_j}$ for $i \neq j$ and $i, j \in [1, n]$. In other words, in the steady-state equilibrium, the value of being unemployed is equal across sectors. Thus, the unemployed workers are indifferent between different sectors. The size of the sectors is then determined using the trade-off conditions. If the value of being unemployed varies between sectors, there will be flows of unemployed workers to the sectors, in which unemployment is more valuable until the utility gaps vanish. Therefore, the equilibrium is defined by n price equations, n job destruction equations, n job creation equations, a lump-sum payroll tax equation, n experience-rated tax equations, and finally $n - 1$ trade-off conditions (the size of the population is normalized to the unity).

3 Unemployment Insurance and Job Reallocation

Obviously, the high non-linearity of the framework developed above does not allow for any tractable results. Accordingly, in order to investigate the impact of UI systems on inter-sectorial labor reallocation, we have performed several numerical exercises. Our analysis will focus on a developing country – namely Turkey. Turkey was characterized by the absence of UI until very recently. In fact, the Turkish Government is in the process of initiating an unemployment insurance system. The first unemployment benefit payments took place in 2002. Thus, choosing Turkey as a benchmark country not only facilitates the calibration, but also gives us the possibility of comparing a situation where there is no UI to that of an equilibrium disturbed by UI.

We have calibrated our model to reproduce the main features of four major sectors of the Turkish Economy, namely: industry, trade, transportation and communication, and finally, construction, whose main characteristics are documented below. These sectors differ in their labor turnover rates as well as in their productivity levels. This makes it possible for us to consider not only changes in the size of the sectors, but also in the total output of the economy. The latter can be used as an efficiency criterion. In order to provide more detailed analysis, we will not handle the four sectors all at once. We will take into account two sectors at a time, and repeat the same analyses a second time for the two remaining sectors. According to the definition given above, for a two-sector model, the equilibrium is defined by a set of 10 non-linear equations (2 price equations, 2 job destruction equations, 2 job creation equations, 2 experience-rated tax equations, a lump-sum payroll tax equation, and finally, a trade-off condition).

First, we will consider the outcome of policy changes (explained below) on the transportation and communication sector and the construction sector – more precisely a high-productivity low-turnover (HPLT) sector and a low-productivity high-turnover (LPHT) sector, respectively. Then, we will repeat the same analysis for the industry and the trade sectors, representing high-productivity high-turnover (HPHT) and low-productivity low-turnover (LPLT) sectors, respectively.

Our numerical exercises are twofold. In a first attempt, we will carry out two sets of simulations to analyze the effects of introducing an UI system with a payroll taxation on the reallocation of labor between different sectors starting from a situation without unemployment benefits. Second, we will extend the analysis to the financing mode of the UI system, once again running two sets of simulations to present the effects of introducing experience rating on the reallocation of labor as well as on the changes in the total production of the economy.

3.1 Turkish UI Characteristics

An UI scheme was absent in Turkey until 1999, even though Turkey accepted the ILO Convention No. 102 describing the minimum social security standards in 1952. The first study on introducing an UI system in Turkey appeared in the late 1950s, and the first draft UI law was prepared in 1967. Twenty-two draft UI laws were prepared between 1967 and 1992, but none of them were passed by Parliament (Akmaz, 2000). The Unemployment Insurance Law was finally accepted by Parliament in August, 1999, and the premia collection started in June 2000. As already mentioned, the first benefit payments took place in March 2002. The UI system is a compulsory scheme and covers mainly the members of SSK (Workers' Pension Scheme), and to a much lesser extent some other types of employees defined by the Law. The scheme is financed by the contributions of employers (2% out of the contribution base for SSK), employees (1%) and the State (1%). The initial contribution rates were 1 point higher for each category, i.e., 3%, 2% and 2%, respectively, but in 2002 these rates were declined in order to reduce employment costs.

To be able to benefit from UI, the workers must satisfy strict eligibility conditions. The workers who have paid premia for at least 600 days in the last three years, including full contributions for the last 120 days prior to unemployment, and who have lost their job involuntarily or due to no fault of their own, can benefit from UI. The duration of unemployment payments is tied to the number of contribution days. Workers who have paid premia for 600, 900 and 1080 days in the last three years can benefit from the UI for 180, 240 and 300 days, respectively. The UI scheme not only provides unemployment benefits, but also health insurance, maternity assistance, occupational development, training programs and job-search assistance to the unemployed beneficiaries as long as the eligibility conditions continue. The daily amount of UI benefits is calculated in the following way: 50% of the average net insurable daily wage over the last four months prior to unemployment. This sum is paid monthly at the end of each month. However, UI benefits cannot exceed the net monthly minimum wage.

The UI payments since March 2002 are summarized in Table 1. The

	Number of Beneficiaries	Payment Amount (Billions TL)
2002 March	5.710	1.254,87
2002 April	13.126	2.413,77
2002 May	20.463	3.212,91
2002 June	26.472	3.842,78
2002 July	32.902	4.914,75
2002 August	36.068	5.150,41
2002 September	39.333	6.204,26
2002 October	39.692	6.391,67
2002 November	40.637	6.566,11
2002 December	41.953	6.862,91
2003 January	42.882	7.091,24

Table 1: UI Payments. Source: ISKUR (The Employment Agency)

Table shows that the number of beneficiaries has increased, first due to the increase in the number of eligible workers, and second due to the severe economic crisis that Turkey has undergone the last two years. This crisis has increased the number of unemployed workers significantly.

For simplicity's sake, we have not taken the eligibility conditions mentioned above into account in our numerical exercises. Instead, in line with our theoretical model, we have assumed that all unemployed workers can benefit from the UI payments regardless of their past employment experience. Furthermore, we have ignored the revealed contributions scheme, as we are trying to assess the impact of different financing schemes on the reallocation of labor across sectors.

3.2 Empirical Evidence

For the selected sectors, some of the indicators necessary for calibrating the model are presented in Table 2. These indicators have been obtained from our own calculations using the data from the Turkish State Institute of Statistics. Instead of a reference year, we have used the averages of the 1997-2001 period. Sectorial unemployment rates have been calculated by taking into account the branch of economic activity of the unemployed worker's last workplace. Sectorial unemployment rates must rather be calculated using the number of unemployed workers currently searching for a job in that sector. However, as our main concern is on UI, we have abstracted our analysis from other factors that can change workers' opportunities in different sectors. Since there was no UI for the reference period, we have assumed that the expected value of unemployment in any sector has remained the same, thus, workers are assumed to be searching for work in the last sector they were employed in. To calculate the sectorial job destruction rates, we have excluded the voluntary quits and have only considered the workers who lost their jobs for one of the three following reasons: dismissal, job liquidation or the job was temporary and finished. In a steady state, the job destruction rates must be equal to the job creation rates. Thus, job destruction rates represent the relative labor turnover rates. Relative productivity ratios have been obtained by comparing the value of output per worker for each sector. The size of a sector is calculated by adding up all the workers of that sector whether employed or unemployed. Let us recall that we have considered dual economies, i.e., we are only taking into account two sectors at a time. Therefore, in Table 2, we have presented only the relative sizes of the sectors

	Unemployment Rate	Job Destruction	Relative Productivity	Relative Size
Transportation & Communication	5.9%	3.7%	3.2	40%
Construction	12.0%	16.8%	1.0	60%
Industry	8.1%	5.2%	1.8	53%
Trade	6.7%	4.2%	1.6	47%

Table 2: Empirical evidences for selected sectors. Authors' calculations from data of Turkish State Institute of Statistics.

in these two dual economies.

3.3 Benchmark Calibration

In this subsection, we will present the results of a numerical solution of the model using calibrated parameters, which illustrate the salient features of the Turkish economy. Using the case of no unemployment insurance as our benchmark, the model has been calibrated to mimic the evidence displayed in Table 2. The absence of UI implies that the parameters e and b are nil. We have interpreted the time period of unit length to be one year. A significant problem we encountered using the Turkish data was the difficulty of finding an appropriate measure for the real interest rate due to high inflation rates and repeated financial crisis. In order to avoid the problems caused by the fluctuations in the former interest rates, we used an approximation for the expected interest rates. Using the Central Bank Business Survey, we subtracted the weighted average of expectations for the yearly short-term Turkish Lira credit interest rate from the weighted average of expectations on the yearly inflation rate, obtaining a reasonable 5% for the yearly expected real interest rate. As a matter of fact, the interest rate serves as a discount factor for our model, thus using expected rates seems reasonable. In line with Mortensen and Pissarides (1999a, b), a matching function of the Cobb-Douglas form was assumed, such that $m(v_i, u_i) = ku_i^{\eta}v_i^{1-\eta}$, where k is a mismatch parameter and η and $1-\eta$ are elasticities of the matching function with respect to the search input. This parameter is set at $\eta = 0.5$, which is in the range of the estimates provided by Blanchard and Diamond (1989) and Pétrongolo and Pissarides (2001). Due to the lack of better information, the share of workers from the surplus of any match was assumed to be equal to the share of firms, i.e., $\beta = 0.5$. The equality between η et β implies that the Hosios-Pissarides condition holds (Hosios, 1990 and Pissarides, 2000)[6]. This is quite standard in matching models and implies that a decentralized equilibrium is efficient when there is no UI. The elasticity of substitution between the two intermediate goods σ is assumed to be greater than one and fixed to 1.5. This assumption is consistent with Acemoglu (2001). Since the parameters β and σ are subject to caution to a certain extent, we relaxed the assumption that $\beta = \eta$ and tested the robustness of our results for different values of β and σ in Appendix (3). Qualitatively, our results hold for a various range of reasonable parameter values[7]. The lower bound of the productivity range is set to zero and is supposed to be the same in each sector. Baseline parameters are reported in Table 3.

The four remaining parameters – α_i, λ_i, h_i, ε_{u_i} – are used to reproduce the

[6] A generalization of the n-sectors model of the standard Hosios-Pissarides condition is provided in Appendix 3.

[7] We have considered equal bargaining power in different sectors. This assumption is not deemed too restrictive due to the lack of accurate data on this parameter. Moreover, introducing different bargaining power leads to an additional heterogeneity in the model that we would rather avoid here in order to focus on the comprehensible mechanism.

Variables	Notation	Value
Matching elasticity	η	0.5
Bargaining power	β	0.5
Interest rate	r	0.05
Mismatch parameter	k	1
Elasticity of substitution	σ	1.5
Productivity lower support	ε_l	0

Table 3: Baseline parameters.

size, job destruction rate, productivity and unemployment rate of each sector. Let us recall here that sectors are calibrated two by two, i.e. transportation and construction and industry and trade. Parameter α_i is fixed in order to reproduce the relative size of the sectors given in Table 2. The arrival rate of the job specific shock λ_i and the cost of advertising a vacant job h_i are calibrated in order to fit the job destruction rate and the unemployment rate of the sector. It may be noticed that the hiring costs increase with the sectors' productivity. This assumption is similar to the customary idea that vacancy costs are proportional to real wage costs (Pissarides, 2000), which has also been rationalized by Fredriksson and Holmlund (2001) in the following way:

> "...think of a world where firms allocate their workforce between production and recruitment activities. In such a set up the cost of recruiting - the vacancy cost - consists of the alternative cost, i.e., the marginal product of labor."

Finally, the upper support of the idiosyncratic productivity ε_{u_i} is set to mimic productivity differentials between sectors. Calibrated parameters are reported in Table 4.

Sector	α_i	λ_i	h_i	ε_{u_i}
Transportation &				
Communication	0.34	0.049	0.90	1.75
Construction	0.66	0.250	0.20	0.45
Industry	0.51	0.073	0.80	0.85
Trade	0.49	0.056	0.80	0.75

Table 4: Sectorial parameters.

3.4 Numerical Exercises

3.4.1 Introducing Unemployment Insurance

For the first numerical exercise, our main concern will be job reallocation across industries induced by unemployment benefits. As mentioned above, four sectors will be considered. Figures 1 and 2 present the evolution of implicit subsidies and resulting changes in the relative sizes of the sectors after the UI has been introduced. Implicit subsidies are calculated by the difference between the firm's tax payments for a given sector to the unemployment insurance fund and the unemployment benefits paid to the workers in that sector. The transportation and communication sector and the construction sector are presented in Figure 1. Figure 2 presents the industry and trade sectors. According to the Turkish blueprint, the monthly benefit depends on the average monthly salary over the last four months of employment. The benefit is equal to 50 percent of this average salary. However, the monthly benefits are subject to a maximum limit, which is the legal minimum wage. The upper bounds of unemployment benefits used in Figures 1 and 2 reflect this application. We have performed a pre-calibration of the model and have calculated the minimum wage to be equal to 0.16. According to this pre-calibration, 50 percent of the average wage in each sector is higher than this minimum wage. Thus, in our simulations, the value of unemployment benefits is iterated until $b = 0.16$.

At first glance, it is remarkable that introducing UI decreases (increases) the size of stable (volatile) sectors independently from their relative productivities. This is the natural outcome of the evolution of implicit subsidies, which is determined by the labor turnover rates. The average employment spells in the stable sectors are higher than those in the volatile sectors. As a matter of fact, both the unemployment rates and the destruction rates are higher in these latter sectors. With a payroll taxation scheme, a higher sectorial unemployment rate implies a higher subsidy. Hence, an increase in unemployment benefits will raise the subsidy, which in turn implies an increase in the size of the volatile sectors.

Figure 1 about here

Figure 2 about here

It is worth noting that the definition of the subsidy is not exactly the same as the one in the earlier studies mentioned above. In those papers, the subsidy concerns only the firms, since they offer a contract to the workers that includes unemployment periods as well as working periods. Hence, UI serves as a tool to reduce the cost of labor. In our model, the relationship between the firms and the workers only involves the productive periods and does not continue after separation. A rise in the unemployment benefits increases the workers' outside opportunities, giving them more leverage in the negotiations and increasing the firms' labor costs. The relative value of unemployment benefits is higher for the workers in the volatile sector as they have a higher probability of being unemployed. Therefore, enhancing the unemployment benefits increases the asset value of being unemployed more significantly in the volatile sector than in the stable sector. This leads to a flow of unemployed workers towards the volatile sector. In turn, the higher number of unemployed workers makes the vacant jobs more profitable to the firms in this sector. Furthermore, it remains valid that firms in the volatile sector would have to pay higher taxes if the UI budget was balanced at the sectorial level. In summary, although the subsidies are not explicit like in the implicit contract models, the stabler sectors implicitly subsidize the volatile sectors.

At the same time, increasing benefits leads to a higher unemployment rate in both sectors. This result is classical and can be explained as follows: enhancing unemployment benefits increases workers' threat point in the negotiations. This has a substantial negative impact on labor market tightness. Furthermore, as the exit rate from unemployment is an increasing function of labor market tightness, the unemployment rate increases. Finally, higher unemployment benefits increase the reservation productivity of the jobs, implying a higher destruction rate.

In our framework, the effects of enhancing unemployment benefits on total output, net of vacancy costs, are similar to those found in the standard UI literature (Hosios, 1990 or Pissarides, 2000), and have thus been abstracted from our analysis. It is worth noting that aggregate output is a measure of social welfare, since it has been assumed that individuals are risk-neutral. Briefly speaking, in a decentralized equilibrium, job creation and destruction decisions are efficient only if the bargaining power of the workers is equal to the elasticity of the matching function, ($\beta = \eta$), and if there is no UI. Therefore, in this case, net total output is also maximized. As we assumed $\beta = \eta$ in our calibrations, an increase in the unemployment benefits disturbs the efficient allocation of resources, and thus decreases the total output of the economy, net of vacancy costs. However, for $\beta < \eta$, labor market tightness, θ, is too high. Thus, enhancing unemployment benefits could improve efficiency and increase the total output by decreasing θ. Furthermore, as noted in Pissarides (2000), if job creation is inefficient, job destruction will also be low.

3.4.2 Financing Unemployment Insurance

In our framework, unemployment benefits are financed by two instruments: a lump-sum payroll tax and an experience-rated tax. The choice of the financing instrument is not neutral and is likely to lead to different outcomes depending on the economic sector. Basically, we want to compare the effects of the financing schemes on heterogenous economic sectors. First, we will consider the transportation and construction sectors, and second, we will turn to the industry and trade sectors. The characteristics of the sectors remain exactly as described above.

Transportation and Construction

At first glance, it is striking that a switch from a lump-sum tax system ($e_i = 0$) to a perfectly experience-rated system ($e_i = 1$) drives the implicit subsidy to zero and causes the size of the stable sector (transportation) to increase and that of the volatile sector (construction) to decrease, as depicted in

Figure 3. Indeed, when the experience rating index is worth one, the firm will undertake the entire cost of an unemployed worker. In that case, the subsidy disappears. Unemployment benefits cause the volatile sector to grow relative to the stable sector due to the implicit subsidy, as previously explained. Accordingly, increasing the experience rating, and thus reducing the subsidy from the stable sector to the more volatile sector, induces an expansion in the size of stable sector. Hence, the potential virtue of experience rating is to stabilize employment by decreasing the lay-off subsidy.

Figure 3 about here

Figure 4 plots the number of jobless workers, the number of employees and the unemployment rates as a function of the experience rating index for both sectors. The total unemployment rate is also given (dotted lines). From Figure 4, it is obvious that an increase in the degree of experience rating results in a decrease in the unemployment rate for each sector, although the magnitude of that decrease is not the same across sectors. Consequently, the total unemployment rate is lowered. As for the composition of the population, aside from the fact that labor reallocation occurs from the construction to the transportation sector, experience rating shifts workers from unemployment to employment. Experience rating effects have already been documented in matching models[8]. Basically, higher experience rating enhances labor hoarding, and thus, decreases job destruction since firing a worker becomes more costly to the firm. Conversely, it lessens job creation due to the fact that the

[8] See Cahuc and Malherbet (2002) and L'Haridon and Malherbet (2002).

expected profit from new jobs declines. From this standpoint, experience rating acts exactly like standard job protection schemes. However, experience rating also has a fiscal compensation. By shifting a portion of the unemployment benefits burden to the firm, the UI fund requires less resources, and consequently, payroll taxation is lowered. This fiscal effect strengthens labor hoarding and tails away expected labor costs[9]. In our simulations, which take into account both job creation and job destruction effects, the overall impact of experience rating is proved to be positive, thus reducing unemployment.

Figure 4 about here

If the effects of experience rating are *a priori* well defined for unemployment rates, things become less obvious for output. Figure 5 plots the production and the average productivity of each sector. Higher experience rating raises net output in the transportation sector and decreases it in the construction sector. Furthermore, the average productivity is lessened in both sectors. To explain output changes, the channels through which the experience rating passes must be considered. There are two channels. First, experience rating by reducing unemployment rates in both sectors also increases the number of employed workers, and thus the production level in each sector. This is the positive effect of experience rating, which we will call the extensive effect. Second, experience rating by diminishing the threshold productivity also reduces average productivity. This is the negative effect of experience rating, which we will call the intensive effect. In the end, the total impact depends on

[9]The overall impact on job creation is therefore ambiguous.

which effect dominates in each sector. Finally, for the transportation sector, the extensive effect dominates the intensive effect, and therefore, production is increased. The opposite occurs in the construction sector.

Figure 5 about here

As previously pointed out in Figure 5, production is increased in one sector (transportation) and decreased in another (construction). From this point of view, the net effect on total output remains ambiguous. Figure 6 plots the net output as a function of the experience rating index. Up to a certain level in the experience rating index, the production increase in the transportation sector dominates the decrease in the construction sector, causing total output to increase. Afterwards, the opposite occurs, and total output decreases. Finally, total output, net of the vacancy costs, exhibits a bell-shaped curve.

Figure 6 about here

The shape of the net output stems from the discrepancy between the production levels in the two sectors as well as from the composition effects, which pass through the reallocation of the labor force. Experience rating decreases the implicit subsidy to the volatile sector (construction), which is also the less productive sector. The labor force is, therefore, reallocated from the less productive sector to the more productive (transportation) sector. Accordingly, labor reallocation from low productivity to high productivity sectors is likely to cause an increase in production, but does not guarantee, per se, a rise in total output. The impact of experience rating on total output depends also on its effect on unemployment. Broadly speaking, it is not the productivity differential itself, but the effect combined with the unemployment changes that determines a production increase or decrease.

This point highlights the effects of experience rating in a broader way. Policy recommendations are likely to change depending on whether the unemployment rate or an efficiency criterion is considered.

Industry and Trade

Now we will turn to the next two sectors – industry and trade. As we underlined above, experience rating induces the labor force to be reallocated from the volatile sector (industry) to the stable sector (trade). In step with the previous case, implicit subsidies will be driven to zero, and consequently, the relative size of the stable sector will expand. This point is depicted in Figure 7.

Figure 7 about here

Figure 8 plots the number of jobless workers, the number of employees and the unemployment rates for both sectors as a function of the experience rating index. The total unemployment rate is also given (dotted line). The experience rating effects for industry and trade are identical to those underscored for transportation and construction. The labor force composition is affected, *i.e.*, the number of job seekers is lowered and the number of employed workers is increased. Consequently, the unemployment rates unambiguously fall in both sectors.

Figure 8 about here

Things turn out to be slightly different for sectorial net output and productivity. Figure 9 plots the net output and the average productivity for each sector as a function of the experience rating index. An increase in the experience rating index decreases production in the high productivity sector (industry) and induces a bell-shaped curve in the low productivity sector (trade). The average productivity decreases in both sectors. The rise in the experience rating degree causes a rather small gain in the number of employed workers and a sharp drop in the average productivity in the industry sector. Accordingly, the intensive effect widely offsets the extensive effect, and production falls. Conversely, such an increase leads to a broader gain in the number of workers and to a slimmer decrease in the average productivity in the trade sector. In this sector, however, the overall effect on production remains ambiguous, and the production plot is bell-shaped. The extensive effect dominates the intensive one up to a certain degree of experience rating, and then the opposite occurs.

Figure 9 about here

The previous graph shows that higher experience rating tends to decrease the production in the industry sector and to have an ambiguous effect in the trade sector. The global effect is, therefore, ambiguous and presumably negative. Figure 10 plots total output as a function of the experience rating index. The shape of the net output is decreasing. The labor force is reallocated towards the less volatile and productive sector (trade). This reallocation from the high productivity sector to the low productivity sector is, therefore, likely to diminish total production. However, and for the same reasons we have underscored for the transportation and the construction sectors, this effect is not sufficient enough, *per se*, to drive down total output. Indeed, and in step with the previous case, the experience rating impact on total output depends mostly on its effect on unemployment.

Figure 10 about here

Experience rating is, to a certain extent, a means of correcting the inefficiency induced by unemployment benefits by driving implicit subsidies to zero and by reallocating the labor force towards stable sectors. In our numerical exercises, it is also proven to be an efficient way to decrease the unemployment rates. Accordingly, it may be worthwhile to finance unemployment benefits through an experience-rated scheme. However, the reallocation effect towards the stable sectors is not always efficient once a production criterion is considered. Indeed, there is no clear-cut effect of experience rating on the net output, hence, the suitability of experience rating needs to be analyzed according to the structural specificities of each sector.

4 Conclusion

In this paper, we have explored the impact of UI on the allocation of labor across industries. The theoretical framework provided is an equilibrium search-and-matching model of a segmented labor market that includes endogenous job creation and destruction decisions. To assess the reallocation of labor, we proposed a mechanism that endogenously determines the size of each sector, with the help of the search decisions of the unemployed workers. Our most fundamental finding reconfirms the insight provided by several earlier studies: the employment shares of implicitly subsidized industries are higher than they should be without subsidies. The subsidy occurs because of the imperfection of UI financing. With a payroll taxation scheme, the stabler industries contribute more to the UI system than the UI benefits their workers receive, thus undertaking a portion of the UI cost of the volatile industries. The novelty of our model is that it takes into account both sides of the labor market. Earlier studies have focused on the employment and lay-off decisions of firms and have ignored workers' search decisions. In our framework, changes in the UI system affected the job creation and destruction decisions of the firms as well as the expected utility streams of workers, causing a reallocation of labor.

Due to analytical complexity, the model was solved numerically. Two sets of exercises were provided to this end. First, a more generous UI system financed by payroll taxation was proved to allocate labor from stable sectors to volatile ones. This result stems from the evolution of the implicit subsidies between sectors. At the same time, the unemployment rates increased in all the sectors. Second, unemployment compensation financing was considered through an experience-rated scheme. A higher degree of experience rating implied lower inter-sectorial subsidies. That led to the reallocation of labor in the opposite direction – towards the stable sectors. Furthermore, experience rating was also proved to be a means for decreasing unemployment in all sectors using reasonable parameter values. When we focused on net output, however, the results remained less obvious. Our model suggests that there is no clear-cut experience rating effect on net output. From this standpoint, policy recommendations are likely to change according to the retained efficiency criterion (total unemployment or total output). The suitability of such a financing scheme must, therefore, be carefully designed and in accordance with the structural characteristics of each sector.

Obviously, our model has some limitations that future work should go beyond. First, the reallocation of labor is limited to unemployed workers. Although the job destruction induced by UI implicitly affects the employed workers, an extension of the model, including on-the-job search, could be more instructive. Second, our model focuses on UI and does not take into account other features of "social assistance income support," such as family support and the informal sector. Both are likely to play an important role in developing countries.

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5 Appendix

5.1 Price Equations

The intermediate goods are sold in competitive markets. For given price levels p_i, the profit maximization problem for the final good reads as:

$$\underset{Y_i}{Max}\left(\sum_{i=1}^{n}\alpha_i Y_i^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}-\sum_{i=1}^{n}p_i Y_i.$$

The first order conditions imply the following inverse demand functions:

$$p_i=\alpha_i Y_i^{\frac{-1}{\sigma}}\left(\sum_{i=1}^{n}\alpha_i Y_i^{\frac{\sigma-1}{\sigma}}\right)^{\frac{1}{\sigma-1}}=\alpha_i Y_i^{\frac{-1}{\sigma}}Y^{\frac{1}{\sigma}}.$$

The above equation gives the prices as a function of intermediate goods and the final good.

The production of intermediate goods in sector i is given by $Y_i = L_i\overline{\varepsilon_i}$, where $\overline{\varepsilon_i}$ is the average production per filled job in the sector. Replacing L_i by $N_i(1-u_i)$ and using equation (5), we obtain the price equations alternatively as:

$$p_i=\alpha_i\left(\overline{\varepsilon_i}N_i\frac{\theta_i m(\theta_i)}{\lambda_i F(\varepsilon d_i)+\theta_i m(\theta_i)}\right)^{\frac{-1}{\sigma}}\left(\sum_{i=1}^{n}\left(\overline{\varepsilon_i}N_i\frac{\theta_i m(\theta_i)}{\lambda_i F(\varepsilon d_i)+\theta_i m(\theta_i)}\right)^{\frac{\sigma}{\sigma-1}}\right)^{\frac{1}{\sigma-1}},$$

where the average production $\overline{\varepsilon_i}$ verifies:

$$\overline{\varepsilon_i}=\varepsilon_{u_i}+\int_{\varepsilon_{di}}^{\varepsilon_{u_i}}(\xi-\varepsilon_{u_i})dF(\xi).$$

5.2 Surplus

The surplus associated to a continuing job satisfies the following equation:

$$S_i(\varepsilon)=\Pi_{ei}(\varepsilon)+V_{ei}(\varepsilon)-\Pi_{vi}-V_{ui}+\tau_{ei}.$$

Making use of the free-entry condition $\Pi_{vi} = 0$ with equations (8) and (11), we get:

$$(r+\lambda_i)S_i(\varepsilon) = p_i\varepsilon - \tau + (r+\lambda_i)(\tau_{ei} - V_{ui}) \\ + \lambda_i \left[\int_{\varepsilon_l}^{\varepsilon_{di}} (V_{ui} - \tau_{ei}) dF(\xi) + \int_{\varepsilon_{di}}^{\varepsilon_{u_i}} (\Pi_{ei}(\xi) + V_{ei}(\xi)) dF(\xi) \right].$$

Rewriting this latter expression, the surplus of a continuing job reads as:

$$(r+\lambda_i)S_i(\varepsilon) = p_i\varepsilon - \tau - rV_{ui} + r\tau_{ei} \\ + \lambda_i \left[\int_{\varepsilon_{di}}^{\varepsilon_{u_i}} \left(\Pi_{ei}(\xi) + V_{ei}(\xi) - V_{ui} + \tau_{ei} \right) dF(\xi) \right],$$

and using the unexpended equation given above, the surplus yields:

$$(r+\lambda_i)S_i(\varepsilon) = p_i\varepsilon - \tau - rV_{ui} + r\tau_{ei} + \lambda_i \int_{\varepsilon_{di}}^{\varepsilon_{u_i}} S_i(\xi) dF(\xi).$$

Finally, using the sharing rules, the expected utility of an unemployed worker (9) and equation (16), we can rewrite the surplus as:

$$(r+\lambda_i)S_i(\varepsilon) = p_i\varepsilon - \tau - b - \frac{\theta_i \beta h_i}{1-\beta} + r\tau_{ei} + \frac{\lambda_i p_i}{r+\lambda_i} \int_{\varepsilon_{di}}^{\varepsilon_{u_i}} (\xi - \varepsilon_{di}) dF(\xi).$$

5.3 Efficiency

Instantaneous total production of the economy net of vacancy costs, denoted by Ω, is:

$$\Omega = \sum_{i=1}^{n} (p_i Y_i - h_i V_i).$$

The first term on the right-hand side is the value of the total output of the economy[10]. The second term is the loss due to the searching costs of vacancies

[10] Note that $\sum_{i=1}^{n} p_i Y_i = Y$, given the price equations (2).

and can be alternatively written by $h_i\theta_i U_i$. While optimizing the output, the social planner must consider the inertia in the evolution of unemployment and output in each sector. The problem of the social planner can, therefore, be written by:

$$\underset{\theta_i,\varepsilon_{di}}{Max} \int_0^{+\infty} \Omega e^{-rt} dt$$

subject to:

$$\dot{U_i} = \lambda_i F(\varepsilon d_i)(N_i - U_i) - \theta_i m(\theta_i) U_i \tag{A1}$$

and:

$$\dot{Y_i} = \varepsilon_{u_i}\theta_i m(\theta_i) U_i + \lambda_i (N_i - U_i) \int_{\varepsilon_{di}}^{\varepsilon_{u_i}} (\zeta) dF(\zeta) - \lambda_i Y_i \tag{A2}$$

Equation (A1) is the same with equation (4), and equation (A2) gives the evolution of sectorial output. The first term on the right-hand side is the output of new jobs. The second term is the new output of the existing jobs hit by a shock. Finally, the last term shows the sector's output loss every time a shock occurs.

Hamiltonien of the problem is:

$$\begin{aligned} H &= [p_i Y_i - h_i \theta_i U_i] e^{-rt} + \mu_{i1} [\lambda_i F(\varepsilon d_i)(N_i - U_i) - \theta_i m(\theta_i) U_i] \\ &\quad + \mu_{i2} [\varepsilon_{u_i} \theta_i m(\theta_i) U_i + \lambda_i (N_i - U_i) \int_{\varepsilon_{di}}^{\varepsilon_{u_i}} (\zeta) dF(\zeta) - \lambda_i Y_i] \end{aligned}$$

where μ_{i1} for $i = 1, ..n$ are the multipliers associated to (A1), and μ_{i2} are those associated to (A2). The first order maximization conditions are:

$$\frac{\partial H}{\partial \theta_i} = 0, \frac{\partial H}{\partial \varepsilon_{di}} = 0, \text{ and } \frac{\partial H}{\partial U_i} = -\dot{\mu_{i1}}, \frac{\partial H}{\partial Y_i} = -\dot{\mu_{i2}} \tag{A3}$$

which imply:

$$-h_i e^{-rt} - (\mu_{i1} - \mu_{i2}\varepsilon_{u_i}) [m(\theta_i) + \theta_i m'(\theta_i)] = 0, \tag{A4}$$

$$\mu_{i1}\lambda_i(N_i - U_i)F'(\varepsilon_{di}) - \mu_{i2}\lambda_i(N_i - U_i)\varepsilon_{di}F'(\varepsilon_{di}) = 0 \tag{A5}$$

$$-h_i\theta_i e^{-rt} - \mu_{i1}[\lambda_i F(\varepsilon d_i) + \theta m(\theta)] + \mu_{i2}[\varepsilon_{u_i}\theta_i m(\theta_i) - \lambda_i \int_{\varepsilon_{di}}^{\varepsilon_{u_i}} (\zeta) dF(\zeta)] = -\dot{\mu}_{i1} \tag{A6}$$

$$p_i e^{-rt} - \mu_{i2}\lambda_i = -\dot{\mu}_{i2} \tag{A7}$$

respectively.

Simplifying equation (A5) gives $\mu_{i1} = \mu_{i2}\varepsilon_{di}$. In the steady-state, differentiation of (A4) with respect to time imply $\dot{\mu_{ij}} = -r\mu_{ij}$ for $j = 1, 2$. Substituting this equality in (A6) and (A7) and replacing the μ_{ij} from (A4) after some rearrangements, we obtain two sets of equations that are uniquely solved for the socially efficient θ_i and ε_{di}, such that:

$$p_i\varepsilon_{di} = \frac{h\theta_i\eta(\theta_i)}{1-\eta(\theta_i)} - \frac{p_i\lambda_i}{r+\lambda_i}\int_{\varepsilon_{di}}^{\varepsilon_{u_i}}(\zeta - \varepsilon_{di})dF(\zeta). \tag{A8}$$

$$[1-\eta(\theta_i)]\frac{p_i(\varepsilon_{u_i} - \varepsilon_{di})}{r+\lambda_i} = \frac{h_i}{m(\theta_i)}, \tag{A9}$$

where $\eta(\theta_i) = -\theta_i m'(\theta_i)/m(\theta_i)$ is the elasticity of the matching function with respect to unemployment.

Comparing equations (A8) and (A9) with (15) and (18), we can note that job destruction and creation in the decentralized equilibrium are efficient if $\beta = \eta(\theta_i)$ and $b = \tau = \tau_{ei} = 0$. In other words, when the workers' bargaining power is equal to the elasticity of the matching function, the economy's total net output is maximized, and any unemployment benefit will disturb the efficiency of the economy.

5.4 Robustness Checks

This annex is devoted to analyzing the robustness of our results. The two parameters, which are subject to caution, are taken into account here – the bargaining power of the workers (β) and the elasticity of substitution between intermediate goods (σ). The values of the parameters are iterated for β and σ in the range [0.2, 0.8] and [0.4, 1.9], respectively. Since the paper focuses on the reallocation effects of the UI schemes, a natural criterion for testing the robustness of our results is the size of the sectors. The simulation framework is a two-sector model, therefore, the size of the first sector indirectly implies the size of the second. As in the body of the paper, two sets of exercises have been performed. The first one deals with the introduction of unemployment benefits and the second one with their financing. The results are provided in Tables 5 through 12.

5.4.1 Reallocation and UI Benefits

As for the introduction of the unemployment benefits, the results remain the same qualitatively. The sizes of the transportation and industry sectors continue to decrease and increase respectively with the level of the unemployment benefits when the two parameters are iterated within the range given above.

Table 5 to 8 about here

5.4.2 Reallocation and UI Financing

Concerning the financing of the unemployment benefits, the results also remain the same qualitatively. The sizes of the transportation and industry sectors continue to increase and decrease respectively with the experience rating index when the two parameters are iterated within the range given above.

Table 9 to 12 about here

Sector Size Transportation (HPLT)	$b = 0$	$b = 0.05$	$b = 0.10$	$b = 0.16$
$\beta = 0.2$	0.4068	0.4060	0.4044	0.4012
$\beta = 0.3$	0.4043	0.4027	0.4005	0.3962
$\beta = 0.4$	0.4015	0.3995	0.3967	0.3916
$\beta = 0.5$	0.3987	0.3963	0.3930	0.3868
$\beta = 0.6$	0.3957	0.3929	0.3890	0.3815
$\beta = 0.7$	0.3923	0.3890	0.3842	0.3746
$\beta = 0.8$	0.3878	0.3839	0.3779	0.3638

Table 5: Size of the transportation sector as a function of the bargaining power of the workers and the level of unemployment benefits.

Sector Size Industry (HPHT)	$b = 0$	$b = 0.05$	$b = 0.10$	$b = 0.16$
$\beta = 0.2$	0.5217	0.5224	0.5234	0.5251
$\beta = 0.3$	0.5230	0.5238	0.5249	0.5268
$\beta = 0.4$	0.5239	0.5249	0.5261	0.5283
$\beta = 0.5$	0.5248	0.5258	0.5272	0.5296
$\beta = 0.6$	0.5255	0.5266	0.5282	0.5311
$\beta = 0.7$	0.5261	0.5275	0.5293	0.5329
$\beta = 0.8$	0.5267	0.5283	0.5307	0.5357

Table 6: Size of the industry sector as a function of the bargaining power of the workers and the level of unemployment benefits.

Sector Size Transportation (HPLT)	$b = 0$	$b = 0.05$	$b = 0.10$	$b = 0.16$
$\sigma = 0.4$	0.2773	0.2759	0.2738	0.2695
$\sigma = 0.9$	0.3232	0.3214	0.3188	0.3137
$\sigma = 1.3$	0.3728	0.3706	0.3675	0.3617
$\sigma = 1.5$	0.3987	0.3963	0.3930	0.3868
$\sigma = 1.9$	0.4520	0.4493	0.4456	0.4388

Table 7: Size of the transportation sector as a function of the elasticity of substitution and the level of unemployment benefits.

Sector Size Industry (HPHT)	$b = 0$	$b = 0.05$	$b = 0.10$	$b = 0.16$
$\sigma = 0.4$	0.4916	0.4921	0.4928	0.4943
$\sigma = 0.9$	0.5049	0.5056	0.5066	0.5085
$\sigma = 1.3$	0.5181	0.5191	0.5203	0.5226
$\sigma = 1.5$	0.5248	0.5258	0.5272	0.5296
$\sigma = 1.9$	0.5380	0.5393	0.5409	0.5437

Table 8: Size of the industry sector as a function of the elasticity of substitution and the level of unemployment benefits.

Sector Size Transportation (HPLT)	$e = 0$	$e = 0.2$	$e = 0.5$	$e = 0.8$	$e = 1$
$\beta = 0.2$	0.4012	0.4026	0.4047	0.4066	0.4079
$\beta = 0.3$	0.3962	0.3983	0.4012	0.4040	0.4058
$\beta = 0.4$	0.3916	0.3943	0.3981	0.4017	0.4040
$\beta = 0.5$	0.3868	0.3903	0.3952	0.3998	0.4027
$\beta = 0.6$	0.3815	0.3860	0.3923	0.3981	0.4016
$\beta = 0.7$	0.2943	0.3197	0.3659	0.3974	0.4013
$\beta = 0.8$	0.3638	0.3732	0.3851	0.3951	0.4009

Table 9: Size of the transportation sector as a function of the bargaining power of the workers and experience rating index.

Sector Size Industry (HPHT)	$e = 0$	$e = 0.2$	$e = 0.5$	$e = 0.8$	$e = 1$
$\beta = 0.2$	0.5251	0.5247	0.5242	0.5238	0.5235
$\beta = 0.3$	0.5268	0.5263	0.5256	0.5250	0.5246
$\beta = 0.4$	0.5283	0.5276	0.5267	0.5259	0.5254
$\beta = 0.5$	0.5296	0.5288	0.5276	0.5266	0.5260
$\beta = 0.6$	0.5311	0.5300	0.5285	0.5273	0.5265
$\beta = 0.7$	0.5329	0.5314	0.5295	0.5279	0.5270
$\beta = 0.8$	0.5357	0.5335	0.5309	0.5287	0.5276

Table 10: Size of the industry sector as a function of the bargaining power of the workers and experience rating index.

Sector Size Transportation (HPLT)	$e = 0$	$e = 0.2$	$e = 0.5$	$e = 0.8$	$e = 1$
$\sigma = 0.4$	0.2695	0.2708	0.2725	0.2740	0.2749
$\sigma = 0.9$	0.3137	0.3159	0.3189	0.3216	0.3233
$\sigma = 1.3$	0.3617	0.3647	0.3690	0.3730	0.3754
$\sigma = 1.5$	0.3868	0.3903	0.3952	0.3998	0.4027
$\sigma = 1.9$	0.4388	0.4432	0.4493	0.4550	0.4586

Table 11: Size of the transportation sector as a function of the elasticity of substitution and experience rating index.

Sector Size Industry (HPHT)	$e = 0$	$e = 0.2$	$e = 0.5$	$e = 0.8$	$e = 1$
$\sigma = 0.4$	0.4943	0.4940	0.4937	0.4933	0.4932
$\sigma = 0.9$	0.5085	0.5079	0.5075	0.5066	0.5063
$\sigma = 1.3$	0.5226	0.5219	0.5212	0.5200	0.5194
$\sigma = 1.5$	0.5296	0.5288	0.5280	0.5266	0.5260
$\sigma = 1.9$	0.5437	0.5427	0.5417	0.5399	0.5391

Table 12: Size of the industry sector as a function of the elasticity of substitution and experience rating index.

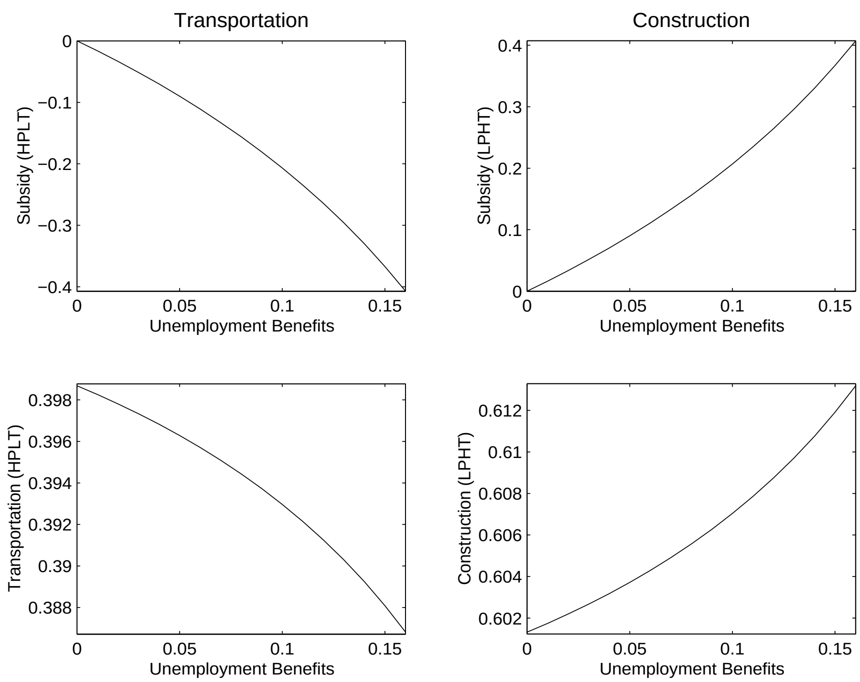

Figure 1: Subsidy and size of the transportation sector and the construction sector as a function of the unemployment benefits.

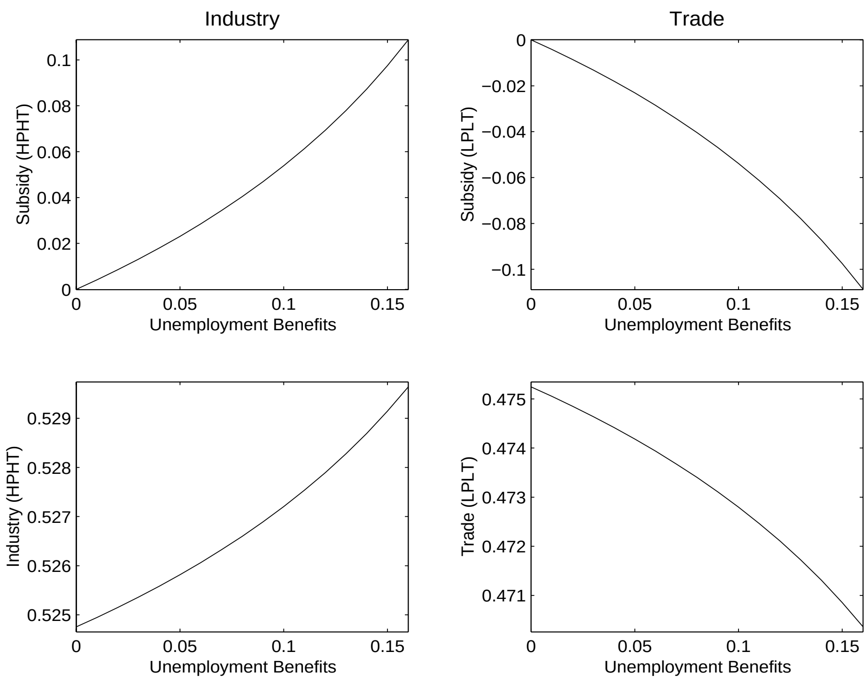

Figure 2: Subsidy and size of the industry sector and the trade sector as a function of the unemployment benefits.

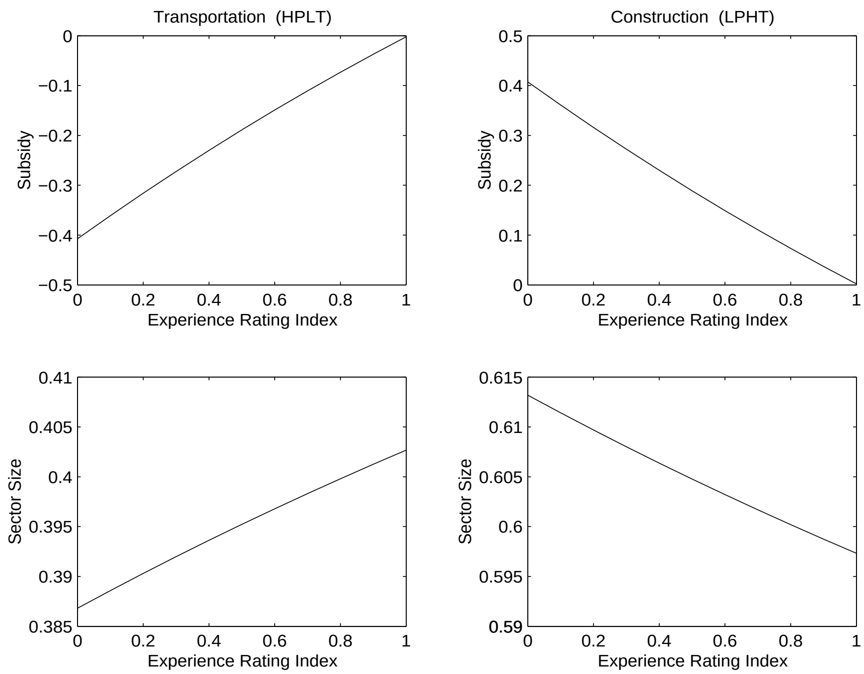

Figure 3: Subsidy and size of the transportation sector and the construction sector as a function of the experience rating index.

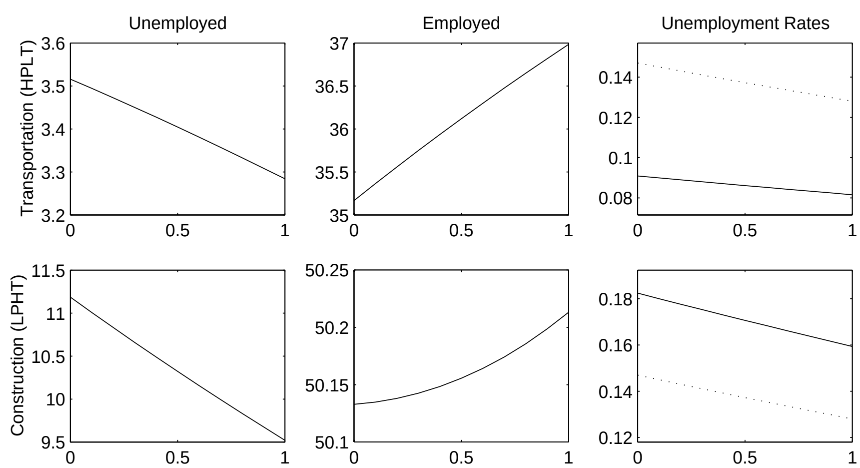

Figure 4: Number of jobless workers, number of workers and unemployment rates as a function of the experience rating index. Dotted lines refer to total unemployment rate.

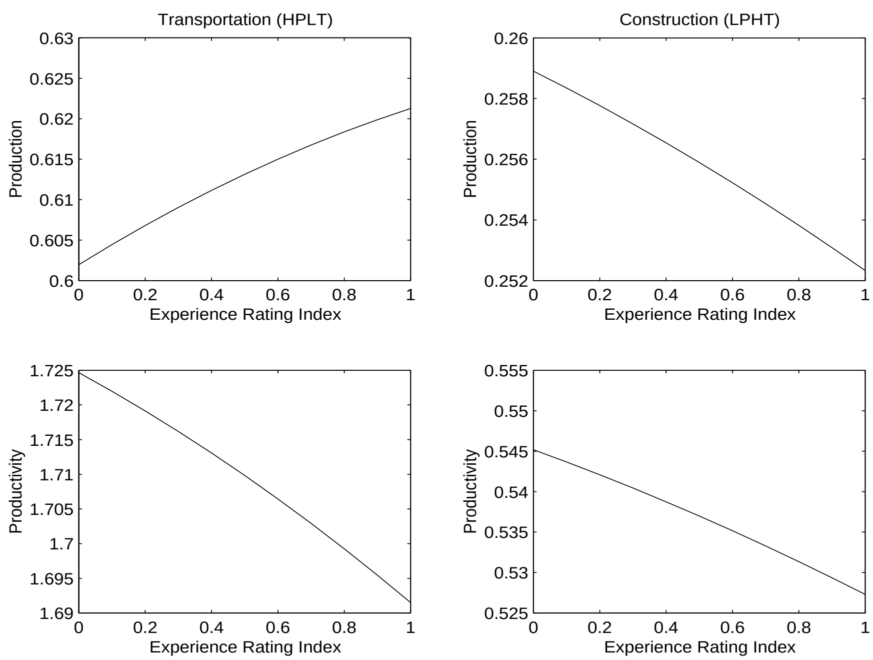

Figure 5: Sectorial production and productivity as a function of the experience rating index.

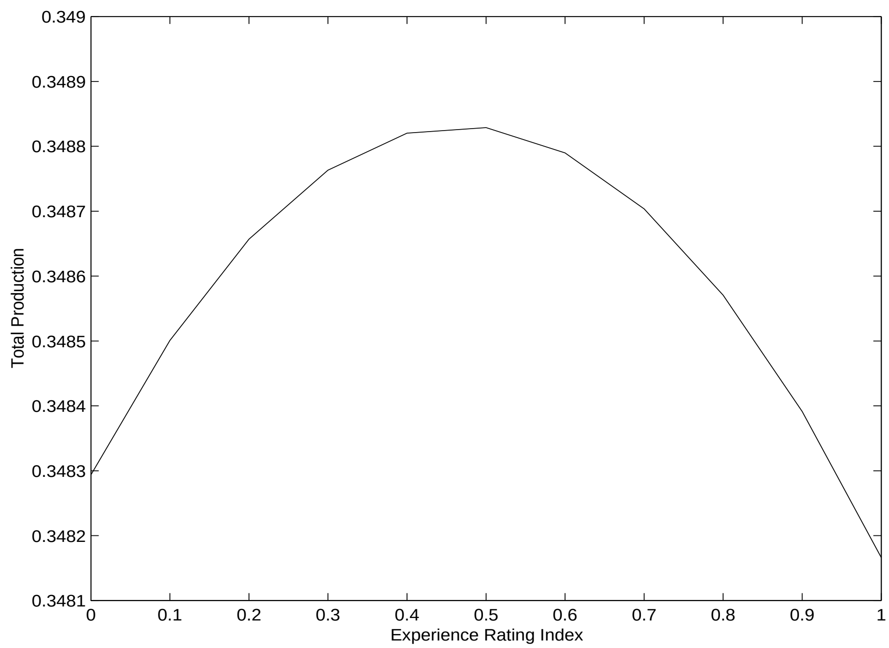

Figure 6: Total production net of vacancy costs as a function of the degree of experience rating.

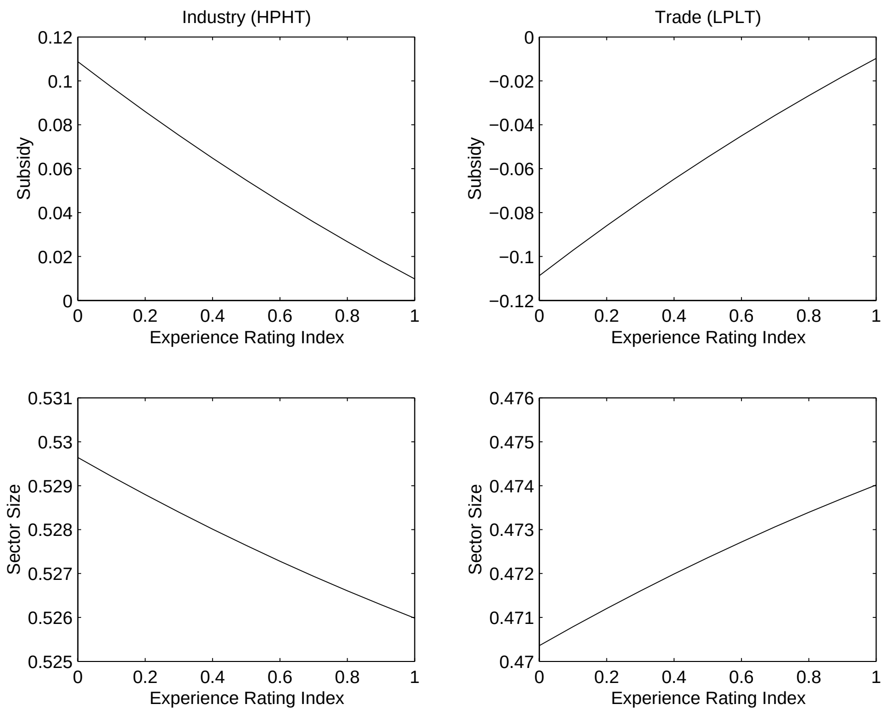

Figure 7: Subsidy and size of the industry sector and the trade sector as a function of the experience rating index.

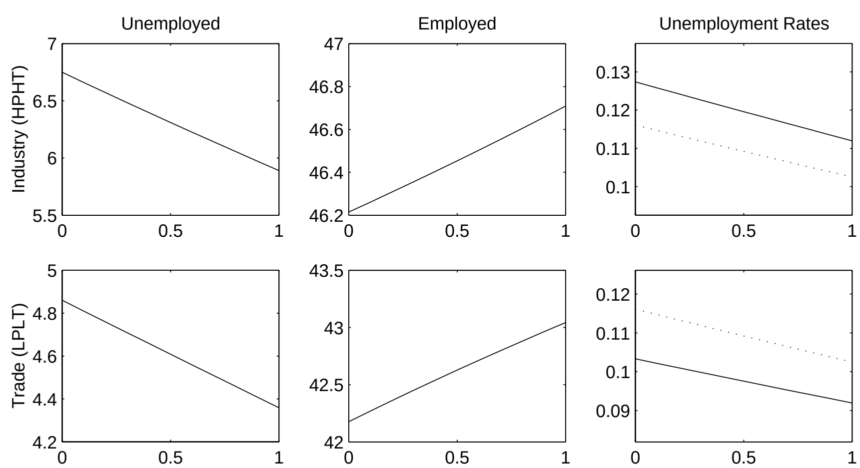

Figure 8: Number of jobless workers, number of workers and unemployment rates as a function of the experience rating index. Dotted lines refer to total unemployment rate.

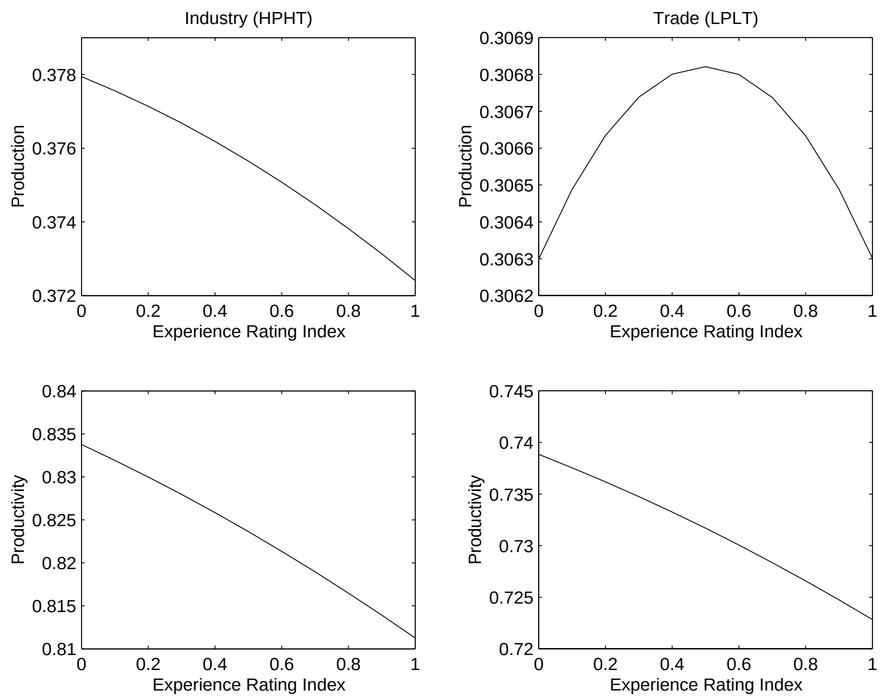

Figure 9: Sectorial production and productivity as a function of the experience rating index.

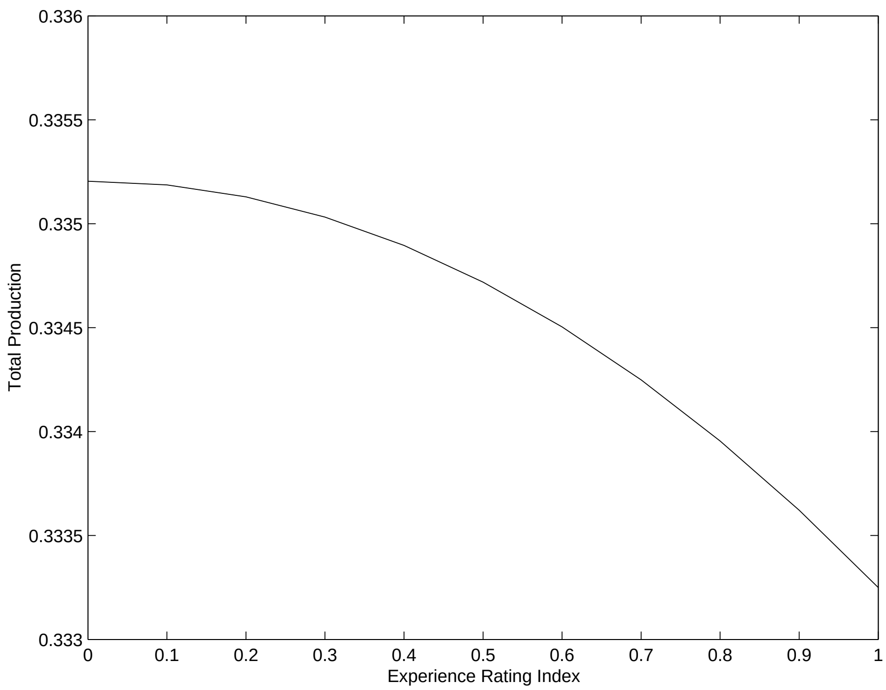

Figure 10: Total production net of vacancy costs as a function of the degree of experience rating.