Skilled and Unskilled Employment in a Spanish Business Cycle Model

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Abstract

We analyze to what extent skill heterogeneity in the labor market with different wage formation mechanisms can explain the features of the Spanish labor market. The model assumes two types of workers with differences in skills. Skilled labor sets wages in an efficiency way while unskilled labor does it through a union. We calibrate the model with Spanish data and assess it to account for differences in the labor market among skilled and unskilled workers.
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1 Introduction

Among European countries, Spain is the one that has the highest rate of unemployment. This high level of unemployment has proved to be one of the most difficult to reduce, although the Spanish labor force is one of the smallest in Europe. One explanation of this may be found in mechanisms that drive the Spanish labor market. This paper aims to furnish a representation of the labor market to account for the heterogeneity as well as the Spanish specifity.

Ortega (1998) analyses the Spanish business cycle related to its main European neighbours. She finds that the Spanish cycle is not different from neighbouring European economies although employment is more volatile. Some features of the Spanish business cycle seem to be especially important in order to characterize and explain its labor market.[1] In particular, it is important to introduce a distinction between skilled and unskilled labor, if we are to explain behaviors in the Spanish labor market. Indeed, some papers (See e.g., Sneessens et al. (1997)) have stressed the importance of heterogeneity to account for the high rate of unemployment in Spain. The Spanish economy has been shown to have an important structural unemployment rate, especially in the low skilled labor market. Although the skilled labor force has increased steadily during the last two decades, it is still much smaller compared to the size of the unskilled labor force. Further, the skilled unemployment rate has also risen during the whole period, but remains lower than the unskilled unemployment rate. A model of business cycles for Spain should take into account its high unemployment rate. This can be implemented using a model of imperfect competition.

To do so, we need to know more about the Spanish labor market in terms of skilled and unskilled labor. Skilled employment is less volatile than unskilled employment, both of them being less volatile than output. Even though both types of labor are procyclical, unskilled labor follows output more closely. Productivity of skilled workers is twice as volatile as that of unskilled workers. Finally, correlation of both types of productivities with output remains high after some periods, almost as high as the instantaneous correlation. All these facts illustrate the need to decouple the skilled and unskilled labor markets. Movements in the skilled labor market seem to be explained by changes in productivity rather than changes in the level of skilled employment, yielding a higher stability of skilled employment compared to unskilled.

The behavior of both types of agents is quite different within the cycle and much can be learned as soon as they are analyzed separately. Skilled workers benefit from high employment protection which ensures a great stability of employment. As a consequence, the adjustment to a shock is essentially done in terms of productivity while employment does not change much. On the other hand, there exist more unskilled workers; given the high rate of unskilled unemployment, this yields a lower employment security. Firms prefer to maintain a stable productivity of their workers, which implies that most of the adjustment is done by varying employment.

[1] Data sources and computation of the Spanish statistics are shown in Appendix I.

All this suggests that this duality on the labor marker is an important stylized fact of the Spanish business cycle that it would be interesting to have a model to account for it. Some articles have begun to include heterogeneity in the labor market. Kydland (1995) considers a RBC model with two types of agents — high and low skilled workers — with different productivities in the production function. He calibrates the model on US data although he points the lack of some heterogeneity measurements out. Some models have reported good results for replicating the Spanish business cycle, e.g., Puch and Licandro (1997). However none of them have tried to replicate the special duality features of the labor market within a RBC framework. This article introduces skill heterogeneity in the Spanish business cycle and compares the results to a benchmark model, Hansen by (1985), calibrated with Spanish data. This allows us to asses what we gain including heterogeneity.

Furthermore, as pointed out by Viñals and Jimeno (1997), the way the salary is determined in Spain can help to explain the special features of the Spanish unemployment rate. Dolado et al. (97) analyze the collective bargaining and wage dispersion in Spain, and find that agreed wages are binding only for semi-skilled and unskilled workers. The present article thus considers two institutional arrangements for the wage setting of skilled and unskilled workers in the Spanish labor market. As the skilled labor force is much smaller than the unskilled labor force, skilled labor wages are set following the efficiency wage theory. The rationality for the special effort function comes from Bewley (1997) who analyzed the wage rigidity through a survey of three hundred business people, labor leaders, business consultants and counselors of unemployed people in the US. According to this theory, firms pay special attention to the morale, which depends on relative wages. Workers not only compare their present wages to one they can earn in some other firm but also to the wage they earned the previous period. The household perceives increases in wages as an approbation and a reward. In this way, the firm promotes high productivity, good morale and a good company reputation which helps future recruiting and reduces turnover costs. On the contrary, workers feel insulted by a pay cut.

Unskilled labor wages are settled by a union. Milner and Nombela (1995) analyze the main union features in Spain. They show that Spain has quite a centralized system of unions. Taken from that article, Table 1 shows data on the presence of unions in Spain:

Table 1: Union Presence in Spain 1978-1990

Year	Employees	% Covered	% Voting
1978	8456.6	53.9	–
1980	8032.5	76.3	–
1982	7733.8	81.2	29.4
1986	7653.9	82.0	43.3
1990	9273.4	82.2	44.7

The number and the percentage of employees represented by the bargaining system has increased over the period considered. This can be explained to be a consequence of compulsory union elections: in Spain, workers have to vote for the unions councils which represent them in the bargaining process with the firm.

Abellán et al. (1997) also analyze implications of the collective bargaining in Spain. The bargaining is done at two levels, regional and sectorial bargaining, which must be accepted by all firms belonging to that sector or region. This leads us to assume in our model that unskilled workers are represented by a centralized union. As we have shown, union agreements are extended to 82% of total employees and are voted by half of them.

This paper allows us to assess whether the proposed wage setting mechanisms are able to reproduce the main features of the Spanish business cycle. We also include a second version of the model with imperfect information, to asses the importance of lags in the response of the economy to technological shocks.

The article is organized as follows: section 2 describes the behavior of the different agents and explains both models. I first consider a model with two types of agents in which unskilled labor sets wages through a union in a complete information setting. I also consider an incomplete information version of this model. In both models the wages and employment of skilled workers are determined through an efficiency wage mechanism. Section 3 deals with calibration of the models. Section 4 analyzes the business cycle properties of the different models. Finally, section 5 concludes.

2 Description of the Economy

This section presents the behavior of the households, the firm and the government. We later present two alternative models, with and without perfect information for the wage setting of unskilled workers. The equilibrium of each economy is then defined.[2]

2.1 The Households

The economy has three types of infinitely-lived households: capitalists, skilled and unskilled workers. Each group differs in size, which is measured by the labor force of each group. N_u denotes the unskilled labor force— *i.e.* unskilled aggregate labor supply, whereas N_s is the aggregate labor supply for skilled workers. The number of capitalists is normalized to one and its consumption is such that the sum of the consumption of the three different types of households in steady state equals total consumption. This procedure takes into account the relative size of the worker's labor force while simplifying the size of the capitalists is not important in the subsequent analysis.

When each individual is born, he perfectly knows the group he belongs to. We further assume that there is neither training nor learning — *i.e.* we consider

[2] Hereafter, aggregate variables are denoted in upper case whereas variables per efficiency units are given in lower case, e.g., $y_t = \frac{Y_t}{X_t}$.

a static heterogeneity among all types of households. All households have the same utility function

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left(C_{j,t} - \overline{C}\right)^{1-\sigma}}{1-\sigma} \tag{1}$$

where β is the subjective discount factor, which will turn out to be the same for the three types of agents. $C_{j,t}$ denotes consumption of each household values and $\overline{C}$ is a minimum level of consumption. $j = s, u, k$ depending on whether the household is skilled, unskilled or a capitalist[3].

Aggregate consumption of the economy corresponds to the sum of optimal consumption of the three groups, taking into account the different size of each group:

$$C_t = N_s C_{s,t} + N_u C_{u,t} + C_{k,t}$$

We assume that workers, skilled and unskilled, have the same time endowment and each offer one unit of labor. They however differ in the way they are hired by the firm. We assume that neither skilled nor unskilled workers have access to asset markets, and are thus liquidity constrained. This assumption implies that there is no risk sharing between workers. While being restrictive, this assumption allows to deal with heterogeneity within groups, as some workers will be unemployed. This prevents to use the perfect insurance mechanism traditionally implemented in dynamic models including unemployment as, e.g., Hansen (1985). On the other hand, the capitalist has complete access to asset markets and can be perfectly insured against bad realizations of the technological shock.

2.1.1 The Capitalist

In each and every period the capitalist chooses how much to consume and how much to save for the next period. Savings are used to form the capital he will rent to the firm.

The capitalist rents capital to the firm and receives $r_t K_t$, r_t being the rental rate paid by the firm in the present period. This revenue is used to consume, $C_{k,t}$, invest, I_t, and pay lump–sum taxes, T_t. We therefore have the following budget constraint:

$$C_{k,t} + I_t + T_t = r_t K_t \tag{2}$$

Investment is used to form capital according to the following law of accumulation

$$I_t = K_{t+1} - (1-\delta) K_t \tag{3}$$

[3] This parameter plays an essential role when solving the problem of the union. Otherwise, the optimality condition would be fully simplified.

where $\delta \in [0,1]$ is the depreciation rate of capital. The capitalist maximizes (1) subject to (2) and (3).

The set of first order conditions defining the optimal consumption and savings plan of the capitalist can be stated as follows:

$$\left(C_{k,t} - \overline{C}\right)^{-\sigma} = \beta E_t \left[\left(C_{k,t+1} - \overline{C}\right)^{-\sigma} (1 + r_{t+1} - \delta)\right] \tag{4}$$

to which we add the following no-Ponzi game condition

$$\lim_{j \to \infty} \beta^{t+j} \left(C_{k,t+1+j} - \overline{C}\right)^{-\sigma} K_{t+1+j} = 0 \tag{5}$$

The relation (4) is the optimal intertemporal decision which states how much capital to accumulate for the next period: The capitalist will postpone consumption up to the point where the expected discounted marginal utility of future consumption equals that of present consumption. Finally, equation (5) furnishes a terminal condition to the evolution of K_t.

2.1.2 The Unskilled Worker

We present in this section the general problem of an unskilled worker. He is completely liquidity constrained and has no access to financial markets. Thus, in every period workers only have to choose how much to consume. They therefore face a static problem. A worker maximizes the utility function (1) subject to the following constraints

$$\begin{aligned} C_{u,t} \leq W_{u,t}(1-\tau_u) & \qquad \text{if employed} \\ C_{u,t} \leq B_{u,t} & \qquad \text{if unemployed} \\ C_{u,t} \geq \overline{C} & \end{aligned}$$

where $W_{u,t}$ denotes the wage the unskilled worker receives during the period. τ_u is the tax rate he pays, this finances unemployment benefits, $B_{u,t}$. This benefit is provided by the government as a fixed proportion, κ_u, of the wage. As $(1 - \tau_u) > \kappa_u$, earnings of an employed worker are always greater than unemployment benefits. We also check that $C_{u,t} \geq \overline{C}$ is always verified for our calibration.

It is worth noting that the wage formation scheme is essential in determining the level of consumption as it will be optimal for the household to consume its entire revenue, net wages or benefit depending on its situation on the labor market. A trade union, with and without perfect information, is used to represent unskilled households.

Trade Union with Perfect Information We consider a Right-To-Manage model. The trade union acts as a monopsonist. It sets the wage, taking the firm's labor demand into account and given the decisions of the other firms. There are three possibilities: to be hired by firm j, to be hired by another firm or to be unemployed. If the worker is hired by firm j, with probability $n_{j,t}$ (the average employment rate) he earns $(1-\tau)W_{j,t}$, the average wage net of taxes. If the worker is not hired by the firm j, he will either remain unemployed during the period, with probability $(1-n_t)$, and receive B_t as unemployment benefits or find a job in another firm, with probability n_t, earning the average wage net of taxes, $(1-\tau)W_t$.

The trade union maximizes the expected utility of its members, given by

$$\begin{aligned}
&n_{j,u,t}N_u \frac{((1-\tau_u)W_{j,u,t}-\overline{C})^{1-\sigma}}{1-\sigma} \\
&+(1-n_{j,u,t})N_u \left[n_{u,t}\frac{((1-\tau_u)W_{u,t}-\overline{C})^{1-\sigma}}{1-\sigma} + (1-n_{u,t})\frac{(B_{u,t}-\overline{C})^{1-\sigma}}{1-\sigma} \right]
\end{aligned}$$

When setting the wage, the union faces a trade-off with employment. It takes the effect of wages on employment as given, via the labor demand

$$W_{j,u,t} = \theta \frac{Y_{j,t}}{n_{j,u,t}N_u}.$$

At a symmetric equilibrium, the wage, $W_{j,u,t}$, and employment, $n_{j,u,t}$, respectively chosen by the trade union and the firm are the same for all trade unions

$$\begin{aligned}
W_{j,u,t} &= W_{u,t} \qquad \forall j \\
n_{j,u,t} &= n_{u,t} \qquad \forall j
\end{aligned}$$

and the optimal wage setting rule is thus

$$\frac{(1-\sigma)(1-\tau_u)W_{u,t}}{((1-\tau_u)W_{u,t}-\overline{C})} = (1-n_{u,t})\left[1-\left(\frac{B_{u,t}-\overline{C}}{((1-\tau_u)W_{u,t}-\overline{C})}\right)^{1-\sigma}\right] \tag{6}$$

This last expression states that the trade union sets the unskilled wage such that the increase in marginal utility it implies is equal to the marginal loss it implies through the decrease in total unskilled employment. Notice that *ex–ante* all members of the union are homogeneous. However *ex–post* some of them will be unemployed, according to a lottery with a uniform probability distribution.

Trade Union with Imperfect Information In the previous section, trade unions had perfect information as to the state of the economy when setting wages. We now introduce a restriction on the information set of the trade union. The union has to set the wage without knowing the current realization of the shock: the union sets the real wage before the technological shock, perfectly known by the firm, occurs. Let $\Omega_t = \left(z_t, K_t, W_{t-1}^u\right)$ denote the complete set of information of the union used in the previous section. The firm knew the level of wages for unskilled and capital from the previous period as well as the current technological shock when it had to make its decisions.

Here, the trade union faces a different information set, $\{\Omega_t^*; \Omega_t^* \subset \Omega_t\}$, such that $z_t \notin \Omega_t^*$. Once the union has set the wage, the shock occurs and the relevant information set is $\Omega_t = \{\Omega_t^*, z_t\}$.

The optimal wage setting rule is then similar to the previous case except that uncertainty is introduced in the employment rule. The firm sets the real wage for unskilled labor but employment will depend on the current shock of the economy, which is not known at that moment. The wage setting rule is then given by

$$\frac{(1-\sigma)(1-\tau_u)W_{u,t}}{((1-\tau)W_{u,t}-\overline{C})} = \left[1 - \left(\frac{B_{u,t}-\overline{C}}{((1-\tau_u)W_{u,t}-\overline{C})}\right)^{1-\sigma}\right] E\left[(1-n_{u,t})|\Omega_t^*\right]$$

The decision of the firm[4] is then conditional on the expectation of employment, $E(n_{u,t}|\Omega_t^*)$, instead of the true value, $n_{u,t}$.

2.1.3 The Skilled Worker

Skilled workers supply all their labor endowment but choose how much effort to devote to work. As the firm cannot directly control the level of effort, it creates incentives to induce workers to increase their effort. Different incentive schemes can be found in the literature. In this paper a dynamic "gift exchange" efficiency wage scheme is assumed. Workers compare their wages with those obtained in previous periods as well as with an alternative wage they could earn in a similar company. This special wage characterization is taken from Collard and de la Croix (1997), who show the dynamic implications of comparisons of current versus previous wages by individuals. Comparisons with salaries earned by peers is also an important mechanism that can lead workers to increase their effort. An explanation for such an effort function, based upon a survey for the U.S., can be found in Bewley (1997), who stresses the importance for workers of real wage comparisons with previous earned wages as well as comparable firms' wages. This affects the standard of living of the households and can be viewed as a kind of incentive or punishment related to the effort devoted.

The utility function depends positively on consumption and negatively on effort, and is separable in the two. The household maximizes its intertemporal utility given by

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{\left(C_{s,t}-\overline{C}\right)^{1-\sigma}}{1-\sigma} - d_t \left(e_t - \phi - \gamma \log\left(\frac{W_{s,t}}{W_{s,t}^a}\right) - \psi \log\left(\frac{W_{s,t}}{W_{s,t-1}}\right)\right)^2\right]$$

[4] A technical issue about how this idea has been implemented can be found in Appendix II.

$C_{s,t}$ and e_t denote respectively skilled consumption and effort, $W_{s,t}$ and $W^a_{s,t}$ are present and alternative wages for skilled workers. ϕ, γ, ψ are positive parameters which determine the effort function. d_t, is a dummy variable which takes the value 1 when the agent is employed and zero otherwise. The household is also submitted to the standard set of constraints

$$\begin{aligned} C_{s,t} &\leq W_{s,t}(1-\tau_s) && \text{if employed} \\ C_{s,t} &\leq B_{s,t} && \text{if unemployed} \\ C_{s,t} &\geq \overline{C} \end{aligned}$$

The alternative wage is given by

$$W^a_{s,t} = n_{s,t}W_{s,t} + (1-n_{s,t})B_{s,t}.$$

and takes only the wage the household can earn out of the firm in a job which matches its skill. Hence, it is not possible to take jobs for which the agent does not have the right skill.

The set of first order conditions defining the optimal consumption and effort plan of each skilled household can be stated as

$$C_{s,t} = W_{s,t}(1-\tau_s)n_{s,t} + (1-n_{s,t})B_{s,t} \quad (7)$$

$$e_t = \phi + \gamma \log\left(\frac{W_{s,t}}{W^a_{s,t}}\right) + \psi \log\left(\frac{W_{s,t}}{W_{s,t-1}}\right) \quad (8)$$

Equation (7) states the optimal consumption for the skilled households when they are employed, $n_{s,t}$, or unemployed, $(1-n_{s,t})$. If they are employed they have to pay a proportion of τ_s of their wage-income as taxes. Equation (8) defines the effort function, which is taken into account in the firms' plan to determine the labor hiring for this kind of workers.

2.2 The Firm

The firm produces a homogeneous good which can either be consumed or invested. The production function is of the Cobb-Douglas type:

$$Y_t = z_t K_t^{\alpha}(X_t N_u n_{u,t})^{\theta}[e_t(X_t N_s n_{s,t})]^{1-\alpha-\theta} \quad (9)$$

where K_t, $n_{s,t}$ and $n_{u,t}$ denote respectively capital, skilled and unskilled employment rate. N_s and N_u denote the size of the labor supply of skilled and unskilled workers. e_t denotes the level of effort which is determined endogenously by the firm and, as will be shown later, is constant within the business cycle. X_t is a variable which implies a exogenous growth as $X_t = \nu X_{t-1}$.

$\alpha \in [0,1)$ represents the elasticity of output with respect to capital, whereas $\theta \in (0,1)$ measures that of unskilled labor. Technology is assumed to be constant returns to scale: $\alpha + \theta + (1-\alpha-\theta) = 1$.

As an efficiency wage mechanism is considered, the firm is no more a price taker, and the economy departs from the Walrasian equilibrium. To choose the wage that optimizes the effort of the workers, the firm takes the effort norm of the workers, equation (8), into account. We assume that the firm has no control on the "social past wage" which is one of the reference wages for the workers. In this setting, past wages are treated as an externality: when skilled wages are set, the firm does not realize that it will influence next period wages and effort, which implies a static problem for the firm. The alternative assumption in which the firm realizes that it can affect next period wages, has been proved but it yields to an unrealistic wage evolution in which wages are not steady but adjust up and down.

z_t represents a technological shock that is assumed to follow an exogenous stationary $AR(1)$ process:

$$\log(z_t) = (1-\rho_z)\log(\overline{z}) + \rho_z \log(z_{t-1}) + \varepsilon_t \tag{10}$$

with $|\rho_z| < 1$ and ε_t is a Gaussian white noise with $E(\varepsilon_t) = 0$ and $E(\varepsilon_t^2) = \sigma_z^2$. $\text{Log}(\overline{z})$ is the unconditional mean of $\log(z_t)$.

The firm chooses K_t, $n_{u,t}$, $n_{s,t}$ and W_s so as to maximize its profit:

$$Y_t - W_{s,t}N_s n_{s,t} - W_{u,t}N_u n_{u,t} - r_t K_t$$

subject to (8) and (9).

The first order conditions are given by

$$r_t = \alpha \frac{Y_t}{K_t} \tag{11}$$

$$W_{s,t} = (1-\alpha-\theta)\frac{Y_t}{n_{s,t}N_s} \tag{12}$$

$$W_{u,t} = \alpha \frac{Y_t}{n_{u,t}N_u} \tag{13}$$

$$N_s n_{s,t} = (1-\alpha-\theta)\frac{Y_t}{e_t}\frac{\gamma+\psi}{W_{s,t}} \tag{14}$$

Equation (11) states that the rate of return of one unit of capital at period t is equal to its marginal productivity. Equations (12) and (13) correspond, respectively, to skilled and unskilled labor demand. Equation (14) defines the rule for the wage of the skilled workers, it states that the firm will increase wages for skilled workers until the marginal cost it implies equals the marginal return of increasing effort.

Taking equations (13) and (14), we end up with a static wage setting behavior which corresponds to the so-called Solow condition:

$$\frac{\partial e(W_{s,t}, W_{s,t}^a, W_{s,t-1})}{\partial W_{s,t}} \frac{W_{s,t}}{e(W_{s,t}, W_{s,t}^a, W_{s,t-1})} = 1$$

This states that the firm considers a wage that keeps the marginal productivity of effort equal to the average productivity. It implies that in this model the firm chooses the real wage such that effort is constant over the business cycle:

$$e_t = \gamma + \psi \tag{15}$$

2.3 The Government

The Government plays a passive role in this economy. It levies a lump-sum tax, T_t, from the capitalists and a proportion of the wage of skilled and unskilled workers, τ_s and τ_u. This amount is used to finance unemployment benefits, distributed to unskilled and skilled households that are unemployed, $B_{u,t}$ and $B_{s,t}$. Each benefit corresponds to a proportion, κ_s and κ_u, of the wage of skilled and unskilled workers, respectively. Taxes, T_t, are collected such that the Government budget constraint is always balanced:

$$T_t + N_s n_{s,t} \tau_s W_{s,t} + N_u n_{u,t} \tau_u W_{u,t} = (1 - n_{s,t}) N_s B_{s,t} + (1 - n_{u,t}) N_u B_{u,t}$$

2.4 The Models

I now consider the two unskilled wage formations previously presented to define two alternative models to be studied in the sequel. The wages modelitation is a good representation for the considered period in Spain. Each model is evaluated as to its ability to mimic the main stylized facts of the Spanish economy that we have already reported.

Model I uses a union with perfect information to set the wage of unskilled workers and an efficiency wage mechanism to set that of the skilled. Given our definition, most of the population is considered as unskilled households. In Spain, labor relationships have created during the considered period a system with strong unions which represent or decide on the labor conditions for this group. Unions are aware of the wages as well as employment of their members. However, they do not bargain on the benefits which are chosen by the government as a proportion of the wage. In Model I, the union perfectly knows the state variables when it chooses wages. More particularly, it observes the state of nature. Thus, a positive shock will increase both wages and employment. Unemployment is microfounded in this model because of the union behavior: the union finds it optimal to set a higher wage than would be optimal in a Walrasian model, so that a firm will be willing to hire less workers than in a Walrasian framework.

The skilled population is smaller than the unskilled one. We assume that the firm creates incentives for its skilled workers to be more productive. This skilled group can be thought of as a managerial factor. They supply the total amount of time they are endowed with but can choose how much effort to devote to those hours. (15) shows that it is essential for the firm to give an incentive to keep workers' effort constant over the whole cycle. As the firm uses the wage to keep the effort constant, it pays higher wages than in a Walrasian model and labor demand is lower than in the Walrasian case. As skilled workers always devote their total amount of leisure, the labor market of skilled labor does not clear, and so unemployment appears.

Model II extends Model I to an imperfect information environment. Unions usually negotiate next's period wage at least one period in advance. When the union bargains on wages, it does not know the current state of nature. When the shock occurs, the wage has already been predetermined for that period, the firm hires the workers taking the shock into account. As no adjustment can be done in prices, it will be done in terms of quantities. The different information set produces a higher volatility of employment and a lower volatility of the unskilled wages. Skilled wage remains determined through fair wage motivations.

2.5 The Equilibrium

The equations characterizing households and firms behavior, provide a set of equilibrium conditions[5]. Both, Model I and II have the same equilibrium conditions, except in terms of the information set considered.

The decentralized equilibrium for each model is a set of policy rules for $\{c_t, i_t, y_t, e_t, n_{s,t}, n_{u,t}, k_{t+1}, w_{s,t}; \text{ for } t \geq 0\}$ such that the equilibrium conditions for each model hold.

3 Calibration

The model is calibrated for the Spanish economy using annual data from 1970 to 1994.[6] We also calibrate Hansen's model with Spanish data to have a benchmark for comparison. Table 3 reports the key ratios of the Spanish economy for the period 1970-1994.

Table 2: Benchmark Values for the Spanish Economy

$\frac{i}{y}$	$\frac{k}{y}$	N_s/N_u	n_s	n_u
0.31	2.61	0.09	0.90	0.87
ν	$\frac{w_s n_s}{y}$	$\frac{w_u n_u}{y}$	$\kappa_s = \kappa_u$	$\tau_s = \tau_u$
1.0204	0.10	0.56	0.42	0.074

ν, the rate of growth of technical progress, is computed as the average rate of growth of output for the period considered. k is the average capital for the same period. The ratio of skilled to unskilled labor supply, N_s/N_u, is used to take the different sizes of both groups into account. All these ratios are benchmark values that are used to calibrate the model.

[5] The conditions for each different model can be seen in Appendix III.

[6] Data series were kindly provided by L. Puch and O. Licandro (1997), as well as by Fonseca and Sneesens (1997). More information on the data can be found in the appendix II.

κ_s and κ_u are known in the literature as replacement ratios, i.e., the earnings of unemployed people compared to the earnings of the employed. Given the available data, the replacement ratio is the average for the period 1970-88. As it cannot be differentiated among skilled and unskilled replacement ratios, the same value is used for both groups. The same procedure is done for tax rates, τ_s and τ_u. In order to compute tax rates we only consider payments by workers and employees to the social security system that cover unemployment benefits. As historical data have not been found, the current tax rate has been used as a proxy for the whole period considered.

The autoregressive parameter, ρ_z, is 0.7 for both models. It is based on an AR(1) process of the technological shock. This is computed as the difference of output and capital and labor with sizes α and $(1-\alpha)$, respectively. The standard deviation of the technological shock, σ_z, is calibrated to replicate the standard deviation of HP-filtered output in the Spanish Economy. This implies that each model is characterized by a different value for σ_z, as shown in table 4.

Table 3: σ_z for the models

Hansen	Model I	Model II
0.0262	0.0225	0.0208

We see that both proposed models are able to reproduce the standard deviation of output with a lower standard deviation of the technological shock compared to Hansen's model. This comes from the fact that both models take heterogeneity into account as well as rigidities in the labor market dynamics.

δ, the physical depreciation rate, is determined using the law of motion of capital:

$$\delta = \frac{i}{y} / \frac{k}{y} + 1 - \nu$$

θ represents in this model the relative factor share of unskilled labor, which is computed from data series

$$\theta = \frac{w_u n_u}{y}$$

and thus takes the value of 0.56. α, the relative factor share of the capital input, is computed from

$$\alpha = 1 - \theta - \frac{w_s n_s}{y}$$

and thus takes the value of 0.35. These values imply a factor share of skilled labor of 0.1. $\beta^* = \beta/\nu^\sigma$, represents the individual discount factor without growth, which is just the inverse of net productivity:

$$\beta^* = \left[\alpha \frac{y}{k} + 1 - \delta\right]^{-1}$$

Finally, the last equation links the interest rate to the individual discount factor as $r = (1-\beta^*)/\beta^*$, which implies a steady state value of $r = 0.035$.

Table 4: Parameters of the model

α	θ	δ	β^*	γ	σ	$\frac{\overline{c}}{w_u}$
0.35	0.56	0.097	0.966	0.9	4/3	0.34

Both Models deal with efficiency wages and so ϕ, γ and ψ have to be calibrated to determine the effort function. The parameter ϕ is calibrated such that skilled employment is 0.9 in steady state, the average employment obtained from the data series. This implies $\phi = \gamma[1+\log((1-\tau_s)n_s+(1-n_s)\kappa_s)]+\psi(1+\log(\nu))$. We have two further parameters to calibrate. γ is set to 0.9 as in Danthine and Donaldson (1990), who propose a static effort function close to the one we use in a dynamic setting. They calibrate γ in their effort function to have a positive correlation with productivity and monetary rewards. According to Collard and de la Croix (1997), ψ is set such that the model mimics the relative standard deviation of skilled employment in the Spanish economy. The performance of our models will be evaluated without reference to this statistical moment. This parameter takes a value of 0.74 for Model I and 0.72 for Model II

$\frac{\overline{c}}{w_u}$ is used to calibrate the parameter $\overline{c}$ in the model. This parameter is positive and refers to the minimum consumption level households want to achieve. The value of $\frac{\overline{c}}{w_u}$ is pinned down such that $\sigma = 4/3$, which is taken from the range of optimal estimated values for the intertemporal substitution of consumption computed in Hansen and Singleton (1982). The value of σ determines the elasticity of substitution of consumption between two periods. This is approximated by $1/\sigma$ and takes a value of 0.75, which is inside the range of values estimated. Larger values for σ imply a lower elasticity, which especially affects the wage setting of the union.

4 Cyclical properties of the model

In this section, we assess whether the proposed models are able to account for the main features, especially those related to the heterogeneity of the Spanish labor market.

We also report a calibration for Spain of Hansen's indivisible labor model (1985), which can be considered as a stochastic general equilibrium benchmark model. To do so, we calibrate that model using the same data sources and ratios of the Spanish economy used in the other two models in order to be able to compare all three. Most of the ratios used are close to the original ones used by Hansen except the ratio k/y, which is lower in our case.

Table 5 reports the relative standard deviation and contemporaneous correlation of HP-filtered aggregate variables in the Spanish economy with their theoretical counterpart. We define productivities as $Pn_i = Y/n_i$, $i = s, u$.

Table 5: Second Order Moments and Correlations with HP filter

	Spanish Data		Hansen		Model I		Model II	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
c	0.82	0.88	0.40	0.80	0.66	0.99	0.64	0.99
i	1.88	0.89	2.60	0.98	1.77	1.00	1.85	0.99
n_s	0.61	0.66	-	-	0.61	0.82	0.61	0.83
n_u	0.83	0.90	-	-	0.90	1.00	0.97	1.00
n	0.81	0.89	0.72	0.94	0.87	1.00	0.93	1.00
Pn_s	0.75	0.79	-	-	0.61	0.82	0.60	0.82
Pn_u	0.44	0.58	-	-	0.10	1.00	0.07	0.41
Pn	0.47	0.61	0.40	0.80	0.13	0.97	0.11	0.62

(1): relative standard deviation with respect to output

(2): present correlation with output

As explained previously, ψ is chosen to match the standard deviation of skilled employment in each model, so that the discussion will not rely on this moment.

Alternatively, a different detrending filter is used to analyze the robustness of the results. Canova (1998) shows how different filters can affect the results of the data. He emphasizes the idea that each filter removes different frequencies from the data and thus can leads to alternative outcomes. Burnside (1998) agrees with Canova in the relevance of the filtering process leading different outcomes. However, he rejects the major influence of the detrending filter in business cycles stylized facts since the definition of "cycles" and "trend" are not unique. It seems clear to analyze the data with several alternative filters to improve the explanation power of the models. In Fiorito and Kollintzas (1994) two alternative detrending methods are used. One is a first order difference process which is often used in econometrics. However, it assumes a unit root process which does not seem to be the case of the data series used here. We therefore only focus on the second filter proposed by Fiorito and Kollintzas, cycles being the residuals from a quadratic trend such as:

$$\log(Y_t) = \alpha + \beta t + \gamma t^2 + \varepsilon_t$$

Table 6 shows the relative standard deviations and contemporaneous correlations with output using this last filter for actual data, for both proposed models and Hansen's benchmark model. As previously, the parameter ψ is chosen to match the actual standard deviation of skilled labor while the standard deviation of the technological shock is chosen such that both models replicate the standard deviation of actual output. The parameter ψ takes values that are larger than those obtained with the previous detrending procedure, while for both models the standard deviations of the technological shock are less than the ones found with the previous filter. This implies that we need to impose less variance on the shock in order to reproduce the standard deviation of actual output, but a larger comparison with previous wages to replicate the standard deviation of the skilled labor.

Table 6: Relative Standard Deviation with a quadratic trend

	Data		Hansen		Model I		Model II	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
c	0.83	0.90	0.56	0.83	0.74	0.99	0.73	0.98
i	1.83	0.89	2.31	0.95	1.62	0.99	1.66	0.99
n_s	0.58	0.67			0.58	0.73	0.58	0.72
n_u	0.83	0.96			0.90	1.00	0.94	0.99
n	0.80	0.95	0.62	0.86	0.86	1.00	0.90	0.99
Pn_s	0.75	0.82			0.70	0.82	0.70	0.82
Pn_u	0.32	0.66			0.10	1.00	0.08	0.76
Pn	0.34	0.70	0.56	0.83	0.14	0.97	0.13	0.81
σ_z			0.022		0.0143		0.0134	
ψ					1.74		1.62	

(1): relative standard deviation with respect to output

(2): present correlation with output

First of all, both models reproduce quite well the lower standard deviation of consumption and the larger standard deviation of investment related to output with both types of filters. They do better than Hansen's because of the liquidity constraint on consumers. As these cannot smooth consumption over time, the response of consumption to the shock is larger and closer to actual moments.

Both models mimic the ranking of relative standard deviation, and more particularly, they generate a higher standard deviation of unskilled labor than that of skilled labor, as is observed in the data. This is explained by the rigidity of unskilled compared to skilled wages, which implies that the main adjustment mechanism is driven by quantity considerations.

The standard deviation of the productivity of skilled labor is larger than that of unskilled labor. Both models reproduce this fact with both types of filters quite well. However, the standard deviation of unskilled productivity is too low compared to that observed in the actual data. This implies that the mechanism mainly adjusts via quantities instead of prices. This last effect biases the standard deviation of total productivity towards too low values.

All these results may be better understood with an analysis of the dynamics of the model. An efficiency wage setting is considered for the skilled workers. The household compares its present wage with the one it earned in the previous period as well as with an alternative one. An increase in current productivity reduces unemployment, yielding a higher alternative wage. By equation (8), the effort devoted by workers reduces. To compensate this effect, the real wage paid by the firm increases. However, it cannot rise too much to prevent effort from increasing by the incentive effect of wages, given that the firm wants to keep effort constant, as equation (15) reflects. This implies that wages rise less than in the competitive case, and that the firm hires more skilled workers. As the shock vanishes, two effects appear. On the one hand, the wage decreases to adjust the effort to the reduction of the alternative wage. On the other hand, as skilled workers compare present to previous wages, the firm cannot decrease the former too much in order to adjust the effort to the high wage it was set in the previous period. Both effects imply a slow adjustment of the skilled wage to its steady state.

For unskilled workers a union is considered. In Model I, unskilled employment deviates less than in Model II because unskilled wages immediately adjust to the shock. On the contrary, Model II displays a fixed unskilled wage, at least in the short run. The unskilled wage adjusts to the shock one period later, which leads employment to react more to the shock than in Model I. The union sets a wage without knowing the realization of the shock. When the shock happens, the union cannot adjust the wage to the new situation, thus the firm will hire or fire more workers than in the perfect information case.

We can conclude from this analysis that both Models I and II are close to the Spanish stylized facts considering both type of filters. In particular, both are able to reproduce the relative higher standard deviation of skilled compared to unskilled labour as well as the standard deviation of skilled productivity. They also do well compared to Hansen's model in the standard deviation of consumption and investment. The novelty of the proposed models is the ability to reproduce the differences among workers, skilled and unskilled, which helps us to understand the main features of the labor market and its relation with the business cycle.

Concerning correlations, they are displayed in tables 5 and 6. We show in Appendix IV eight figures with the past, present and future correlations of four main variables of the labor markets with output as well as the actual data. The first four figures show correlations obtained from the model with the HP filter while the second four figures do it with the quadratic trend filter.

For skilled employment, detrended with the HP filter, the correlations with output from period t-4 to t-1 are below actual correlations while correlations from period t to t+4 closely follow the actual ones. Results are quite different with the quadratic trend filter, which in general compresses the range of values of the correlations for both models. Unskilled employment almost match exactly the hump-shape curve of correlations with the HP filter while it is a bit higher with the quadratic trend filter.

Most of the correlations with output are too high as only one exogenous shock exists. Related to the labor market moments, most of them follows the shape of the actual data, although their absolute values do not match actual ones. Model II reaches the peak with a delay of one period because the wage is settled on before the shock is known. This implies that the adjustment cannot be done in the current period and must be postponed, reducing the current correlation with output.

5 Conclusion

We have shown the importance of taking heterogeneity in the Spanish labor market into account in order to explain several main stylized facts. The labor market has been divided into skilled and unskilled labor, skilled workers being characterized by having a degree. We assume that the difference between both markets lies only in the wage formation mechanism. For the skilled workers we assume a efficiency wage setting, as they are a small group with a very high qualification and are thus rewarded in a fair way in order to be induced to devote a higher effort. On the contrary, unskilled workers, which are most of the population, are represented by a union that sets the wage. We also present a second model in which the union has imperfect information about the current shock when the wage is set. The model improves the results of a benchmark model for the Spanish case and is close to main economic moments for Spain.

Calibrating both models with Spanish data reproduce quite well the Spanish labor market. In terms of correlations, specially the model with imperfect information in order to reproduce the current correlation of unskilled productivity with output reproduce good results. This second model points out the importance of taking lags into account in the response to the shock, as the data show.

Some extra work should be done in order to improve some aspects of the problem. Correlations can be more accurate in absolute terms and some of them are quite far from actual ones. This comes from the fact that we only use one kind of shock, a technological one. Results could be improved by adding an additional shock, e.g., a government expenditure which follows a stochastic process.

The analysis of the Spanish labor market should not neglect the different features of workers in terms of skills, education or contracts. This would help to implement specific economic policies for different groups as a function of their features.

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7 APPENDIX I: Spanish Data

This section explains the way data are collected and how moments for the Spanish economy are computed.

Data for employment and labor force participation are collected from “encuesta de población activa” (Active population survey), on the Instituto Nacional de Estadística[7]. They range from 1964 to 1995[8] and are collected by level of studies. The skilled group consists of people with a university degree. This classification is applied to unemployment and labor force participation data. A better approach would be to classify the workers according to job they have and the level of skill required by. However no data on this are available at the moment.

Data for wages are collected from "encuesta de structure salarial" (survey of wage structure) and measures "ganancia media por trabajador/año" (average yearly earnings per worker). Those data are collected by level of studies. The definition of skilled and unskilled wage is consistent with the previous one on employment. However, only one year survey (1995) exists, the skilled-unskilled wage ratio is computed from it. To improve the analysis, longer data series would be needed.

The remaining data comes from Contabilidad Nacional Española.[9] They range from 1970:1 to 1994:4, 100 quarters. These are added to put them in annual terms, the data the model uses. Then, we have data on durable consumption, non durable consumption, investment, public expenditures, exports, imports and variation of inventories. Output is the sum of internal demand, plus exports less imports.

Non durable consumption is considered as household consumption. Investment is the sum of investment and durable consumption.

The current model considers a closed economy and neglects the public sector as well as inventories. This implies that output is the sum of consumption plus investment (as defined previously).

The moments for the Spanish economy are computed with a method advocated by Uhlig (1995). We only consider data from 1970 to 1994, 25 observations. All original data that were given in quarterly terms have been summed to work in annual terms. All series are detrended with a Hodrick-Prescott filter assuming a value of $\lambda = 400$. This is the value of λ used in Correia, Neves and Rebelo (1992) to have yearly series.

8 APPENDIX II: Union with Imperfect Information

The algorithm we use begins each period with the solution of the model with perfect information. This gives a decision rule for the unskilled wage, which depends on the state variables

$$\widehat{w}_{u,t} = \pi_{wu,k}\widehat{k}_t + \pi_{wu,z}\widehat{z}_t + \pi_{wu,wu}\widehat{w}_{u,t-1}$$

[7] I thank R. Fonseca for providing data related to the labor market.

[8] We only consider 1970:1 to 1994:4.

[9] I thank L. Puch for providing data. A better explanation about how they were arranged can be found in L. Puch and O. Licandro (1997).

As information is imperfect, the union takes the best predictor conditional on the information it has at the moment of the decision

$$\widehat{w}_{u,t} = \pi_{wu,k}\widehat{k}_t + \pi_{wu,wu}\widehat{w}_{u,t-1} + \pi_{wu,z}E_t(\widehat{z}_t/\widehat{z}_{t-1})$$

This implies a new decision rule for the unskilled wage

$$\widehat{w}_{u,t} = \pi_{wu,k}\widehat{k}_t + \pi_{wu,wu}\widehat{w}_{u,t-1} + \pi_{wu,z}\rho_z\widehat{z}_{t-1}$$

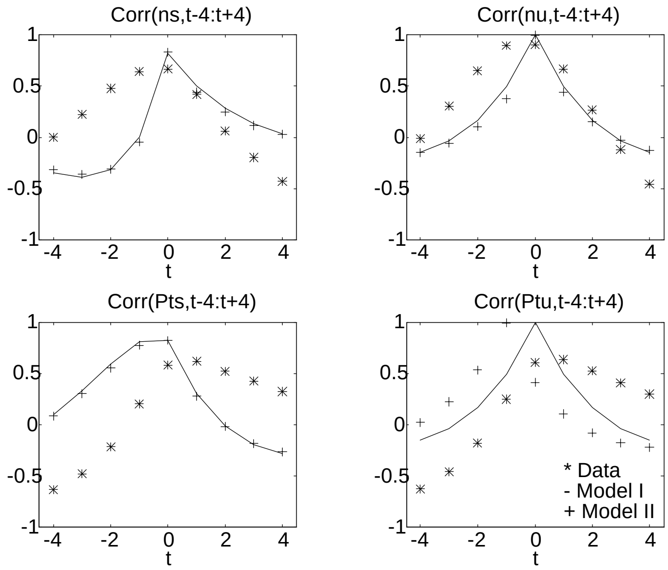
Apart from this new decision rule, the rest of the policy rules are the same.

9 APPENDIX III: The equilibrium conditions

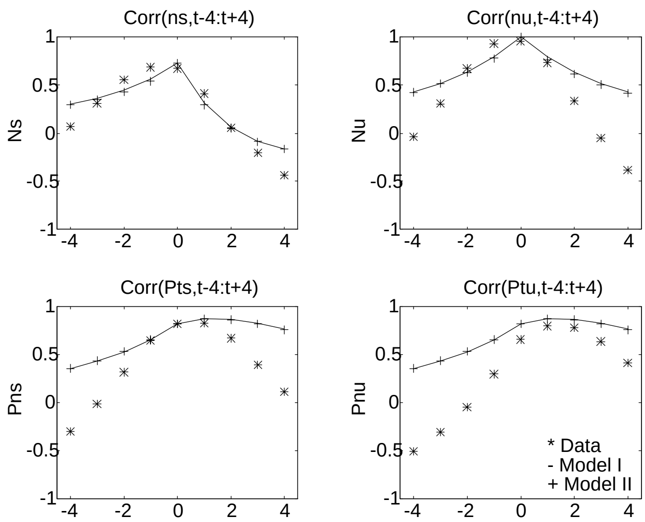
In this appendix we show the identical equilibrium conditions for Models I and II,

$$(c_{k,t} - \overline{c})^{-\sigma} = \lambda_t$$
$$c_{s,t} = w_{s,t}(1 - \tau_{s,t})n_{s,t} + (1 - n_{s,t})b_{s,t}$$
$$c_{u,t} = w_{u,t}(1 - \tau_{u,t})n_{u,t} + (1 - n_{u,t})b_{u,t}$$
$$e_t = \phi + \gamma \log\left(\frac{w_{s,t}}{w_t^a}\right) + \psi\left[\log\left(\frac{w_{s,t}}{w_{s,t-1}}\right) + \log(\nu)\right]$$
$$w_{s,t} = (1 - \alpha - \theta)\frac{y_t}{n_{s,t}}$$
$$w_{u,t} = \theta\frac{y_t}{n_{u,t}}$$
$$w_{u,t} = \frac{((1 - \tau_u)w_{u,t} - \overline{c})(1 - n_{u,t})}{(1 - \sigma)(1 - \tau_u)}\left[1 - \left(\frac{b_{u,t} - \overline{c}}{((1 - \tau_u)w_{u,t} - \overline{c})}\right)^{1-\sigma}\right]$$
$$b_{u,t} = \kappa_u w_{u,t}$$
$$\lambda_t = \beta^* E_t\left[\lambda_{t+1}\left(\alpha\frac{y_{t+1}}{k_{t+1}} + 1 - \delta\right)\right]$$
$$y_t = z_t k_t^{\alpha} n_{u,t}^{\theta}(e_t n_{s,t})^{1-\alpha-\theta}$$
$$y_t = c_{k,t} + N_s c_{s,t} + N_u c_{u,t} + i_t$$
$$T_t = (1 - n_{s,t})b_{s,t} + (1 - n_{s,t})b_{u,t} - n_{s,t}\tau_s w_{s,t} - n_{u,t}\tau_u w_{u,t}$$
$$\nu k_{t+1} = i_t + (1 - \delta)k_t$$
$$w_t^a = n_{s,t}(1 - \tau_s)w_{s,t} + (1 - n_{s,t})b_{s,t}$$
$$b_{s,t} = \kappa_s w_{s,t}$$
$$\log(z_t) = (1 - \rho_z)\log(\overline{z}) + \rho_z \log(z_{t-1}) + \varepsilon_t$$
$$e_t = \gamma + \psi$$

10 APPENDIX IV: Figures



Correlations with the HP Filter



Correlations with the Trend Filter