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Spanish Unemployment Persistence and the Ladder Effect

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Abstract

This paper aims to examine to what extent a “ladder” e.ect may contribute to explain changes in unemployment -skilled workers who do not find a job that matches their skills, accept jobs that were previously occupied by less qualified staff. We develop a dynamic general equilibrium model. The model is then calibrated for the Spanish economy. Our results replicate the observed decline in the ratio of high to low-skilled vacancies, and explain how firms substitute high for low-skilled employment. These results also suggest that in the Spanish case, ladder e.ect can be better explained by increases in training costs interpreted as a biased-shock against low-skilled workers.

Keywords: Matching models, low-skilled unemployment, mismatch

JEL Classification: E24, J64

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1 Introduction

Since the last seventies, there has been a reduction in the demand for low-skilled relative to highly skilled workers in many industrialised countries (see OECD (1994)). This phenomenon is usually accompanied by a deterioration of economic conditions of low–skilled workers. In Europe, this problem has manifested itself in a large increase in the unemployment rate together with an increase in the duration of unemployment for low–skilled relative to highly skilled workers (Drèze and Sneessens (1997)). In the US and UK, this phenomenon is associated with greater wage inequality across skill groups (see Krugman (1994)). It is also generally observed that many workers in Europe have obtained high levels of education. This latter phenomenon has led to a structural change in the composition of the labour force, which has essentially taken place for new entrants in the labour market (see Robinson and Manacorda (1997)).

The large increases in low-skilled unemployment rates in the EU countries may be explained in different ways. One standard explanation is "skill mismatch" resulting from relative wage rigidities in the face of biased technological shock. Another explanation arises from job competition between highly and low-skilled workers: by applying to low-skilled jobs, highly skilled workers manage to increase their probability to get a job displacing low-skilled ones- the so-called "ladder effect". Firms may wish to hire highly skilled workers for low-skilled jobs, for instance, to avoid training cost (see Thurow (1975)), or because they have a high productivity (see Gautier (1999)). The fact that highly skilled workers may occupy low-skilled positions has been documented in several countries (see Van Ours and Ridder (1995), and Muysken and Ter Weel (1998), for the Netherlands, and Green *et al.* (1999), for the UK).

This explanation is particularly relevant for Spain where the proportion of educated workers has sharply increased after 1980 (see García Montalvo (1995), and Blanco (1997)). Specifically it increases more from middle of the 1980's than before. For instance, EPA (Spanish Labour Population Survey) data shows that in 1988 only 17.3% of the labour force attained upper–secondary schooling and 28.4% in 1996.[1] In Table 1, we categorise employment and unemployment rates into educational and occupational categories. The Table shows that the ratio of the highly to low–skilled labour force averages about 30% and that it rose considerably during the period 1988-1996. At the same time, the unemployment rate of the low–skilled workers rose too. For instance, illiterate workers and those with primary and low-secondary schooling have experienced a marked increase in unemployment rates (from 19% in 1988 up to 23% in 1996). In the same period, the proportion of low-skilled jobs filled by highly skilled workers rose from 9.8% in 1988 to 15.1% in 1996.[2]

Alba-Ramirez (1993), finds that Spanish highly skilled workers on low-skilled jobs are

[1] More information about composition of the labour force by education in appendix A.

[2] We have analysed these proportions for the whole of the economy. Although the ladder effect is relevant in all groups of workers, it seems to have a stronger importance in women and young workers than in among older men.

mainly young skilled workers, without experience, who need a first job in order to obtain on-the-job training. After some time, they become the main job turnover group, which implies they move into jobs that require higher educational levels than their original ones. García-Serrano and Malo (1996), analyse the substitutability between education and on-the-job training. They conclude that Spanish firms hire highly skilled workers to reduce investment in specific human capital formation. Beneito *et al.* (1996), also conclude that in Spain education is a substitute for on-the-job training, and suggest that this fact is a source of inefficiency in the allocation of resources by generating overeducation'.[3]

The aim of this paper is to examine to what extent a ladder effect may contribute to explain changes in the unemployment rate and unemployment differences across skill groups in Spain. To this aim, we develop an intertemporal general equilibrium model with two types of workers (highly and low-skilled)) and two types of jobs. We distinguish two kinds of shocks: (i) a demand shock and (ii) a supply shock. The first case, a general training shock, can be interpreted as a skill-biased technological shock against low-skilled workers as well as a supply shock. Production technology is such that highly skilled jobs can be filled only by educated workers, while low–skilled jobs may be filled by both types of workers. Following Pissarides (2000), we assume that trade in the labour market is represented by a matching process with a Nash wage bargain. There are three matching functions [4] for each sort of employment. Highly skilled workers look for highly skilled jobs, but if they do not find them, they look for low-skilled jobs as a temporary stop gap.

We find that the "ladder effect" increases after each shock. However, employment and vacancies variables have not the same importance and evolution facing each shock. The model can replicate the observed decline in the ratio of highly to low–skilled vacancy rates. This decline is best explained by a decrease in both types of vacancies, as produced by a training cost change. Moreover, the evolution of the decrease in low-skilled employment is better reproduced by introducing training cost changes than highly skilled labour force changes.

The second section presents the model, showing the specific circumstances that generate a ladder effect. The third section describes the data and our calibration procedure. The forth section analyses the response of some key variables to (i) the introduction of a training cost for low-skilled workers and (ii) an increase in the relative size of the highly skilled labour force. We evaluate the implications of these shocks on the model steady state, thereby enabling us to perform comparative static exercises. We study transitional dynamics. The last section offers some concluding remarks.

[3] These studies use different data surveys and estimation methods.

[4] Dolado *et al.* (2000), build a matching model closely related to our approach. Their results focus on the youth overeducation in Spain. Their model exogenously set the wages mechanism whereas our model sets wages in a Nash bargaining process. This is important in terms of posting vacancies and in the evolution of endogenous probabilities.

2 A model of the ladder effect

2.1 Trade in the labour market

We consider an economy with of two types of workers: highly skilled and low–skilled. Highly skilled workers can perform low–skilled jobs, whereas low–skilled workers are unproductive in highly skilled jobs. In each period there are L^h highly skilled workers and L^l low–skilled workers. L^h and L^l are exogenous. Because firms observe the workers' skill level, low–skilled workers can only apply to low–skilled jobs. Highly skilled workers can apply to both types of jobs. This creates an asymmetry among workers pertaining to the competition between highly and low–skilled workers on the low–skilled job markets, which is the source of the ladder effect. Although there are no differences in terms of productivity between highly and low-skilled workers when working on a low–skilled job, firms can incur into a general training cost whenever they hire low–skilled workers.

All variables $V^{\tau}_{j,t}$, $U^{\tau}_{j,t}$, $N^{\tau}_{j,t}$ and $H^{\tau}_{j,t}$ where $j, \tau \in \{h, l\}$ are ratios divided by their corresponding labour force. Let $N^h_{h,t}$ denote the proportion of highly skilled workers working as highly skilled, $N^h_{l,t}$ denote the proportion of highly skilled workers working as low-skilled, and U^h_t denote the highly skilled unemployment rate. We have

$$N^h_{h,t} + N^h_{l,t} + U^h_t = 1.$$

Likewise, denote N^l_t and U^l_t the proportion of low–skilled working and unemployed. We have

$$N^l_t + U^l_t = 1.$$

Following Pissarides (2000), we assume that trade in the labour market is an uncoordinated and costly activity. Whenever a firm posts vacancies only a fraction of each of them will be filled – $V^h_{j,t}$ and $V^l_{j,t}$ vacancies rate highly skilled and low-skilled jobs respectively. We take a constant returns to scale the Cobb-Douglas matching function relating the number of matches to the number of vacancies and the number of job seekers.

We assume that high-skilled workers. This group can fill highly skilled jobs or low-skilled jobs. And low-skill educated workers can fill only the rest of low-jobs not filled by highly skilled workers.

We distinguish two matching functions to fill low-skilled jobs: workers with more education take first low-skilled vacancies. We assume that the efficiency matching factors of highly skilled workers will be larger than the efficiency matching factor of low-skilled workers.

Let us now be more precise on the timing of events, and first consider highly skilled workers. A given highly skilled individual first looks for a highly skilled job, such that $H^h_{h,t} \equiv H^h_h \left(V^h_t, U^h_t + N^h_{l,t}\right)$ are formed in period t. Implicit in this formulation is the fact that job seekers are composed of highly skilled workers who do not work in highly skilled jobs in period t.

When the highly skilled job seeker does not match with a firm in period t, she goes on the low–skilled labour market and attempts to get a match as a low–skilled worker.

Then, $H^h_{l,t} \equiv H^h_l \left(V^l_t L^l / L^h, 1 - N^h_{h,t+1}\right)$ are formed on this market. The level of low–skilled vacancies posted by firms has to be adjusted for the relative size of the two populations, in order to preserve the absence of size effects in the matching process.

Finally, low–skilled workers can be employed on a low–skilled job — not already occupied by highly skilled workers — such that the level of hirings for the low–skilled is $H^l_t \equiv H^l \left(V^l_t - H^h_{l,t} L^h / L^l, U^l_t\right)$, where only those vacancies not filled by the highly skilled workers remain available to the low–skilled workers. Like the previous case, the ratio L^h/L^l adjusts for the different sizes of each group.

It is worth noting that, as in Pissarides (2000), each matching function only depends on aggregate quantities, thus reflecting the fact that firms and job seekers have no control on the matching process. This assumption reflects the existence of the traditional positive trade externalities and congestion effects, associated with the matching process. The evolution of the level of each type of employment is therefore given by:

$$N^h_{h,t+1} = H^h_{h,t} + (1-s)N^h_{h,t} \tag{1}$$

$$N^h_{l,t+1} = H^h_{l,t} \tag{2}$$

$$N^l_{t+1} = H^l_t + (1-\mu)N^l_t \tag{3}$$

where $s, \mu \in (0,1)$ denote the constant exogenous separation rates for each type of employment. The second law of motion (equation (2)) represents the fact that highly skilled workers do not occupy a low–skilled job for more than one period, but rather go back on the search. We can interpret it as a temporary job for highly skilled workers, which is consistent with the high turnover rate for this group of workers. Since 1984, in Spain one third of the level of unemployment comes from temporary jobs.[5]

$p^h_{h,t}$ is the probability that a highly skilled unemployed worker will be employed in a highly skilled job in the next period; $p^h_{l,t}$ is the probability that a highly skilled unemployed worker will be employed in a low-skilled job; and p^l_t is the probability that a low-skilled unemployed worker will be employed in a low-skilled job in the next period. Thus:

$$p^h_{h,t} = \frac{H^h_{h,t}}{U^h_t + N^h_{l,t}},\ p^h_{l,t} = \frac{H^h_{l,t}}{1 - H^h_{h,t} - (1-s)N^h_{h,t}} \text{ and } p^l_t = \frac{H^l_t}{U^l_t}. \tag{4}$$

In Figure (**??**) we can observe flows in and out of employment. Below we express the unemployment dynamic to explain the evolution in both labour markets:

$$U^h_{t+1} = 1 - H^h_{h,t} - H^h_{l,t} - (1-s)N^h_{h,t}$$

$$U^l_{t+1} = 1 - H^l_t - (1-\mu)N^l_t.$$

[5]We have checked that the total destruction rate is consistent with our calibration of separation rate of highly skilled workers in a low-skilled job. For more details see Section 3.2.

	1988	1990	1992	1994	1996
high-sk. emp. as high-skilled. (N_h^h)	36.9	39.7	40.2	41.5	45.3
high-sk. emp. as low-skilled.(N_l^h)	42.3	45.0	43.6	36.5	34.6
high-sk. unemployment (U^h)	20.6	15.2	16.1	21.9	20.0
low-sk. emp. as low-skilled.(N^l)	80.7	83.4	80.9	75.0	76.9
low-sk. unemployment (U^l)	19.2	16.5	19.0	24.9	23.0
rat. high ov. low-skilled. popul. (L^h/L^l)	20.8	24.6	28.3	33.5	39.5
ladder effec. ind. ($N_l^h L^h/(N_l^h L^h + N^l L^l)$)	9.8	11.7	13.2	14.0	15.1

Source: Own calculations from EPA data. The superscript denotes the education: high-skilled (h) and low-skilled (l). The subscript indicates the occupation. Education:h=superior and upper secondary and l=low secondary, primary and without studies. Occupation h=range 1-3 in EPA classification (see appendix B) and l=range 0 and range 4 to 9 from EPA classification.

Table 1: Labour rates by education-occupation (%)

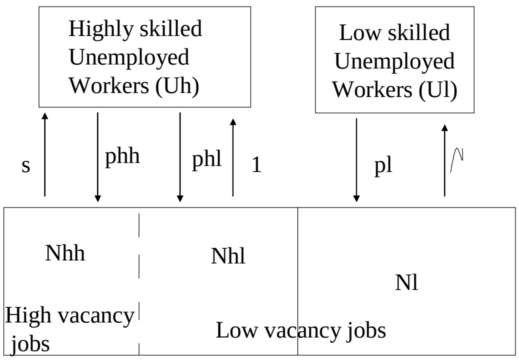

Figure 1: Flows in and out of employment

2.2 Firms

We assume a continuum of firms with measure one. In each period, the jth firm has access to a constant returns to scale technology represented by the following production function:

$$Y_{j,t} = AK_{j,t}^{\alpha}(L^h N_{h,j,t}^h)^{\theta} \left(L^h N_{l,j,t}^h + L^l N_{j,t}^l\right)^{1-\alpha-\theta} \tag{5}$$

where $K_{j,t}$ is the level of physical capital, $N_{h,j,t}^h$ is the highly skilled employment rate in high-skilled jobs, $N_{l,j,t}^h$ is the low–skilled employment rate in low skilled jobs and $N_{j,t}^l$ is the employment rate of low-skilled workers in low-skilled jobs. We assume there is perfect substitution in terms of productivity between low-skilled workers and highly skilled workers in order to fill a low-skilled job. The value of A is a positive constant that represents the level of total factor productivity. Finally, $\alpha,\ \theta \in (0,1)$ respectively denote the elasticity of output with regards to physical capital and highly skilled employment.

Each period, the firm invests a level $I_{j,t}$ to form capital that standardly accumulates as:

$$K_{j,t+1} = I_{j,t} + (1-\delta)K_{j,t} \tag{6}$$

where $\delta \in (0,1)$ is the constant depreciation rate. It also posts vacancies. $V_{j,t}^h$ and $V_{j,t}^l$ are vacancies rates for respectively highly and low–skilled jobs, and the firm incurs a linear cost ϖ_h and ϖ_l per posted vacancy. These vacancies determine the employment that will be used in the following period. The law of motion of each type of employment are given by:

$$N_{h,j,t+1}^h = q_{h,t}^h V_{j,t}^h + (1-s)N_{h,j,t}^h \tag{7}$$

$$N_{l,j,t+1}^h = q_{l,t}^h V_{j,t}^l \frac{L^l}{L^h} \tag{8}$$

$$N_{j,t+1}^l = q_t^l \left(1-q_{l,t}^h\right) V_{j,t}^l + (1-\mu)N_{j,t}^l \tag{9}$$

where $q_{h,t}^h$, is the probability of filling highly skilled vacancies, $q_{l,t}^h$, is the probability of filling a low–skilled vacancy with a highly skilled individual and q_t^l, is the probability of filling a low–skilled vacancy with a low–skilled worker. These probabilities are thus given by

$$q_{h,t}^h = \frac{H_{h,t}^h}{V_t^h},\ q_{l,t}^h = \frac{H_{l,t}^h}{V_t^l}\frac{L^h}{L^l} \text{ and } q_t^l = \frac{H_t^l}{V_t^l - H_{l,t}^h L^h/L^l}. \tag{10}$$

It is worth noting that these probabilities are determined by aggregate quantities and thus reflect the trade externalities implied by the search process. $w_{h,t}^h$, $w_{l,t}^h$ and w_t^l are the bargained wages. And finally, when hiring a low–skilled worker, the firm has to train her and therefore incurs a proportional cost $\varkappa$ per hiring. We suppose that a low-skilled worker needs training when she is hired in a new firm, (i.e. it can lead to a change in technology). We also suppose that a highly-skilled worker has an exogenous general skill from her education, which avoids this training cost.

The period t instantaneous profit can be expressed as[6]

$$\begin{aligned}\Pi_{j,t} &= Y_{j,t} - w^h_{h,t}N^h_{h,j,t}L^h - w^h_{l,t}N^h_{l,j,t}L^h - w^l_t N^l_{j,t}L^l \\ &\quad -I_{j,t} - \omega_h V^h_{j,t}L^h - \omega_l V^l_{j,t}L^l - \varkappa H^l_t L^l\end{aligned} \tag{11}$$

Each firm j determines its factor demand and investment plan— both on the good and the labour market — maximising its market value:[7]

$$\Upsilon(S^F_{j,0}) = \sum_{t=0}^{\infty} \mathcal{R}_t \Pi_{j,t}$$

subject to (5)–(11) where $\Upsilon(S^F_{j,0})$ denotes the value of firm $\mathcal{R}_t = \prod_{\tau=0}^{t}(1+r_\tau)^{-1}$ and r_t is the real interest rate. Finally, the set of each firm's state variables is $S^F_{j,t} = \{K_{j,t}, N^h_{h,j,t}, N^h_{l,j,t}, N^l_{j,t}\}$. Hereafter $X^k_{j,t}$, $X^h_{h,j,t}$, $X^h_{l,j,t}$ and $X^l_{j,t}$ will denote the Lagrange multipliers associated to the capital and employment laws of motion respectively. The first order conditions associated with the control variables investment, $I_{j,t}$ and vacancies, $V^h_{j,t}$ and $V^l_{j,t}$, are given by

$$X^k_{j,t} = 1 \tag{12}$$

$$q^h_{h,t}X^h_{h,j,t} = \omega_h \tag{13}$$

$$q^h_{l,t}X^h_{l,j,t} + q^l_t(1-q^h_{l,t})X^l_{j,t} = \omega_l + \varkappa q^l_t(1-q^h_{l,t}). \tag{14}$$

Equation (12) represents the optimal level of investment, the marginal cost of capital goods for the firm that is one. Equation (13) represents the optimal level of highly–skilled vacancies posted by a firm. It states that the firm will post highly–skilled vacancies up to the point where the expected marginal value of filling an additional highly–skilled job ($q^h_{h,t}X^h_{h,j,t}$), is just compensated by the marginal cost to post a highly–skilled vacancy (ω_h). The first order condition (14), the marginal value for the firm to fill a low-skilled job receives a similar interpretation, up to the point the marginal cost of posting a vacancy is complemented by an additional cost of training to hire a low-skilled worker. If we suppose no training cost $\varkappa$ then $q^h_{l,t}X^h_{l,j,t} + q^l_t(1-q^h_{l,t})X^l_{j,t} = \omega_l$. A part of the left side is the expected marginal value corresponding to fill the vacancy with a highly-skilled worker and the other part the expected marginal value corresponding to fill the vacancy with a low-skilled worker. Both depending on their different probabilities to fill this vacancy.

The parameters will be chosen in a such a way that the firm prefers highly–skilled workers to low–skilled ones to fill a low-skilled vacancy[8]:

$$X^h_{l,j,t} \geqslant X^l_{j,t}. \tag{15}$$

[6] After rearranging, $\varkappa H^l_t L^l = \varkappa q^l_t V^l_t L^l - \varkappa q^l_t H^h_{l,t} L^h = \varkappa q^l_t (1-q^h_{l,t}) V^l_t L^l$.

[7] The interested reader is lead to Appendix A.1 for the optimality conditions associated to the firm's problem.

[8] We have checked that assumption 15 is validated ex-post.

2.3 Households

We now present the behaviour of each type of household — highly–skilled and low–skilled, indexed by i. Following Andolfatto (1996), households of the same type are assumed to be identical *ex ante*. The random matchings and separations in the labour market induce different states in the labour market which can lead to *ex post* heterogenous wealth positions, which would then make the problem intractable as we would have to keep track of each individual story. For the sake of simplicity, we assume that there exists a perfect insurance market, which allows risk averse households to fully insure against the different income fluctuations and labour market transitions. We assume that the labour force is randomly assigned across jobs at the beginning of each period. Thus, the representative household assumption can be made and the probability of employment status in any period is given by the different proportions of the employment status. A detailed description of the household problem with full insurance is provided in Appendix A.2.

2.3.1 Low–skilled households

In each period, a low–skilled household i can be in two alternative states in the labour market. We assume that it is employed with probability N_t^l and unemployed with probability $U_t^l = 1 - N_t^l$. Depending on the state, the instantaneous utility function of the low–skilled household i is given by:

$$\begin{aligned} u_{i,t}^l &= \log(C_{i,t}^l - \Gamma^l) \quad \text{if employed} \\ u_{i,t}^{l\star} &= \log(C_{i,t}^{l\star} - \Gamma^{l\star}) \quad \text{if unemployed} \end{aligned}$$

where $C_{i,t}^l$ and $C_{i,t}^{l*}$ respectively denote the level of consumption of an employed and unemployed low–skilled household. Γ^l and Γ^{l^*} represent a utility cost — expressed in terms of physical goods — associated with the state in the labour market. This cost is assumed to be constant over the business cycle.

The household enters the period with a level of assets $B_{i,t}^l$ carried over from the previous period, from which she gets interest revenues. When employed, the household receives the real wage, w_{ijt}^l, bargained with the firm. When unemployed, she receives an unemployment insurance associated with the insurance contract signed with an insurance company.[9] These revenues are then used to consume $C_{i,t}^l$ or $C_{i,t}^{l\star}$, and to buy new assets. Households take fully insurance against the different income fluctuations and labour market transitions. A perfect insurance system avoids the loss of wealth associated unemployment.[10] They Therefore, the consolidated budget constraint after the insurance

[9] Appendix A.2 proves that households will choose to be fully insured against the risk of unemployment.

[10] Where the optimal insurance after optimatisation of the problem is:

$$\varrho_{it}^l = w_{ij,t}^l + \Gamma^l - \Gamma^{l^*}.$$

and after the insurance the marginal utility functions of individuals are the same but the consumption values are different, such as $C_{it}^l = C_{it}^{l^*} + \Gamma^l - \Gamma^{l^*}$.

contract faced by the low–skilled household[11] is

$$N_t^l C_{i,t}^l + (1 - N_t^l) C_{i,t}^{l\star} + B_{i,t+1}^l \leq N_t^l w_{ijt}^l + (1 + r_t) B_{i,t}^l. \tag{16}$$

The problem of the representative household i is therefore to maximise the expectation of the discounted sum of its instantaneous utility with respect to the consumption and the assets she holds:

$$\sum_{t=0}^{\infty} \beta^t \left\{ N_t^l u_{i,t}^l + (1 - N_t^l) u_{i,t}^{l\star} \right\}$$

subject to equation (16).

2.3.2 Highly–skilled households

Like low–skilled households, a highly–skilled household faces different states in the labour market. She can be either employed as a highly–skilled worker with probability $N_{h,t}^h$, employed as a low–skilled worker with probability $N_{l,t}^h$, or unemployed with probability $U_t^h = 1 - N_{h,t}^h - N_{l,t}^h$. For each state, the instantaneous utility function of the highly–skilled household i is given by:

$$\begin{array}{rcll} u_{h,i,t}^h & = & \log(C_{h,i,t}^h - \Gamma^h) & \text{if employed as high–skilled} \\ u_{l,i,t}^h & = & \log(C_{l,i,t}^h - \Gamma_l^h) & \text{if employed as low–skilled} \\ u_{i,t}^{h\star} & = & \log(C_{i,t}^{h\star} - \Gamma^{h^*}) & \text{if unemployed} \end{array}$$

where $C_{h,i,t}^h$, $C_{l,i,t}^h$ and $C_{i,t}^{h^*}$ respectively denote the employed household's consumption when she works as a highly–skilled or low–skilled worker and her consumption when unemployed. Γ^h represents a cost, in terms of physical goods, associated with the highly–skilled working activity. Γ_l^h and Γ^{h^*} are the same costs previously defined for low-skilled households. These costs are assumed to be constant over the business cycle.

The consolidated budget constraint after the insurance contract faced by the highly–skilled worker is similar to that faced by the low–skilled. Now however, the household may be in three alternative states

$$\begin{array}{rl} & N_{h,t}^h C_{h,i,t}^h + N_{l,t}^h C_{l,i,t}^h + U_t^h C_{i,t}^{h\star} + B_{i,t+1}^h \leq \\ \leq & N_{h,t}^h w_{h,ijt}^h + N_{l,t}^h w_{l,ijt}^h + (1 + r_t) B_{i,t}^h. \end{array} \tag{17}$$

The highly–skilled worker solves the same problem as the low–skilled worker. She maximises the discounted sum of its instantaneous utility with respect to consumption and the assets she holds:

$$\sum_{t=0}^{\infty} \beta^t \left\{ N_{h,t}^h u_{h,i,t}^h + N_{l,t}^h u_{l,i,t}^h + U_t^h u_{i,t}^{h\star} \right\}$$

subject to equation (17).

[11] Implicit in this formulation is that the insurance problem has already been solved.

2.4 Wage determination

Following Pissarides (2000), we assume that wages are determined by a Nash bargaining process between the firm and the household. The rent is shared according to the Nash solution of the bargaining problem. Because of the coexistence of different types of workers, there are different wage bargaining processes which give rise to different levels of wages. At the beginning of every period, there is a re-negotiation between firms and workers.

Let ξ_h^h, ξ_h^l and ξ^l denote the exogenous parameters, which measure the bargaining power of highly–skilled households applying for highly–skilled and low–skilled jobs and low–skilled workers, the level of wages in a symmetric equilibrium can be shown to be:[12].

$$\begin{aligned} w_{ht}^h &= \xi_h^h \left(\theta \frac{Y_t}{L^h N_{ht}^h} + p_{ht}^h X_{ht}^h \right) + \\ & \quad + (1-\xi_h^h) \left(\Gamma^h + \frac{N_{lt}^h}{1-N_{ht}^h} (w_{lt}^h - \Gamma_l) \right) \end{aligned} \tag{18}$$

$$w_{lt}^h = \xi_l^h \left((1-\alpha-\theta) \frac{Y_{jt}}{L^h N_{l,jt}^h + L^l N_{jt}^l} \right) + (1-\xi_h^h)\Gamma^l \tag{19}$$

$$w_t^l = \xi^l \left((1-\alpha-\theta) \frac{Y_{jt}}{L^h N_{l,jt}^h + L^l N_{jt}^l} + p_t^l X_t^l \right) + (1-\xi^l)\Gamma^l \tag{20}$$

which just amounts to the standard total rent sharing rule between the participant of the bargaining process. The firm acquires the gain in marginal labour productivity and the expected marginal value of a newly created job, $X_{h,t}^h$ and X_t^l. When a highly-skilled worker is in a low-skilled vacancy, the separation rate is 1, and the gain for the firm is only the marginal labour productivity. The share accrued by the worker is given by the differential in the disutility of work. It is worth noting that for the highly-skilled worker, who fills a highly-skilled vacancy takes into account the disutililty of work and of working in a low-skilled vacancy.[13]

2.5 Equilibrium

A perfect foresight equilibrium of this economy is a sequence of prices $\{\mathcal{P}_t\}_{t=0}^{\infty} = \{w_{h,t}^h, w_{l,t}^h, w_t^l, r_t\}_{t=0}^{\infty}$ and a sequence of quantities $\{\mathcal{Q}_t\}_{t=0}^{\infty} = \{\{\mathcal{Q}_t^H\}_{t=0}^{\infty}, \{\mathcal{Q}_t^F\}_{t=0}^{\infty}\}$. $\{\mathcal{Q}_t^H\}_{t=0}^{\infty} = \{C_{h,t}^h, C_{l,t}^h, C_t^{h^*}, C_{it}^l, C_{it}^{l^*}, B_t^h, B_t^l\}_{t=0}^{\infty}$ and $\{\mathcal{Q}_t^F\}_{t=0}^{\infty} = \{Y_t, I_t, K_t, N_{h,t}^h, N_{l,t}^h, N_t^l, V_t^h, V_t^l\}_{t=0}^{\infty}$ such that:

(i) given a sequence of prices $\{\mathcal{P}_t\}_{t=0}^{\infty}$, $\{\mathcal{Q}_t^H\}_{t=0}^{\infty}$ is a solution to the representative household's problem;

(ii) given a sequence of prices $\{\mathcal{P}_t\}_{t=0}^{\infty}$, $\{\mathcal{Q}_t^F\}_{t=0}^{\infty}$ is a solution to the representative firm's problem;

[12] See appendix A.3 for a detailed exposition of the bargaining process

[13] Notice as well that $\Gamma^{l^*} = \Gamma^{h^*} = 0$ and $\Gamma^l = \Gamma_l^h$.

(iii) given a sequence of quantities $\{\mathcal{Q}_t\}_{t=0}^{\infty}$, $\{\mathcal{P}_t\}_{t=0}^{\infty}$ clears the goods markets in the sense

$$Y_t = C_t + I_t + \varpi_h V_t^h L^h + \varpi_l V_t^l L^l + \varkappa H_t^l V_t^l$$

and the capital markets.[14]

(iv) wages are set according to the rent sharing mechanism.

(v) labour market flows are determined by hiring functions, $H_{h,t}^h$, $H_{l,t}^h$ and H_t^l.

3 Data and calibration

We are now to analyse the response of some key variables following two alternative types of shocks: either a relative labour demand shock (changes in training costs) or a relative labour supply shock (changes in proportion of highly skilled workers).

Since the model has no any analytical solution, we rely on numerical simulations of the model. The model is calibrated for Spanish data. Simulation exercises are solved with the DYNARE sofware developed by Juillard (1996).[15]

3.1 The data

The model is calibrated for Spanish quarterly data. Macroeconomic time series are borrowed from Puch and Licandro (1997), who elaborated on the National Accounts of the Spanish Economy (Contabilidad Nacional de España). Aggregate consumption is given by the sum of non-durable consumption and government expenditures, and investment is the sum of durable consumption and fixed investment.

In order to obtain data consistent with the measure of the "ladder effect" problem, we rely on the Linked Labour Population Survey (Encuesta de Población Activa enlazada, EPA hereafter). This quarterly survey collects panel data of individuals during six consecutive quarters periods. The sample runs from 1987:1 to 1996:4. It covers a large number of individuals and characteristics, such as formal education attainment, occupation, employment status, age and gender. It defines 5 groups of education and 10 groups of occupation (range 0–9). highly skilled workers are defined, for our purpose, as those with a level of education greater or equal to upper-secondary education. Therefore, low–skilled workers essentially consist of illiterate and uneducated workers, primary or low–secondary educated workers. highly skilled occupations are taken to be managers, professionals and technicians and support professionals (range 1–3 in EPA classification), the rest (range 0,4–9 in EPA are armed forces, clerks, service, skilled agricultural/fishing,

[14] Where C_t is equal to the sum of different households consumption taking into account their different labour market probabilities.

[15] More about DYNARE and the underlying relaxation algorithm can be found in Laffargue (1990) and Boucekkine (1995).

Craft-Transport, Plant-Manufacture and unskilled group) is taken to define low–skilled occupations.[16]. Ratios are reported in Table 2.

Aggregated Ratios and Probabilities		
capital/output ratio	k/y	9.8458
investment/output ratio	i/y	0.2877
consumption/output ratio	c/y	0.6923
high–skilled workers in high–skilled occupations	N_h^h	0.4027
high–skilled workers in low–skilled occupations	N_l^h	0.4102
low–skilled workers in low–skilled occupations	N^l	0.7958
prob. for a high–skilled to find a high–skilled job	p_h^h	0.0526
prob. for a high–skilled to find a low–skilled job	p_l^h	0.0915
prob. for a low–skilled to find a low–skilled job	p^l	0.1384
ratio high over low–skilled population	L^h/L^l	0.2847
Not filled high–skilled vacancies over high–sk. labour force	$V_h^\star$	0.0093
Not filled low–skilled vacancies over low–sk.labour force	$V_l^\star$	0.0082

Table 2: Aggregated Ratios and Probabilities (average)

The "ladder effect" is measured as the percentage of highly educated workers who occupy a job with low–skilled requisites (N_l^h in our model). Finally, those highly educated workers in a highly skilled occupation and those low educated workers in a low–skilled occupation are represented as N_h^h and N_l^l, respectively. The highly skilled (low–skilled) population, L^h (L^l), is given by the sum of highly (low) educated employed and unemployed workers.

Table 2 reports the probability of finding a job for each type of individual. For our estimations and stylised facts we have used the definitions of education and occupation in the linked EPA survey.[17] For instance, p_h^h (or p_h^l) — the probability that a highly skilled unemployed individual finds a highly skilled (or a low–skilled job) — is measured as the proportion of highly educated unemployed workers who find a highly skilled (low–skilled)

[16] More detailed employment data in Appendix B.

[17] The proportions and probabilities data are that we have used to solve the model (except to $p_{l,t}^h$ value set in steady state, see calibration section).

job from one period to the other. Likewise, the probability that a low–skilled unemployed finds a (low–skilled) job, p^l is measured as the proportion of low–skilled unemployed who are employed in a (low–skilled) occupation from one period to other, corrected by total population.

Vacancies are measured by the number of vacancies not filled at the end of period as reported by the National Employment Office (INEM). These data also range from 1987:1 to 1996:4 and are categorised in terms of occupations following the same definition as EPA data for employment.[18] They are taken in terms of proportion of the high-skilled or low-skilled total population.

3.2 Calibration

Table 3 reports the calibrated value of behavioural parameters. These values are obtained from the model to their empirical counterpart. For instance, the different elasticities of output are set in steady state to be a constant returns to scale Cobb-Douglas. The discount rate, β, is set such that, using the Euler equation associated to the capital accumulation decision, the model matches a capital/output ratio of 9.8 — obtained from Spanish Quarterly data. Likewise, the depreciation rate, δ, is 0.0292.

Cost of vacancies ω_l and ω_h are set in steady state. We suppose that the cost of being unemployment is $\Gamma^{h^*} = \Gamma^{l^*} = 0$. We also suppose that the cost of working in a low-skilled job is the same for both high and low skilled worker. Those together with the cost of working as highly-skilled worked in a highly-skilled job Γ^h are set in steady state. It is supposed that $\Gamma^h > \Gamma^h_l = \Gamma^l > \Gamma^{h^*} = \Gamma^{l^*}$.

Training costs are set to zero in our benchmark case, but a sensitivity analysis to changes in this parameter will also be considered. The total factor productivity is set such that, in steady state, output is equal to 1.

γ, the elasticity of the matching process with regards to the number of vacancies is assumed to be the same in each function and is set to $\gamma = 0.5$,.[19] which lies within the range of estimated values for the Spanish economy. The bargaining power of households ($\{\xi^j_i\}_{i,j\in\{h,l\}}$) is also set to *0.5*, such that it is equal to the elasticity of matching with respect to vacancies. As shown in Hosios (1990), this implies that the Nash bargaining process yields a Pareto optimal allocation of resources.

First of all, the three matching functions are specified as

$$
\begin{aligned}
H^h_{h,t} &= \overline{H}^h_h (V^h_{h,t})^\gamma (1 - N^h_{h,t})^{1-\gamma} \\
H^h_{l,t} &= \overline{H}^h_l \left(V^h_{h,t} \frac{L^l}{L^h} \right)^\gamma (1 - N^h_{h,t+1})^{1-\gamma} \\
H^l_t &= \overline{H}^l \left(V^l_t - \frac{L^h}{L^l} H^h_{l,t} \right)^\gamma (1 - N^l_t)^{1-\gamma}
\end{aligned}
$$

[18] National definitions according with R.D. 2240/79 from 14 of August. Using by INEM and EPA.

[19] We suppose that $\gamma = 0,5$. Unlike *Chapter 3*, what we aim to collate in a simple way in a baseline model are the heterogeneity of agents with skill disparities.

Behavioural parameters

elasticity of output wrt capital	α	0.3471
elasticity of output wrt high–skilled labour	θ	0.1143
depreciation rate	δ	0.0292
discount factor	β	0.9940
cost of posting low-vacancies	ω_l	0.8626
cost of posting high-vacancies	ω_h	0.0652
cost of working in a high-job	Γ^h	0.7314
cost of working in a low-job	$\Gamma_l^h = \Gamma^l$	0.5363
cost of no working	$\Gamma^{h^*} = \Gamma^{l^*}$	0.0000
training costs	$\varkappa$	0.0000
total factor productivity	A	0.6083
elasticity of matching w.r.t. vacancies	γ	0.5000
bargaining power	$\{\xi_i^j\}_{i,j\in\{h,l\}}$	0.5000

Table 3: Behavioural parameters

In the steady state, we set $H^h_{l,t} = N^h_{l,t}$. Given probabilities of finding a job, and the level of the employment rates, we are able to compute the average number of hirings as

$$H^h_h = p^h_h(1 - N^h_h), \text{ and and } H^l = p^l(1 - N^l).$$

In order to solve the model, we get the value of p^h_l at steady state using the probability of finding a low-skilled job by a highly skilled workers $p^h_{l,t} = \frac{H^h_{l,t}}{1-H^h_{h,t}-(1-s)N^h_{h,t}}$. These numbers can then be used to calibrate $\overline{H}^h_h$, $\overline{H}^h_l$ and $\overline{H}^l$ in steady state respectively. As we have remarked in the description of the model, we assume that firms prefer to hire a highly skilled worker in a low-skilled job, that is the efficiency factor of the matching function $\overline{H}^h_l$ is higher than the other parameters and its influence can be seen in that their wages become more competitive.

The exogenous quit rates are calibrated using equations (7)–(10) evaluated in steady state. Therefore, we obtain

$$s = \frac{H^h_h}{N^h_h} \text{ and } \mu = \frac{H^l}{N^l} \; .$$

The separation rate for highly skilled workers in a highly skilled job s, is larger than the separation rate for low-skilled workers, μ. This is consistent as a high turnover rate in the skilled workers. We set the separation rate for highly skilled workers in a low-skilled job to the value of one. In our economy, the total destruction is about 11%. This is consistent with the average of destruction rate for Spanish firms in Díaz-Moreno and Galdón (2000).[20]

Skilled and unskilled vacancies, V^h and V^l, are defined as the sum of highly and low–skilled hirings and unfilled highly and low–skilled vacancies. This permits obtaining the probability that a firm fills a highly skilled vacancy with a highly skilled worker, q^h_h and the probability of filling a low–skilled vacancy with a highly or low–skilled worker, q^h_l and q^l, as defined in equation (10). Wage variables are set in steady state. Notice that highly skilled wages are highest. And slightly low-skilled wages larger that highly skilled wages when the worker is highly educated in a low-skilled job. These numbers are reported in Table 4.

4 Analysis of results

This section proposes an analysis of the response of some key variables characteristic of the labour market to exogenous permanent shocks to *(i)* the training cost of low-skilled workers and *(ii)* the relative size of the highly skilled labour force. We first perform a static exercise assessing the steady state implications of such changes in the model. We then study the transitional dynamics delivered by the model in the face of such shocks. This comparative analysis enables us to offer some insights on the role played by the ladder effect in Spanish unemployment dynamics.

[20] They estimate quaterly job flows for Spanish economy for the period 93:II to 95:I.

Labour market variables and probabilities		
hirings of high–sk. workers for high–skilled jobs	H_h^h	0.0314
hirings of high–sk. workers for low–skilled jobs	H_l^h	0.0547
hirings of low–sk. workers for low–skilled jobs	H^l	0.0282
effi. factor of high–sk. workers for high–sk. jobs	$\overline{H}_h^h$	0.2014
effi. factor sk. workers for low–sk. jobs	$\overline{H}_l^h$	0.7234
effi. factor sk. workers for low–sk. jobs	$\overline{H}^l$	0.3275
prob. of finding a low-sk. jobs by a high-sk. work.	p_l^h	0.6867
wages of high-sk. workers for high-skilled jobs	w_h^h	0.9027
wages of high-sk.workers for low-sk. jobs	w_l^h	0.5632
wages of low-skilled workers	w^l	0.5801
high–skilled separation rate	s	0.0780
low–skilled separation rate	μ	0.0355
prob. firm fills h-skilled vac. with h-skilled workers	q_h^h	0.7715
prob. firm fills l-skilled vac. with h-skilled workers	q_l^h	0.7620
prob. firm fills l-skilled vac. with low–skilled workers	q^l	0.7751
high–skilled vacancies	V^h	0.0407
low–skilled vacancies	V^l	0.1532

Table 4: Calibrated parameters (Labour Market)

4.1 Demand side: training cost

We model the relative demand shock as a change in the cost of training new low-skilled employed.[21] This change in the training cost may be seen as a consequence of a technological change. We assume that highly skilled workers do not require training: Given their education level, we assume that they have exogenous general skills. In our model the increase of this training cost can be interpreted as a skilled-biased technological shock against low-skilled workers. Highly skilled workers are willing to accept low-skilled vacancies temporarily. Despite their high separation rates, firms hire highly skilled workers to avoid general training costs inherent to the hiring of low-skilled workers. This training cost affects employment asymmetrically. An increase in this training cost decreases total employment but more largely low-skilled employment.

Thus, we now analyse the effects of a permanent increase in the training cost paid by the firm when hiring a low–skilled worker, $\varkappa$. Figures 2–3 report the effects of a permanent shock in $\varkappa$ ranging from values 0.0 to 0.2, on the steady state of some key variables characterising the labour market.

An increase in $\varkappa$ induces firms to reduce low-skilled employment. It therefore increases the marginal value of low-skilled jobs, and decreases the marginal values of highly skilled ones (see Figures 2 and 3). As the wage bargaining process implies that wages are strongly correlated with the marginal productivity of employment, the real wage paid to highly skilled workers when employed on highly skilled jobs, reduces more than that received by low–skilled workers on low–skilled occupation (see Figure 2), reducing the wage gap among them.

The increase in the value of the shock has two opposite effects for the highly skilled workers. On the one hand, the cost of low–skilled employment rises and firms will reduce hirings of both low and highly skilled workers. On the other hand, firms will partially substitute highly skilled workers for low–skilled ones to fill low–skilled vacancies as the former do not require any training. Overall, the low-skilled employment decreases most (see Figure 2). This substitution effect explain the huge drop in N^l. Besides, noteworthy is the fact that N^l drops dramatically more than both $N_l^h$and N_h^h (see upper–left panel of Figure 2), illustrating the substitution effect between highly and low–skilled workers in low–skilled occupations due to the increase in the training cost.

The reduction in the marginal value and the increase in the training cost therefore discourages posting vacancies, whatever their type, as illustrated by Figure 2. For values of $\varkappa$ larger than 0.1, the reduction in the number of highly skilled vacancies is larger than the reduction in low–skilled vacancies. This reduction in both types of vacancies and the increase in unemployment reverses the congestion effect.[22] Therefore, the probability that a firm fills a vacancy rises whatever the type of posted vacancy. But, as the increase

[21] We have also considered a permanent non-biased technological shock. As in literature the increase in the productivity of labour increases employment and decreases unemployment. However the effect in the equilibrium unemployment rates will be neutral. Interesting further research will be to keep in temporary technological shocks in order to experience if there exists some relationship between technological shock and "ladder effect".

[22] Under the presence of coordination failures on the labour market, an increase of competition among firms creates a congestion effect that lowers the probability of filling up a vacant job.

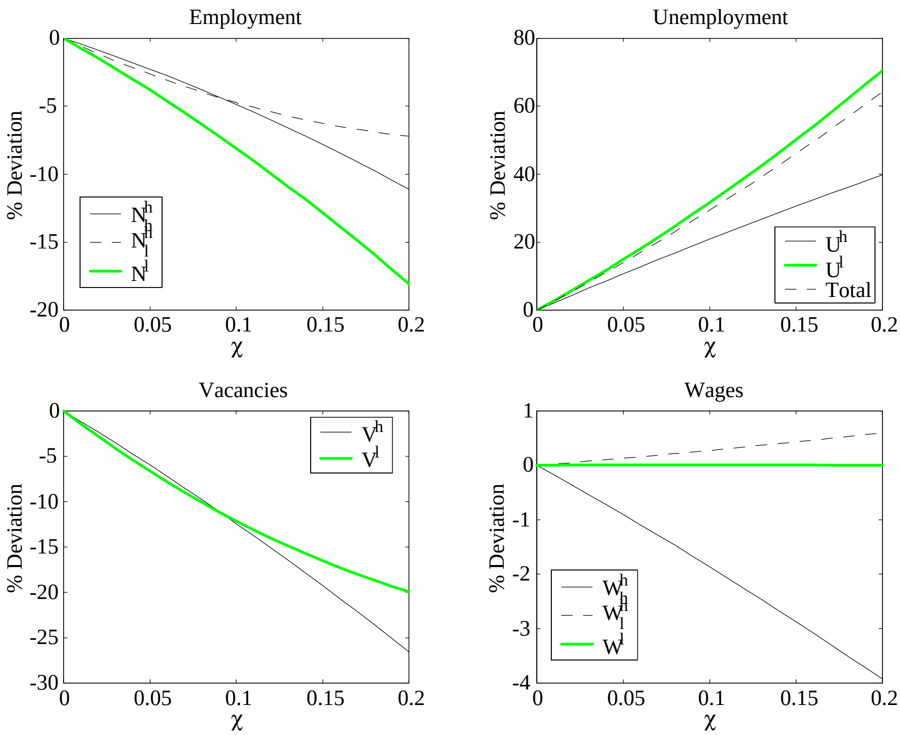

Figure 2: Steady state implication of training cost shock

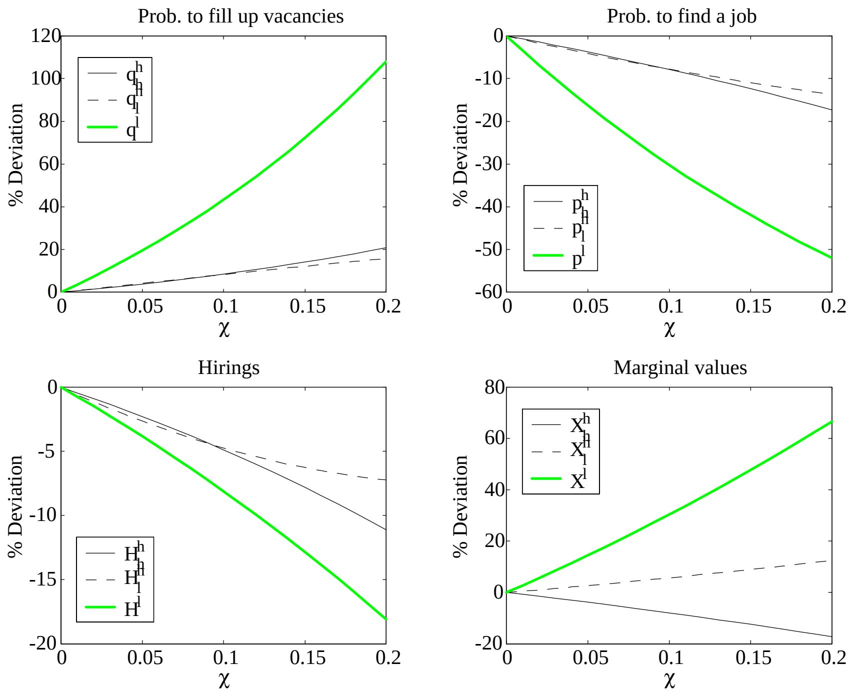

Figure 3: Steady state implication of training cost shock

in unemployment is higher for low–skilled workers than for highly skilled ones, the rise in this probability is much higher in the case of low–skilled workers, q^l (by an order of about 5 when $\varkappa$ takes value 0.2) . Likewise, the implied negative trade externality explains the larger decrease in the probability to find a job for low–skilled workers. The investment behaviour of firms leads to employment reduction for these types of occupation.

Our results are consistent with Van Ours and Ridder (1995), which give evidence that low- and highly skilled unemployment are strongly correlated and that low-skilled unemployment fluctuates more strongly. For instance, in face of a value of $\varkappa = 0.1$, N_h^h and N_l^h decrease by 5%, while N^l drops by an amount of 10%. This shows up in the measure of the ladder effect reported in Figure 4.

The ladder effect, measured in terms of stocks,

$$\frac{L^h N_l^h}{L^h N_l^h + L^l N^l} \times 100,$$

illustrates the previous analysis. As the ladder effect increases by 3% when $\varkappa = 0.1$ to 11% in face of $\varkappa = 0.2$, once again reflecting the expected substitution effect between highly and low–skilled workers that is at work in the face of a training cost applied to low–skilled workers.

This effect is far from proportional, and the higher the training cost, the larger the ladder effect becomes. It could be interpreted that in a society with rapid technological progress, those less qualified will need more training to be able to work even in less

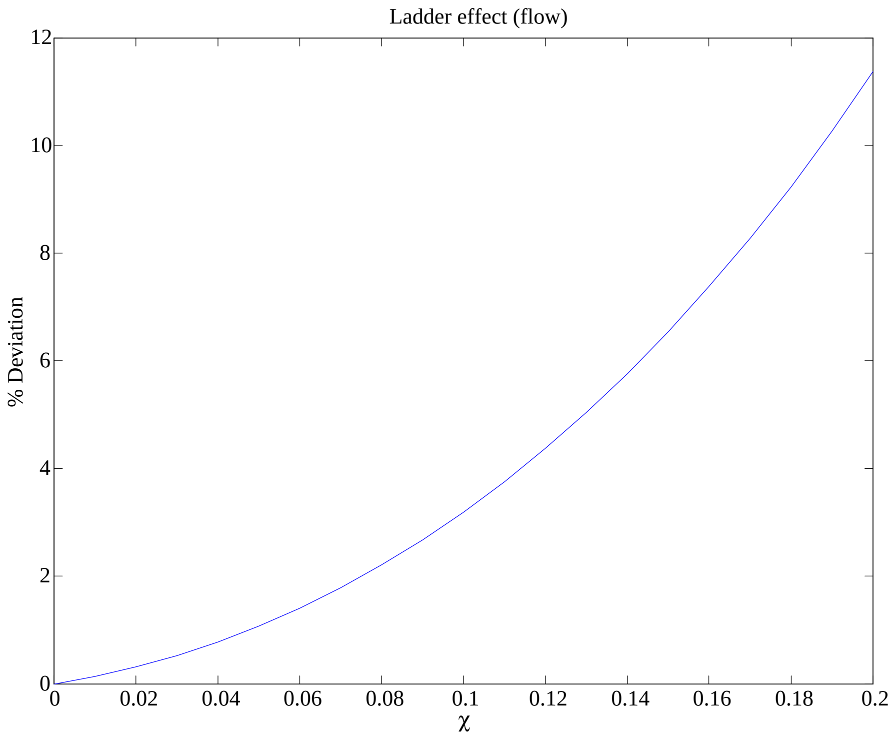

Figure 4: The ladder effect when $\varkappa$ changes

qualified vacancies. Stated otherwise, the low–skilled vacancies will require larger skills and the cost of qualifying low–skilled workers will rise more than proportionally.

Then, highly skilled workers take priority over low-skilled workers to fill these vacancies. This leads to an increase in low-skilled unemployment. The effect is an increase in the "ladder" effect indicator.

4.2 Supply Side: skilled labour force

There is a large amount of literature about the increase of skills in the labour force (see Green *et al.* (1999)). This section analyses the effects of a permanent increase in the relative size of the highly skilled labour force — a positive shift in L^h/L^l — which might be interpreted as an increase in the aggregate education attainments of workers.

Figures 5–6 report the effects of a shock ranging from 1 to 19% on the steady state of some key variables characterising the dynamics in the labour market.

The first direct implication of a permanent increase in the relative availability of highly skilled workers is to shift downward the probability for this type of worker to find a job. Indeed, the higher relative availability of this type of labour creates a congestion effect on the supply side which, via the matching process, makes it much harder for highly skilled workers to find a job. Thus, as can be seen from Figure 6, both p_h^h and p_l^h drop. For instance, the probability for a highly skilled worker to find a highly skilled job diminishes by 4% in face of a 5% permanent increase in L^h/L^l. On the contrary, it exerts a positive trade externality that benefits the firms and makes the probability of filling a vacancy higher. Noteworthy is that this effect does exist both for highly skilled jobs (q_h^h) and low–skilled jobs (q_l^h), as skilled workers may apply to such jobs. Nevertheless, the effect is more pronounced on highly skilled jobs. Conversely, the probability to fill a low–skilled job with a low–skilled worker (q^l) is lowered, as low–skilled workers are proportionally scarcer, thus increasing the competition among firms and creating a relative congestion effect.

The marginal values of employment that also depend on the labour market tightness through the wage setting mechanism do not all increase. Indeed, only the marginal value of low–skilled jobs increase while that of highly—skilled occupations decrease. This implies that firms post a higher number of low–skilled vacancies whereas the number of highly skilled decreases, as Figure 5 shows. This together with the evolution of the probability to fill vacancies implies that employment of low–skilled workers and highly skilled workers employed as low–skilled increase, whereas that of highly skilled decreases. Therefore low–skilled unemployment diminishes while highly skilled unemployment increases, the overall effect on total unemployment being slightly positive.

The overall effect on wages is easily understood in the light of previous results as increases in the marginal productivity of all types of employment exerts an upward pressure on wages, which is countered by the decrease in the tightness of the highly skilled labour market. Thus, while the real wages paid in compensation to low–skilled job increase, those paid to highly skilled job decreases.

Beside these aggregate effects, the measure of the ladder effect — as reported in Figure 7 — reflects the earlier story, as increases in the relative size of the highly skilled labour

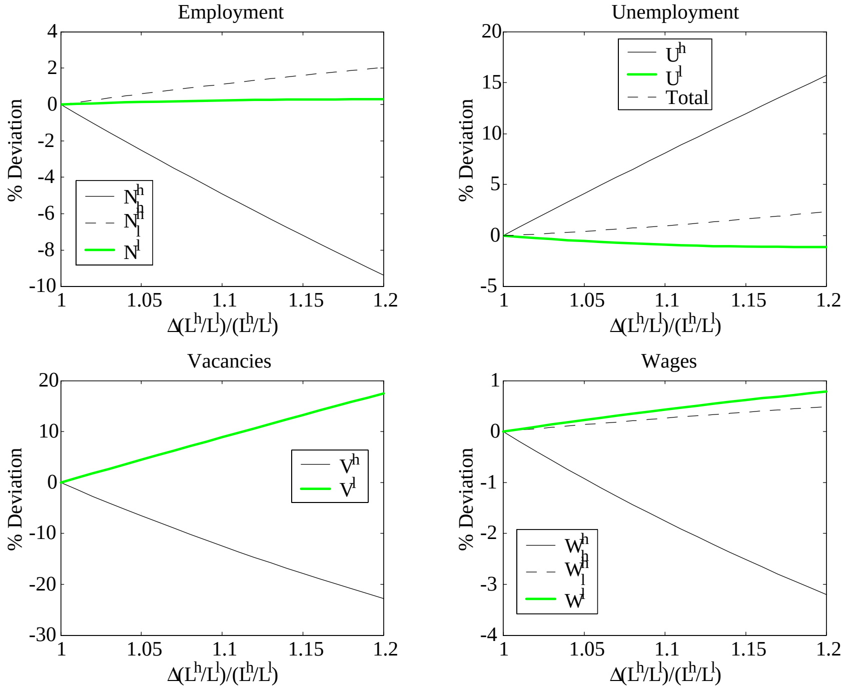

Figure 5: Steady state implication of relative labour force shock

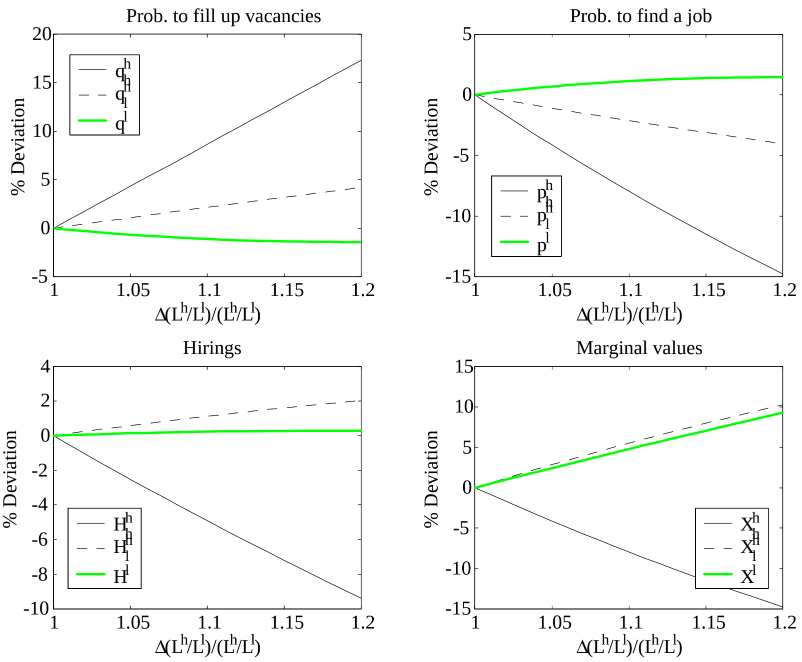

Figure 6: Steady state implication of relative labour force shock

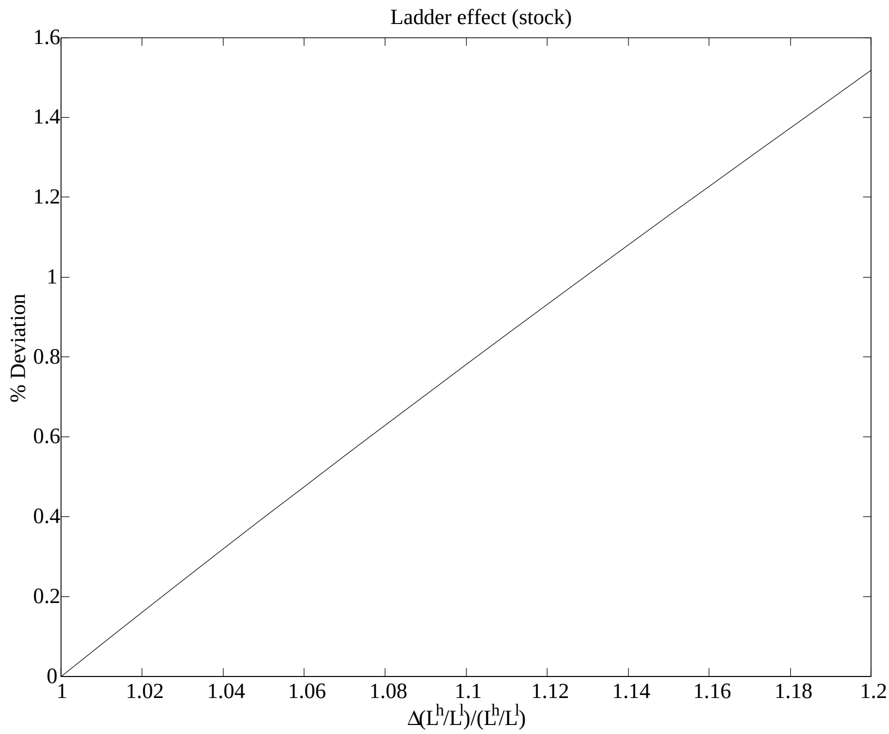

Figure 7: The ladder effect when L^h/L^l changes

force lead to an increase in the ladder, implying that more extensive use of low–skilled workers in low–skilled jobs is at work. This is explained as the increase in the probability to fill a low–skilled vacancy with a highly skilled worker makes it worth increasing the use of this type of labour. In others an increase in the availability of highly skilled workers implies that firms substitute low–skilled workers for highly skilled ones in low–skilled occupations. However, this is not enough to compensate for the rise in the highly skilled labour supply, implying a larger level of highly skilled unemployment. It seems to provide a pretty good explanation to the positive correlation between the rise in the number of educated workers and in the highly skilled unemployment rate in the Spanish economy during the eighties.

Figures from 8 to 9 finally report the transitional dynamics of employment, unemployment and vacancies that follows a 5% rise in the relative availability of highly skilled labour force. As expected, firms instantaneously post a larger number of low–skilled vacancies whereas the number of highly skilled vacancies drops by a larger amount (7.5%). Therefore, the probability of filling a highly skilled job increases due to the negative congestion effect and that associated with low–skilled vacancies decreases by a congestion effect. Therefore, highly skilled employment decreases whatever its utilisation while low–skilled employment increases, explaining the behaviour of unemployment rates.

Nevertheless, the decrease in highly skilled employment yields an increase in the probability of filling a highly skilled vacancy, pushing upward the marginal value of highly

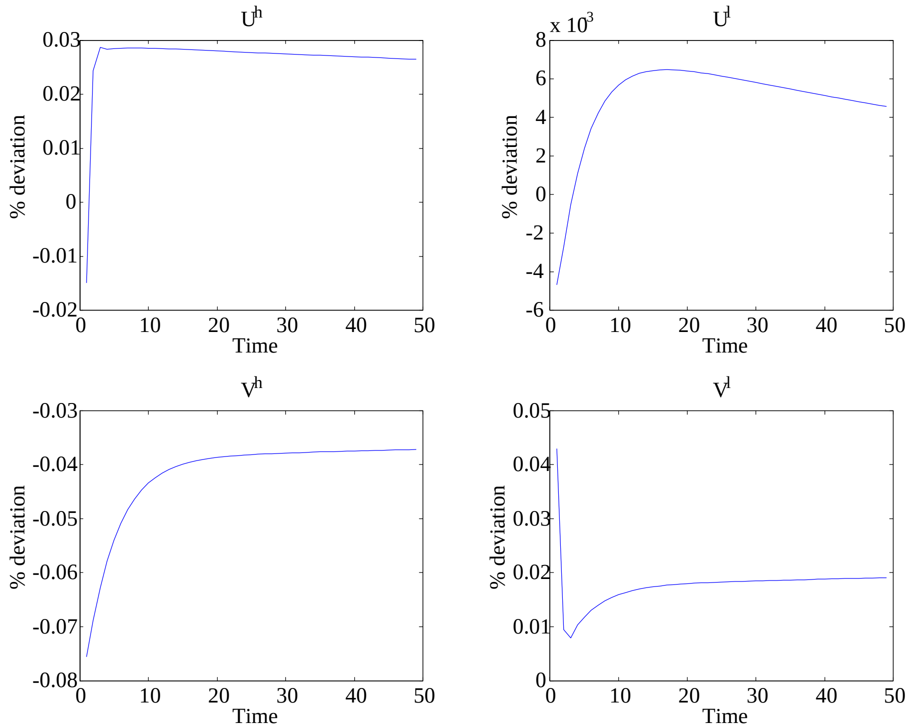

Figure 8: Transitional dynamics in unemployment and vacancies

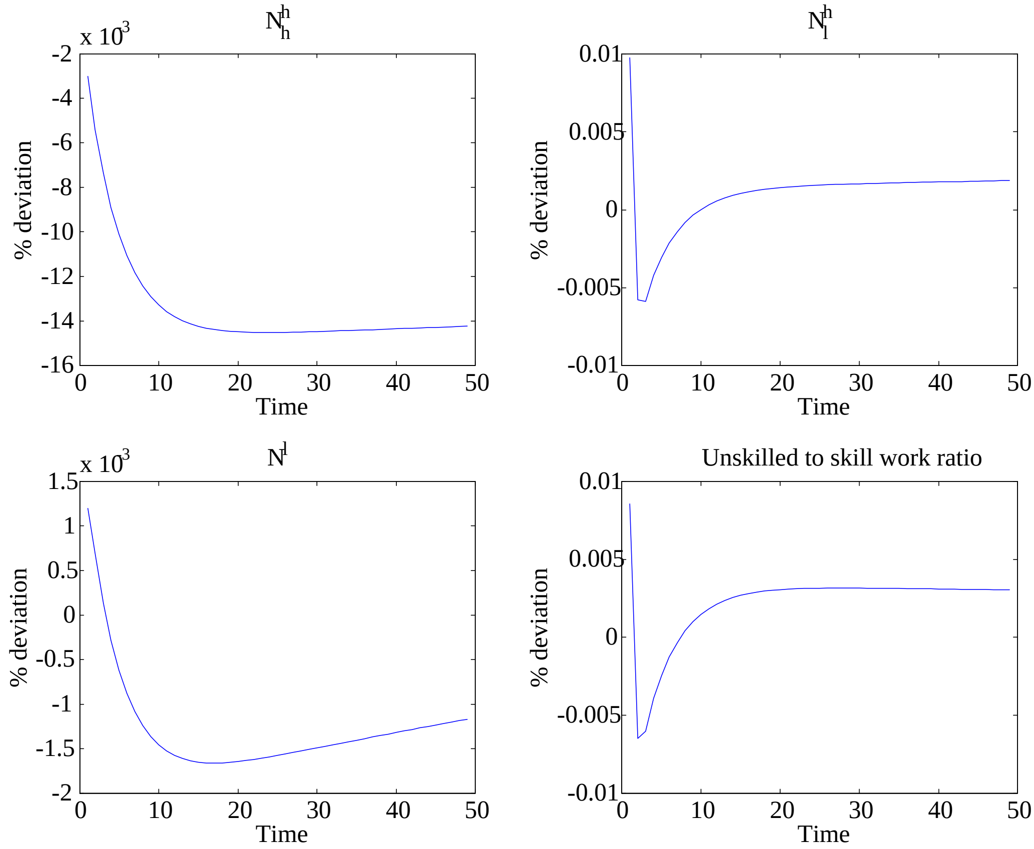

Figure 9: Transitional dynamics in employment

skilled employment, such that after their initial decline highly skilled vacancies go upward. However, this is not enough to push highly skilled employment back to the initial steady state.

4.3 Comparative analysis

This analysis deserves additional comments that may shed light on the recent Spanish experience. We have introduced both demand and supply changes. Both shocks are significant to explain evolution of labour market variables, but the importance of these changes is different.

Ladder effect and relative wages

From the last two sections, we observe that both training cost and relative labour force changes are important to explain the "ladder effect" and reproduce the same relative wages evolution. They have similar effects in both features, such a ladder effect indicator increases. Both explain that highly skilled workers take low-skilled jobs leading to a low-skilled unemployment persistence. When we introduce a change in the training cost, both

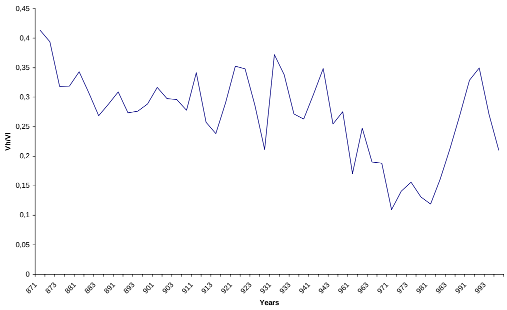

Figure 10: Vacancy ratio V^h/V^l

highly skilled employment and low-skilled employment proportions decrease (see Figure 2). Since the former drops more than the latter, the ladder effect indicator increases very significantly. Nevertheless, when a change in the relative highly skilled labour force occurs the ladder effect is due to both an increase in highly skilled employment working in low-skilled jobs and the fact that low-skilled employment increases at a slower rate (see Figure 5). In both shocks real wages paid to low–skilled job increase, while paid to highly skilled job decreases.

Employment and vacancies

Their effects on unemployment and vacancies rates are totally different. Both changes reproduce the increase in highly skilled unemployment observed the studied period. However, the training cost change only reproduces the employment data (see Table 1). Low-skilled unemployment only increases with the introduction of a training cost. In the other shock, the low-skilled unemployment rate decreases. Hence, the training cost can better explain the evolution of the "ladder effect".

Figures 10-12 report actual vacancies for the Spanish economy for our benchmark sample. The ratio of highly to low–skilled vacancies diminishes within this period. Indeed, as predicted by the model under any shock the ratio of highly skilled vacancies to low-skilled vacancies reduces (see Figure 10). In the face of a labour supply shock, firms post a lower number of highly skilled vacancies. This reduction is even larger in the case of a greater training cost. Decreases in the number of highly skilled vacancies would rather be explained by both labour force and the training cost shocks as shown in Figure 11. When there was a change in the number of highly skilled workers, low–skilled vacancies increased in the model. While the decrease in the number of the low–skilled vacancies posted observed from Figure 12 provides empirical support to the training cost shock.

These results are understood in our framework of temporary jobs for highly skilled employees who work in low-skilled jobs. The model is built with a exogenous separation rate of 1 for this group. It leads to highly skilled employees to accept low-skilled vacancies temporarily, given that a highly skilled worker really wants to fill a highly skilled job. It is consistent with the Spanish context where fixed-term employment contracts are more flexible from 1984. The number of temporary employment has growth from 15.6% in 1985 to 33.6% in 1996 (see Dolado *et al.*, 2001). From our results, firms prefer to take a highly

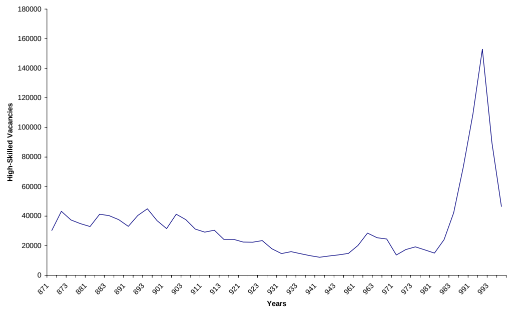

Figure 11: Highly skilled vacancies

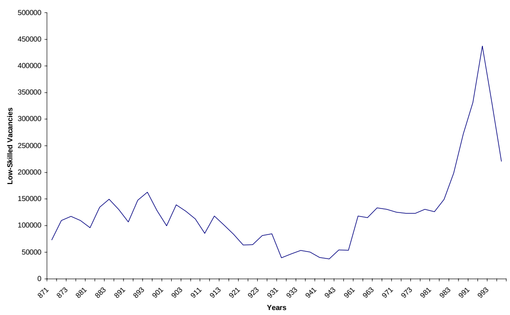

Figure 12: Low-skilled vacancies

skilled worker for a low-skilled job to avoid general training costs of low-skilled workers, which is interpreted as a technological change. This leads to an increase in low-skilled unemployment. It is also consistent with the idea that general skills of highly skilled workers allow more flexibility to change the job. However, the importance of the increase of the number of highly skilled workers is not negligible at all as we have commented in this section. The change in the labour supply can also reproduce the increase in the indicator of ladder effect in Spain. These results indicate futher research should be done to study interrelations between demand and supply.

5 Conclusion

This paper attempts to shed light on alternative explanations for the "ladder effect" phenomenon, which is a signifcant source of Spanish unemployment persistence.

We have used a calibrated version of the model to assess the implications of labour demand and supply shocks. The labour demand shocks are related to the increase of the training cost in low-skilled vacancies and are seen as a biased technological progress against low–skilled workers. Labour supply shocks, often associated with increases in the number of highly-skilled workers, are introduced as increases in the relative availability of a highly–skilled labour force. Our results indicate that the ladder effect generated by the model may account for the recent Spanish experience. The model can replicate the observed decline in the ratio of high to low–skilled vacancies, and shows how firms substitute high for low–skilled employment. We argue that the Spanish ladder effect reflected by an increase in the training cost as a result of a biased shock against low–skilled workers is better reproduced than the increase in the number of highly-skilled workers. The positve change in the training cost of the low-skilled workers better reproduce the evolution on employment and in particular the decrease of low-skilled employment, as well as the evolution of the vacancy data.

What remains to be investigated is the extent to which the ladder-effect merely reflects the role of education as an entry screening device by firms, which in turn would imply that official job descriptions may have little relation to job-content.

Appendix A

Appendix A.1 : Decisions Rules of Firm j.

Recall that production function of the firm j is given by:

$$Y_{j,t} = AK_{j,t}^{\alpha}(L^h N_{h,j,t}^h)^{\theta} \left(L^h N_{l,j,t}^h + L^l N_{j,t}^l\right)^{1-\alpha-\theta}. \tag{A.1.1}$$

Accumulation of capital is,

$$K_{j,t+1} = I_{j,t} + (1-\delta)K_{j,t} \tag{A.1.2}$$

The law of motion of each type of employment are given by:

$$N^h_{h,j,t+1} = q^h_{h,t}V^h_{j,t} + (1-s)N^h_{h,j,t} \quad \text{(A.1.3)}$$

$$N^h_{l,j,t+1} = q^h_{l,t}V^l_{j,t}\frac{L^l}{L^h} \quad \text{(A.1.4)}$$

$$N^l_{j,t+1} = q^l_t\left(1-q^h_{l,t}\right)V^l_{j,t} + (1-\mu)N^l_{j,t}. \quad \text{(A.1.5)}$$

At period t instantaneous profit can be expressed as

$$\Pi_{j,t} = Y_{j,t} - w^h_t N^h_{h,j,t}L^h - w^l_t N^h_{l,j,t}L^h - w^l_t N^l_{j,t}L^l - I_{j,t} - \omega_h V^h_{j,t}L^h - \omega_l V^l_{j,t}L^l - \varkappa H^l_t L^l. \quad \text{(A.1.6)}$$

Then the firm solves the recursive problem

$$\max \Upsilon(S^F_{j,t}) = \Pi_{j,t} + \frac{1}{1+r_{t+1}}\Upsilon(S^F_{j,t+1})$$

subject to (A.1.1)–(A.1.6). We form the Lagrangian for this problem. Let us denote the Lagrange multipliers associated to $K_{j,t}$, $N^h_{h,j,t}$, $N^h_{l,j,t}$ and $N^l_{j,t}$ respectively by $X^k_{j,t}$, $X^h_{h,j,t}$, $X^h_{l,j,t}$ and $X^l_{j,t}$.

The first order conditions associated to the control variables investment, $I_{j,t}$ and vacancies, $V^h_{j,t}$ and $V^l_{j,t}$, are given by

$$X^k_{j,t} = 1 \quad \text{(A.1.7)}$$

$$X^h_{h,j,t} = \frac{\omega_h}{q^h_{h,t}} \quad \text{(A.1.8)}$$

$$q^h_{l,t}X^h_{l,j,t} + q^l_t(1-q^h_{l,t})X^l_{j,t} = \omega_l + \varkappa q^l_t(1-q^h_{l,t}). \quad \text{(A.1.9)}$$

Equation (A.1.7) represents optimal level of investment, the marginal cost of capital goods for the firm that is one. Equation (A.1.8) represents the optimal level of highly–skilled vacancies posted by a firm. The first order condition (A.1.9) is the marginal value for the firm to fill a low-skilled job complemented by an additional cost of training to hire a low-skilled worker.

The marginal values of the capital and the different types of employment for the firm are given by the envelope theorem as:

$$\Omega^k_{jt} = \frac{\partial \Upsilon_{j,t}(S^F_{j,t})}{\partial K_{j,t}} = \alpha\frac{Y_{j,t+1}}{K_{j,t+1}} + 1 - \delta$$

$$\Omega^h_{h,jt} = \frac{\partial \Upsilon_{j,t}(S^F_{j,t})}{\partial N^h_{h,j,t}} = \theta\frac{Y_{j,t}}{L^h N^h_{h,j,t}} - w^h_{j,t} + (1-s)X^h_{h,j,t}$$

$$\Omega^h_{l,jt} = \frac{\partial \Upsilon_{j,t}(S^F_{j,t})}{\partial N^h_{l,j,t}} = (1-\alpha-\theta)\frac{Y_{j,t}}{(L^h N^h_{l,j,t} + L^l N^l_{j,t})} - w^h_{l,j,t}$$

$$\Omega^l_{jt} = \frac{\partial \Upsilon_{j,t}(S^F_{j,t})}{\partial N^l_{j,t}} = (1-\alpha-\theta)\frac{Y_{j,t}}{(L^h N^h_{l,j,t} + L^l N^l_{j,t})} - w^l_{j,t} + (1-\mu)X^l_{j,t}.$$

Combining both envelope conditions and first order conditions, we get the Euler equations related to $K_{j,t}$, $N^h_{h,j,t}$, $N^h_{l,j,t}$ and $N^l_{j,t}$,

$$\left(\alpha\frac{Y_{j,t+1}}{K_{j,t+1}}+1-\delta\right)=1+r_{t+1} \tag{A.1.10}$$

$$X^h_{h,j,t}=\frac{1}{1+r_{t+1}}\left(\begin{array}{c}\theta\frac{Y_{j,t+1}}{L^hN^h_{h,j,t+1}}-w^h_{j,t+1}+\\+(1-s)X^h_{h,j,t+1}\end{array}\right) \tag{A.1.11}$$

$$X^h_{l,j,t}=\frac{1}{1+r_{t+1}}\left(\begin{array}{c}(1-\alpha-\theta)\frac{Y_{j,t+1}}{(L^hN^h_{l,j,t+1}+L^lN^l_{j,t+1})}-\\-w^h_{l,j,t+1}\end{array}\right) \tag{A.1.12}$$

$$X^l_{j,t}=\frac{1}{1+r_{t+1}}\left(\begin{array}{c}(1-\alpha-\theta)\frac{Y_{j,t+1}}{(L^hN^h_{l,j,t+1}+L^lN^l_{j,t+1})}-\\-w^l_{j,t+1}+(1-\mu)X^l_{j,t+1}\end{array}\right). \tag{A.1.13}$$

Furthermore, parameters will be chosen in such a way that the firm will prefer to hire a highly skilled worker instead of a low skilled worker for an unskilled vacancy,

$$X^h_{l,j,t}\geqslant X^l_{j,t}.$$

This condition will be satisfied at the steady state.

Appendix A.2 : The households

We follow Andolfatto (1996), in order to solve the problem of households. Workers flows are determined according to the matching process we described in section 2.3. Therefore, workers are randomly selected playing a game of "musical chairs". At the beginning of each period, the whole labour force is randomly shuffled across a given set of jobs.

A.2.1 The low-skilled consumer problem

This section presents the derivation of the optimal behaviour of the low–skilled consumer, insisting on insurance issues.

At the beginning of each period low–skilled households face different probabilities of being employed or unemployed as this is contingent on its status in the labour market in the previous period. This therefore implies that 2^N different possible stories in the labour market are to be considered after N periods, each of which corresponds to a particular individual employment path and therefore a different story of accumulation. This leads to heterogeneity, which makes the resolution of the model extremely complicated. For the sake of simplicity, we follow Hansen (1985), and assume that there exists a perfect insurance system which may eliminate *ex–post* heterogeneity.

The instantaneous utility functions are given by

$$u^l_{i,t} = \log(C^l_{i,t}-\Gamma^l) \quad \text{(employed)} \tag{A.2.1}$$

$$u^{l*}_{i,t} = \log(C^{l*}_{i,t}-\Gamma^{l*}) \quad \text{(unemployed)} \tag{A.2.2}$$

where $u_{i,t}^l$ and $u_{i,t}^{l*}$ are the respective instantaneous utility functions for employed and unemployed households. As in the main body of the text, we let C_{it}^l and C_{it}^{l*} denote the respective low-skilled household's consumption when employed and unemployed. Γ^l and Γ^{l^*} can be interpreted as a utility cost, expressed in terms of goods, associated with the situation of the household in the labour market. We assume $\Gamma^l > \Gamma^{l^*}$, which ensures that the consumption of an employee is greater than that of an unemployed household.

At the very beginning of each period — before the matching process has taken place — the low-skilled household does not know what the situation, either employed or unemployed, will be in that period. As a consequence, the household seeks to maximise her expected value. Since there N_t^l denotes the percentage of low–skilled households that are employed. And $\beta \in (0,1)$ is the discount factor of the household. The low-skilled household maximises the problem

$$\mathcal{V}^L(S_{i,t}^l) = N_{i,t}^l u_{i,t}^l + (1 - N_{i,t}^l) u_{i,t}^{l*} + \beta \mathcal{V}^L(S_{i,t+1}^l), \tag{A.2.3}$$

where state variables are $S_{i,t}^l = S_{i,t}^l\{B_{j.t}^l, B_{i,t}^{l*}\}$ depending whether the household is employed or unemployed, are to be considered. We made use of the fact that by definition of p_t^l and the law of motion of N_{t+1}^l

$$N_{t+1}^l = p_t^l(1 - N_t^l) + (1 - \mu)N_t^l \tag{A.2.4}$$

The household faces the two budget constraints

$$C_{it}^l + \tau_t^l \varrho_{it}^l + B_{it+1}^l \leq (1 + r_t)B_{it}^l + w_{it}^l, \text{ if employed} \tag{A.2.5}$$

$$C_{it}^{l\star} + \tau_t^l \varrho_{it}^l + B_{it+1}^{l\star} \leq (1 + r_t)B_{it}^{l\star} + \varrho_{it}^l, \text{ if unemployed} \tag{A.2.6}$$

where $B_{i,t}^l$ and $B_{i,t}^{l*}$ denote bond holdings carried over from the previous period. At the beginning of each period. The household receives the real wage, w_{it}^l when employed and the insurance payment, ϱ_{it}^l, when unemployed. Its expenditures, either employed or unemployed, are consumption, insurance contracts purchased at price τ_t^l and bonds.

The problem of the household is therefore to solve the Bellman equation — and therefore maximise the intertemporal utility function — subject to (A.2.5) and (A.2.6). $\Lambda_{i,t}^l$ and $\Lambda_{i,t}^{l*}$, denote the Lagrange multipliers associated with budget constraint of the representative low-skilled household when employed and unemployed respectively. The problem may be stated as a Lagrangian in the following way:[23]

$$\begin{aligned}\mathcal{L} = \; & N_t^l u_{i,t}^l + (1 - N_t^l) u_{i,t}^{l*} + \beta \mathcal{V}^L(S_{i,t+1}^l) \\ & + N_t^l \Lambda_{i,t}^l \left((1 + r_t)B_{it}^l + w_{it}^l - C_{it}^l - \tau_t^l \varrho_{it}^l - B_{it+1}^l\right) \\ & + (1 - N_t^l)\Lambda_{i,t}^{l*} \left((1 + r_t)B_{it}^{l\star} + \varrho_{it}^l - C_{it}^{l\star} - \tau_t^l \varrho_{it}^l - B_{it+1}^{l\star}\right)\end{aligned}$$

The first order necessary conditions associated to the problem are therefore First order conditions with respect to C_{it}^l, $C_{it}^{l\star}$, ϱ_{it}^l are:

$$(C_{it}^l - \Gamma^l)^{-1} = \Lambda_{it}^l \tag{A.2.7}$$

$$(C_{it}^{l\star} - \Gamma^{l\star})^{-1} = \Lambda_{it}^{l\star} \tag{A.2.8}$$

$$-\alpha_{i,t}^l \tau_t^l \Lambda_{it}^l + (1 - \alpha_{i,t}^l)(1 - \tau_t^l)\Lambda_{it}^{l\star} = 0 \tag{A.2.9}$$

[23] Note that the Lagrange multipliers are just normalized by N_t^l and $1 - N_t^l$ for convenience.

Equations (A.2.7) and (A.2.8) state that the Lagrange multipliers Λ_{it}^{l} and $\Lambda_{it}^{l\star}$ are equal to the marginal value of consumption, considering the alternative states of being employed or unemployed respectively. The first order condition (A.2.9) represents the marginal value to be fully insured against unemployment.

The first order conditions related to B_{it+1}^{l} and $B_{it+1}^{l\star}$ are:

$$\Lambda_{it}^{l} = \beta\frac{\partial\mathcal{V}^{L}(S_{i,t+1}^{l})}{\partial B_{it+1}^{l}} \tag{A.2.10}$$

$$\Lambda_{it}^{l*} = \beta\frac{\partial\mathcal{V}^{L}(S_{i,t+1}^{l})}{\partial B_{it+1}^{l*}} \tag{A.2.11}$$

Finally the envelope therefore implies

$$\frac{\partial\mathcal{V}^{L}(S_{i,t}^{l})}{\partial B_{it}^{l}} = (1+r_t)\Lambda_{it}^{l} \tag{A.2.12}$$

$$\frac{\partial\mathcal{V}^{L}(S_{i,t}^{l})}{\partial B_{it}^{l*}} = (1+r_t)\Lambda_{it}^{l\star} \tag{A.2.13}$$

Envelope conditions together with first order conditions related to optimal portfolio composition yields the following Euler conditions:

$$\Lambda_{it}^{l} = \beta(1+r_{t+1})\Lambda_{it+1}^{l} \tag{A.2.14}$$

$$\Lambda_{it}^{l\star} = \beta(1+r_{t+1})\Lambda_{it+1}^{l\star}. \tag{A.2.15}$$

Insurance Company for low-skilled households: The expected profit of the insurance company is given by the difference from the gain of the prime of insurance times the insurances and the payment of insurance to people who were unemployed. We assume free entry on the insurance market, profits are driven to zero, such that

$$\Pi_t = \tau_t^{l}\varrho_{it}^{l} - (1-N_t^{l})\varrho_{it}^{l} = 0$$

We assume the company insures the current unemployment risk. The company can not differentiate from the state of low-skilled households. People insurance against the probability of being unemployed and the optimal prime for the company is

$$\tau_t^{l} = 1 - N_t^{l}. \tag{A.2.16}$$

Using these results in the optimal choice for insurance (A.2.16) in equation (A.2.9), we end up with

$$\Lambda_{i,t}^{l} = \Lambda_{i,t}^{l*}$$

for low-skilled households, whether they were employed or unemployed in the previous period. This condition actually states that the marginal utility of wealth is independent from the state of the household in the labour market, which therefore eliminates heterogeneity in saving behaviour. Using this condition together with equations (A.2.7) and (A.2.8), we obtain $C_{it}^{l} = C_{it}^{l^*} + \Gamma^l - \Gamma^{l^*}$. Low-skilled households have different consumption levels when employed or unemployed, $C_{i,t}^{l}$ and $C_{i,t}^{l^*}$, but they prefer to be completely insured in terms of utility.

It also implies that equations (A.2.14) and (A.2.15) are equivalent and households accumulate the same quantity of bonds whether they are employed or unemployed, $B_{it+1}^{l} = B_{it+1}^{l^*} = B_{it+1}$. As a matter of fact, households choose to be completely insured, and have the same wealth in any state. This implies that saving decisions are independent of the employment history of the household. The optimal insurance is found using constraints (A.2.5) and (A.2.6):

$$\varrho_{it}^{l} = w_{ij,t}^{l} + \Gamma^l - \Gamma^{l^*}.$$

As soon as households choose to be fully insured, and provided the employed labour force is selected randomly across jobs at the beginning of each period, we are back with the standard representative consumer, and the notation used to distinguish employment status may be eliminated. The representative low-skilled household i maximises the expectation of the discounted sum of its instantaneous utility with respect to the consumption and the assets she holds:

$$\sum_{t=0}^{\infty} \beta^t \left\{ N_t^l u_{i,t}^l + (1 - N_t^l) u_{i,t}^{l^\star} \right\}$$

subject to (A.2.17). Equation (A.2.17) is the consolidated budget constraint after we introduce perfect assurance:

$$N_t^l C_{i,t}^l + (1 - N_t^l) C_{i,t}^{l^\star} + B_{i,t+1}^l \leq N_t^l w_{ijt}^l + (1 + r_t) B_{i,t}^l. \qquad \text{(A.2.17)}$$

A.2.2.The highly-skilled consumer problem

Like the problem of the low–skilled worker, the highly–skilled worker faces different states on the labour market.

$C_{h,it}^{h}$, $C_{l,it}^{h}$, and $C_{it}^{h^\star}$ denote the respective highly-skilled household's consumption and Γ^h, Γ^l and Γ^{h^*} can be interpreted as a utility cost, expressed in terms of goods, associated with the situation of the household in the labour market. We suppose that $\Gamma_l^h = \Gamma^l$, given that they work in a low-skilled job. We further assume $\Gamma^h > \Gamma^l > \Gamma^{h^*}$, which ensures that consumption of an employee in a highly-skilled vacancy is greater than that in a low-skilled vacancy and both greater than that of an unemployed household.

$B_{h,it}^{h}$, $B_{l,it}^{h}$ and $B_{it}^{h^\star}$ denote contingent claims purchased by the highly-skilled household in the previous period. At the beginning of each period, the household receives the value of bonds purchased in the previous period, either highly-employed, low-employed or unemployed. She also receives the wage when employed as a highly-skilled, the wage when employed as a low-skilled plus the insurance payment for this unsatisfactory situation and the insurance payment when unemployed. Its expenditures, either employed or unemployed, are consumption, insurance and purchase of bonds.

The instantaneous utility contingent to be employed in a highly-skilled or low-skilled job and unemployed are,

$$u^h_{h,it} = \log(C^h_{h,it} - \Gamma^h) \quad \text{(employed in a highly-skilled job)} \tag{A.2.18}$$
$$u^h_{l,it} = \log(C^h_{l,it} - \Gamma^l) \quad \text{(employed in a low-skilled job)} \tag{A.2.19}$$
$$u^{h*}_{it} = \log(C^{l*}_{i,t} - \Gamma^{l*}) \quad \text{(unemployed)} \tag{A.2.20}$$

As in the problem of a low–skilled worker, the highly-skilled household maximises the recursively problem

$$\mathcal{V}^H(S^h_{it}) = N^h_{h,t}u^h_{h,i,t} + N^h_{l,t}u^h_{l,i,t} + (1 - N^h_{h,t} - N^h_{l,t})u^{h*}_{i,t} + \beta\mathcal{V}^H(S^h_{it+1}), \tag{A.2.21}$$

where state variables have three alternative states depending whether the household is employed as highly-skilled or low-skilled or unemployed. $\beta \in (0, 1)$ is the discount factor. We made use of the fact that by definition of $p^h_{h,t}$, $p^h_{l,t}$ and the law of motion of $N^h_{h,t+1}$ and $N^h_{l,t+1}$.

$$N^h_{h,t+1} = p^h_{h,t}(1 - N^h_{h,t}) + (1 - s)N^h_{h,t} \tag{A.2.22}$$
$$N^h_{l,t+1} = p^h_{l,t}(1 - N^h_{h,t+1}). \tag{A.2.23}$$

Highly skilled worker maximises her household's problem taking into account her discounted expected value — solve the Bellman equation subject to the budget constraints

$$C^h_{h,it} + \tau^h_t\varrho^h_{it} + \tau^{h^*}_t\varrho^{h^*}_{it} + B^h_{h,it+1} \leq (1 + r_t)B^h_{h,it} + w^h_{h,it} \tag{A.2.24}$$
$$C^h_{l,it} + \tau^h_t\varrho^h_{it} + \tau^{h^*}_t\varrho^{h^*}_{it} + B^h_{l,it+1} \leq (1 + r_t)B^h_{l,it} + w^h_{l,it} + \varrho^h_{it} \tag{A.2.25}$$
$$C^{h^*}_{it} + \tau^h_t\varrho^h_{it} + \tau^{h^*}_t\varrho^{h^*}_{it} + B^{h^*}_{it+1} \leq (1 + r_t)B^{h^*}_{it} + \varrho^{h^*}_{it} \tag{A.2.26}$$

where $\varrho^{h^*}_{it}$ and ϱ^h_{it}, are the insurance contracts with respective prices $\tau^{h^*}_t$ and τ^h_t. The household chooses among both type of contracts to be insured against the probability of being unemployed or employed in a low-skilled job. When she works as a low–skilled employee, she receives ϱ^h_{it} to compensate the wage differential with respect to a highly–skilled job. When unemployed, she receives $\varrho^{h^*}_{it}$ as unemployment benefit. $\Lambda^h_{h,it}$, $\Lambda^h_{l,it}$ and $\Lambda^{h^*}_{it}$ denote the Lagrange multipliers associated to budget constraint of the representative highly-skilled household when highly-employed, low-employed and unemployed, respectively.

As in the problem of the low–skilled worker, we first form the Lagrangian

$$\begin{aligned}
\mathcal{L} = {} & N^h_{h,t}u^h_{h,i,t} + N^h_{l,t}u^h_{l,i,t} + (1 - N^h_{h,t} - N^h_{l,t})u^{h*}_{i,t} + \beta\mathcal{V}^H(S^h_{it+1}) \\
& + N^h_{h,t}\Lambda^h_{h,i,t}\begin{pmatrix} (1 + r_t)B^h_{h,it} + w^h_{h,it} - C^h_{h,it} - \\ -\tau^h_t\varrho^h_{it} - \tau^{h^*}_t\varrho^{h^*}_{it} - B^h_{h,it+1} \end{pmatrix} \\
& + N^h_{l,t}\Lambda^h_{l,i,t}\begin{pmatrix} (1 + r_t)B^h_{l,it} + w^h_{l,it} + \varrho^h_{it} - C^h_{l,it} - \\ -\tau^h_t\varrho^h_{it} - \tau^{h^*}_t\varrho^{h^*}_{it} - B^h_{l,it+1} \end{pmatrix} \\
& (1 - N^h_{h,t} - N^h_{l,t})\Lambda^{h*}_{i,t}\begin{pmatrix} (1 + r_t)B^{h^*}_{it} + \varrho^{h^*}_{it} - C^{h^*}_{it} - \\ -\tau^h_t\varrho^h_{it} - \tau^{h^*}_t\varrho^{h^*}_{it} - B^{h^*}_{it+1} \end{pmatrix}.
\end{aligned}$$

The first order conditions with respect to $C^h_{h,it}$, $C^h_{l,it}$, $C^{h^*}_{it}$, ϱ^h_{it} and $\varrho^{h^*}_{it}$ are:

$$(C^h_{h,it} - \Gamma^h)^{-1} = \Lambda^h_{h,it} \quad \text{(A.2.27)}$$
$$(C^h_{l,it} - \Gamma^l)^{-1} = \Lambda^h_{l,it} \quad \text{(A.2.28)}$$
$$(C^{h^\star}_{it} - \Gamma^{h^*})^{-1} = \Lambda^{h^\star}_{it} \quad \text{(A.2.29)}$$
$$-N^h_{h,t}\tau^h_t\Lambda^h_{h,it} + N^h_{l,t}(1-\tau^h_t)\Lambda^h_{l,it} - (1 - N^h_{h,t} - N^h_{l,t})\tau^h_t\Lambda^{h^\star}_{it} = 0 \quad \text{(A.2.30)}$$
$$-N^h_{h,t}\tau^{h^*}_t\Lambda^h_{h,it} - N^h_{l,t}\tau^{h^*}_t\Lambda^h_{l,it} + (1 - N^h_{h,t} - N^h_{l,t})(1-\tau^{h^*}_t)\Lambda^{h^\star}_{it} = 0. \quad \text{(A.2.31)}$$

Equations (A.2.27), (A.2.28) and (A.2.29) state that the Lagrange multipliers $\Lambda^h_{h,it}$,$\Lambda^h_{l,it}$ and $\Lambda^{h^\star}_{it}$ are equal to the marginal value of consumption in the corresponding state on the labour market. The first order conditions (A.2.30) and (A.2.31) represent the marginal values to be fully assured taking into account the probability of being employed in a low-skilled job or unemployed respectively.

The first order conditions related to $B^h_{h,it+1}$, $B^h_{l,it+1}$ and $B^{h^\star}_{it+1}$ are:

$$\Lambda^h_{h,it} = \beta\frac{\partial\mathcal{V}^H(S^h_{it+1})}{\partial B^h_{h,it+1}} \quad \text{(A.2.32)}$$
$$\Lambda^h_{l,it} = \beta\frac{\partial\mathcal{V}^H(S^h_{it+1})}{\partial B^h_{l,it+1}} \quad \text{(A.2.33)}$$
$$\Lambda^{h^*}_{it} = \beta\frac{\partial\mathcal{V}^H(S^h_{it+1})}{\partial B^{h^\star}_{it+1}}. \quad \text{(A.2.34)}$$

Envelope theorem related to $B^h_{h,it}$, $B^h_{l,it}$ and $B^{h^\star}_{it}$ yields

$$\frac{\partial\mathcal{V}^H(S^h_{it})}{\partial B^h_{h,it}} = (1+r_t)\Lambda^h_{h,it} \quad \text{(A.2.35)}$$
$$\frac{\partial\mathcal{V}^H(S^h_{it})}{\partial B^h_{l,it}} = (1+r_t)\Lambda^h_{l,it} \quad \text{(A.2.36)}$$
$$\frac{\partial\mathcal{V}^H(S^h_{it})}{\partial B^{h^*}_{it}} = (1+r_t)\Lambda^{h^*}_{it}. \quad \text{(A.2.37)}$$

Envelope conditions together with first order conditions related to optimal portfolio composition yields the following Euler conditions:

$$\Lambda^h_{h,it} = \beta(1+r_{t+1})\Lambda^h_{h,it+1} \quad \text{(A.2.38)}$$
$$\Lambda^h_{l,it} = \beta(1+r_{t+1})\Lambda^h_{l,it+1} \quad \text{(A.2.39)}$$
$$\Lambda^{h^\star}_{it} = \beta(1+r_{t+1})\Lambda^{h^\star}_{it+1}. \quad \text{(A.2.40)}$$

Similarly to the low-skilled problem, we can express the problem of an insurance company for highly-skilled households as

$$\Pi = \tau^h_t\varrho^h_{it} + \tau^{h^*}_t\varrho^{h^*}_{it} - N^h_{l,t}\varrho^h_{it} - (1 - N^h_{h,t} - N^h_{l,t})\varrho^{h^*}_{it} = 0,$$

from which we get $\tau_t^h = N_{l,t}^h$ and $\tau_t^{h^*} = (1 - N_{h,t}^h - N_{l,t}^h)$.

These results together with household's first order conditions implies:

$$\Lambda_{h,it}^h = \Lambda_{l,it}^h = \Lambda_{it}^{h\star}$$
$$B_{h,it}^h = B_{l,it}^h = B_{it}^{h\star}$$

which, together with the Frischian demand for consumption, yields

$$C_{h,it}^h - \Gamma^h = C_{l,it}^h - \Gamma^l = C_{it}^{h\star} - \Gamma^\star.$$

Therefore, the levels of insurance are given by $\varrho_{it}^h = w_{h,it}^h + \Gamma^l - \Gamma^h - w_{l,it}^h$ and $\varrho_{it}^{h^*} = w_{h,it}^h + \Gamma^{h^*} - \Gamma^h$.

To summarise, as in the low–skilled worker problem, as soon as households choose to be fully insured, and provided the employed labour force is selected randomly across jobs at the beginning of each period, we are back with the standard representative consumer, and the notation used to distinguish employment status may be eliminated. A representative highly-skilled household i therefore maximises the expectation of the discounted sum of her instantaneous utility with respect to the consumption and the assets she holds:

$$\sum_{t=0}^{\infty} \beta^t \left\{ N_{h,t}^h u_{h,i,t}^h + N_{l,t}^h u_{l,i,t}^h + (1 - N_{h,t}^h - N_{l,t}^h) u_{i,t}^{h\star} \right\}$$

subject to (A.2.41). Equation (A.2.42) is the consolidated budget constraint when we introduce perfect assurance:

$$N_{h,t}^h C_{h,i,t}^h + N_{l,t}^h C_{l,i,t}^h + U_t^h C_{i,t}^{h\star} + B_{i,t+1}^h \leq N_{h,t}^h w_{h,ijt}^h + N_{l,t}^h w_{l,ijt}^h + (1 + r_t) B_{i,t}^h. \quad \text{(A.2.41)}$$

Appendix A.3 : Wage determination

This section is devoted to the exposition of the wage bargaining process, which is determined by a Nash bargaining criterion, therefore yielding a surplus sharing rule. At the beginning of every period a re-negotiation simultaneously occurs between the firm and workers of each group. Otherwise there will be many wages as workers and the macroeconomic dynamic would be done with respect to a wages distribution. Therefore, workers negotiate their wages with the firm and they account for separations and hirings probabilities.

The wage setting behaviour is obtained maximising the following Nash criterion with respect to the wages which maximise the weighted product of the workers' and the firm's net return from the different job match.

The gains of the firm corresponds to marginal values. Thus, let $\Omega_{\ell,jt}^\tau$ the surplus of the firm associated to each group of employment. The gains for workers' correspond to the sum of the utilities when they are employed minus the sum of utilities when the negotiation fails and they become unemployed. Let $\frac{\Psi_{\ell it}^\tau}{\Lambda_{it}}$ the different surplus of workers associated to each group of workers in terms of goods. Where $(\tau, \ell) = \{(h,h),(h,l),(l,.)\}$

and ξ_ℓ^τ are the exogenous parameters of bargaining powers of each group of workers. Thus, the Nash bargaining criterion problem to solve is

$$\max_{w^\tau_{\ell ijt}} \left(\Omega^\tau_{\ell,jt}\right)^{1-\xi^\tau_\ell} \left(\frac{\Psi^\tau_{\ell it}}{\Lambda_{it}}\right)^{\xi^\tau_\ell}.$$

We define the surplus of the firm and the workers as following:

A.3.1. The firm j surplus

Let us first characterise the surplus which accrues to a firm j when it employs a highly–skilled worker on a highly–skilled position. This is essentially given by the marginal value of a highly–skilled employment, $\Omega^h_{h,jt}$. From the optimal condition associated with a highly–skilled employment, we get

$$\Omega^h_{h,jt} = \theta \frac{Y_{jt}}{L^h N^h_{h,jt}} - w^h_{h,ijt} + (1-s) X^h_{h,jt} \tag{A.3.1}$$

Likewise in the case of a highly–skilled worker employed on a low–skilled position, the marginal value of employment is given by

$$\Omega^h_{l,jt} = (1-\alpha-\theta) \frac{Y_{jt}}{L^h N^h_{l,jt} + L^l N^l_{jt}} - w^h_{l,ijt}. \tag{A.3.2}$$

Finally, when it hires an additional low–skilled worker, this gain is given by

$$\Omega^l_{jt} = (1-\alpha-\theta) \frac{Y_{jt}}{L^h N^h_{l,jt} + L^l N^l_{jt}} - w^l_{ijt} + (1-\mu) X^l_{jt} \tag{A.3.3}$$

where $X^h_{h,jt}$ and X^l_{jt} are the Lagrange multipliers associated to employment laws of motion.

A.3.2.The household i surplus

Let us now present the determination of the surplus which accrues to each type of worker.

The low–skilled worker:

A low–skilled worker, when employed in period t, instantaneously derives utility associated to her extra gains in the labour market (Λ_{it} times the wage revenues net of disutility of labour in terms of goods). Furthermore, in the next period, she may still be employed with probability $(1-\mu)$ or laid off with probability μ. Therefore, the utility gain of an employed low–skilled worker in the labour market, $\Upsilon^e_{l,it}$, is given by

$$\Upsilon^e_{l,it} = \Lambda_{it}(w^l_{ijt} - \Gamma^l) + \beta\left((1-\mu)\Upsilon^e_{l,it+1} + \mu \Upsilon^u_{l,it+1}\right)$$

where Λ_{it}[24] is the marginal utility of consumption. Likewise, when unemployed, the low-skilled household gets, Υ^u_{lit}

$$\Upsilon^u_{l,it} = -\Lambda_{it}\Gamma^{l^*} + \beta\left(p_{l,t}\Upsilon^e_{l,it+1} + (1-p_{l,t})\Upsilon^u_{l,it+1}\right).$$

[24]From Appendix A.1, we can see that $\Lambda^l_{i,t} = \Lambda^{l*}_{i,t} = \Lambda_{i,t}$

Then, the net surplus of a low–skilled worker in the labour market is given by

$$\Psi^l_{it} \equiv \Upsilon^e_{l,it} - \Upsilon^u_{l,it} = \Lambda_{it}(w^l_{ijt} + \Gamma^{l\star} - \Gamma^l) + \beta(1 - \mu - p_{l,t})\Psi^l_{it+1}. \tag{A.3.4}$$

The highly–skilled worker:

A highly–skilled worker may be employed either in a highly–skilled or a low–skilled vacancy, or may be unemployed. When employed as a highly–skilled worker, she instantaneously derives utility $\Lambda_{it}(W^h_t - \Gamma^h)$, and in the following period she may be unemployed or employed on either a highly or a low–skilled position. Therefore, the utility gain in the labour market for a highly–skilled worker employed on a highly–skilled position is given by

$$\Upsilon^h_{h,it} = \Lambda_{it}(w^h_{h,ijt} - \Gamma^h) + \beta \begin{pmatrix} (1-s)\Upsilon^h_{h,it+1} + sp^h_{l,t}\Upsilon^h_{l,it+1} + \\ +s(1-p^h_{l,t})\Upsilon^h_{u,it+1} \end{pmatrix}$$

where $\Upsilon^h_{h,it}$, $\Upsilon^h_{l,it}$ and Υ^h_{uit} respectively denote the utility gain when a highly–skilled worker employed in a highly–skilled job, in a low–skilled job or unemployed worker.

Following the same procedure, the value of a highly-skilled worker employed in a low–skilled position is

$$\Upsilon^h_{l,it} = \Lambda_{it}(W^h_{l,ijt} - \Gamma^l) + \beta \begin{pmatrix} p^h_{h,t}\Upsilon^h_{h,it+1} + (1-p^h_{h,t})p^h_{l,t}\Upsilon^h_{l,it+1} + \\ +(1-p^h_{l,t})(1-p^h_{h,t})\Upsilon^h_{u,it+1} \end{pmatrix}$$

and similarly the value when unemployed is

$$\Upsilon^h_{u,it} = -\Lambda_{it}\Gamma^{h\star} + \beta \begin{pmatrix} p^h_{h,t}\Upsilon^h_{h,it+1} + (1-p^h_{h,t})p^h_{l,t}\Upsilon^h_{l,it+1} + \\ +(1-p^h_{l,t})(1-p^h_{h,t})\Upsilon^h_{u,it+1} \end{pmatrix}.$$

The surplus of a highly–skilled worker, when employed on a highly–skilled position, is actually given by the gain from being employed as a highly-skilled worker minus the gain from being employed as a low–skilled worker times the probability that this event occurs, minus the gain from being unemployed, times the probability of being unemployed. Such that the overall surplus is given by (using the law of large number)

$$\begin{aligned} \Psi^h_{h,it} &\equiv \Upsilon^h_{h,it} - p^h_{l,t-1}\Upsilon^h_{l,it} - (1-p^h_{l,t-1})\Upsilon^h_{u,it} = \Lambda_{it}(w^h_{l,ijt} + \Gamma^{h^\star} - \Gamma^l) \\ \Psi^h_{h,it} &= \Lambda_{it}\Bigg(w^h_{h,ijt} - \Gamma^h - \frac{N^h_{l,t}}{1-N^h_{h,t}}(w^h_{l,ijt} - \Gamma^l) \\ &\quad + \left(1 - \frac{N^h_{l,t}}{1-N^h_{h,t}}\right)\Gamma^{h^*}\Bigg) + (1 - s - p^h_{h,t})\Psi^h_{h,it+1}. \end{aligned} \tag{A.3.5}$$

When bargaining on a low–skilled job, the only opportunity left is unemployment such that the surplus is now given by the difference between the utility gains from being employed on a low–skilled position minus the utility gains from being unemployed

$$\Psi^h_{l,it} \equiv \Upsilon^h_{l,it} - \Upsilon^h_{u,it} = \Lambda_{it}(W^h_{l,ijt} + \Gamma^{h^\star} - \Gamma^l). \tag{A.3.6}$$

We now examine the Nash bargaining process that determines the real wage in each case.

The Nash–Bargaining process

The wage setting behaviour is obtained maximizing the following Nash criterion

$$\max_{W^{\tau}_{\ell ijt}} \left(\Omega^{\tau}_{\ell,jt}\right)^{1-\xi^{\tau}_{\ell}} \left(\frac{\Psi^{\tau}_{\ell it}}{\Lambda_{it}}\right)^{\xi^{\tau}_{\ell}}$$

where $(\tau,\ell) = \{(h,h),(h,l),(l,.)\}$. The first order condition associated to this program – making use of the definitions of the corresponding surpluses — yields

$$\frac{\xi^{\tau}_{\ell}}{1-\xi^{\tau}_{\ell}}\Omega^{\tau}_{\ell,jt} = \frac{\Psi^{\tau}_{\ell,it}}{\Lambda_{it}}.$$

The marginal values of employment of the household and the firm together with the above equation implies

$$w^h_{h,t} = \xi^h_h\left(\theta\frac{Y_t}{L^hN^h_{h,t}} + p^h_{h,t}X^h_{h,t}\right) + (1-\xi^h_h)\left(\begin{array}{c}\Gamma^h + \\ +\frac{N^h_{l,t}}{1-N^h_{h,t}}(w^h_{l,t}-\Gamma^l)\end{array}\right) \quad \text{(A.3.7)}$$

$$w^h_{l,t} = \xi^h_l\left((1-\alpha-\theta)\frac{Y_{jt}}{L^hN^h_{l,jt}+L^lN^l_{jt}}\right) + (1-\xi^h_h)\Gamma^l \quad \text{(A.3.8)}$$

$$w^l_t = \xi^l\left((1-\alpha-\theta)\frac{Y_{jt}}{L^hN^h_{l,jt}+L^lN^l_{jt}} + p_tX^l_t\right) + (1-\xi^l)\Gamma^l \quad \text{(A.3.9)}$$

assuming a symmetric equilibrium, and using the fact that, in our calibration, We have assumed $\Gamma^{l^*} = \Gamma^{h^*} = 0$.

Appendix B: Stylised facts and data definitions

Spanish education levels have steadily grown from the beginning of the 80's and especially from the middle of the 80's. We can see in Table **??** the evolution of education level for the Spanish labour force. The Illiterate and Primary Schooling have steadily reduced the weight in the Spanish labour force. The increase in education has greatly enlarged the secondary group and has made the top educated people (Upper-secondary +Superior schooling) increase its weight by 100% in the labour force.

But the most problematic issue is the high persistence of the unemployment rates in those low-skilled groups. Illiterate and Primary Schooling have worsened their unemployment rates during the last decade while the top educated largely reduce unemployment rates in the booms and do not increase so much in the crisis (see Table **??**).

Employment data

Linked labour Population Survey (Encuesta de Población Activa enlazada, EPA hereafter). This quarterly survey collects data of same individuals during six consecutive quarters periods. It covers a large number of individuals and characteristics, such as formal education attainment, occupation, employment status, age and gender. For our estimations and stylised facts we have used the definitions of education and occupation in the linked EPA survey.[25]. We have estimated our data in the introduction and in the section data and calibration at following. We have divided as below between high and low skilled categories the education and the occupation. Then, we have observed the state of worker in the period and her situation by education and by occupation to estimate the percentages of labour market (i.e. N_h^h = a person who is highly-educated and is employed in a highly-skilled category). To estimate probabilities we have observed an unemployed worker with her education in a period and we estimated what the probability would be that the same person take a high or low skilled job in the next period. Data are estimated by quarters from 1988 to 1996.

Definitions:

- We use 5 groups of education:

1. Illiterate and uneducated persons.
2. Primary education.
3. Low-secondary education.
4. Upper-secondary education.
5. Superior.

Highly–skilled individuals are defined, for our purpose, as those with a level of education greater of equal to upper-secondary education. Therefore, low–skilled individuals essentially consist of illiterate and uneducated persons, primary or low–secondary educated people.

- We use 10 groups of occupation (range 0–9 in EPA and INEM classification):

1. 1.Business and civil service management.

   2.Technicians and scientifics and intellectual professionals.

   3.Technicians and support professionals.

   4.Clerical employees.

   5.Workers in restaurant, catering, personal and security.

   6.Skilled agricultural and fishing workers.

   7.Artesans and skilled manufacturing, construction and mining (Craft-Trade workers).

   8.Facilities and machine operators, fitters (Plant-Machine Operators).

   9.Unskilled workers.

   10.Armed Forces.

[25] For estimations of proportions and probabilities we have used the SAS (Statitical Analysis System) program.

Highly–skilled occupations are taken to be managers, professionals, technicians and support professionals (range 1–3 in EPA classification), the rest (range 0,4–9 in EPA) are armed forces, clerks, service, skilled agricultural\fishing, Craft-Transport, Plant-Manufacture and unskilled group) is taken to define low–skilled occupations.

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