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OMITTED VARIABLES IN THE MEASUREMENT OF A LABOR QUALITY INDEX: THE CASE OF SPAIN

by Aitor Lacuesta,* Sergio Puente and Pilar Cuadrado

Bank of Spain

Traditional measures of labor quality might have the shortcoming of missing some features of the very important increase in labor utilization within European countries. In particular, we explore the case of Spain. Despite showing one of the most important increases in labor quality in the EU according to standard methods, it also presents a negative TFP growth. The paper shows the importance of considering—on top of observed changes in the composition of the labor force by gender, age, education, tenure, and nationality—changes in both average and relative productivities of those above-mentioned socio-demographic groups over time. We first use a time varying weight index in order to capture the decrease in relative productivities across characteristics. Once this issue is considered the estimated growth of labor quality decreases notably and the index becomes flat between 2002 and 2006. We relate this slowdown to the increasing over-education of the Spanish workforce in the recent past. We then incorporate a selection model into the labor force. We argue that in the recent past there has been a massive entry of workers with below average unobserved abilities, generating a decrease in quality of labor. Indeed labor quality slightly decreased from 1995 onwards (always increasing without the selection model).

1. Introduction

On January 16, 2008, the president of the European Central Bank, Jean-Claude Trichet suggested that the recent low productivity growth in Spain was not surprising given the important number of new jobs that were created during the last decade. Indeed, an important percentage of those new jobs have been filled by a massive inflow of low-qualified immigrants (*El País*, January 17, 2008).[1] This argument could have been generalized in the case of Spain to the enormous amount of new entrants into the labor force, especially women and the unemployed, which are expected to have a lower productivity because they have less experience than previous participants in the labor market.[2]

Underlying these words, there is the idea that the composition of the labor force in Spain has changed enormously in recent years; this fact has created an important effect on aggregate productivity. However, in addition to the above-mentioned factors—that would tend to decrease aggregate productivity in the economy—there has also been an important increase in the educational attainment

Note: The views in this paper reflect those of the authors and not those of the Bank of Spain.

*Correspondence to: Aitor Lacuesta, Banco de España, Alcalá 48, 28014-Madrid, Spain (aitor.lacuesta@bde.es).

[1]The foreign born population represented less than 1 percent in 1995; it achieved 11 percent in 2008.

[2]The female employment rate increased from 26 percent in 1995 to 44 percent in 2008, and the unemployment rate decreased from 23 percent in 1995 to 11 percent in 2008.

of the labor force which would tend to have the opposite effect.[3] The combination of all these factors together makes it fairly difficult to conclude whether compositional changes in the labor force might explain what happened with labor productivity in the last decade.

One way of considering labor heterogeneity in macroeconomic models is by incorporating a variable proxying human capital in the labor input. This means generating a quality index that multiplies the number of hours worked in the economy in a particular year (Aaronson and Sullivan, 2001; Schwerdt and Turunen, 2007). In order to construct the quality index, the labor force is divided into several cells: usually gender, age, and educational attainment (Zoghi, 2007). Education and age—which in this literature is considered as a proxy for experience in the labor market—are the two main variables to concretize the idea of human capital (Becker, 1993). Differences in gender express a different labor behavior of males and females during their life cycles. Each cell is considered an isolated island within which all hours worked have the same productivity, but facing different productivities when compared with each other.

The main difficulty of the approach is to get a proxy for the productivity of a particular island. The question, for example, is how the productivity of a 20-year-old male with primary education compares with that of a 30-year-old female with secondary education. Economic theory tells us than in a competitive market wage differentials should represent productivity differentials; this is the information that has been traditionally used.[4] Ho and Jorgenson (1999) used the average compensation share attributable to a particular cell. The Bureau of Labor Statistics (1993) and Schwerdt and Turunen (2007) used a regression approach to predict the compensation for each particular cell. We will follow this latter methodology. The regression approach allows the researcher to increase the dimensionality of factors in the quality adjustment with fewer observations at the cost of losing some flexibility, since the wage regressions do not usually incorporate all possible interactions of variables.

Other authors have generated labor quality indexes for the Euro area and Spain in the recent past. For instance, Schwerdt and Turunen (2007) showed that the quality of labor in the Euro area increased at an average rate of 0.47 percent per year between 1984 and 2005. They used the regression approach including gender, age, and education with data on wages from 1994 to 2001 from the European Community Household Panel (ECHP) and data on hours from the Labor Force Survey. Using the same methodology and datasets, Ward-Warmedinger *et al*. (2008, pp. 42–3) show the labor quality index for each country in the Euro area; Spain appears as the country showing the highest increase in labor quality between 1992 and 2005 (close to 0.8 percent per year). This is the case because of the enormous educational upgrading of the latest Spanish generations.

[3]According to Ward-Warmedinger *et al*. (2008), in 1992 only 15 percent of the population between 25 and 54 attained tertiary education. This figure increased to 32 percent in 2007.

[4]There are other methodologies that have been used to obtain quality indexes, many of them focused on only one variable: education. For example Barro and Lee (1996) used actual years of schooling to compare the human capital stock of different countries. Puente and Pérez (2004) incorporated data on schooling grades in a comparable exam for different countries to adjust for educational quality. However, in these studies, the way in which labor quality and productivity are linked is assumed, rather than estimated.

The same article also shows that education is the highest contributor to the index growth. Moral and Hurtado (2003) follow the approach of Ho and Jorgenson to build a labor quality index for the Spanish economy from the second quarter of 1987 to the first quarter of 2003. In addition to the traditionally used dimensions (gender, age, and educational attainment), they include sector of activity. They obtain information on wages from the Structural Earnings Survey (SES-1995). They incorporated some assumptions in the analysis to solve the absence of microdata on total number of hours and salaries, for all the relevant cells. They found that a labor quality index grows at an average of 0.38 percentage points per year (pp), and slightly faster since 1995 (0.5pp). Among the components of quality, they also confirm that educational attainment was the main positive factor. In both Ward-Warmedinger *et al*. (2008) and Moral and Hurtado (2003), labor quality increased continuously since 1992.

Our paper builds on this previous research. First, as will be further discussed in Section 3, we incorporate microdata from the Labor Force Survey and the three available waves of the SES (1995, 2002, and 2006). Compared to the ECHP used in Schwerdt and Turunen (2007), this earnings dataset should have lower measurement error since it is filled out by the employers according to Social Security records. Moreover, the dataset incorporates many more observations which allow a proper treatment of the factors in an isolated fashion. In particular, we are going to be able to incorporate actual tenure and immigration on top of gender, age, and educational attainment.[5] The theoretical explanation of the inclusion of tenure and immigration in the computation of an index of labor quality will be provided in the next section.

One of the main interests of the paper is to analyze whether those additions affect the contributions of the main demographic variables in the labor quality. This is done in Section 4. In our framework, it is very easy to decompose the quality index growth into different components in different periods of time. It will be noted that although educational attainment is the most relevant component of the quality index, the decrease in tenure and the increase in immigration drain, at the beginning and at the end of the period, respectively, an important part of the potential quality growth. However, even with the inclusion of these two factors labor quality growth has remained positive and substantial since 1992.

Nevertheless, as has been noted by Izquierdo and Lacuesta (2006), Goerlich and Mas (1999), Arellano *et al*. (2002), and Pijoan-Mas and Sánchez-Marcos (2010), the wage structure has changed considerably in recent years. In particular, the wage distribution appears to have been compressed lately, invalidating the usage of a constant measure of quality during the period of analysis. In Section 5, using wage information from SES-1995, SES-2002, and SES-2006, we analyze whether results fixing the wage to one particular year are robust to important changes in the relative productivities over time. Indeed, it is found that changes in relative returns to education and age have been compressed considerably over time, and the growth of quality would have been much smaller using a mixture of

[5]We decided not to include sector since theoretically this is not a characteristic of the individual that makes him more or less productive (Zoghi, 2007). In principle, agents should move among sectors, equalizing wages for a particular skill regardless of the sector the worker is in.

all datasets. One potential explanation for the reduction of relative returns to education over time is increasing over-education. Since the beginning of the 1980s, the increase in supply of university degree holders has not been offset by an increase in demand for highly skilled workers (Abadie, 1997; Del Río and Ruiz-Castillo, 2001; Febrer and Mora, 2005). This has forced many highly educated workers to accept low-qualified jobs. The paper assesses the importance of this issue, considering interactions of educational levels with different types of occupation in a setting with fixed wages. It is observed that an important part of the effect of varying wages on labor quality growth could be explained with this addition.

Section 6 incorporates a new addition to the typical index of labor quality since we believe that considering time-varying weights in the computation of the quality index is not enough to capture the features of the Spanish labor market. By construction, a time varying index only takes into account changes in relative productivities instead of both relative and absolute changes. However, it would be naive to expect no change in absolute productivities given the recent enormous employment increase in Spain. In 1988 the employment rate between the ages of 16 and 64 was 48.6 percent; it is now 66.6 percent. Moreover, the increase in employment rate has been widespread in almost all socio-demographic dimensions.[6] It is very likely that those who participated in the labor market at the beginning of the 1990s were different in many aspects to those who recently decided to participate (in addition to their observed differences in terms of education, age, or tenure). Indeed, it is likely that the former group were more favorably selected since only a few decided to enter the labor force; nowadays working is a widespread option. The paper proves that particular statement; once this issue is taken into account, the growth of labor quality is decreased substantially.

Section 7 incorporates the different quality adjusted labor inputs into a Cobb–Douglas production function for the aggregate Spanish economy. Moral and Hurtado estimated that approximately 46 percent of the Solow residual in the aggregate economy—when estimated without quality adjustment—could be attributed to this factor.[7] Our empirical results are similar; when adding time varying weights and the selection mechanism into the labor force, the negative growth of the TFP in recent years is notably reduced.

2. Empirical Model

The problem of obtaining a measure of labor quality is essentially a problem of aggregating either different types of workers or different types of working hours. This problem encompasses two different, related questions. First, the assessment of the productivity level of a worker or an hour; and second, the way in which these individual productivities are aggregated.

[6]Grouping the population in 30 cells by gender, age (5) and education (3), 27 increased the employment rate between 1995 and 2006. The average increase is 10pp. The three groups that did not increase occupation rate were very young and low skilled individuals.

[7]See López-Salido *et al*. (2006) for an in-depth discussion on this issue.

The first question is usually addressed by making the assumption that relative wages correspond to relative productivity levels, something which we are also going to assume. Clearly, this is not always true. An unfair wage scheme, possibly resulting from a poor wage setting mechanism, might not reflect productivity differentials. Moreover, different endowments of other factors, like capital, could affect labor productivity through complementarities. However, wages are often the most objective way of assessing productivity, reducing enormously the dimensionality of the problem.

Concerning the aggregation of different productivities, the most general framework would be an unconstrained function that maps the amount of each type of worker into a quality adjusted measure of labor. Unfortunately, this framework is not feasible for two reasons. First, we only observe some workers' characteristics instead of all variables affecting productivity. Second, the shape of the aggregator function is not known and it would be very difficult to estimate it in an unconstrained way.

To solve the first problem we will define several groups of workers according to some observed variables, and we will assume that the productivity of all the workers in a given group is the same.[8] The relative productivity of two different groups, as mentioned above, is going to be estimated as the relative average wage, using data from the SES. In order to save degrees of freedom while maintaining some flexibility, continuous variables should be categorized, and the number of variables and categorical groups should be maintained low. Consequently, we are considering three educational levels (primary, secondary, and university), three age levels (16–34, 35–54, and over 55), three different experience levels in the firm (less than 2 years, between 2 and 7, over 7), and two genders. In addition, we would like to incorporate nationality defined by three new categories: native, EU immigrant, and non-EU immigrant. This amounts to a total of 162 different groups when considering all possible interactions. Zoghi (2007) justifies the inclusion of gender, age, and education into the measurement of a quality index. In addition, we consider tenure and nationality. Tenure is certainly important from the point of view of human capital since there is some learning that is acquired by repeating a particular action within the current firm. In the Spanish case, the inclusion of this variable appears to be crucial. First, the enormous job creation during the last decade makes the variable "age" a very imperfect measure of total experience in the market. Second, given the existing types of contracts in the Spanish labor market, specific training acquired in the firm is very much correlated with tenure.[9] Additionally, immigration has increased considerably from 1998 onwards, contributing to more than half of the total employment growth; Izquierdo *et al.* (2009), Amuedo-Dorantes and De La Rica (2007), and Fernández and Ortega (2008) show that the skills of immigrants in Spain are not completely comparable to those of natives, at least in the short run. Indeed the wage differential between natives and immigrants could be attributed to an imperfect portability of origin country human capital (Sanromá *et al.*, 2008) jus-

[8]We will use H^i to represent hours worked in a given group i.

[9]See Dolado and Stucchi (2008) to see how firms and workers wait until the acquisition of a permanent contract to invest in human capital.

tifying the inclusion of nationality in a human capital index. Moreover, both Izquierdo *et al*. (2009) and Fernández and Ortega (2008) show that assimilation is not complete over the long run.

Let us imagine that relative productivities across the abovementioned subgroups were fixed over time and equal to relative wages in a particular year (w_i). If this was the case, we could obtain a quality index, which we denote by Q_t^{Fix} using the following formula (starting at 100):[10]

$$Q_t^{Fix} = \frac{1}{c} \frac{\sum_{i=\{1,\ldots,162\}} w^i H_t^i}{\sum_{i=\{1,\ldots,162\}} H_t^i}. \tag{1}$$

Wages are estimated using a linear regression.[11] An estimation with 54 dummy variables in the wage regression corresponding to all the abovementioned combinations between gender, age, education, and tenure is available upon request.[12] However, interactions of variables will not provide much additional information with respect to a linear specification, and in order to make clear the more important points of the paper we will use a linear regression model without interactions such as the following one:[13]

$$\begin{aligned} w_i &= \alpha_0 + \alpha_1 Gender_i + \alpha_2 Age_i + \alpha_3 Educ_i + \alpha_4 Tenure_i + \alpha_5 F_i + \alpha_6 EU15_i + \varepsilon_i \\ &= w(\boldsymbol{X}_i) + \varepsilon_i. \end{aligned}$$

Changes in Relative Productivities

As has been mentioned, relative wages have varied notably over time. However, we could not directly plug observed time-varying wages in (1) since all macroeconomic shocks that are independent of labor quality and affect average would distort the estimated growth of labor quality. That is the reason why the index needs to be computed by chaining growth rates year by year and only relative variations of productivity are going to play a role. Define ΔH_t and ΔL_t as the growth rate of total hours worked, not adjusted and adjusted by labor quality, respectively:

[10]The c is the constant that sets $Q_1(c) = 100$.

[11]See Zoghi (2007) for a comparison of the regression approach with respect to average contributions.

[12]In this estimation, we separate in a linear way a dummy variable for foreigner (*F*) and another being equal to 1 when a foreigner does not belong to the EU-15 (*No-EU15*). This approach solves the problem of a low number of degrees of freedom by assuming that the possible effect of nationality is independent of the effects of other variables. In this way, we only need to estimate two new relative wages, and then we can apply them uniformly to all groups.

[13]Note that age, education, and tenure have more than two groups, so α_2, α_3, and α_4 are vectors of coefficients of the corresponding dummies. As a robustness check we redid all computations including dummies by region, type of contract, and coverage of the collective agreement in order to clean up the coefficients of the relevant variables. Results are both quantitatively and qualitatively very similar and are available upon request.

$$\Delta L_t^{\text{var}} = \sum_i \frac{\frac{1}{2}\left(w_t^i + w_{t-1}^i\right) H_{t-1}^i}{\sum_i \frac{1}{2}\left(w_t^i + w_{t-1}^i\right) H_{t-1}^i} \Delta H_t^i \tag{2}$$

$$Q_t^{\text{var}} = Q_{t-1}^{\text{var}}(1 + \Delta L_t - \Delta H_t).$$

Of course this formula is very data demanding, because it needs as many wage observations as years, and this is not the case in Spain, where we only have access to three waves of wage structure data. For this reason, we cannot apply this general methodology and we need to interpolate missing wages. Once the wage for a group i in a particular year $t = \{1995, 2002, 2006\}$ is estimated, we interpolate the missing wages for each group.

$$w_t \begin{cases} w_{1995}^i & \text{if } t \leq 1995 \\ w_{1995}^i \left(\frac{w_{2002}^i}{w_{1995}^i} \right)^{(t-1995)/7} & \text{if } 1995 < t \leq 2002 \\ w_{2002}^i \left(\frac{w_{2006}^i}{w_{2002}^i} \right)^{(t-2002)/4} & \text{if } t > 2002. \end{cases}$$

Changes in Average Productivities

The previous framework assumes that everybody entering the labor force in recent years has the same productivity as those who, having the same demographic characteristics, have been working for some time.[14] However, this assumption does not necessarily need to hold in reality, and in the following sections we will provide evidence of this. If the quality of new entrants varies over time, the average productivity of each particular group would vary accordingly. Indeed, if the quality for all groups decreases over time, the average productivity of all groups would follow a downward trend. In order to capture how self-selection in the labor market might affect the average productivity of the economy, we need to enlarge the previous model.

Let us assume that a person decides to participate in the labor force if the wage offered is bigger than a reservation wage $w_i^R = w_i^R(X_i, u_i) = w_i^R(X_i) + u_i$. Since we only observe those individuals whose wage is above the reservation wage, the model for the average wage in the economy changes accordingly.

Define $X = \{Gender, Age, Educ, Tenure, F, EU\}$ and α as a time varying vector of 10 coefficients:

$$E\left(w_{it} \mid X_{it}, w_{it} > w_{it}^r\right) = 1 + \alpha_t X + E\left(\varepsilon_{it} \mid w_{it} > w_{it}^R\right).$$

[14]Tenure only specifies the time someone has been working for the last employer, not the actual total experience in the labor force, whereas age is also an imperfect measure given the big changes in participation rates.

Let us assume that $(\varepsilon_i, u_i) \sim N\left[\begin{pmatrix}0\\0\end{pmatrix}, \begin{pmatrix}\sigma^{\varepsilon} & \sigma^{\varepsilon u}\\ & \sigma^{u}\end{pmatrix}\right]$, then, the employment rate of a group i is such that:[15]

$$P(w_i > w_i^r) = P\left(\frac{u_i - \varepsilon_i}{\sqrt{\sigma^{\varepsilon} + \sigma^{u} - 2\sigma^{\varepsilon u}}} < \frac{w(X_i) - w^r(X_i)}{\sqrt{\sigma^{\varepsilon} + \sigma^{u} - 2\sigma^{\varepsilon u}}}\right) = \Phi(\gamma(X_i)).$$

In this case, only those for whom the offered wage is higher than their reservation wage decide to participate. Define M as the Mills ratio. Therefore, the average ability in the economy is a function of the proportion of individuals who decide to participate:

$$E(\varepsilon_{it} \mid w_{it} > w_{it}^r) = \frac{\sigma_t^{\varepsilon} - \sigma_t^{\varepsilon u}}{\sqrt{\sigma_t^{\varepsilon} + \sigma_t^{u} - 2\sigma_t^{\varepsilon u}}} \frac{\phi(\gamma_t(X_i))}{\Phi(\gamma_t(X_i))} = \beta_t \boldsymbol{M}_{it}.$$

Notice that the inclusion of this parameter makes the average wage in the economy vary according to the sign of β.

$$E(w_{it} \mid X_i, M_{it}) = \alpha_t X_i + \beta_t \frac{\phi(\gamma_t(X_i))}{\Phi(\gamma_t(X_i))} = \alpha_t X_i + \beta_t M_{it}.$$

The good news is that we could estimate the extra-parameter (called the Mills ratio) by assuming a probit model for the probability of being working (Heckman, 1979).[16,17]

$$P(working_{it} \mid X_i) = \overline{\Phi(\gamma_t(X_i))}.$$

Once we add the Mills ratio into the wage equation, we estimate β_t and wages could be predicted for each particular group given different relative prices for skills and different Mills ratios. We use interpolation of missing wages as before. A positive sign in front of the Mills ratio means that those with high reservation wages are less productive, meaning that increasing participation would lead to a decrease in average productivity. A positive sign is coherent with both unobserved terms going in opposite directions. The computation of the quality index would be:

[15]Φ and ϕ refer, respectively, to the cumulative distribution function and density function of a normal distribution N(0,1).

[16]The dependent variable takes the value 1 if employed and 0 if unemployed or inactive. The independent variables are gender, age, and education. We acknowledge the fact that we do not have access to good instruments of participation in the labor force survey and the SES. The identification of the empirical model comes in this case from a functional form, but this is the best we can do at this stage.

[17]The exact procedure is the following. First, we estimate the probit for 1995, 2002, and 2006 using data from the Labour Force Survey (LFS, second quarter). Second, we infer a Mills ratio for each individual in each wave of the SES. Third, we estimate β_t using the previous equation.

$$\Delta L_t^{\text{var},mills} = \sum_i \frac{\frac{1}{2}\left(w_t^i(X_i, M_{i,t}) + w_{t-1}^i(X_i, M_{i,t})\right) H_t^i - \frac{1}{2}\left(w_t^i(X_i, M_{i,t-1}) + w_{t-1}^i(X_i, M_{i,t-1})\right) H_{t-1}^i}{\sum_i \frac{1}{2}\left(w_t^i(X_i, M_{i,t-1}) + w_{t-1}^i(X_i, M_{i,t-1})\right) H_{t-1}^i} \Delta H_t^i \quad (3)$$

$$Q_t^{\text{var},mills} = Q_{t-1}^{\text{var},mills}(1 + \Delta L_t - \Delta H_t).$$

Notice that now variations in the Mills ratio make the weight vary even if relative returns do not change.[18] In particular we allow for absolute and relative changes in the productivity of particular groups that increase the employment rate.

3. Data

In order to estimate a quality adjusted series of labor using the previous methodology, we need data on hours worked per type of worker and wages per hour at the same level of aggregation. We will use education, gender, age, tenure, and nationality.

Regarding hours worked we use microdata from the Labor Force Survey. The periodicity is quarterly and the sample period is from the beginning of 1987 to 2006.[19] The question used to compute hours worked is the number of weekly hours worked in the usual activity.[20] Tenure captures the number of months that someone has worked in the current job.[21]

Figure 1 compares the number of workers and the number of hours worked per week per worker that are officially provided by the Spanish Bureau of Statistics (INE) and those series computed with our microdata. We show that our numbers reflect very well the evolution of the official figures. In this regard, it is observed that between 1987 and 2006 there has been a big increase in the number of workers facing an average annual growth rate of 2.8 percent. This is despite the 1991–94 recession that ended up with a net loss of 800,000 jobs. After that date, there has

[18]This is because the first term in the numerator uses the Mills ratio at t, whereas the second uses it at $t - 1$.

[19]From 2005 the LFS have had sample weights that are compatible with the population figures coming from the 2001 census and the "padrón continuo." These new weights were necessary due to the massive entry of immigrants in the late 1990s. In addition to that change, INE revised all official results from 1995 onwards in order to account for the past population change that was not taken into account in previous waves. However, INE only provides microdata with weights consistent with this methodology from 1999 onwards. Before that date we use the old datasets (methodology LFS-2002); however, this break is not very important for the years 1996–98 as it could be seen in the Bank of Spain Economic Bulletin, April 2005, pp. 12–14.

[20]There are other alternatives such as the number of effective weekly hours which could recover better the period of vacations, sickness leave, or extraordinary hours. We have chosen the first alternative because we believe those particular periods should not be taken into account in the measurement and because INE publishes usual hours as the measure of hours worked per worker.

[21]Whereas everybody has answered the questions on nationality, gender, age, and education, there are some missing values (less than 1 percent of the sample) for hours worked and tenure. We impute these variables using several covariates without missing observations in the whole sample. In particular we use for each year the gender, age, educational attainment, sector, and occupation. We restrict the estimation to have a number of hours worked between 0 and 80 and tenure between 0 and 70.

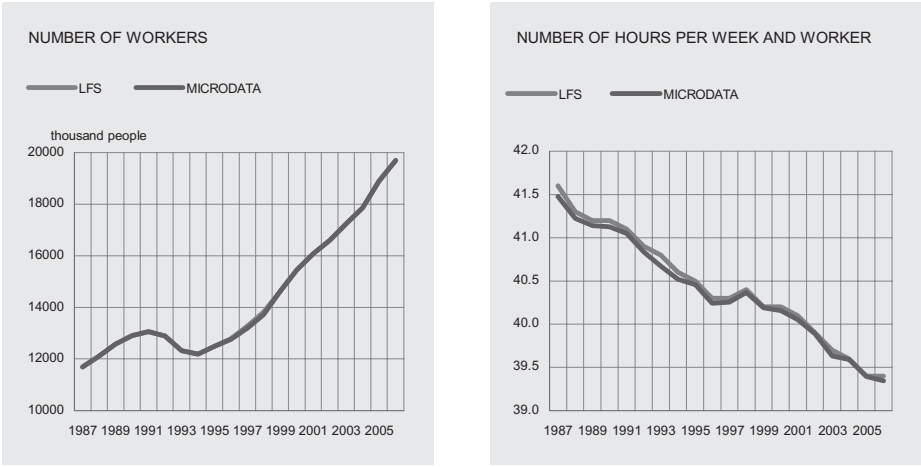

Figure 1. Labour Input; Number of Workers and Hours Per Week and Worker
Source: INE and Banco de España.

been an impressive recovery of the total number of workers. Indeed, between 1998 and 2006 the number of workers grew at an annual growth rate of 4.6 percent. On the other hand, during the same period, there has been an important decline of hours worked per week. The series show an annual decline of –0.3 percent. That is the reason why the total number of hours worked has been growing at a lower rate than the number of workers.

Apart from changes in the abovementioned quantities, the Spanish labor force has experienced a noticeable change in terms of its composition. Table 1 shows the changes in this regard (in number of hours worked) according to the Labour Force Survey (LFS).

Women had entered the labor force, pushing up its percentage in the total number of hours worked. This increase in percentage has been pretty constant over the whole period of time. In terms of age, both very young individuals and the elderly have decreased their importance, while individuals between 35 and 55 have been gaining weight in the number of hours worked. Additionally, the educational level of the workforce has increased at a continuous and fast pace during the whole period of analysis. Despite this fact, qualified occupations have not faced the same expansion, increasing the level of over-education in the economy. In terms of tenure, between 1988 and 1992 and in the last period over 2002 there has been an important reduction of the tenure of the workforce. Instead, between 1992 and 2002, the distribution of years worked in the firm is pretty constant. Finally, the number of immigrants has increased disproportionately after 1997, especially in recent years.

All these abovementioned changes and their interactions will affect the quality of labor, depending on the relative number of efficiency units that we impute to a particular group. As was suggested in the previous section, we are going to do that with the information on earnings that comes from the Structural Earnings Survey (SES). Currently, there are three available waves: 1995, 2002, and 2006. This survey only includes workers who were on the payroll of a firm on

TABLE 1

CHANGES IN THE PERCENTAGES OF THE GROUPS IN THE TOTAL NUMBER OF HOURS

Percentage of Hours Worked	1988	1992	1997	2002	2006
Gender					
Males	71.6	69.6	67.8	65.4	63.5
Females	28.4	30.4	32.2	34.6	36.5
Age					
Between 16 and 34 years old	42.6	43.4	40.6	40.8	39.4
Between 35 and 54 years old	43.1	43.3	48.1	48.3	49.3
55 years old and more	14.2	13.3	11.3	10.9	11.3
Education					
Low	56.5	46.8	35.4	23.4	16.3
Medium	32.9	40.9	48.2	56.9	62.3
High	10.6	12.3	16.4	19.6	21.5
Tenure					
Less than 2 years	22.9	30.6	32.5	29.4	30.9
Between 2 and 7 years	23.7	22.3	18.7	24.6	26.3
7 years and more	53.3	47.0	48.8	46.0	42.8
Nationality					
Spanish	99.7	99.4	99.2	94.4	87.6
Foreign from EU-15	0.1	0.2	0.4	1.0	1.4
Rest of foreigns	0.2	0.3	0.5	4.6	11.0

Source: INE and Banco de España.

October 31 of the current year. The firm should be made up of at least ten workers,[22] and the sample contains only workers whose main source of income is their salary and were working in all sectors except agriculture, fishing, public administration, and housekeeping.[23] In terms of characteristics of the worker, the survey provides information about gender, age, nationality, educational attainment,[24] and the number of months that the worker has been working for the current firm.

The information on payments is quite precise in the survey and we include as wages the gross ordinary salary plus extraordinary payments made by the firm on an annual basis. It does not include non-monetary payments, arrears, indemnifications, or other expenses. We will study the worker's hourly wage so we need information about working time. We have data about the agreed regular schedule and the hours that someone worked in a non-regular fashion. Since we only have information about non-regular hours of work in October, we extrapolate the number in that particular month to the rest of the year.[25] It is important to note that a large fraction of the sample did not work the whole year in the firm.[26] In

[22]The absence of small firms should be taken into account when we draw conclusions from our analysis. 2006 is the first year that includes information on small firms.

[23]In particular, they have information on workers corresponding to the sectors between C and K and between M, N, and O.

[24]The codification of educational attainment in 2002 corresponds to the same codification of the EPA since 2000. The codification in 1995 corresponded to the one used in the EPA between 1992 and 1999.

[25]We must assume that October is a regular month in order to perform the extrapolation correctly.

[26]At least one third of workers did not work the whole year. There are various reasons: they may have been hired or fired in the course of the year, injured, or required a maternity break.

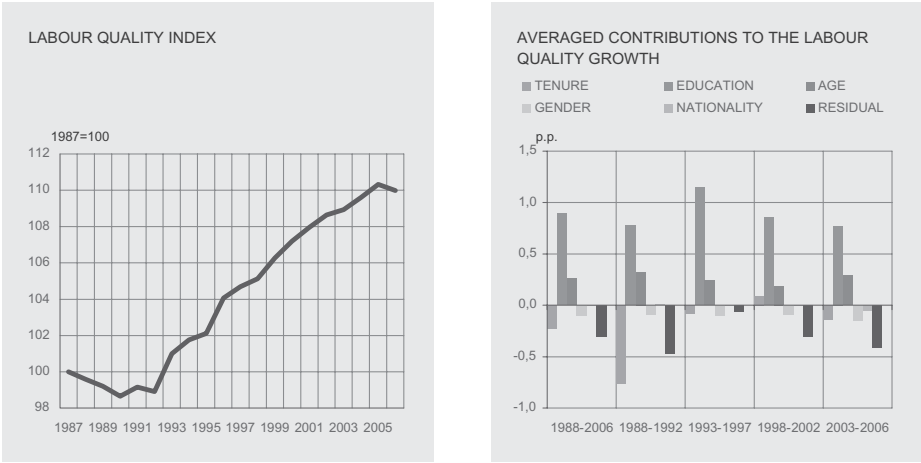

Figure 2. Labour Quality Input for the Whole Economy, Fixed Weight 1995
Source: INE and Banco de España.

order to compute the hourly wage for those workers, we divide the payments by the actual time at work for that person.

One advantage of using the SES instead of other Spanish datasets with information about salaries, such as the European Community Household Panel, is the sample size. The number of observations in this dataset is 186,763 (as opposed to around 10,000 in the ECHP), which allows a more detailed analysis of variables, according to the abovementioned methodology.

4. Labor Quality Using a Fixed Wage and its Contributors

Figure 2 shows the estimation of the labor quality index for the whole economy using information on wages in 1995.[27] Overall the index grows at an average annual rate of 0.53 percent. Only between 1988 and 1992 does the index decline, with a negative growth of –0.22 percent. After that, there is a period of stable and very dynamic growth of the quality of labor, with an average annual growth rate of 1.14 percent between 1993 and 1997. Finally, the index starts moderating its rhythm with a growth rate of 0.74 percent between 1998 and 2002 and 0.30 percent between 2003 and 2006. Indeed, 2006 is the first year during the last 15 that presents a negative growth rate.

These results are very similar to those obtained by Moral and Hurtado (2003) with aggregate data on hours. Indeed they found a quality growth rate of 0.38 percent per year during the period 1987–2003, with the decline in labor quality in the first part of the sample.

[27]We have wage information for 1995, 2002, and 2006. For simplicity we only show the estimation of the index using the information of 1995. In the following section the index for all the other years will be discussed. We consider nationality in 1995 using the wage differential between native and foreigners observed in 2002. In the Appendix we provide the numerical indexes.

Figure 2 also shows the contribution of education, age, tenure, gender, and nationality to the overall growth of the index in several sampling periods. Education is the factor that has had the most influence on the positive evolution of the index. During the whole period of time it contributed 0.89pp to the quality growth. This is the counterpart of the important and continuous educational upgrading of the Spanish labor force. Although in recent years the contribution has been decelerating with respect to the period 1993–97 when it contributed with 1.15pp, the positive impact of education is still relevant and is expected to be relevant in the near future while the new generations with high levels of education keep replacing the older ones. However, the contribution should be decreasing over time.

On the other hand, the age of an individual is a proxy for the stock of general experience that is embodied in a person. In principle, we expect individuals to increase their abilities the more years they spend in the labor force independently of whether they stay at the same firm or they switch to another. In that sense, aging should increase the abilities of the population via more experience; that is the reason why it is not surprising to see a positive contribution of aging in the quality index during the whole period. The contribution is 0.26pp and is pretty constant over the whole period.[28] As long as the population gets older in the future, the contribution of aging might become smaller because of the typical concavity of wage profiles over the life cycle.

The age distribution does not fully characterize the way productivity varies with years in the labor market. Indeed, the more years someone works in a particular job, the more productive he is with respect to another worker that has spent the same number of years in the labor market but in other firms. This is what we capture with the variable years within a firm. Indeed, this factor is the second in terms of quantitative importance after education. The big reduction of tenure contributed negatively to the job quality with –0.23pp. Indeed, during the period 1988–92 this factor is the main one responsible for the decline in labor quality. After that date, the negative contribution moderates and even becomes positive between 1998 and 2002. However, in the last period (2003–06), tenure decreases again, contributing negatively to the index (–0.14pp). Notice that the contribution of this factor is much more volatile than the contribution of education. Variations of tenure are difficult to predict since this is a factor that is affected by the cycle.

Because earnings differentials are assumed to be an image of relative productivities, and women earn less than males even when controlling for all the other relevant characteristics, it is not surprising that the increase in female participation produced a negative effect on the quality index. Its contribution is small and pretty constant, around –0.11pp.

Concerning the effects of migration, the big inflow of immigrants in Spain has impacted labor quality, with a negative contribution of –0.01pp over the whole period. However, since the phenomenon is quite recent it is not surprising that the impact starts becoming important in 1998 and especially since 2003.

Finally, it is worth noting that the residual (the part of the variation in quality that cannot be accounted by univariate changes) is quite important, especially at

[28]Only between 1998 and 2002 was the contribution slightly smaller, because the age distribution did not change much within this period compared to the others.

the beginning and end of the sample. The residual is capturing some interactions between variables, both in wages (an example would be that an educated worker has more experience premium than a non-educated worker) and in quantities (another example would be that women tend to have less experience). A closer look at these interactions reveals that most of the residual can be accounted for by interactions between experience and other variables. This means that the importance of experience is larger than its univariate contribution suggests.

Summarizing, wage differentials have generated an increasing quality of labor during the last 15 years. This issue contrasts with the recent stagnation in productivity growth.

5. The Importance of Changes in Relative Productivities Over Time

As was suggested in Section 2, the more wage information we have, the better the approximation to any aggregator function that maps individual characteristics to aggregate production. However, our previous computations fix the salary in 1995, and it is well known that there have been in the recent past many changes in the returns to different characteristics (see Goerlich and Mas, 1999; Arellano *et al.*, 2002; Izquierdo and Lacuesta, 2006; Pijoan-Mas and Sánchez-Marcos, 2010) that might end up changing the estimation of individual productivities and consequently the quality index.

Table 2 shows the regressions used to compute the quality index. The three columns of the table show the coefficient in front of the characteristics for three different wage regressions by year. It is clear that relative returns to education and age have compressed over the years. This is not surprising since, as it was pointed out in Izquierdo and Lacuesta (2006), returns to education and age have decreased significantly when comparing the first two waves of data. In that paper, it was also shown that returns to tenure and gender did not change that much between the two waves.[29]

In order to show how those changes in returns affect the quality index, we redo the previous exercise using earnings from SES-1995, SES-2002, and SES-2006. The sample of each wave is slightly different and we need to take those differences into account. In particular, in 2002 and 2006 there is information on the nationality of the worker that is absent in the 1995 wave. Furthermore, the codification of education is different and the coverage of the survey has been extended over time.[30] In order to do a fair comparison we homogenize the information to be similar to 1995.

Figure 3 shows the three quality indexes using fixed relative wages (equation (2) using a fixed wage) and a time varying weight index (equation (2)). The average annual growth rate for the quality index given the earnings structure in 1995 is 0.52 percent, whereas using that of 2002 the growth rate is 0.29 percent, and

[29]Actually, returns to tenure change in different parts of the distribution of earnings, but on average those differences cancel out.

[30]In 2002 and 2006 the coverage of the survey was extended to some non-market services (education, health, and social services sectors). In 2006 small enterprises were added. In order to do a fair comparison we homogenize the information on education, drop the observations regarding the abovementioned sub-sectors from the 2002 and 2006 sample, and drop small firms from 2006.

TABLE 2

Effect of Time Varying Weights to the Labour Quality Estimation

Estimated Coefficients	SES-1995	SES-2002	SES-2006
Foreign	–	–0.05	–0.05
	–	(0.0066)	(0.0045)
	–	***	***
Foreign from EU-15	–	0.22	0.14
	–	(0.0137)	(0.0105)
	–	***	***
Female gender	–0.24	–0.26	–0.25
	(0.0027)	(0.0022)	(0.0022)
	***	***	***
Age between 16 and 34 years old	–0.28	–0.21	–0.18
	(0.0047)	(0.0042)	(0.0041)
	***	***	***
Age between 35 and 54 years old	–0.03	–0.06	–0.07
	(0.0042)	(0.0039)	(0.0038)
	***	***	***
Medium education	0.20	0.13	0.12
	(0.0027)	(0.0024)	(0.0025)
	***	***	***
High education	0.79	0.68	0.57
	(0.0041)	(0.0034)	(0.0033)
	***	***	***
Less than 2 years of experience	–0.50	–0.50	–0.49
	(0.0033)	(0.0028)	(0.0029)
	***	***	***
Between 2 and 7 years of experience	–0.22	–0.29	–0.24
	(0.0030)	(0.0027)	(0.0027)
	***	***	***
Constant	2.20	2.49	2.59
	(0.0039)	(0.0039)	(0.0038)
	***	***	***
Number of observations	135.083	156.967	144.203
R-squared	0.42	0.44	0.41

Notes: Standard errors in parentheses.
Significant at: *10%; **5%; ***1%.
Source: INE and Banco de España.

using that of 2006 it is 0.18 percent. This higher index growth when 1995 relative wages are used is apparent during the whole period but the difference is especially important between 1998 and 2005.

Given this discrepancy, our best estimation of the real index of quality for the period 1988–2006 would be a combination of the three quality indexes following equation (2). Using this time varying weights index, the real average annual growth rate during the whole period would have been 0.42 percent. The slowdown of the index after 1997 is much more pronounced than what was evident using only one wave.

We attribute the gap of the three series to the direct effect of two components: education and age (especially the former). These are the dimensions in which, as was commented before, contributions differ considerably over the period. In order to gain more insight into what is underlying the decrease of relative returns, we enlarge the wage equation in such a way that we can control for specific changes in the Spanish labor market that might have affected relative returns. Since the 1980s,

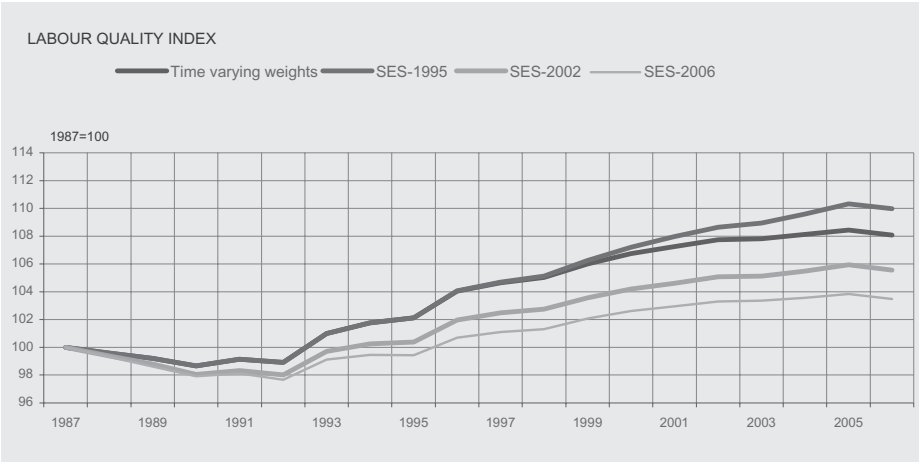

Figure 3. Effect of Adding Time Varying Weights to the Labour Quality Estimation
Source: INE and Banco de España.

the increase in the supply of university degree holders has not been offset by an increase in demand (Abadie, 1997; Del Río and Ruiz-Castillo, 2001; Febrer and Mora, 2005), as is clear in Table 1.[31] This fact made many highly educated workers accept low-qualified jobs. Indeed the change in educational distribution over time has not been matched by changes in the distribution of occupations. Therefore, adding different types of occupation into the regression should clearly modify the contribution of education downward.

According to Zoghi (2007), it is not clear whether or not one would like to include occupation into the computation of a labor quality index. However, in practice, there would be reasons to incorporate occupations into the empirical analysis; for example, if an individual's education does not fully reflect their ability, but is just a signal of their potential ability. Indeed, this is especially important in the Spanish economy where every employee is assigned to a particular Social Security contribution group.

In order to check whether over-education might be an important contributor to the slowdown of the labor quality increase, once we consider time-varying weights, we enlarge the regression model with a set of interactions of the three levels of education and the four levels of occupations (11 dummies). These interactions should capture better the real skill level of workers. The new model is estimated with wages in 1995. Figure 4 compares three quality indexes: the usual 1995 fixed wage, the 1995 fix wage enlarged with the interactions between occupations and education, and the time varying weights. It is clear from the figure that the enlargement of the 1995 wage equation captures the reduction in the quality growth rate obtained when using time varying wages.

[31]Notice we only have occupations from 1994 onwards because of a change in the definition of occupation (CNO-94).

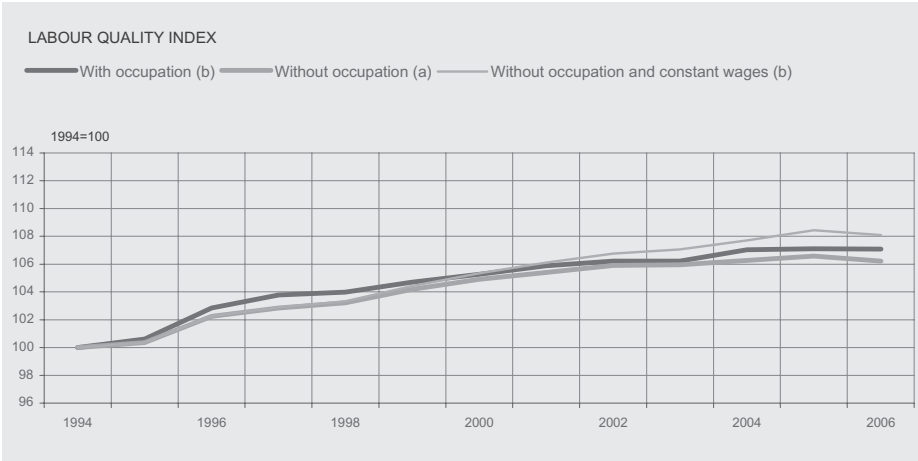

Figure 4. Effect of Adding Occupation to the Labour Quality Estimation

Source: INE and Banco de España.
a. With time varying wages.
b. Corresponding to SSE-1995.

6. The Importance of Changes in Both Relative and Average Productivities Over Time

6.1. *Motivation of the Selection Model*

Equations (1) and (2) in Section 2 were defined in terms of variables that were fully observable by the econometrician. But individuals can have heterogeneous productivities even after conditioning on these set of observable variables. If this is the case, it is sensible to expect that for a group of individuals with similar observable characteristics, those who are working are among the most productive. This is not important if occupation rates are steady over time. But this is not the case in Spain. As Figure 5 shows, the employment rate has been rising since the mid-1990s, as a consequence of both a drop in unemployment rate and an increase in participation rates. If the previous reasoning is true, these new workers should have a lower than average productivity, thereby generating a drop in average productivity by means of a compositional effect. This hypothesis appears to be confirmed with the evolution of real wages in Figure 5. The growth rate of real wages became negative just when the employment rate started rising.

If we had yearly wage data, changes in relative employment rates would be eventually captured by a quality index with time varying coefficients, because the drop in relative productivity for those groups with a faster occupation growth will be included in the future wages that are going to be used. Therefore, with enough data on wages, there is no need of additional corrections in the quality index in order to capture the *relative* unobservable composition effect. Also, the approach with varying wages followed in Section 5 could capture the trend of these relative effects between two years with wage information, but not in the intermediate years, for which annual wage data is needed.

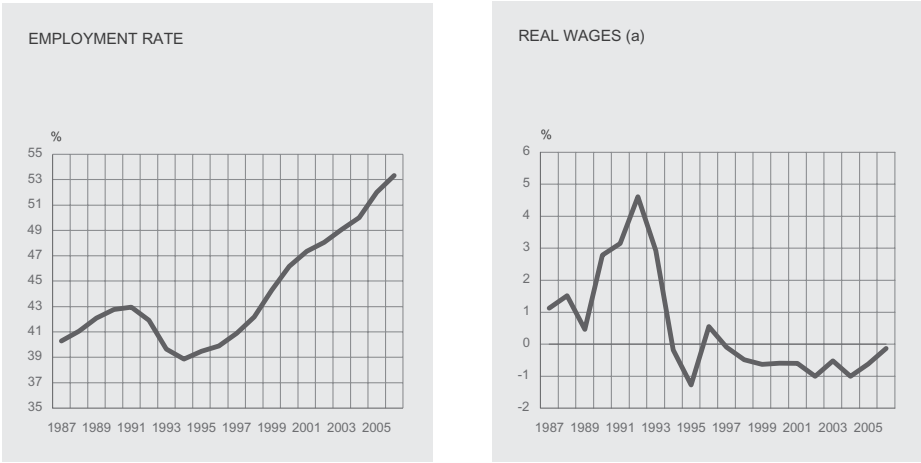

Figure 5. Evolution of Occupation Rate and Real Wages in Spain

Source: INE and Banco de España.
a. Annual change rate.

However, if the increase in employment rate occurs across all groups, time varying wages are not capable of capturing the generalized productivity fall.[32] As mentioned previously, the occupation rate increased between 1995 and 2006 in 27 of the 30 demographic groups considered. As a consequence, a correction taking into account the selection mechanism would be needed, even with yearly wage data.

Of course, one can argue that the fall in real wages observed in Figure 5 is due to a short run excess of labor supply, caused by the increase in employment rate. If this is true, demand will eventually follow supply, and real wages will rise again. Hence, the temporary drop in wages should not be taken into account in a labor quality index. It is difficult to distinguish between the two theories (unobservable differences in productivity and temporary labor demand shortage) from the available data, because both imply the same drop in real wages while occupation is rising, and we do not have enough historical data to see what happens when employment stops rising. Nevertheless, we will try to get some informal evidence by exploiting differences between men and women. It is sensible to expect that men and women compete with each other inside each of the 15 demographic groups defined by education (3) and age (5). Therefore, under the demand shortage interpretation, differences in employment rate variations between men and women should not have any influence on the gender wage differential: both male and female wage should respond equally to variations in the employment rate of any gender. On the other hand, if there are productivity differences not related to any observable variable, then the wage of men, relative to women, should rise for those groups in which the women's participation rate is growing faster than the men's one (and vice versa), because the selection mechanism implies that those new workers have less productivity than previous ones, and this effect is stronger for women.

[32]This is because, according to equation (2), the index only responds to changes in relative wages. A change in the average wage level does not affect the index.

TABLE 3
Differential Wage Growth by Gender

	1995–2002	2002–06	Pooled
Differential employment rate change by gender	–0.314	–0.410	–0.360
P-value	0.237	0.026	0.066
Number of observations	15	15	30

Source: INE and Banco de España.

Using the available wage data for 1995, 2002, and 2006, we can compute these differentials in wage variation between genders, and regress them against differences in employment rate variations.[33] The hypotheses to test are the following:

– H_0: The estimated slope is equal to zero (this corresponds to the demand shortage interpretation).
– H_1: The estimated slope is negative (this corresponds to the selection interpretation).

Table 3 shows the estimated coefficient, and the p-value associated with the previous hypotheses, for three periods: 1995–2002, 2002–06, and a pooled estimation.[34] Results point toward the selection interpretation. We acknowledge that the empirical evidence is weak due to the scarce number of observations, but it reinforces our departing hypothesis.

In summary, there are two reasons (absence of yearly data on wages, and generalized increase in occupation) to include a selection mechanism in the estimation of the labor quality index. This is done in the next subsection.

6.2. *Results of the Selection Model*

The way in which we are going to include a selection mechanism in the quality index is by using a Mills ratio, as it was described in Section 2, equation (3). Note that this empirical strategy assumes a functional form. Consequently, the results here are by no means definite, and should be understood as a first assessment of the potential importance of the selection problem.

Figure 6 shows the way the average Mills ratio for workers has changed over time. The pattern follows inversely the evolution of employment rates. Between 1987 and 1991 the Mills ratio decreases because of the increase in labor participation, but between 1992 and 1995 that particular increase is compensated by an increase in unemployment, which is the reason the Mills ratio increases. After that time the Mills ratio decreases notably.

Table 4 shows the effect of adding the Mills ratio to the regressions in Table 2. The coefficient in front of the Mills ratio is positive, meaning that the

[33]Note that the number of observations is very low (five age groups, three education groups), so it is very difficult to assess the significance of the estimators; results should be taken as informal evidence.

[34]All three regressions include a constant; the last one also includes a dummy indicating the period from which the observation is taken.

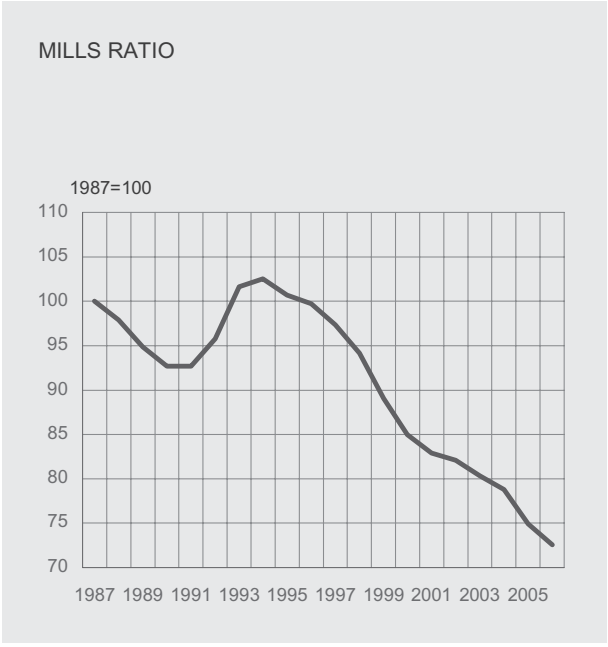

Figure 6. Evolution of the Mills Ratio Selection Parameter in Spain
Source: INE and Banco de España.

incorporation of new workers in the economy decreases the average productivity. Regarding the other variables, their coefficients fall for those groups with low occupation rates, like old or female workers. This means that part of the high wage we previously estimated for them is indeed due to the selection mechanism. Inclusion of the Mills ratio also delivers some new sensible results: the life cycle earnings profile now has an inverted U-shape, and the gender gap decreases over time.

The next step is to predict wages for 1995, 2002, and 2006 using the three equations in Table 4, and then interpolate for the intermediate years. Recall that this procedure takes into account the variations in average wage level that come from the effect of the Mills ratio. With these predicted wages, and using equation (3), we finally obtain a labor quality index that includes the selection mechanism. This is depicted in Figure 7.

Incorporation of the Mills ratio increases the quality index growth between 1991 and 1996 and decreases the slope from then on, reflecting the selection effect coming from the fall and increase in occupation rates, respectively. It decreases the average yearly growth rate of the index between 1996 and 2007, from 0.40 percent with only varying wages to –0.10 percent with time varying wages and the Mills ratio. Indeed, this factor has a higher impact than varying wages in the latter period. This latter negative growth rate since 1997 implies that the selection mechanism has some role in explaining the low productivity growth in recent years. This is assessed in the next section.

TABLE 4
EFFECT OF ADDING A SELECTION MODEL TO THE LABOUR QUALITY ESTIMATION

Estimated Coefficients	SES-1995	SES-2002	SES-2006
Foreign	–	–0.05	–0.05
	–	(0.0066)	(0.0045)
	–	***	***
Foreign from EU-15	–	0.22	0.14
	–	(0.0137)	(0.0105)
	–	***	***
Female gender	–0.45	–0.40	–0.33
	(0.0156)	(0.0097)	(0.0078)
	***	***	***
Age between 16 and 34 years old	–0.08	–0.02	–0.06
	(0.0156)	–0.0128	(0.0128)
	***	128	***
Age between 35 and 54 years old	0.32	0.23	0.10
	(0.0258)	(0.0189)	(0.0178)
	***	***	***
Medium education	0.25	0.22	0.19
	(0.0049)	(0.0060)	(0.0067)
	***	***	***
High education	0.96	0.85	0.68
	(0.0134)	(0.0111)	(0.0118)
	***	***	***
Less than 2 years of experience	–0.50	–0.50	–0.49
	(0.0033)	(0.0028)	(0.0029)
	***	***	***
Between 2 and 7 years of experience	–0.22	–0.29	–0.24
	(0.0030)	(0.0027)	(0.0027)
	***	***	***
Mills ratio	0.42	0.33	0.21
	(0.0305)	(0.0214)	(0.0209)
	***	***	***
Constant	1.64	2.03	2.30
	(0.0411)	(0.0298)	(0.0291)
	***	***	***
Number of observations	135.083	156.967	144.203
R-squared	0.42	0.44	0.41

Notes: Standard errors in parentheses.
Significant at: *10%; **5%; ***1%.
Source: INE and Banco de España.

7. TFP OF THE MARKET ECONOMY AFTER ADJUSTING FOR THE QUALITY OF LABOR

Once we have a quality index that incorporates heterogeneity in the labor force, we could add it to any aggregate production function of the market economy.[35] In particular we use the typical Cobb–Douglas with capital and hours worked augmented with the characteristics of the workers:

$$Y_t = TFP_t F(K_t, H_t, Q_t)$$

[35]We only have an accurate estimation for the capital in the market economy and that is the reason why we need to exclude non-market services. Capital is estimated using the perpetual inventory of the stock of capital.

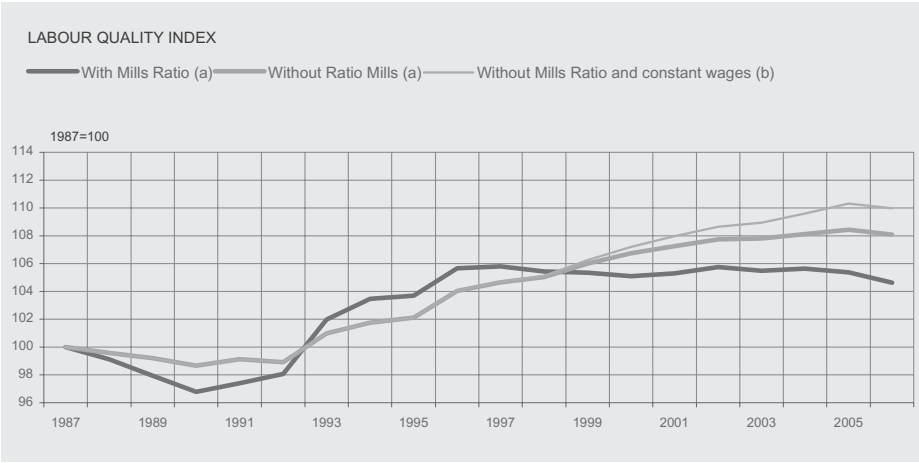

Figure 7. Effect of Adding a Selection Model to the Labour Quality Estimation

Source: INE and Banco de España.
a. Time varying weights.
b. Corresponding to SSE-1995.

$$Y_t = TFP_t K_t^{1-\alpha}(H_t Q_t)^{\alpha}$$

where Y represents the Value Added in real terms, K is the stock of capital of the market economy, H is the total number of hours worked, and Q is the quality index. On the other hand, α is set to 0.60 in order to approximate the labor share in the GDP in recent years.[36] With this equation Total Factor Productivity (TFP) is the residual of the abovementioned equation.

Given our first estimation of labor quality, this factor contributes with 0.30 pp to the Value Added growth in annual terms (see Figure 8). Indeed, its contribution is much higher than the contribution of TFP (0.12pp). This means that the growth of our quality index explains almost three quarters of a TFP growth calculated without labor quality.

It is clear that the evolution over time of labor quality contribution differs considerably from the evolution of TFP contribution. The latter is pretty high for the first period of the sample and decreases sharply during the later years.[37] On the other hand, labor quality contribution starts at negative rates, increasing subsequently and only decelerating at the very end. This means that accounting for labor quality could help to explain part of the recent drop in unadjusted TFP growth.

Once we take into account time-varying weights and the Mills ratio, the contribution of the quality of labor during the period 1998–2002 almost vanishes (see Figure 9), and it is slightly negative for the period 2003–06. This fact generates the additional exhaustion of the negative contribution of the TFP since 1998 (only slightly negative in the last period), which means that a substantial part of the recent

[36]This value corresponds to the average share of labor income over total value added. The estimation for TFP does not change qualitatively, even in the case of setting different labor shares over time.
[37]There is a very recent acceleration of TFP growth in annual terms.

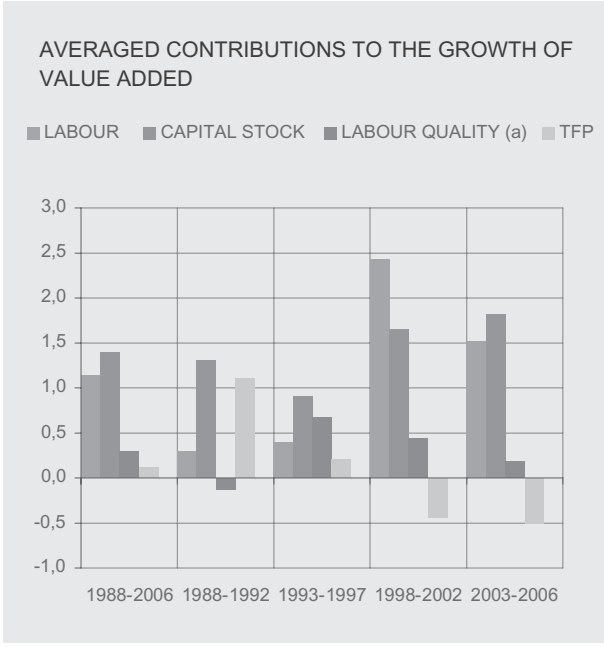

Figure 8. Total Factor Productivity of the Market Economy

Source: INE and Banco de España.

a. With constant wages from SSE-1995, without Mills ratio or occupation.

productivity slowdown in Spain can be explained by a reduction in labor quality growth.

The recent close-to-zero contribution of labor quality should not be interpreted as a low importance of taking into account changes in labor quality. Instead, the correct interpretation is that, although education had a very important contribution to labor quality growth, there are other factors, also very important, that could offset this positive contribution of education, at least in the short run.

8. Conclusions

The paper departs from the traditional way of measuring an index of labor quality in order to explain a recent empirical puzzle in the Spanish economy: despite showing one of the most important increases in labor quality in the EU according to standard methods, it also offers a negative increase in TFP growth. The changes in the wage structure as well as the enormous increase in occupation rates makes necessary the addition of time varying weights as well as a participation mechanism. The addition of these issues changes the prediction of the absolute and relative productivities of every demographic sub-group of the population, achieving completely different results.

In the estimation of a labor quality index for Spain between 1988 and 2006, we first include the typical human capital variables gender, age, education plus tenure,

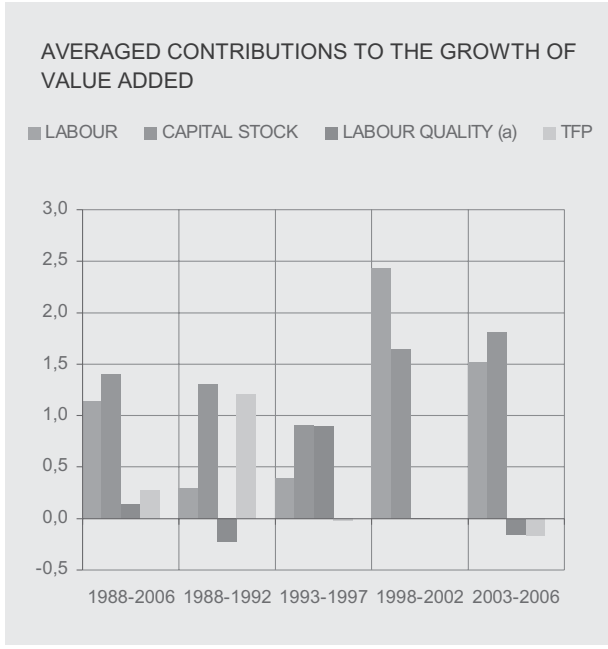

Figure 9. Total Factor Productivity of the Market Economy

Source: INE and Banco de España.
a. Time varying wages and with Mills ratio.

and nationality. In this first stage we fix the weights to the wage differential in 1995. The index consists of disaggregating the total number of hours worked into different cells with particular characteristics and weighting them by the market wage of each particular group. Overall, the index grows at an average annual rate of 0.50 percent. Only between 1988 and 1992 does the index decline, with a negative growth of –0.22 percent. There is then a period of a very dynamic growth of labor quality, with an average annual growth rate of 1.14 percent between 1993 and 1997. Finally, the index starts moderating its pace, with a growth rate of 0.74 percent between 1998 and 2002 and 0.31 percent between 2003 and 2006.

The construction of the index enables its disaggregation into different components. Education is the factor that has had the most influence on the positive evolution of the index. However, at the beginning of the sample, the important reduction in tenure pushed the index down more vigorously. During the latter years, skill upgrading was not as strong as before, and immigration and tenure depressed the quality of labor to slower growth rates. In the future, the increasing importance of immigrants and the slowdown of education might push down the quality of labor even more. However, during the last year we observed a decrease in the rate of temporary contracts, partly due to a higher destruction of temporary contracts. This phenomenon might push labor quality up if it continues over time.

This labor quality increase is puzzling given the observed slowdown in productivity growth during the last decade. One potential explanation underlying this

fact might be that our measure of productivity is not really capturing the recent changes in the composition of the Spanish labor force. Indeed, in order to construct the index we kept relative productivities constant during the whole period. However, the productivity of each characteristic has varied across time as it has been apparent by important changes in the underlying wage structure. In order to check this issue, we computed the index of quality using wage information from the Structural Earnings Survey 1995, 2002, and 2006; we found that there are notable differences between the three indexes. In particular, the index of quality computed using the 1995 information would have been growing more than the other two, which is intuitive since wage differentials were higher in 1995 than in 2002 and 2006. This evidence reinforced the idea that the usage of time varying wages is more appropriate when incorporating more years into the analysis. From one year to the other, the decrease in relative returns to education is one of the main contributors to the decrease in the growth of the labor quality index. One possible explanation underlying this change in relative wages is the increasing importance of over-education in the economy. In order to asses the importance of this factor we incorporate interactions of occupation and education into the measure of the quality index with fixed wages.

On top of changes in relative returns, both the average productivity of the Spanish economy and the average real wages have suffered an important decline in recent years. This issue has occurred at the same time as an enormous net employment creation. In 1988 the employment rate between the ages of 16 and 64 was 48.6 percent; it is now 66.6 percent. It is very likely that those who participated in the labor market at the beginning of the 1990s were different in many aspects to those who decide to participate nowadays, despite having the same characteristics (gender, education, and age). Indeed, it is likely that they were more favorably selected since only half of them worked, and now working is a more general option. The paper also shows that this factor had a negative effect on the quality of labor in recent years. The paper enlarges the index of quality of labor with a selection model that enables changes in average productivities to be related to changes in employment rates. With the addition of the selection model, the index of labor quality has slightly decreased since 1995.

Finally, we included labor quality in a standard growth accounting exercise setting for the market economy and for each particular sector. The main result in this respect is that a substantial part of the recent slowdown in productivity can be explained by a drop in labor quality growth rates over the last years of the sample. Once we take into account time varying weights and the Mills ratio, the contribution of the quality of labor during the period 1998–2002 almost vanishes, meaning that these two factors had a negative effect on labor quality that could compensate the quality increase from other factors such as education. The distinction between the two compensating effects is very important, because it can be expected that the shortage of qualified labor demand mentioned previously as underlying the decrease in wage differentials is a temporary phenomenon. Also, the increase in employment, and hence the inclusion of less productive people into the labor force, is again temporal. Therefore, disentangling a null contribution into a positive and permanent component and a negative and transitory one allows us to expect future improvements in labor quality, and hence in productivity.

Appendix: Labor Quality Index

TABLE A1

Quality Labour Indexes for the Whole Economy

1987 = 100	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Quality labour indexes																				
SES-1995	100.0	99.6	99.2	98.7	99.1	98.9	101.0	101.7	102.1	104.1	104.7	105.1	106.3	107.2	108.0	108.6	108.9	109.6	110.3	110.0
SES-2002	100.0	99.4	98.8	98.1	98.3	98.0	99.7	100.2	100.4	102.0	102.5	102.7	103.6	104.2	104.6	105.1	105.1	105.5	105.9	105.6
SES-2006	100.0	99.3	98.6	97.9	98.1	97.7	99.1	99.5	99.4	100.7	101.1	101.3	102.1	102.6	102.9	103.3	103.4	103.6	103.8	103.5
Time varying weights	100.0	99.6	99.2	98.7	99.1	98.9	101.0	101.7	102.1	104.0	104.6	105.0	106.0	106.8	107.3	107.8	107.8	108.1	108.5	108.1
Time varying weights and mills ratio	100.0	99.1	97.9	96.8	97.4	98.1	102.0	103.5	103.7	105.7	105.8	105.4	105.3	105.1	105.3	105.7	105.5	105.6	105.4	104.6
Addendum																				
1994 = 100		1994		1995		1996		1997		1998		1999		2000		2001		2002		2003		2004		2005		2006
SES-1995 with occupation		100.0		100.6		102.9		103.8		104.0		104.7		105.3		105.9		106.2		106.2		107.0		107.1		107.1

Source: Spanish Bureau of Statistics (INE) and Banco de España.

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