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**“Young Employment, Job-Skill Composition and  
Minimum Wages: Evidence from a “Natural  
Experiment”**

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**NIPE WP 4 / 2008**

NÚCLEO DE INVESTIGAÇÃO EM POLÍTICAS ECONÓMICAS  
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# Young Employment, Job-Skill Composition and Minimum Wages: Evidence from a "Natural Experiment"\*

João Cerejeira Silva<sup>†</sup>

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## Abstract

Empirically very little is known about the impact of an increase in the minimum wage of young workers on the job-skill composition. This is an important question because small (or zero) effects on teenage employment may mask a substitution of more for less-skilled teenagers. Therefore, the estimation of the elasticity of substitution between skilled and unskilled workers is required. This paper will consider the increase in the minimum wage of young workers that took place in Portugal on the 1st January, 1987. This change is of particular interest, not only because it was so large (33% in real terms) and affected a significant share of workers under 20 years old (about 20%), but also because it motivated a decrease in the wage premium earned by young skilled workers from 1.24 to 1.20. The results are consistent with the view that the minimum wage increase had some negative impact on employment of unskilled workers, the most affected group: an increase of 1% in wage induced by the increase in minimum wage reduces employment of this group of workers between 0.42% to 0.47%. Nevertheless, this negative impact was partially compensated by the substitution of more for less-skilled teenagers, because there is some evidence that the elasticity of substitution between young workers with different skills is different from zero.

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# 1 Introduction

The debate on minimum wage (MW) focuses mainly on its impact on the level of employment or on income distribution. This paper evaluates the impact of an increase in the minimum wage of young workers on the number of jobs as well as on the composition of jobs, in terms of skills.

The employment effects of minimum wages remains one of the most contentious policy questions in economics (see Brown, 1999). Much of the recent empirical research has concluded that minimum-wage effect on young employment is absent or positive (Card and Krueger, 1994), but there are also recent studies that find significant negative effects for young or low-wage workers in the US (Neumark and Wascher, 2000).

Although there is some theoretical work about the impact of labour market regulations on the composition of jobs, labour productivity and welfare (Acemoglu, 2001), empirically very little is known about the impact of an increase in the minimum wage of young workers on the job-skill composition. This is an important question because small (or zero) effects on teenage employment may mask a substitution of more for less-skilled teenagers. Therefore, the estimation of the elasticity of substitution between skilled and unskilled workers is required<sup>1</sup>.

The main identification problem in the estimation of the elasticity of substitution of workers with different skills is that the relative demand and supply of skilled workers are set simultaneously. Some authors estimate this elasticity considering exogenous variations of the relative supply of skills using, for example, time and state specific child labour and compulsory school attendance laws as instruments (e.g. Ciccone and Peri, 2005). This work will consider the increase in the minimum wage of young workers that took place in Portugal on the 1st January, 1987. This change is of particular interest not only because it was so large (33% in real terms) and affected a significant share of workers under 20 years of age (about 20%), but also because it motivated a decrease in the wage premium earned by young skilled workers from 1.24 to 1.20.

The results are consistent with the view that the MW increase had some negative impact on employment of unskilled workers, the most affected group: an increase of 1% in wage induced by the increase in MW reduces employment of this group of workers between 0.42% to 0.47%. Nevertheless, this negative impact was partially compensated by the substitution of more for less-skilled teenagers, because there is some evidence that the elasticity of substitution between young workers with different skills is different from zero.

The rest of the paper is organized as follows. Section 2 presents the background of the relevant literature and describes the minimum wage-fixing mechanisms framework in the Portuguese labour market. Section 3 describes the data and summarizes wage and employment growth for both skill and age groups. Section 4 presents the estimation method and discusses the results in terms of

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<sup>1</sup>This elasticity, which is the slope of the relative demand curve for more skilled workers, is also a very important parameter in several other subjects in economics.

employment and composition effects of the MW increase. Finally, Section 5 concludes.

## 2 Background

### 2.1 Minimum wage-fixing mechanisms and treatment of young workers

In Portugal, the monthly MW was introduced in 1974 to improve the pay conditions of the poorer workers<sup>2</sup>. Initially the MW system covered only non-agricultural and non-domestic workers over 19 years of age who worked in enterprises which employed over 5 workers. Three years after the introduction of the mandatory minimum wage, the government decided to create a special rate for young workers, up to 20 years old, equivalent to 50% of the adult rate. One year later, in 1978, the youth rate was split into two sub-rates: 50% for workers aged under 18, and 75% for those aged between 18-19.

The largest change concerning age coverages took place in January 1987, when workers aged 18 or older became entitled to the full minimum wage from the age of 18. Also, the MW rate for workers aged 17 rose to 75% of the statutory minimum. Table 1 highlights the major changes that tookplace in 1987.

Table 1: Monthly minimum wage rates applicable to workers, according to their age

	Age Group		
	17	18-19	$\geq 20$
Before 1978	50%	50%	100%
1978 to 1986	50%	75%	100%*
After 1st Jan. 87	<b>75%</b>	<b>100%*</b>	100%*

Note: \* 80% if trainee. Source: Diário da República

The 1987 law induced an increase of 50% in the MW for workers aged 17 (as it was raised from 50% to 75%), and, for workers aged 18 or 19 years, an increase of 33%, considering the national MW at the same level. In terms of nominal changes, while the national MW increased 12%, the 18-19 year-olds saw their MW increased by 49,3%, and the MW for 17 years-old rose by 68%<sup>3</sup>.

The justification for this new law relied legal rights and citizenship, since in the past, the age at which an individual would be entitled to full rights and duties in the legal system was 21. The change to the law was announced in the daily papers on the last day of 1986, as noted by Pereira (2003). Therefore, these large and focused changes in the MW legislation are likely to have been exogenous with respect to employment conditions, and provide an ideal opportunity

<sup>2</sup>For a comprehensive survey on the evolution of the Portuguese minimum wage see Ghellab (1998).

<sup>3</sup>See Table 8 in Appendix B.

for studying the effects of minimum wage policy on the youth labour market. Pereira (2003) and Portugal and Cardoso (2006) used the same change in the legal framework, arguing that it offers a "natural experiment" in which a very well-identified exogenous variation has a clear advantage over the most common methodologies like time-series and cross-section studies, where there is typically little variation and possibly MW adjustments are based on employment trends or expectations.

## 2.2 Related Minimum Wage Research

There is limited literature on the relationship between minimum wages and labour market outcomes in Portugal.

Ribeiro (1993) carried out an empirical study to assess the disemployment effects of MW, and found an employment rate elasticity to monthly minimum wage increase that ranges between -0.1 and -0.2. Pereira (2003) and Portugal and Cardoso (2006) examine the impact of the reform reported above on youth labour market outcomes using firm level data. Portugal and Cardoso (2006) modeled gross worker flows, accessions and separations, and found that the major effect on teenagers of a rising MW is the reduction of separations from the employer, which more than compensates for the reduction of accessions to new and continuing firms<sup>4</sup>. In contrast, Pereira (2003) estimates negative and statistically significant effects of the increase in MW on the employment of 18-19 year-olds, with an implied elasticity in the range of -0.2 to -0.4, as well as a positive spillover effect on the employment of 20-25 year-olds from this reform<sup>5</sup>.

Elsewhere, there are several works that examine the impact of minimum wages on youth employment, with results that differ considerably across studies (see Neumark and Washer (2003) or Brown (1999) for a survey). As an example, Abowd, Kramarz, Margolis and Philippon (2000) examine the impact of MW on youth employment in both France and the US using household survey data, and conclude that real MW wage changes are typically associated with significant employment effects, in line with competitive labour market theory. More recently, Hyslop and Stillman (2004) analyse the effects of a large reform in the MW affecting youth workers in New Zealand since 2001. They did not find robust evidence of adverse effects on youth employment or hours worked, but found a positive effect on hours worked by 16-17 year olds.

Small (or zero) effects on teenage employment may mask a substitution of more for less-skilled teenagers. A binding minimum wage increases the wage of non-skilled workers, making them less profitable and, therefore, may increase the number of jobs for skilled workers. In spite of the existence of some theoretical work about the impact of labour market regulations on the composition of jobs,

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<sup>4</sup>This result is consistent with the Dube, Naidu and Reich (2005) study on San Francisco's citywide MW adoption, in which they found a job tenure increase among workers affected by the reform.

<sup>5</sup>The differences between these later studies may be due to firm-selection and weighting issues.

labour productivity and welfare (see for example Teulings (2000) or Acemoglu (2001)), surprisingly, there have been few studies that use the variation in MW to estimate its effect on job composition in youth labour markets. In fact, there are many studies that try to look at the effects of minimum wages on the distribution of wages, e.g. Neumark, Schweitzer and Wascher (2000), but do not explicitly take into account skill composition of jobs. One exception is the recent Dube, Naidu and Reich (2005) study on San Francisco’s citywide MW adoption, which reports that full-service restaurants increased their use of tipped workers, which is consistent with a change in either job quality or skill-intensity in that sector after the MW reform<sup>6</sup>.

### 3 Data and Descriptive Statistics

The data used in the analysis in this paper comes from the “Quadros de Pessoal” (QP) data set, an extensive data source that covers nearly all of the wage earners in the private sector each year. It is produced by the Statistics Department of the Portuguese Ministry of Labour and Solidarity and all firms with wage-earners are legally required to reply to this inquiry<sup>7</sup>. The data set, which matches the firm, the establishment and each of the workers, includes the worker’s gender, age, skill, occupation, schooling, tenure and earnings, as well as the firm’s location, industry, employment level, sales volume and legal setting.

From the original data set, the observations were selected on the following basis. First, we dropped part-time workers as well as workers that did not work the normal period in the month of the survey (24% in 1989, 23% in 1988, 22% in 1987 and 23% in 1986 and 1985). Then we retained only the workers with no missing values in the variables used in our analysis, such as education level or date of birth and only those working in non-agriculture or non-fishery firms, and located in the continental Portugal. The final data set comprises 71%, 72%, 73%, 71% and 69% (in 1985, 1986, 1987, 1988 and 1989, respectively) of the full observations data set<sup>8</sup>.

#### 3.1 Minimum wages and youth employment

Table 2 and other tables and figures in the Appendixes A and B describe the relationship between the minimum wages in Portugal and youth employment. Some facts can be easily stated. The first is that compliance with minimum wage legislation was high. In fact, the share of workers aged 17 earning less than 75% of the national MW falls from 53.7% in 1986 to 35.4% in 1987. Similarly, the

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<sup>6</sup>Welch and Cunningham (1978) also estimated the effects of MW on youth employment, but in terms of age composition.

<sup>7</sup>See Appendix C for more details.

<sup>8</sup>which means that we have considered 1344691, 1366463, 1412985, 1426847 and 1506500 workers in 1985, 1986, 1987, 1988 and 1989, respectively.

share of workers aged 18 or 19 earning less than the national MW in 1987 was 15,6 percentage points lower than in 1986. This can be seen clearly in figures in the Appendix A. The second fact is that wage distributions in 1986 for young workers usually show two spikes: one at the sub-minimum wage, and another at the general compulsory MW. In 1987, a very sharp spike can be observed around the national MW for the 18-19 age group and around 75% of the full MW for workers aged 17.

Also, hourly labour earnings of the affected groups increased about 5 percentage points more than the increase observed for other groups. Interestingly, gross employment increased in all groups. It is important to note that the possibility to register a worker as an apprentice was not extensively used by employers. In fact, the share of apprentices remains roughly unchanged in the age categories directly affected by the change.

Table 2: Descriptive statistics - all workers (age 17-19)

	1986	1987	1988
Age 17			
Hourly Labour Earnings (HLE)	96.74	116.43	129.85
Var. HLE	18.82%	20.35%	11.53%
Below 75 % MW	53.69%	35.36%	26.84%
Apprentices	79.29%	78.90%	77.30%
Total Observations	23,467	24,660	27,128
Age 18-19			
Hourly Labour Earnings (HLE)	122.21	145.25	159.80
Var. HLE	18.30%	18.85%	10.02%
Below Nat MW	54.01%	38.40%	35.23%
Apprentices	56.75%	56.81%	54.69%
Total Observations	59,229	62,461	67,424
Age 20-24			
Hourly Labour Earnings (HLE)	161.10	182.44	199.57
Var. HLE	17.19%	13.25%	9.38%
Apprentices	53.44%	56.75%	58.47%
Total Observations	171,789	185,513	195,992
Age >24			
Hourly Labour Earnings (HLE)	277.16	317.92	345.35
Var. HLE	18.05%	14.71%	8.63%
Apprentices	14.79%	18.90%	19.76%
Total Observations	1,078,174	1,102,501	1,093,342

Note: Hourly Labour Earnings in nominal Portuguese Escudos (PTE).  
 Computations based on “Quadros de Pessoal” (1986-1988).



## 3.2 Skill composition and youngsters employment

### 3.2.1 Skill definition

Since the major goal of this paper is to assess the impact of an increase in the minimum wage of young workers on the job-skill composition, we need to classify workers as skilled or non-skilled, according to some skill definition. In the database used, firms classify their workers in “job levels” (from 1 to 8), according to the tasks and skills required for the job. This classification was defined by law and hence we will classify a worker as non-skilled if he performs totally determined simple tasks, which require only practical knowledge and are easily acquired in a short time (level 1 and 2) (Decree-Law 121/78 of 2nd July). All other workers are classified as skilled. This classification is preferred to the classical definition using educational status of the workers because we have a young labour force with a very small average of years of schooling (around 5 years). Also, the classification procedure is the firm’s task, which implies that skills that are not captured by a schooling measure (e.g. ability) can potentially be observed by the employer.

### 3.2.2 Wage growth and employment growth by skill and age group

Table 3 summarizes wage and employment growth by skill and age groups. Some facts can be assessed. The wage growth was significantly higher for non-skilled workers under 20 years of age. Conversely, for older workers, the skilled group observed wage increases higher than the unskilled group. Therefore, the wage premium of the skilled workers decreased after 1986 only for the young group, as we see in Figure 1.

Table 3: Wage and employment growth by skill and age group

	Skilled		Unskilled	
	86 to 87	87 to 88	86 to 87	87 to 88
Age 17				
Hourly wage growth	15.55%	10.27%	21.06%	11.57%
Var. total hours worked	9.29%	18.14%	5.25%	11.98%
Age 18-19				
Hourly wage growth	16.49%	9.85%	19.97%	9.60%
Var. total hours worked	5.67%	17.49%	6.24%	7.88%
Age 20-24				
Hourly wage growth	13.87%	10.18%	12.89%	8.18%
Var. total hours worked	6.28%	7.75%	12.53%	9.44%
Age >24				
Hourly wage growth	15.22%	9.22%	11.89%	4.12%
Var. total hours worked	2.66%	2.23%	5.23%	1.12%

Note: Computations based on Quadros de Pessal (1986-1988).

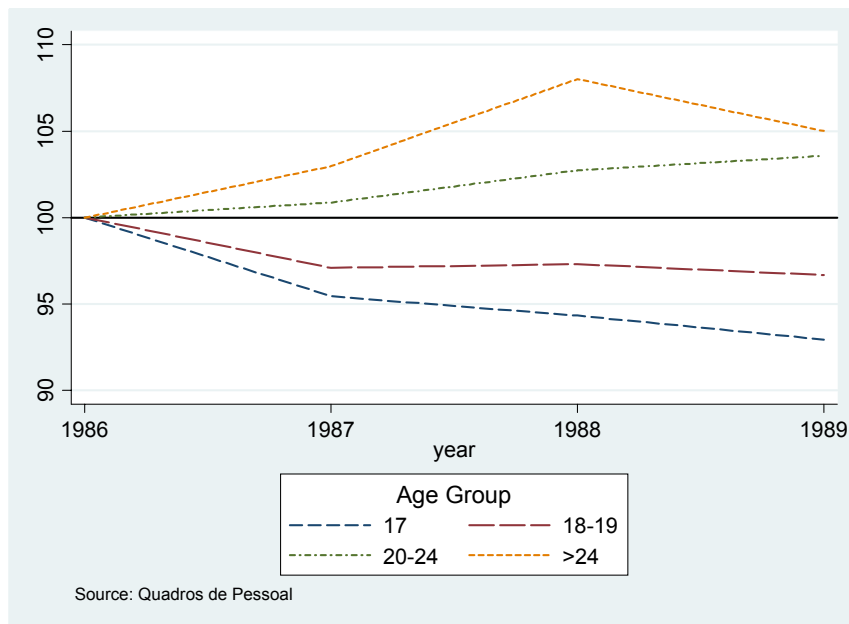


Figure 1: Ratio Skilled/Unskilled: Hourly Wage (1986=100)

Concerning employment variation, measured in hours, employment growth was smaller for non-skilled young workers (under 20 years of age), while the proportion of skilled workers increased between 1986 and 1988 only for the young group (Figure 2).

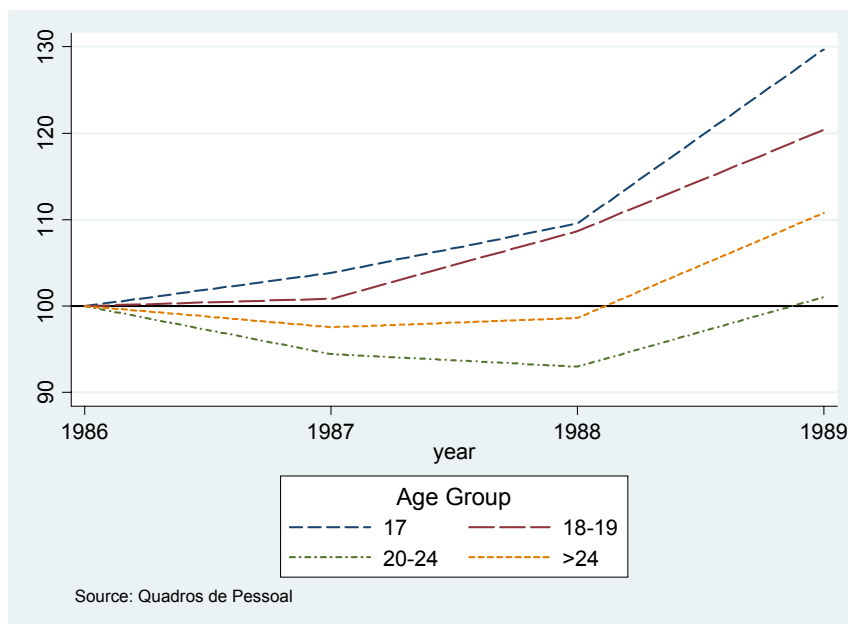


Figure 2: Ratio Skilled/Unskilled: Total Hours Worked (1986=100)

## 4 Estimation Method and Results

The estimation method of the impact of the MW change on young employment and skill composition considers this change as a “quasi-experiment” with “treatment effects” varying across different groups of workers. In order to use this approach, we need to define “treatment” and “control” groups, where the “treated” groups are the ones directly affected by the new legislation. The best known use of this type of methodology in the MW literature is the work of Card and Krueger (1994) on the impact of the 1992 New Jersey MW increase on employment in fast food restaurants. Dolado, Kramarz, Machin, Manning, Margolis and Teulings (1995) label this method as the “differential impact” approach, and it has been used in many other studies (see, for example, Card (1992), Deere, Murphy and Welch (1995), for the US; Dolado *et al.* (1995) for France and Spain; Stewart (2002) for the UK).

The treatment and control groups can be defined in many different ways and this paper considers groups of workers defined according to their location, industrial sector, age and skill type. Some of these groups were directly affected by the MW reform (the treated groups), namely the ones with young workers, but with different intensity according to the share of workers in 1986 that were earning less than the 1987 statutory MW. In fact, we can expect that the impact of the reform varies across geographical areas or sectors, and this can be used to evaluate its effect on employment, hours worked or skill composition. Thus, the

analysis is conducted at "local labour market area" (LLMA) level, which are data-cells constructed by aggregating workers by location  $i$  (18 districts), sector  $j$  (6 sectors)<sup>9</sup>, age/skill group  $s$  (6 groups)<sup>10</sup>, and year  $t$  (5 years, 1985-1989). Using this definition, the maximum number of cells is 3240.

There are some advantages to the use of data at LLMA level instead of firm level as in Pereira (2003) or Portugal and Cardoso (2006). First, there is only a very small percentage of cells with zero observations (just 2,7%), which means that any special concerns with missing values are unnecessary, and therefore the bias induced by firm turnover is reduced. In fact, the exclusion of firms' entries and exits from analysis may be a source of possible biases because the destruction and creation of firms may be endogenous: we can expect an increase in the number of firm closures as well as a decrease in the number of firms created after the MW reform. Finally, local labour markets have more interest for policy analysis. In fact, the effect of a change in the MW policy in a given labour market requires more attention than the effect on a particular firm.

## 4.1 Wage and employment effects

### 4.1.1 Estimation strategy

In order to estimate the impact of the increase in MW on employment of young workers, the following labour-demand equation is estimated by two-stage least squares, exploiting the panel structure of the data:

$$\ln e_{ijst} = \alpha_0 + \alpha_1 \ln w_{ijst} + \alpha_2 \mathbf{X}_{ijst} + \alpha_{it} + \alpha_{jt} + \alpha_{st} + \eta_{ijs} + \varepsilon_{1ijst}, \quad (1)$$

where  $e_{ijst}$  is the employment in each cell, measured in terms of the number of workers or hours<sup>11</sup> worked and  $w$  is the cell's average hourly wage.  $\mathbf{X}_{ijst}$  is a vector of variables, including the fraction of women in the labour force, the average education (measured in number of years) and the (log) of the average firm's per worker sales.  $\alpha_{it}$ ,  $\alpha_{jt}$  and  $\alpha_{st}$  denote time dummies for district, sector and age/skill group. All of these variables are included in order to control for labour market demand and supply shocks that are eventually correlated with the MW reform.  $\eta_{ijs}$  is a cell fixed effect and  $\varepsilon$  is the error term, that we assume normally distributed and iid.

The first stage equation is

$$\ln w_{ijst} = \beta_0 + \beta_1 MWI^{86,85} \times T_{ts} + \varepsilon_{2ijst}, \quad (2)$$

and uses a "minimum wage intensity" (MWI) variable as an instrument to the (log of) the average hourly wage in each data-cell. This MWI variable is defined as the share of workers aged 17-19, in 1986 or 1985<sup>12</sup>, potentially

<sup>9</sup>The sectors considered are: manufacturing (including water and electricity), construction, retailing and hotels/restaurants, transportation, financial services (including banking and insurance), and other services.

<sup>10</sup>We considered 3 age groups (17 to 19, 20 to 24 and older than 24 years), and two skill groups (skilled and non-skilled).

<sup>11</sup>Hours worked include normal hours plus overtime hours.

<sup>12</sup>We also used the MWI measured in 1985, as a robustness check, in order to account for the possibility of firms' labour force adjustment prior to the reform.

affected by the MW legislation (earning less than the new statutory MW in 1987).  $T_{ts}$  is a dummy variable that identifies the treated group with value one if  $t \in \{1987, 1988, 1989\}$  and  $s$  is the teenage group, and value zero otherwise.

The use of panel data with more than two time-observations is more robust than a typical cross-section analysis conducted with differences observed in two different time periods. The control groups are not only the cells with workers aged over 19, but also the groups with young workers observed in 1986 and 1985. Also, the  $\alpha_1$  parameter can be interpreted as a medium-run estimate of the labour demand elasticity, because the treated group is observed over three years after the reform.

#### 4.1.2 Results

Table 4 shows the fixed-effects instrumental variables regression results, using those groups with workers aged 17 to 19 as treated groups. The impact of the reform is evaluated using as dependent variable the number of hours worked in each group, as well as the employment level measured by the number of workers. The estimated employment-wage elasticity ranges between -0.332 and -0.415, but with very large standard errors, implying that we cannot reject the hypothesis of no impact on employment rates.

Table 4: Effect of minimum-wage changes on teenagers' average wages, hours worked and employment

Fixed-effects IV regression				
Treated group: workers aged 17-19 ( $t > 1986$ ).	Dependent variable			
Control groups: all others	ln(Nr of hours)		ln(Nr of workers)	
	(1a)	(1b)	(2a)	(2b)
First Stage				
% of affected teens ( $86 \times T$ )	.355		.355	
	(.077)		(.077)	
% of affected teens ( $85 \times T$ )		.323		.323
		(.086)		(.086)
Second Stage				
ln(hourly wage $_t$ )	-.372	-.415	-.332	-.409
robust s.d.	(.260)	(.286)	(.271)	(.280)
N. of obs. ( $n \times t$ )	3152	3153	3157	3153
N. of labour markets ( $n$ )	634	635	634	635

Notes: All the regressions include the following variables: fraction of women, av. education, ln(output per capita) and dummies for. sector  $\times$  year, district  $\times$  year and age/skill group  $\times$  year.  
Robust standard errors in parenthesis.  
\*\*\* Signif.level < 1%, \*\* signif.level < 5%, \* signif.level < 1%.  
Source: "Quadros de Pessoal" Data set

However, the group that was most likely to be affected by the MW change was the unskilled group of young workers. Using just the unskilled groups (see Table 5), we find a significative and robust negative effect of the MW increase

on the employment (measured either as number of hours or workers) of the low-skilled young workers. The labor demand elasticity range is between -0.420 and -0.465 and does not differ significantly when we use the percentage of affected teens in 1986 or 1985. This result, together with the previous one, provides some evidence that this negative impact was stronger on the unskilled young workers than on the skilled, which means that it was partially compensated for the substitution of more for less-skilled teenagers. Next, this hypothesis will be tested directly.

Table 5: Effect of minimum-wage changes on unskilled teenagers' average wages, hours worked and employment

Fixed-effects IV (robust) regression				
Treated group: unskilled workers aged 17-19 ( $t > 1986$ ).	Dependent variable			
Control groups: other unskilled workers	ln(Nr of hours)		ln(Nr of workers)	
	(1a)	(1b)	(2a)	(2b)
First Stage				
% of affected teens ( $86$ ) $\times T$	.560 (.092)		.560 (.093)	
% of affected teens ( $85$ ) $\times T$		.442 (.109)		.442 (.109)
Second Stage				
ln(hourly wage $_t$ )	-465*** (.141)	-420* (.223)	-463*** (.138)	-439** (.215)
	robust s.d.			
N. of obs. ( $n \times t$ )	1598	1601	1598	1601
N. of labour markets ( $n$ )	321	322	321	322

Notes: All the regressions include the following variables: fraction of women, av. education, ln(output per capita) and dummies for. sector  $\times$  year, district  $\times$  year and age/skill group  $\times$  year.

Robust standard errors in parenthesis.

\*\*\* Signif.level < 1%, \*\* signif.level < 5%, \* signif.level < 10%.

Source: "Quadros de Pessoal" Data set

## 4.2 Job-skill composition

### 4.2.1 Framework and estimation strategy

Consider this simple model, where the local labour market production function is defined as:

$$Y_{ijst} = F \left[ K_{ijst}, A_{ijst} \left( L_{ijst}^{\frac{\sigma-1}{\sigma}} + B_{ijst} H_{ijst}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}} \right], \quad (3)$$

where  $Y_{ijst}$  is the output produced in the LLMA according to a constant returns to scale, constant elasticity of substitution production function.  $L$  and  $H$  denote efficiency units of young unskilled and skilled workers employed in production respectively, and  $K$  is the composite factor that includes all other inputs.  $A, B$  are Hicks-neutral and skill-biased shifts in technology respectively, and  $\sigma$  is the elasticity of substitution between more and less skilled workers.

The relative demand for young skilled workers is given by:

$$\ln(H_{ijst}/L_{ijst}) = -\sigma \ln(w_{ijst}^h/w_{ijst}^l) + \sigma \ln B_{ijst}. \quad (4)$$

Using the Ciccone *et al* (2005) strategy, the term  $\sigma \ln B_{ijst}$  has been written as the sum of a set of control variables  $\mathbf{X}_{ijst}$ , time dummies for district, sector and age group, and a cell's fixed effect ( $\alpha_2 \mathbf{X}_{ijst} + \alpha_{it}^* + \alpha_{jt}^* + \alpha_{st}^* + \eta_{ijs}^*$ ), where all the variables are defined as before. Therefore, the equation to estimate is:

$$\ln(H_{ijst}/L_{ijst}) = \alpha_0^* - \sigma \ln(w_{ijst}^h/w_{ijst}^l) + \alpha_2 \mathbf{X}_{ijst} + \alpha_{it}^* + \alpha_{jt}^* + \alpha_{st}^* + \eta_{ijs}^* + \varepsilon_{1ijst}^*. \quad (5)$$

If the skill premia  $w_{ijst}^h/w_{ijst}^l$  is correlated with the error term due to shocks on labour demand,  $\sigma$  cannot be estimated consistently by OLS. Therefore, IV estimation is used, where the instrument for  $\ln(w_{ijst}^h/w_{ijst}^l)$  is the share of unskilled workers, in 1986 or 1985, affected by the new legislation:

$$\ln(w_{ijst}^h/w_{ijst}^l) = \beta_0^* + \beta_1^* MWI_l^{86,85} \times T_{ts} + \varepsilon_{2ijst}^*. \quad (6)$$

It is more likely to observe a decrease in the skill premia in cells with larger share of unskilled workers (potentially) affected by the MW reform. Therefore, the identifying assumption is that the MW intensity measure only affects relative demand for more skilled young workers through changes in relative wages. This is reasonable as a set of controls and cell's fixed effects are considered.

### 4.2.2 Results

Table 6 summarizes the fixed-effects IV estimates of the elasticity of substitution between skilled and unskilled workers, with robust standard errors in parentheses. Again, employment was measured alternatively as the number of hours worked or the number of workers. The estimated elasticity of substitution ranges between -0.282 and -0.434, but only the last estimate is significantly different from zero.

Table 6: Estimates of the elasticity of substitution between young skilled and unskilled workers

Fixed-effects IV regression				
Treated group: workers aged 17-19.(t>1986)	Dependent variable			
Control groups: all others	$\ln(H_{ijst}/L_{ijst})_{\text{hours}}$	$\ln(H_{ijst}/L_{ijst})_{\text{workers}}$		
	(1a)	(1b)	(2a)	(2b)
First Stage				
% of affected teens (86) $\times T$	-0.580*** (.144)		-0.580*** (.144)	
% of affected teens (85) $\times T$		-0.546*** (.161)		-0.546*** (.161)
Second Stage				
$\ln(w_{ijst}^h/w_{ijst}^l)$	-0.374 robust s.d. (.257)	-0.282 (.348)	-0.434* (.236)	-0.365 (.321)
N. of obs. ( $n \times T$ )	1571	1574	1571	1574
N. of labour markets ( $n$ )	319	320	319	320

Notes: All the regressions include the following variables: fraction of women, av. education,  $\ln(\text{output per capita})$  and dummies for. Sector  $\times$  Year, District  $\times$  Year and Age group  $\times$  Year.  
Robust standard errors in parenthesis. \*\*\* Signif.level < 1%, \*\* signif.level < 5%, \* signif.level < 1%.  
Source: Portuguese Ministry of Labour and Solidarity, "Quadros de Pessoal" Data set

Additional results are presented in Table 7, where the only the young groups were used, which means that older workers were not considered as controls. The results do not differ significantly from the previous ones. There is only one estimate of the elasticity of substitution that is different from zero (-0.456) which is smaller in absolute value than the ones found in Ciccone *et al* (2005) which range between -1.2 and -2. However, these are aggregate long-run estimates, while the ones presented in this paper can be classified as short/medium-run estimates.



Table 7: Estimates of the elasticity of substitution between young skilled and unskilled workers

Fixed-effects IV regression				
Treated group: workers aged 17-19.(t>1986)	Dependent variable			
Control groups: all others aged 17-19	$\ln(H_{ijst}/L_{ijst})_{\text{hours}}$	$\ln(H_{ijst}/L_{ijst})_{\text{workers}}$		
	(1a)	(1b)	(2a)	(2b)
First Stage				
% of affected teens $(86) \times T$	-.941*** (.323)		-.941*** (.323)	
% of affected teens $(85) \times T$		-.704** (.334)		-.704** (.334)
Second Stage				
$\ln(w_{ijst}^h/w_{ijst}^l)$	robust s.d. -.385 (.257)	-.239 (.409)	-.456** (.227)	-.338 (.378)
N. of obs. $(n \times T)$	494	497	494	497
N. of labour markets $(n)$	105	106	105	106

Notes: All the regressions include the following variables: fraction of women, av. education,  $\ln(\text{output per capita})$  and dummies for. Sector  $\times$  Year, District  $\times$  Year and Age group  $\times$  Year.  
Robust standard errors in parenthesis. \*\*\* Signif.level < 1%, \*\* signif.level < 5%, \* signif.level < 1%.  
Source: Portuguese Ministry of Labour and Solidarity, "Quadros de Pessoal" Data set

## 5 Conclusion

This work evaluates the impact of the remarkable change in the MW of young workers that took place in Portugal on the 1st January, 1987 on the number of jobs, as well as on the composition of jobs, in terms of skills. Much of the empirical research is on the employment effects of minimum wages but empirically very little is known about the impact of an increase in the minimum wage of young workers on the job-skill composition.

The results are consistent with the view that the MW increase had a negative impact on employment of unskilled workers, the most affected group: an increase of 1% in wage induced by the increase in MW reduces employment of this group of workers between 0.42% and 0.47%. Nevertheless, this negative impact was partially compensated for the substitution of more for less-skilled teenagers, since there is some, but not robust, evidence that the elasticity of substitution between young workers with different skills is different from zero.

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## 6 Appendix A: Figures

General Notes:

- A = 1986 sub-minimum wage for 17 years olds (11,250 PTE);
- B = 1986 sub-minimum wage for 18-19 years olds (16,875 PTE);
- C = 1987 sub-minimum wage for 17 years olds (18,900 PTE);
- D = 1986 national minimum wage (22,500 PTE);
- E = 1987 national minimum wage (25,200 PTE).

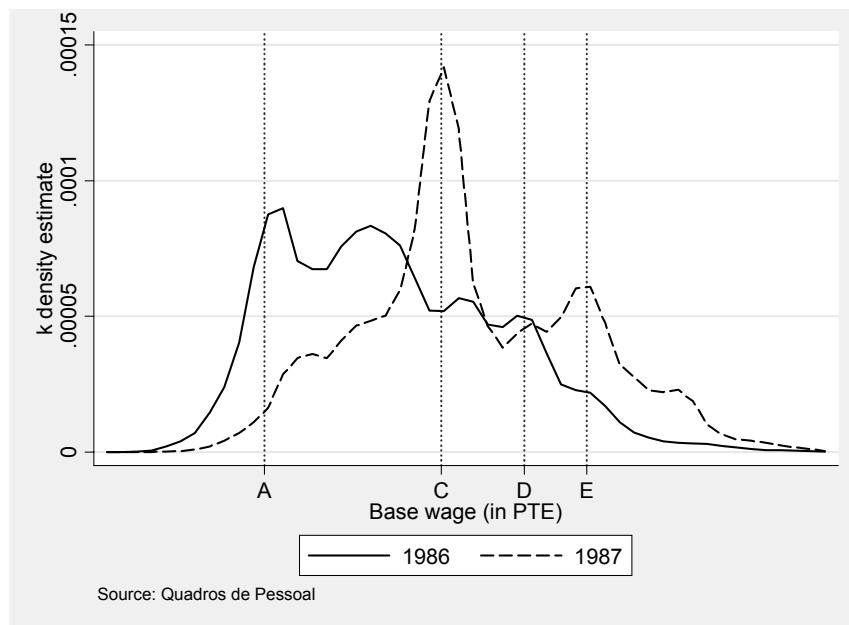


Figure 3: Wage distribution, workers aged 17

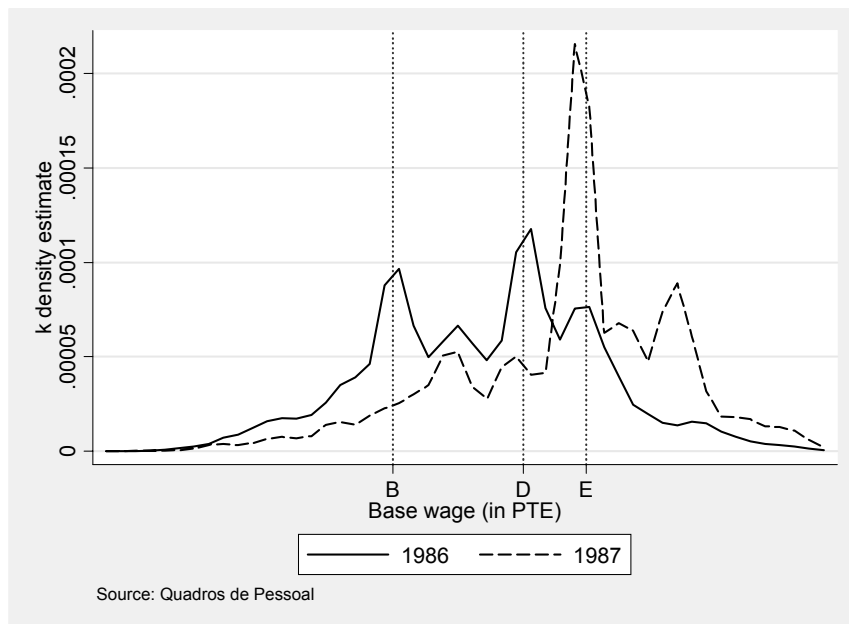


Figure 4: Wage distribution, workers aged 18-19

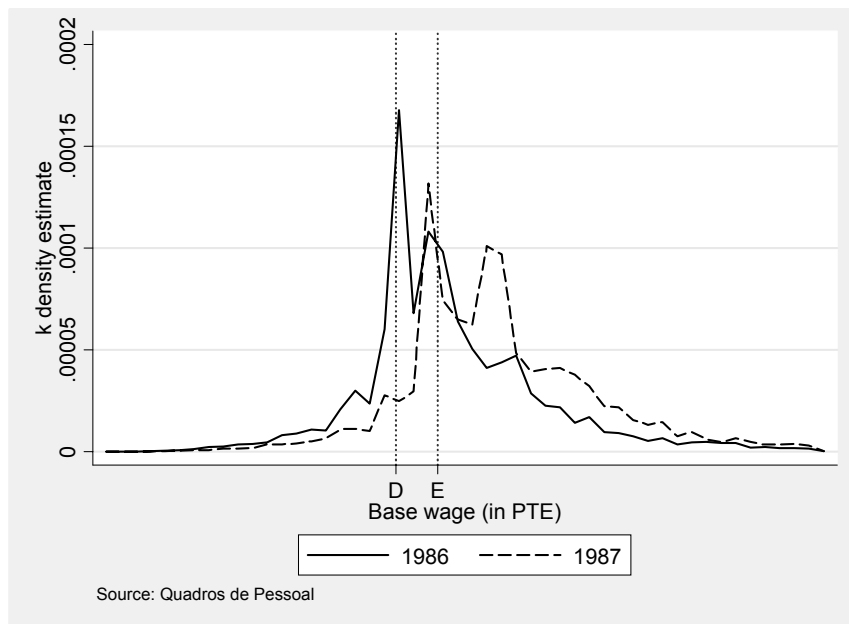


Figure 5: Wage distribution, workers aged 20-24

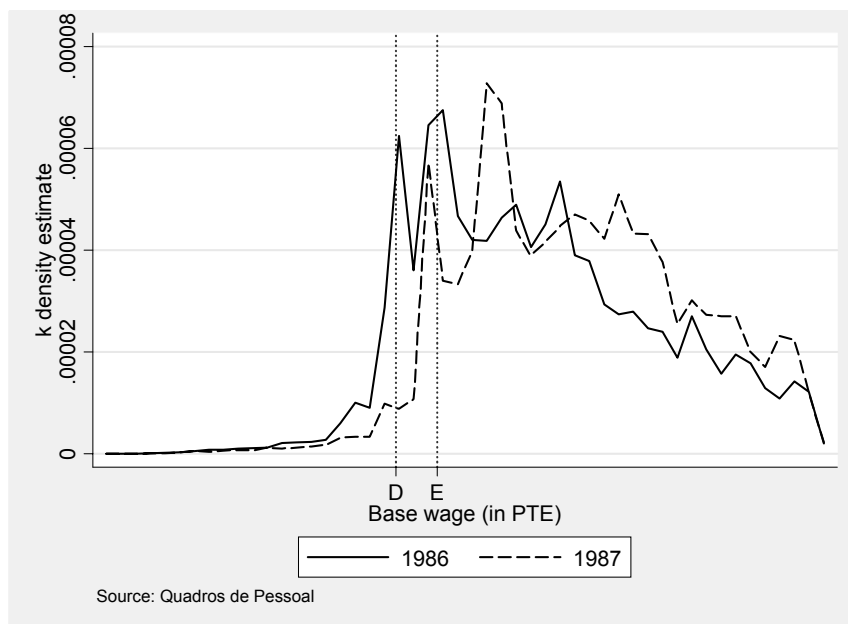


Figure 6: Wage distribution, workers aged >24

## 7 Appendix B: Tables

Table 8: Summary of minimum wage changes

Age Group	Minimum wages		
	1st Jan. 1986	1st Jan. 1987	Difference 1987-1986
17	11,250	18,900	7,650 (68%)
18-19	16,875	25,200	8,325 (49%)
>=20	22,500	25,200	2,700 (12%)

Notes: Values in nominal Portuguese Escudos (PTE). Percentage increase in parenthesis.

Youth minimum wage for 17 years-olds was 50% of the adult rate in 1986 and 75% in 1987.

Youth minimum wage for 18-19 years-olds was 75% of the adult rate in 1986 and 100% in 1987.

Table 9: Descriptive statistics - all workers (aged 17 to 19)

	1985	1986	1987	1988	1989
Age 17					
Skilled	12.08%	11.83%	12.21%	12.81%	14.83%
Male	62.59%	60.63%	58.79%	58.44%	58.16%
Education	4.96	5.05	5.18	5.26	5.34
Tenure	2.81	2.73	2.83	2.40	2.75
Working Hours	188.97	186.58	187.73	192.37	190.84
Base Wage	14,380.46	16,896.93	20,455.44	23,315.94	26,934.31
Hourly Labour Earnings (HLE)	81.42	96.74	116.43	129.85	151.89
Var. HLE		18.82%	20.35%	11.53%	16.97%
Below Nat MW earners	85.71%	83.98%	79.66%	74.43%	68.29%
Below 75 % MW	53.16%	53.69%	35.36%	26.84%	19.15%
Apprentices	79.63%	79.29%	78.90%	77.30%	77.16%
Total Observations	24,429	23,467	24,660	27,128	30,430
Age 18-19					
Skilled	28.39%	27.64%	27.55%	29.38%	31.33%
Male	62.09%	61.14%	59.89%	58.70%	57.88%
Education	5.15	5.26	5.38	5.51	5.66
Tenure	3.37	3.38	3.24	2.95	3.21
Working Hours	187.71	185.55	186.65	191.12	189.37
Base Wage	17,973.74	21,113.36	25,234.98	28,238.10	31,947.83
Hourly Labour Earnings (HLE)	103.31	122.21	145.25	159.80	183.89
Var. HLE		18.30%	18.85%	10.02%	15.07%
Below Nat MW earners	55.68%	54.01%	38.40%	35.23%	31.02%
Apprentices	55.87%	56.75%	56.81%	54.69%	52.54%
Total Observations	60,316	59,229	62,461	67,424	74,875

Notes: Values in nominal Portuguese Escudos (PTE)..

Source: Portuguese Ministry of Labour and Solidarity, "Quadros de Pessoal" data set

Table 10: Descriptive statistics - all workers (aged &gt;19)

	1985	1986	1987	1988	1989
Age 20-24					
Skilled	61.96%	60.83%	59.41%	59.08%	61.02%
Male	57.46%	56.64%	56.70%	55.73%	53.85%
Education	6.04	6.02	6.06	6.13	6.34
Tenure	4.41	4.37	4.27	3.97	4.12
Working Hours	184.66	182.71	183.98	188.83	186.82
Base Wage	22,619.09	26,541.64	30,312.78	33,800.45	38,456.45
Hourly Labour Earnings (HLE)	137.46	161.10	182.44	199.57	231.16
Var. HLE		17.19%	13.25%	9.38%	15.83%
Below Nat MW earners	18.98%	16.28%	14.89%	12.28%	10.48%
Apprentices	19.66%	20.93%	23.03%	23.92%	23.43%
Total Observations	169,663	171,789	185,513	195,992	217,444
Age >24					
Skilled	83.21%	83.74%	83.46%	83.59%	85.09%
Male	70.61%	69.14%	69.01%	68.21%	67.39%
Education	5.75	5.81	5.87	5.92	6.11
Tenure	12.34	12.36	12.34	12.15	12.02
Working Hours	181.62	179.18	180.63	185.86	183.54
Base Wage	33,116.74	39,545.99	45,534.31	50,204.95	57,220.36
Hourly Labour Earnings (HLE)	234.79	277.16	317.92	345.35	398.35
Var. HLE		18.05%	14.71%	8.63%	15.35%
Below Nat MW earners	5.27%	4.34%	3.93%	2.99%	2.49%
Apprentices	2.15%	2.40%	3.13%	3.24%	1.91%
Total Observations	1,071,660	1,078,174	1,102,501	1,093,342	1,137,768
National MW	19,200	22,500	25,200	27,200	30,000
75% of National MW	14,400	16,875	18,900	20,400	22,500

Notes: Values in nominal Portuguese Escudos (PTE)..

Source: Portuguese Ministry of Labour and Solidarity, "Quadros de Pessoal" data set



Table 11: Descriptive statistics - Skilled workers (aged 17 to 19)

	1985	1986	1987	1988	1989
<b>Age 17</b>					
Male	46.68%	44.06%	46.61%	44.99%	46.68%
Education	5.00	5.10	5.26	5.27	5.35
Tenure	3.36	3.06	3.55	2.87	3.03
Working Hours	189.30	186.23	187.71	192.03	190.32
Base Wage	18070.29	21151.62	24918.95	27868.49	31524.68
Hourly Labour Earnings (HLE)	102.19	121.75	140.68	155.13	178.45
Var. HLE		19.13%	15.55%	10.27%	15.03%
Below Nat MW earners	49.22%	48.81%	42.89%	37.80%	34.01%
Below 75% MW	20.83%	23.16%	15.78%	11.57%	9.19%
Total Observations	2952	2776	3010	3476	4514
<b>Age 18-19</b>					
Male	49.13%	47.17%	48.27%	48.06%	48.79%
Education	5.16	5.35	5.46	5.62	5.76
Tenure	3.67	3.55	3.61	3.36	3.70
Working Hours	188.15	186.10	187.05	190.96	189.49
Base Wage	20,414.84	24,210.63	28,343.94	31,570.24	35,417.96
Hourly Labour Earnings (HLE)	117.12	139.84	162.90	178.94	204.36
Var. HLE		19.40%	16.49%	9.85%	14.20%
Below Nat MW earners	27.49%	23.81%	16.80%	12.51%	10.57%
Total Observations	17,121	16,370	17,211	19,807	23,459

Notes: Values in nominal Portuguese Escudos (PTE)..

Source: Portuguese Ministry of Labour and Solidarity, "Quadros de Pessoal" data set

Table 12: Descriptive statistics - Skilled workers (aged &gt;19)

	1985	1986	1987	1988	1989
Age 20-24					
Male	54.24%	52.98%	53.35%	53.53%	52.51%
Education	6.22	6.25	6.26	6.33	6.53
Tenure	4.76	4.66	4.64	4.39	4.53
Working Hours	184.23	182.25	183.66	188.36	186.52
Base Wage	23,872.65	28,124.55	32,300.26	36,159.76	41,136.47
Hourly Labour Earnings (HLE)	145.54	171.37	195.14	215.01	248.84
Var. HLE		17.75%	13.87%	10.18%	15.73%
Below Nat MW earners	12.01%	9.78%	8.01%	5.54%	4.31%
Total Observations	105,119	104,507	110,220	115,792	132,695
Age >24					
Male	71.09%	69.82%	69.62%	69.16%	68.16%
Education	5.89	6.11	6.17	6.20	6.36
Tenure	12.78	12.81	12.86	12.76	12.55
Working Hours	181.58	178.82	180.13	185.40	183.19
Base Wage	33,746.45	41,079.98	47,424.00	52,464.66	59,444.45
Hourly Labour Earnings (HLE)	239.99	289.33	333.37	364.09	416.62
Var. HLE		20.56%	15.22%	9.22%	14.43%
Below Nat MW earners	3.99%	3.17%	2.73%	1.92%	1.67%
Total Observations	891,773	902,861	920,119	913,888	968,096

Notes: Values in nominal Portuguese Escudos (PTE)..

Source: Portuguese Ministry of Labour and Solidarity, "Quadros de Pessoal" data set

Table 13: Descriptive statistics - low-skilled workers (aged 17 to 19)

	1985	1986	1987	1988	1989
Age 17					
Male	64.78%	62.86%	60.48%	60.41%	60.16%
Education	4.95	5.04	5.16	5.26	5.34
Tenure	2.73	2.69	2.73	2.33	2.70
Working Hours	188.93	186.63	187.73	192.43	190.93
Base Wage	13,873.30	16,326.10	19,834.88	22,646.88	26,134.77
Hourly Labour Earnings (HLE)	78.56	93.39	113.06	126.14	147.26
Var. HLE		18.87%	21.06%	11.57%	16.74%
Below Nat MW earners	90.73%	88.70%	84.77%	79.81%	74.26%
Below 75% MW	57.60%	57.78%	38.09%	29.09%	20.88%
Apprentices	90.57%	89.93%	89.87%	88.66%	90.60%
Total Observations	21,477	20,691	21,650	23,652	25,916
Age 18-19					
Male	67.23%	66.47%	64.31%	63.12%	62.03%
Education	514.92%	522.32%	534.77%	546.51%	561.43%
Tenure	3.25	3.31	3.09	2.78	2.99
Working Hours	187.54	185.33	186.49	191.18	189.32
Base Wage	17,006.17	19,930.35	24,052.48	26,852.05	30,364.55
Hourly Labour Earnings (HLE)	97.83	115.47	138.54	151.84	174.55
Var. HLE		18.03%	19.97%	9.60%	14.96%
Below Nat MW earners	66.85%	65.55%	46.62%	44.68%	40.35%
Apprentices	78.01%	78.43%	78.41%	77.44%	76.51%
Total Observations	43,195	42,859	45,250	47,617	51,416

Notes: Values in nominal Portuguese Escudos (PTE)..

Source: Portuguese Ministry of Labour and Solidarity, "Quadros de Pessoal" data set

Table 14: Descriptive statistics - low-skilled workers (aged &gt;19)

	1985	1986	1987	1988	1989
Age 20-24					
Male	62.69%	62.34%	61.62%	58.91%	55.95%
Education	5.74	5.65	5.76	5.84	6.03
Tenure	3.84	3.92	3.73	3.37	3.48
Working Hours	185.36	183.43	184.45	189.51	187.30
Base Wage	20,577.51	24,082.95	27,403.35	30,394.11	34,260.21
Hourly Labour Earnings	124.31	145.15	163.86	177.27	203.49
Below Nat MW earners	30.33%	26.38%	24.95%	22.00%	20.14%
Apprentices	51.69%	53.44%	56.75%	58.47%	60.12%
Total Observations	64,544	67,282	75,293	80,200	84,749
Age >24					
Male	68.26%	65.66%	65.96%	63.41%	62.97%
Education	5.07	4.28	4.39	4.53	4.69
Tenure	10.14	10.02	9.71	9.07	8.96
Working Hours	181.78	181.04	183.13	188.20	185.51
Base Wage	29,995.00	31,645.96	36,000.82	38,697.10	44,530.42
Hourly Labour Earnings	209.02	214.51	240.02	249.91	294.14
Below Nat MW earners	11.62%	10.37%	9.99%	8.43%	7.13%
Apprentices	12.80%	14.79%	18.90%	19.76%	12.80%
Total Observations	179,887	175,313	182,382	179,454	169,672

Notes: Values in nominal Portuguese Escudos (PTE)..

Source: Portuguese Ministry of Labour and Solidarity, "Quadros de Pessoal" data set

Table 15: Descriptive statistics - ratio Skilled/Low-Skilled

	1985	1986	1987	1988	1989
Age 17					
Working Hours	1.002	0.998	1.000	0.998	0.997
Base Wage	1.303	1.296	1.256	1.231	1.206
Hourly Labour Earnings	1.301	1.304	1.244	1.230	1.212
Below Nat MW earners	0.543	0.550	0.506	0.474	0.458
Below 75% MW	0.362	0.401	0.414	0.398	0.440
Total Observations	0.137	0.134	0.139	0.147	0.174
Age 18-19					
Working Hours	1.003	1.004	1.003	0.999	1.001
Base Wage	1.200	1.215	1.178	1.176	1.166
Hourly Labour Earnings	1.197	1.211	1.176	1.179	1.171
Below Nat MW earners	0.411	0.363	0.360	0.280	0.262
Total Observations	0.396	0.382	0.380	0.416	0.456
Age 20-24					
Working Hours	0.994	0.994	0.996	0.994	0.996
Base Wage	1.160	1.168	1.179	1.190	1.201
Hourly Labour Earnings	1.171	1.181	1.191	1.213	1.223
Below Nat MW earners	0.396	0.371	0.321	0.252	0.214
Total Observations	1.629	1.553	1.464	1.444	1.566
Age >24					
Working Hours	0.999	0.988	0.984	0.985	0.988
Base Wage	1.125	1.298	1.317	1.356	1.335
Hourly Labour Earnings	1.148	1.349	1.389	1.457	1.416
Below Nat MW earners	0.343	0.306	0.273	0.228	0.235
Total Observations	4.957	5.150	5.045	5.093	5.706

## Appendix C: The "Quadros de Pessoal" Data Set

The empirical work presented in these three papers is based on the data set "Quadros de Pessoal", of the Ministry of Labour and Social Solidarity (MTSS). Beginning in 1982, and on a yearly basis, this longitudinal data is a standardised questionnaire that all firms with wage-earners are legally required to complete, which guarantees a very high response rate. In addition, the fact that information is directly provided by the employer, besides the legal obligation for this information to be permanently displayed in a public space on the firm's premises, reduces measurement errors and contributes to their reliability. Furthermore, the "Quadros de Pessoal" registry is routinely used by the inspectors of the Ministry to monitor whether the firm wage policy complies with the law.

The data includes information on all companies operating in Portugal, except family businesses without wage-earning employees. This data set covers, roughly, one half of all the active population. The next Table reports the number of records for the years under consideration.

Table 16: Number of records in 1987, 1989, 1991, 1993, 1995, 1997 and 1999

Year	Workers	Firms	Establishments
1987	1 936 801	110.865	132.823
1989	2 169 835	137 155	161 094
1991	2 233 237	148 602	173 551
1993	2 215 481	184 306	193 804
1995	2 232 548	192 270	223 393
1997	2 350 782	213 589	248 664
1999	2 568 456	244 241	284 368

The access to this data set is conditional on the rules presented in the agreement between the University of Minho and the Department of Statistics of the MTSS, and is possible under request.

The data set is made up of three files:

(i) the workers' file, with data from 1985 to 1989 and from 1991 onwards. This includes the worker's identification number (social security number), gender, age, skill, occupation, schooling, tenure, date of the last promotion, profession, earnings and number of working hours. These information is relative to the month of March (from 1985 to 1993) or October (from 1994 to now).

(ii) the firms' file, with data since 1985. The main variables present in this file are: the firm's identification number, location (at county level), the establishment and firm's identification number, sector, legal setting, type of agreement between firm and unions, equity capital, share of national owners in the equity capital, share of foreign owners in the equity capital, share of public owner in the equity capital, yearly sales, number of establishments (since 1994), employment level (observed in March, between 1985 and 1993, and observed in the last week of October, since 1994) and date of the constitution (since 1995).

(iii) the establishments' file, with the firm's identification number and that of the one of the establishment (generated inside each firm), location, sector and number of employees.

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