Topics

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Minimum Wages: Do They Really Hurt Young People?

Abstract: This paper uses a significant increase in the minimum wage in Spain between 2004 and 2010 as a case study to analyse the effects on the individual probability of losing employment, using a large panel of social security records. We show that this individual approach is important, as the possible effects for different types of individuals may differ from other estimates in the literature, based on aggregate or firm-level data, hence complementing them. Our main finding is that older people experienced the largest increase in the probability of losing their job, when compared with other age groups, including young people. The intuition is simple: among the affected (low-productivity) workers, young people are expected to increase their productivity more than older ones, who are in the flat part of their life-cycle productivity curve. Consequently, an employer facing a uniform increase in the minimum wage may find it profitable to retain young employees and to fire older ones.

Keywords: minimum wage, labour demand, firing

JEL Classifications: J23, J38, J63

DOI 10.1515/bejeap-2013-0171

1 Introduction

The impact of a rise in the minimum wage on employment has been extensively studied in the literature. Basic economic theory states that in a perfectly competitive economy, an increase in the minimum wage expels less productive workers from the labour market, and the magnitude of this employment reduction depends on the wage rise required to reach the new minimum wage. However,

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expectations about future productivity could also play an important role (especially for young workers). Moreover, if the assumption of a perfectly competitive economy is not satisfied, employment destruction among less productive workers could be less intense.

There are several studies on the effects of minimum wages on employment, particularly for the United States and the United Kingdom. In their seminal papers, Card and Krueger (1994, 1995 and 2000) found no negative effects on firm-level employment in the US fast food industry. Other papers confirmed more or less these findings, for example Machin and Manning (1997), Portugal and Cardoso (2006) or Dube, Lester, and Reich (2010). On the other hand, there are also papers that find the opposite effect, for example Burkhauser, Couch, and Wittenburg (2000), Neumark and Wascher (2000), Sabia (2009) or Mulligan (2011). Some of these works end up with opposite conclusions despite using very close methodologies in some cases. Hence, the impact of minimum wages on levels of employment is still a controversial issue.¹

Most of the previous studies are focused on aggregate, firm-level, or establishment-level employment data. However, there is a bunch of reasons that can make compatible weak effects on employment levels with strong individual effects on employment probabilities: Substitution of some workers by others, movement of workers across regions or firms, or data (regions or firms) with most of their workers not affected by the increase in the minimum wage. Consequently, it is important to look also for individual employment effects of minimum wages, independently of their possible aggregate effects on employment levels, and this is the purpose of this paper. In this respect, Stewart (2004) analyses the impact of the introduction of a minimum wage in the United Kingdom in April 1999 on the probability of continuing in employment. He uses a difference-in-differences estimator with three different individual micro-

¹ Specifically for the Spanish case, several studies have tried to analyse the impact of minimum wages increases on the labour market, mainly for younger workers. Dolado et al. (1996) find negative effects for workers between 16 and 18 years old, but positive ones for workers over the age of 18. Dolado and Felgueroso (1997), Dolado, Felgueroso, and Jimeno (1997) and Blázquez, Llorente, and Moral (2009) find no effect at all, and Cebrian et al. (2010) find a negative effect on employment. Most of these papers explore this issue using aggregate data (Labour Force Survey, Employment Situation Survey, Wage Structure Survey or similar), finding effects mainly for young workers. From an aggregate point of view this is certainly sensible, because this group has low levels of experience and productivity, so that they earn lower wages, and their weight in the set of people affected by the minimum wage is consequently high. But when the effect on the individual probability of losing one's job is analysed, this is not necessarily true. Indeed, the effect could be more intense for older workers, because the productivity of young people is expected to increase faster.

datasets and he does not find any adverse effect on employment for any of them. However, this could be due to the short period of study because the minimum wage was introduced on 1 April 1999 in UK, and the time span analysed is March 1997 to March 2000 in the case of the Labour Force Survey, autumn 1994 to autumn 1999 in that of the British Household Panel Survey Data (BHPS) and 1994–1999 in the case of the New Earnings Survey Panel Data (NES), which is based on administrative records, like the one we use. In this latter case data refer to April of each year. This leaves only 1 month under the new minimum wage, which could be the reason for the absence of negative effects on employment found in Stewart (2004).

The individual approach is also important when one wants to assess whether minimum wage effects are different or not across different groups of people. In this respect, some efforts have been made in the literature. For example, Neumark, Schweitzer, and Wascher (2004) estimate different effects for different points in the wage distribution, finding the sensible result that low-wage workers are the most strongly affected. Regarding differences by age, the literature is scarcer, probably due to the lack of observations for older workers affected by minimum wages. Neumark and Wascher (1992) obtain a slightly higher effect when the sample contains young adults (16–24) than when only teenagers are considered. However, papers that specifically study the possible different impact for all age groups, including people close to the end of their careers, are very difficult to find.

The Spanish case is particularly interesting to analyse. The government effected a significant increase in the single national minimum wage in mid-2004, of 6.6%. The motivation was the loss of purchasing power suffered by workers on account of the decrease in the real minimum wage between 1999 and 2004. The new minimum did not become obligatory until January 2005, when an additional rise made a total increase in just 1 year of 11.4%. It was the largest increase since 1990. Subsequently, the real minimum wage continued to rise until 2010, albeit at a slower pace. The change in the minimum wage in 2004–2005 affected all workers irrespective of their age, so we do not have an age group that was affected and another age group that was not. However, we can use the “differential impact” approach, because we expect a higher impact for low-productivity workers, or workers with a low-potential productivity, than for other workers. Our identification strategy will be to use some sort of difference-in-differences estimator, comparing the affected group (people with salary in year t less than the real minimum wage in year $t + 1$) with workers with the same low productivity, but in years when the minimum wage did not increase. For this purpose, we use individual data from social security records, which provide information on the entire labour history of individual workers. With this

database, we can estimate the effect of the increase of the minimum wage on the individual probability of remaining in employment for affected workers, defined as those whose wages would have to be raised to reach the new minimum. The fact that real minimum wages were decreasing before 2004 is very convenient, as we can compare an affected individual with a non-affected worker with similar characteristics, *including* wage. The huge amount of observations in our database allows us to properly estimate different effects by age, including people at the last stage of their working lives.

We find that the estimated impact on the probability of losing employment is positive and significantly different from zero for young and older workers, although the magnitude of this effect in the case of older workers is double that in the case of young workers. The negative impact on the probability of remaining in employment might be particularly harmful in the case of older workers because they may be definitively expelled from the labour market. In contrast, young workers have greater chances of finding another job sooner or later, because they are at the beginning of their careers, on the upward-sloping part of their productivity curve (which is not the case for older workers).

The next section sets out the historical developments in minimum wages in Spain. After that, we describe our database (Social Security Administrative Labour Records), discussing its advantages and disadvantages. Section 4 presents the methodology used in this paper and the three models we use to estimate the different possible transitions that may occur as a consequence of increases in the minimum wage. The results for the employment probabilities are then presented in Section 5 and, finally, the conclusions are set out in Section 6.

2 Historical developments in minimum wages in Spain

In Spain, a mandatory minimum wage was established for the first time in 1964, and regional differences disappeared in 1980. Between that year and 1990, Spain had three different minimum wages: one for workers less than 17 years old, another for 17 year olds and the other for workers older than the age of 17. From 1990 to 1998 two minimum wages existed, one for workers aged 17 and younger, and another for workers older than the age of 17. However, since 1998, the minimum wage has been independent of age and has covered all workers irrespective of the sector they are in. The government decides its level each year, usually in January, and it becomes binding since the start of this same year.

Decisions on the level of the minimum wage are made on a discretionary basis, usually taking into account past and predicted inflation, with consultation of employers' and workers' representatives. The minimum wage in Spain is defined in terms of a monthly wage, but is rescaled in proportion to the hours and days actually worked.

The government effected a significant increase in the single national minimum wage in mid-2004, of 6.6%. The motivation was the loss of purchasing power suffered by workers due to the decline in the real minimum wage between 1999 and 2004. This loss of purchasing power was estimated by the government to be 6.6% (see Figure 1). The new minimum wage did not become obligatory until January 2005² when an additional rise made a total increase of 11.4% in just 1 year. It was the largest increase since 1990. From this moment on, real minimum wage kept growing, albeit at a lower pace, until 2010.

Figure 1: Year-on-year growth in the minimum wage and CPI

Source: National Institute of Statistic (INE).

The impact of the minimum wage depends on how close it is to the productivity distribution. Consequently, we can define a directly affected group as workers with a real wage (deflated by the CPI) in year t that is less than the real

² This first 6.6% increase could have been anticipated by firms since mid-2004. However, all other increases were decided in the usual way, i.e. in January of the corresponding year, hence they could not be anticipated in an accurate way.

minimum wage in year $t + 1$. This affected group represents about 1% of all full-time workers each year between 2004 and 2009.

However, in Spain there is another variable closely related to the minimum wage, namely the minimum base for social security contributions. This minimum base is exactly equal to the mandatory minimum wage for lower occupational categories, but is higher for higher occupational categories (see Table 1). We have considered these minimum bases as the relevant minimum wage for higher occupational categories, taking into account the possibility for the employer of downgrading the occupational category of workers in order to pay them less than these minimum bases. As Table 1 shows, minimum social security bases for high groups have also increased, albeit at a lower pace than the minimum wage. This could mean that the impact of the rise in the minimum wage may differ from one occupation to another, because employers could downgrade the occupational category of workers in order to avoid the rise in the minimum social security base. We use separate models to analyse the effect on the individual employment probability for lower and higher categories, because the options available to avoid the increase are different.

Also, another way of avoiding the minimum wage increase is for workers to become self-employed. These two ways of avoiding minimum wage increases without falling into unemployment are analysed in Section 4.

Table 1: Nominal minimum social security base

Occupational category	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Managers	739.1	753.8	768.9	784.2	799.8	836.1	881.1	929.7	977.4	1,016.40	1,031.70
Professionals	613.0	625.3	637.8	650.7	663.6	693.6	731.1	771.3	810.9	843.3	855.9
Technical staff	533.0	543.6	554.4	565.5	576.9	603	635.7	670.8	705.3	733.5	744.6
Others	495.7	505.8	516	526.5	537.3	598.5	631.2	665.7	699.9	728.1	738.9

Note: The minimum wage in 2004 refers to January 2004 and the minimum wage in 2005 refers to January 2005 which reflects the increase in mid-2004. It is in the category “others” that the mandatory minimum wage is exactly the same as the minimum Social Security base.

Source: Social Security System.

3 Data

The Social Security Administrative Labour Records (Muestra Continua de Vidas Laborales, hereinafter MCVL) is an organised set of anonymised micro-data

extracted from social security administrative records, matched with the Municipal Register to include personal data. This dataset is formed by a 4% random sample, representative of the total population of people who had any kind of relationship with the Social Security System in a given year, which includes either having a working affiliation or receiving any social security benefit at some time in the reference year, regardless of how long they have been in this situation. The advantage of this sampling method is that it will include people who have short and frequent relationships with the Social Security System in a given year who could be excluded by a sampling process with a fixed date. This can be a numerous group: on average, around three million people who have worked at some time in a given year were not affiliated on a given day. This group of people consists mainly of women and young workers with short-term contracts. The MCVL sampling process consequently reduces the bias against these collectives. In particular, our sample includes all individuals who have had a relationship with the Social Security System at least once between 2005 and 2010, because we merge all observations from wave 2005 to 2010. People not in the sample are close to inactivity or a similar situation, because if a person returns to the labour market, even for 1 day, this person will be in the sample.

The sample provides detailed monthly information about job characteristics such as type of contract, length, sector of activity, working time, monthly earnings, occupational group, as well as other personal information (sex, age, nationality, place of birth, place of residence, household size, etc.) from the Municipal Register. MCVL data for a given year are published in June of the following year. For a given wave, all these variables are provided in a monthly frequency, covering the entire labour history of each individual since 1980.

The random sampling process selects everybody with a personal identification code belonging to some predetermined set, which is the same every year. This type of sampling ensures that people who maintain their relationship with the Social Security System along several years are always sampled. We merge all six waves from 2005 to 2010, and for each individual, we take the information of the most recent wave. With this procedure, we are sure we have information covering the entire labour history of each sampled person who worked or received benefits at any time between 2005 and 2010. Therefore, we can have accurate information about the transition between employment and unemployment.

For our empirical analysis, the main advantage of the MCVL is that it provides a good picture of wages, because the information does not come from a survey. The disadvantage is that the bias against people with no

relationship at all during the whole period is not completely eliminated. This bias is not too relevant, because these people are very close to inactivity.

The information of working histories starts from 1980, but we study the impact of minimum wages from 2000 to 2010 because during this time there was a period in which the real minimum wage was falling (2000–2004) and another period in which the real minimum wage increased (2005–2010). In this way, we can separate the effect of low wages and minimum wages, using the period 2000–2004 as a control to estimate the effect of low-wages alone on employment and then using 2005–2010 to estimate the effect of the minimum wage increase on employment.

We focus on the transition between employment³ and unemployment, but we have also analysed the transition to self-employment.

Experience in the workplace is computed sequentially from the first affiliation after 1980. We accumulate days worked for the same firm, but from the moment the worker changes to another firm the tenure is set to zero. With this sample, it is not possible to calculate the total experience of the worker in the labour market, because records which end before 1980 are not observable.

We have defined as *failure* the case of a person who works full time throughout a given month under the General Social Security Regime, but 12 months⁴ later does not work on any day of the month as an employee (i.e. excluding self-employment, which is analysed later). The idea behind this definition is that a person is still in the market if he manages to work at least 1 day under the new minimum.

We define those workers with a current real wage below the real minimum 12 months later as the affected group. The idea is that the wages of this group must be increased (in real terms) in order to comply with the new minimum, so the employer has to take the decision either to pay them a higher salary or to fire them.⁵

³ Defined as being employed under the General Social Security Regime.

⁴ The Spanish labour market has a marked seasonality along the year, and all minimum wage increases were done from December to January. Therefore, estimating monthly transitions in the exact month when the increase happened will contaminate the estimation with the typical seasonality of January. For these reasons, we used 12-month transitions in the estimations.

⁵ In Spain, firing decisions can be taken relatively fast. For temporary contracts, around one-third are open-ended, meaning that the worker is hired until his associated project has ended. Firms can finish these contracts very easily. For the remaining temporary contracts, and all the permanent ones, the worker can be fired with a 15 days' notice, provided the firm immediately pays the dismissal costs.

Table 2: Percentage of full-time workers affected by an increase in the real minimum wage 12 months later, by age group

Year	Age				
	Total	16–24	25–32	33–45	45–64
2004	0.88	1.74	1.01	0.69	0.63
2005	0.78	1.53	0.85	0.64	0.59
2006	0.76	1.48	0.79	0.64	0.62
2007	0.59	1.14	0.58	0.53	0.50
2008	0.93	2.06	0.87	0.83	0.77
2009*	0.14	0.27	0.58	0.51	0.11

Note: *2009 refers to January–March 2009 only, because there were falls in the real minimum wage from April.

Source: MCVL.

Table 2 shows the group of affected people, according to the previous definition, as a percentage of all workers in the same age group.⁶ As can be seen, their incidence is higher among young people, a fact that is undoubtedly behind the result usually found in the literature, namely that this group is the most affected by minimum wages. However, from a micro-perspective, nothing in the table suggests that the individual probabilities of losing a job are higher among the young.

Table 3 shows the percentage of workers that had lost their employment 12 months later, depending on whether the worker was affected by the new minimum or not. As can be seen, affected workers are more prone to lose their job than those not affected. The recent crisis raised the probability of losing a job, but the difference between the two groups remains the same.

Table 3: Percentages of workers who lost their employment in the period 2000–2010, classified by affected vs. unaffected

Year	Year									
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009*
Affected workers	ND	ND	ND	ND	16.7	16.6	15.3	18.2	23.7	21.7
Not affected workers	8.6	9.1	8.6	8.6	8.6	8.5	8.7	11.0	15.1	12.6

Note: Between 2000 and 2003 there is no affected group because there were no increases of real minimum wage. *2009 refers to January–March 2009, there were falls in the real minimum wage from April.

Source: MCVL.

⁶ The age groups were selected to have a similar number of affected people in each of them (see Table 4).

Table 4: Full-time workers affected by real minimum wage 12 months later, by age group

Year	Age				
	Total	16–24	25–32	33–45	45–64
2004	1,266	266	424	359	216
2005	1,168	233	370	352	213
2006	1,182	227	350	370	236
2007	941	173	255	315	198
2008	1,400	264	353	478	306
2009*	731	95	194	274	168

Note: *2009 refers to January–March 2009 only, because there were falls in the real minimum wage from April.
Source: MCVL.

In order to estimate properly the impact of minimum wage by age, we need a large enough number of affected people for all age groups. In this respect, Table 4 shows that this number is greater than one hundred for almost all years and groups, including the 45–64 groups, for which the incidence of the minimum wage was the lowest.

4 Methodology

This paper estimates the effect of the increase in minimum wages on employment. This effect may differ by age group and by occupational group.

The motivation for this study is that, from a macroeconomic point of view, one would expect the group of young workers to be more affected than other groups, because young workers receive lower wages. From a microeconomic perspective, however, the picture may be different, because the effect of minimum wages on individual probabilities of employment does not depend on the number of people affected, but rather on things like functional mobility, learning and long-term productivity. All of these issues have an effect that may depend on age.

In the Spanish case, there is a single minimum wage after 1998, which is revised each year in nominal terms. In this study, we analyse the period 2000–2010, which includes a sub-period without increases in the real minimum wage (2000–2004) and another one with increases in the real minimum wage (2005–2009).⁷ We use the

⁷ By contrast, Stewart (2004) uses data from 1994 to April 1999 in the NES to analyse the introduction of the minimum wage in April 1999.

period without increases as a control for the effect of low wages on the employment probability. We try to see what would have happened if the real minimum wage had not been increased.

The main characteristic of the methodology employed is the use of a large individual longitudinal dataset to compare the individual employment probability of people working in month t who had a wage lower than the real minimum wage in month $t + 12$ (the affected group) with that of workers who were receiving a wage higher than the minimum in $t + 12$.⁸ However, a direct comparison of these two groups can lead to an incorrect conclusion because, even in the absence of a minimum wage, workers with lower wages have more probability of losing their employment. In this respect, the increase in the real minimum wage in 2005 after a period of falls in the real minimum wage is very convenient. The fact that it approximates a “quasi-experiment” allows us to use a difference-in-differences estimator to identify the effect of the rise in the minimum wage. The strategy of identification consists of comparing a worker with a real wage below the forthcoming minimum with a worker with similar characteristics but with a real wage above (but near) the minimum, who is therefore not affected by the increase, and also with a worker with similar characteristics and same wage during the period in which the real minimum wage did not increase (2000–2004).

Besides studies focused on aggregate employment effects, which typically estimate some sort of elasticity of employment to minimum wage (for example, Card and Krueger 1994; Sabia 2009), most micro-data-based papers use a logit model to estimate the impact of minimum wage increases on the probability of losing the job (for example, Neumark, Schweitzer, and Wascher 2004; Portugal and Cardoso 2006; Stewart 2004). In most cases, transitions after a 12-month time span are considered, to avoid possible seasonality. Regarding the definition of the treated group, there are mainly two different approaches. The first one is to identify the treated group (for example, those whose wage is below the real minimum 1 year later), and compare it with some comparison group (workers with slightly higher wages, other non-affected ages, etc.) by means of a dummy variable identifying only treated observations. The problem with this approach is that the response of a worker very close to new minimum is assumed to be similar than other worker with a much lower wage. Consequently, most micro-studies (for example Stewart 2004; Portugal and Cardoso 2006) include also a continuous definition of treatment, which takes into account the distance between current wage and the future minimum. Given that, in our sample,

8 We use a span of 12 months because firing has a strong seasonal pattern in Spain.

real minimum wages experienced quite different increases in each year of the 2005–2010 period, we opted for this second definition.

Specifically, the approach used here defines the affected group in terms of a gap between the individual's real wage and the real minimum wage in month $t + 12$, but only if the former is lower than the latter. Consequently, we have a continuous variable measuring the distance from the real wage to the real minimum wage in $t + 12$. This is convenient for our case study, because in the period 2005–2010 the real minimum wage increased with varying intensity from year to year. The variable *wagegap* is defined as:

$$wagegap_{i,t} = \max(m_{i,t+12} - wage_{i,t}; 0) \quad [1]$$

where m is the real monthly minimum wage of individual,⁹ i in month $t + 12$ and $wage$ is the individual monthly real wage of the same individual in month t . The difference in the behaviour of the affected group and the comparison groups, after controlling for individual characteristics, can be interpreted as the effect of the minimum wage. So, we have two groups, one of them with $wagegap = 0$, which includes the two comparison groups defined above, and the other with $wagegap > 0$ which corresponds to the affected group. We propose the following logit model for the probability of losing employment:

$$\Pr[d_{i,t} = 1] = \Lambda\{\beta'x_{i,t} + \theta wagegap_{i,t} + \alpha wage_{i,t} + \Phi'g_{i,t} + \epsilon_{i,t}\} \quad [2]$$

where Λ is the logit transformation. The dummy d_{it} has two possible values: 0 when the worker continues working in $t + 12$ as an employee and 1 if the worker is no longer working in $t + 12$ as an employee. We consider the situation 12 months later to avoid seasonality, which is particularly important in the Spanish labour market. Also, we introduce as a control a vector x_{it} with individual characteristics, including gender, tenure in the firm, nationality, type of contract (temporary or permanent), multiple job-holding, age and family size. We divide individuals into four age groups: group 1, aged 16–24; group 2, aged 25–32; group 3, aged 33–45 and finally, group 4, aged over 45. We have chosen these thresholds to have more or less the same number of affected workers in each age group (see Table 4). For family size, we have four variables, to control for the different ages of the dependants in the family: less than 6 years old, 7–15, 16–65 and over 65 years old. In this way, we capture the different impact of infants, children and retired people on working decisions.

⁹ The real monthly minimum wage is individual because minimum social security contributions are different depending on the occupation group.

θ captures the effect of an increase in the minimum wage on the individual probability of losing employment. *Wagegap* measures how far the wage of a worker is from the new real minimum wage 12 months later. We cannot expect a similar effect for someone who would need a significant increase in their monthly wage as for someone who would need only a small increase to comply with the new minimum. Hence, the gap not only indicates who is affected but also measures to what extent they are affected. Estimation with this variable has more precision than with a simple dummy variable capturing whether the individual is affected or not.

Finally, g_{it} is a set of dummies, which include month, year and the interaction of month and the variable *wagegap* as controls for macroeconomic and seasonal effects.

We add to the previous specification an interaction between *wagegap* and age group. We use this interaction because we want to ascertain whether the effect of minimum wages differs according to the age of workers. The effect could be different as a result of different productivity growth rates across age groups. For demographic groups with high productivity growth rates, minimum wage increases could be non-binding if the increase in productivity is high enough to overcome the increase in minimum wage.

Figure 2 shows real wage growth by age. This graph shows that the maximum wage increases are seen in the intermediate age groups, descending as the age increases until reaching a minimum for older workers of around 1%. By gender we can see that the increase in women's wages is lower for all age groups except the oldest, where increases are similar to men's. These developments

Figure 2: Increase in real wages by age in the period 2003–2004

Source: MCVL.

suggest that the impact of the minimum wage on employment should be higher for women and for old people.¹⁰

The increase in the real minimum wage in Spain depends on the occupational category, through the existence of different minimum bases for social security contributions (see Table 5). The largest cumulative increase was for the lowest occupational category, amounting to 18.4%. This is 7 percentage points more than the increase for the rest of the categories and represents over €108 more per month.¹¹ For that reason, our benchmark model of employment probability is estimated for the lowest occupational category.

Table 5: Cumulative increase from 2004 in the real minimum wage, by occupational category

Period	Occupational category			
	Managers	Professionals	Technical staff	Others
2004–2005	1.13%	1.12%	1.12%	7.76%
2004–2006	2.95%	2.96%	2.98%	9.79%
2004–2007	5.69%	5.68%	5.72%	12.65%
2004–2008	6.76%	6.75%	6.81%	13.80%
2004–2009	11.34%	11.33%	11.39%	18.72%
2004–2010	11.02%	11.00%	11.08%	18.36%

Source: MCVL.

The previous model allows us to estimate if the increase in minimum wage makes low-wage workers more prone to lose their job. However, it cannot be used to assess what happens with those workers who lose their employee status. One possibility is that they simply stop working and become unemployed. But there is another possibility: They can continue working, but as self-employed, because under this status minimum wage provisions do not apply. In Spain, self-employed people still have a minimum social security contribution base, which determines minimum social security taxes. However, it is totally legal for a self-employed worker to have income below this minimum base, and it could be optimal for the individual if this is the only way he has to keep himself attached to the labour market. Hence, it is interesting to see whether those jobs destroyed by the minimum wage end up as unemployed or as self-employed. In order to cover this possibility, we estimate a multinomial logit model (named Multinomial 1 from now on) with the same specification as above, but replacing the dependent

¹⁰ The graph depicts wage increases between 2003 and 2004. Choosing different years (not affected by minimum wage increases) does not alter the picture.

¹¹ Real wages, deflated by CPI, base 2006.

variable with a categorical variable (S_{it}) that takes three possible values: 0, when the worker continues working 12 months later ($t + 12$) as an employee; 1, if the worker does not continue working in $t + 12$; and finally, 2, if the worker works as a self-employed worker in $t + 12$ and not as an employee. Other variables of the model keep the same definition. In this case, we want to estimate the effect of the minimum wage on the transition from employment to unemployment or to self-employment, again only for workers in the lowest occupational category.

Finally, the case of people working in high occupational categories (managers, professionals and technical staff), whose minimum base was also increased, but at a lower pace, deserves a specific analysis. This is because those workers that cannot be paid according to the new minimum base can go to unemployment or self-employment (as before), but there is also a third possibility: The employer could decide to downgrade workers to lower categories, which still have a lower base *level*, to avoid the increase in the minimum social security base (see Table 1). Hence, we have proposed another multinomial logit for analysing the transition to unemployment, to a lower occupational category or to self-employment (which we will refer to as “Multinomial 2”). In this case, we have defined a category variable (M_{it}) that takes four possible values: 0, when the worker continues working as an employee and in the same or in a higher occupational category 12 months later ($t + 12$); 1 and 2, in the same cases as defined above; and finally, 3, when the worker continues working as an employee, but in a lower occupational category, in $t + 12$.

With these three different models, we cover all the possible transitions affecting workers that could have been influenced by the increase in the real minimum wage in the period 2005–2010.

5 Results: probability of losing employment

The sample is restricted to those aged between 16 and 65 in low occupational categories who had a relationship with the Social Security System. In the first column of Table 6, we present the estimation results for our benchmark model, in which the dependent variable d_{it} measures the probability of not working any day in month $t + 12$, conditional on working full time the entire month in t .¹²

All specifications include an interaction term of age with both wage and *wagegap*, as well as other control variables. Standard errors are in parentheses in each case.

¹² These two latter restrictions (working full time the entire month) are needed to ensure that the observed wage is comparable to the minimum.

Table 6: Probability of losing employment.

	Total	Women	Men	January only ^b	48 months ^c
Wage, 16–24 years old (euro)	–0.004*** (6.47 × 10 ^{–5})	–0.005*** (0.000)	–0.004*** (7.62 × 10 ^{–5})	–0.004*** (2.38 × 10 ^{–4})	–0.005*** (1.90 × 10 ^{–4})
Wage, 25–32 years old (euro)	–0.006*** (3.63 × 10 ^{–5})	–0.006*** (6.31 × 10 ^{–5})	–0.005*** (4.5 × 10 ^{–5})	–0.006*** (1.24 × 10 ^{–4})	–0.009*** (1.02 × 10 ^{–4})
Wage, 33–45 years old (euro)	–0.006*** (3.25 × 10 ^{–5})	–0.007*** (6.06 × 10 ^{–5})	–0.005*** (3.88 × 10 ^{–5})	–0.006*** (1.10 × 10 ^{–4})	–0.009*** (9.07 × 10 ^{–5})
Wage, more than 45 years old (euro)	–0.002*** (3.11 × 10 ^{–5})	–0.004*** (7.05 × 10 ^{–5})	–0.001*** (3.52 × 10 ^{–5})	–0.002*** (1.06 × 10 ^{–4})	8.35 × 10 ^{–5} (7.17 × 10 ^{–5})
Wagegap ^a , 16–24 years old (euro)	0.076*** (0.021)	0.073** (0.029)	0.093*** (0.029)	0.051 (0.033)	0.047*** (0.018)
Wagegap, 25–32 years old (euro)	0.026 (0.020)	0.040 (0.028)	0.019 (0.029)	–0.009 (0.025)	0.038** (0.017)
Wagegap, 33–45 years old (euro)	0.051*** (0.020)	0.119*** (0.028)	0.020 (0.028)	0.030 (0.025)	0.061*** (0.017)
Wagegap, more than 45 years old (euro)	0.142*** (0.021)	0.179*** (0.029)	0.092*** (0.029)	0.094*** (0.031)	0.100*** (0.018)
Spanish nationality	–2.452*** (0.020)	–0.023*** (0.037)	–2.637*** (0.024)	–2.594*** (0.071)	–4.643*** (0.073)
Dummy temporary contract	6.436*** (0.016)	6.642*** (0.028)	6.475*** (0.020)	6.479*** (0.056)	4.032*** (0.047)
Tenure in the firm (days)	–0.002*** (7.91 × 10 ^{–6})	–0.002*** (1.43 × 10 ^{–5})	–0.002*** (9.43 × 10 ^{–6})	–0.002*** (2.8 × 10 ^{–5})	–0.002*** (1.95 × 10 ^{–5})
Other family members, 0–6 years old	0.755*** (0.015)	3.050*** (0.025)	–0.381*** (0.019)	1.005*** (0.051)	0.622*** (0.047)
Other family members, 7–15 years old	–0.531*** (0.015)	0.050* (0.026)	–0.755*** (0.017)	–0.442*** (0.051)	–1.119*** (0.044)
Other family member, 16–65 years old	–0.102*** (0.006)	–0.251*** (0.012)	–0.026*** (0.007)	–0.079*** (0.022)	–0.113*** (0.021)
Other family members, over 65 years old	0.076*** (0.020)	–0.283*** (0.037)	0.245*** (0.024)	0.104 (0.069)	–0.361*** (0.065)
<i>N</i>	16,898,400	5,656,671	11,241,729	1,350,746	3,101,399
<i>X</i> ² (<i>p</i> -value)	6,469,947.60 (0.000)	2,191,804.95 (0.000)	4,251,639.04 (0.000)	514,538.31 (0.000)	1,093,497.32 (0.000)

Notes: Marginal effects in percentage points for different specifications of logit model. Other control variables: Year and month dummies, age group, multiple job-holding and the interaction between month and wagegap. ^a Wagegap is only for workers who receive a salary lower than real minimum wage in $t + 12$.

^b This model is like our benchmark, but using only January observations. ^c This model is only estimated for 2000 and 2004 and the employment status 48 months later. ***Significant at 1% level. **Significant at 5% level. *Significant at 10% level.

The marginal effect of wages is negative and significantly different from zero for all age groups.¹³ This captures the fact that wages rise with productivity, and higher productivity makes it less likely that workers will lose their jobs. On top of that, we find that the *wagegap* has an additional effect for workers with a real wage lower than the real minimum wage 12 months later. Therefore, this effect can be interpreted as the effect of yearly increases in the real minimum wage on the probability of losing employment. The *wagegap* effect is positive and significantly different from zero for all age groups, except for workers between 25 and 32 years old. Moreover, the effect is highest among the oldest workers, and almost twice the effect observed for young workers.¹⁴ To obtain some idea of the economic importance of these estimated effects, we have conducted the following exercise: We took a male Spanish worker with a wage equal to the minimum in 2004 and all other variables at their average in 2004, and simulated what would have been his probability of losing employment had the minimum wage increased in that year to the maximum observed in 2010. In other words, we simulate the impact of the accumulated increase in minimum wages for the lowest productivity worker, isolating it from movements in other covariates (including year). According to the estimations of the model, the result of the exercise for the youngest group is that the probability of losing employment 1 year later rises from 11.2% (no *wagegap*) to 24.9% (maximum *wagegap*). A similar exercise for the oldest group yields a substantial increase in the probability, from 11.2% to 41.9%.

Analysing the results by gender (second and third columns), we find that the impact of the real minimum wage for workers between 33 and 45 years old is due, exclusively, to female workers, as the effect on male workers in this age group is non-significant.¹⁵ Figure 2 may shed some light on the interpretation of this fact, since it shows that the productivity growth curve is lower in the case of females, which may explain why the impact on women affects more age groups than in the case of men. The marginal effect of the *wagegap* on older workers is also higher for women.

¹³ Differences across age groups are all significant at 1%.

¹⁴ Differences in the effect of minimum wages across age groups are all significant at 1%, except for the third age group (33–45 years), which is significantly different from the first two age groups only at 5%.

¹⁵ Differences between genders are significant at 1% for the first and third wage groups, at 5% for the second one, and at 10% for the one with 45 years or more. Not surprisingly, these differences are less significant for the age group (older than 45) with less differences in average wage growth (see Figure 2).

Table 6 shows the effects of other control variables. Nationality and tenure in the firm are negative and significant for both genders. Thus, Spanish workers have less probability of losing their employment, and as tenure in the firm increases the probability of losing employment decreases. Also, workers with temporary contracts are more prone to losing their jobs. Finally, we control for dependants in the family. In this case, we find that dependants between 0 and 6 years old and dependants over the age of 65 have a positive and significant effect on the probability of losing employment. Other control variables also have the expected sign.

In the fourth column, we can see results for a model which is the same as the benchmark, but restricted to January observations. This is done for the purpose of comparison with the model in Stewart (2004) using the New Earnings Survey Panel Data.¹⁶ In his model, he analyses the effect only 1 month after introducing the minimum wage. Hence, restricting our sample to January observations makes these two models comparable. We find that the *wagegap* effect is only positive for workers over the age of 45. The effect of the rest of the variables is similar to that in the benchmark model (first column). Therefore, the lack of time to fully observe the effects of the introduction of the minimum wage could be the reason for the absence of significant effects found in Stewart (2004).

In the last column, we show a modified version of our main model. We take workers in year 2000 and their labour status in 2004 and workers in 2004 and their labour status in 2008. In this case, the affected group is workers who had a wage that was lower than the real minimum wage 48 months later. With this model, we wish to assess the relevance of the problem of self-selection. In other words, with our benchmark model we may only see the evolution of surviving workers after the first increase in minimum wage, but with this variation of the main model we can see whether our estimation is affected by this problem. We find that the *wagegap* effect on the probability of losing employment is positive and significantly different from zero for all age groups. Also, the magnitude of the effect is still largest for older workers, being twice that for young workers.

Table 7 shows the estimations by sector of activity. In agriculture there are not enough observations because the majority of workers in this sector are subject to a special social security regime, and hence not well covered in the MCVL. We see that the greatest effects are in the construction sector, although in

¹⁶ This database is based on administrative records and is the most similar to our database. Stewart analyses the period from 1994 to 1999, but the data are yearly and the survey is conducted in April, so that he really only analyses the situation 1 month after the introduction of the minimum wage.

Table 7: Probability of losing employment.

	Industry	Construction	Services
Wage, 16–24 years old (euro)	–0.004*** (1.1×10^{-4})	–0.003*** (2.07×10^{-4})	–0.004*** (8.74×10^{-5})
Wage, 25–32 years old (euro)	–0.006*** (6.55×10^{-5})	–0.005*** (1.3×10^{-4})	–0.006*** (4.5×10^{-5})
Wage, 33–45 years old (euro)	–0.006*** (5.85×10^{-5})	–0.006*** (1.1×10^{-4})	–0.006*** (4.13×10^{-5})
Wage, more than 45 years old (euro)	–0.002*** (4.7×10^{-5})	–0.004*** (1.13×10^{-4})	–0.002*** (4.25×10^{-5})
Wagegap ^a , 16–24 years old (euro)	–0.026 (0.063)	0.254** (0.106)	0.099** (0.021)
Wagegap, 25–32 years old (euro)	–0.019 (0.062)	0.271** (0.109)	0.052** (0.020)
Wagegap, 33–45 years old (euro)	0.037 (0.061)	0.348*** (0.105)	0.078*** (0.020)
Wagegap, more than 45 years old (euro)	0.178*** (0.063)	0.525*** (0.120)	0.162*** (0.021)
Spanish nationality	–1.470*** (0.045)	–2.717*** (0.053)	–2.331*** (0.025)
Dummy temporary contract	6.064*** (0.032)	5.740*** (0.056)	5.616*** (0.020)
Tenure in the firm (days)	-8.42×10^{-4} *** (1.1×10^{-5})	–0.005*** (3.29×10^{-5})	–0.002*** (1.05×10^{-5})
Other family members, 0–6 years old	0.350*** (0.030)	–0.240*** (0.042)	1.151*** (0.019)
Other family members, 7–15 years old	0.668*** (0.029)	–0.755*** (0.039)	–0.438*** (0.019)
Other family member, 16–65 years old	–0.036*** (0.013)	–0.115*** (0.017)	–0.172*** (0.008)
Other family members, over 65 years old	0.101*** (0.038)	0.575*** (0.060)	0.043*** (0.025)
N	3,977,113	2,775,198	9,955,216
χ^2 (p-value)	1,544,532.23 (0.000)	970,603.94 (0.000)	3,851,917.69 (0.000)

Notes: Marginal effects in percentage points for sector (The agriculture sector cannot be analysed because it has a special Social Security regime and hence there are not enough observations) specifications of logit model. Other control variables: Year and month dummies, age group, multiple job-holding and the interaction between month and wagegap. ^aWagegap is only for workers who receive a salary lower than real minimum wage in $t + 12$. ***Significant at 1% level. **Significant at 5% level. *Significant at 10% level.

all sectors the effect for older workers is positive and significantly different from zero, and the marginal effect is greater for older workers than for young workers. Therefore, the main conclusion is maintained. For the rest of the variables, the results are similar to those obtained with the aggregate model, with some differences in the effect of dependants in the family by sector.

The overall conclusion is that increases in the real minimum wage have negative effects on the individual probability of employment for both young and older workers. However, the magnitude of this effect in the case of older workers is double that for young workers. Moreover, for older workers (and to some extent female workers) the negative impact on the probability of employment could be more harmful because the affected workers may be definitively expelled from the labour market, as the probability of future increments in productivity overcoming the effect of the minimum wage is lower. In contrast, young workers have greater chances of finding another job sooner or later because they are at the beginning of their careers, and situated on the upward-sloping part of their productivity curve, which is not the case of older workers. Interestingly, the negative effects of minimum wages on employment appear to be associated with groups with low-productivity growth, which is consistent with this theory.

In the next model (see Table 8), we incorporate the possibility that workers may choose to keep working for the same or different firm, but with self-employed status, so that the firm does not have to increase their wages. We estimate a multinomial logit model with a categorical dependent variable (S_{it}) with three possible values, 0 is when the worker continues working 12 months later ($t + 12$) as an employee; 1 if the worker is unemployed in $t + 12$ and finally, 2 if the worker works as self-employed in $t + 12$.

The marginal effects of wages have the expected sign. Their effect on the probability of maintaining the job is positive and significant, and it is negative and significant in the probability of going to unemployed or self-employed. Other control variables have the same effect as in the benchmark model. Regarding the *wagegap* variable, the effect is negative and significant in the probability of maintaining employment for young and older workers, while it is non-significant for other age groups. In both affected groups, we find positive and significant effects on the probability of going to unemployment. In contrast, we found significant (positive) effect on the probability of working as self-employed only for older workers.¹⁷ As an example, we use an exercise

¹⁷ All differences across age groups are significantly different at 1%, with the following exceptions: The effect of going into unemployment for the two intermediate age groups, and the effect of becoming self-employed for the two youngest groups. Also, the difference between first and third groups in the probability of becoming self-employed is only significant at 5%.

Table 8: Effect on the probability of ending in state (marginal effects in percentage points): Reference group: Employee

	Employed	Unemployed	Self-employed
Wage, 16–24 years old (euro)	0.004*** (6.5×10^{-5})	−0.004*** (6.3×10^{-5})	-1.42×10^{-4} *** (1.81×10^{-5})
Wage, 25–32 years old (euro)	0.006*** (3.64×10^{-5})	−0.006*** (3.57×10^{-5})	-2.64×10^{-4} *** (8.5×10^{-6})
Wage, 33–45 years old (euro)	0.007*** (3.25×10^{-5})	−0.006*** (3.18×10^{-5})	-4.31×10^{-4} *** (8.17×10^{-6})
Wage, more than 45 years old (euro)	0.002*** (3.13×10^{-5})	−0.002*** (3.00×10^{-5})	-1.47×10^{-4} *** (1.05×10^{-5})
Wagegap ^a , 16–24 years old (euro)	−0.071*** (0.021)	0.061*** (0.020)	0.009 (0.006)
Wagegap, 25–32 years old (euro)	−0.012 (0.201)	0.003 (0.019)	0.009 (0.006)
Wagegap, 33–45 years old (euro)	−0.030 (0.019)	0.001 (0.019)	0.016*** (0.006)
Wagegap, more than 45 years old (euro)	−0.130*** (0.021)	0.105*** (0.020)	0.024*** (0.006)
Spanish nationality	2.890*** (0.020)	−2.786*** (0.019)	−0.106*** (0.006)
Dummy temporary contract	−6.440*** (0.016)	6.358*** (0.016)	0.084*** (0.004)
Tenure in the firm (days)	0.003*** (8×10^{-6})	−0.003*** (7.82×10^{-6})	-1.44×10^{-4} *** (2.13×10^{-6})
Other family members, 0–6 years old	−0.762*** (0.015)	0.661*** (0.015)	0.101*** (0.004)
Other family members, 7–15 years old	0.417*** (0.015)	−0.442*** (0.014)	0.024*** (0.004)
Other family member, 16–65 years old	0.065*** (0.006)	−0.059*** (0.006)	−0.006*** (0.002)
Other family members, over 65 years old	−0.125*** (0.020)	0.125*** (0.020)	-6.52×10^{-4} (0.006)
N	16,898,400		
χ^2 (p-value)	622,916.78 (0.000)		

Notes: Other control variables: Year and month dummies, age group, multiple job-holding and the interaction between month and wagegap. ^aWagegap is only for workers who receive a salary lower than real minimum wage in $t + 12$. ***Significant at 1% level. **Significant at 5% level. *Significant at 10% level.

similar to the one previously defined. According to the estimated model, a young, male, Spanish worker in 2004 had probabilities of 10.9% and 0.5% of losing employment or becoming self-employed, respectively. These probabilities would have been increased to 23.6% and 2.2%, respectively, had the minimum wage been increased in 1 year up to the maximum in 2010. The corresponding increase for an older worker is from 11.1% and 0.3% to 33.6% and 16.1%.

In conclusion, young and older workers have a significant and positive effect on the probability of becoming unemployed. Also, the group of older workers has a significant and positive effect to change their employment status to self-employed. Therefore (a small) part of the effect found for older workers in previous logit models is capturing a change to self-employment status.

In the last model estimated (Table 9), we have covered the analysis of workers in higher occupational categories, in which the increase in the minimum social security contribution has been lower. For these occupational categories, the employer could decide either to downgrade workers to lower categories to avoid the increase in minimum wage or to fire them. And as before, workers could choose to work on a self-employed basis.

In order to cover all these possibilities, we have proposed another multinomial logit that covers all these transitions (see Table 9). In particular, we have defined a categorical variable (M_{it}) that takes four possible values: 0 when the worker continues working as an employee and in the same or in a higher occupational category 12 months later ($t + 12$); 1 and 2 in the same cases as defined above; and finally 3 when the worker continues working as an employee, but in a lower occupational category in $t + 12$.

The marginal effects of wages have the expected sign. Their effect on the probability of staying employed is positive and significant, while it is negative and significant in the probability of changing to unemployed, self-employed or to a lower occupational category. Regarding the *wagegap* variable, only young workers of higher occupational categories have a significant and positive effect on the probability of changing to unemployed status or to be downgraded to a lower occupational category, while all these effects for older workers are not significantly different from zero. The presence of high firing costs in the Spanish labour market could explain these results, making young qualified workers more prone to be fired or downgraded than their older counterparts. Another interpretation could be the importance of specific human capital for qualified jobs, which makes an older worker less replaceable.

Table 9: Effect on the probability of ending in state (marginal effects in percentage points) for higher occupation categories: Reference group: Maintaining employment

	Maintaining employment	Unemployed	Self-employed	Downgrade of occupational category
Wage, 16–24 years old (euro)	0.007*** (2.4×10^{-4})	−0.003*** (1.73×10^{-4})	-2.98×10^{-4} *** (8.5×10^{-5})	−0.004*** (1.47×10^{-4})
Wage, 25–32 years old (euro)	0.006*** (6.9×10^{-5})	−0.003*** (5.34×10^{-5})	-3.73×10^{-4} *** (1.9×10^{-5})	−0.003*** (4.54×10^{-5})
Wage, 33–45 years old (euro)	0.006*** (6.92×10^{-5})	−0.003*** (5.16×10^{-5})	-5.32×10^{-4} *** (1.9×10^{-5})	−0.003*** (5.1×10^{-5})
Wage, more than 45 years old (euro)	0.005*** (9.92×10^{-5})	−0.001*** (6.15×10^{-5})	-3.6×10^{-4} *** (2.6×10^{-5})	0.003*** (8.06×10^{-5})
Wagegap ^a , 16–24 years old (euro)	−0.229*** (0.0692)	0.165*** (0.0428)	−0.003 (0.032)	0.094** (0.040)
Wagegap, 25–32 years old (euro)	−0.014 (0.055)	0.050 (0.036)	−0.006 (0.019)	−0.030 (0.035)
Wagegap, 33–45 years old (euro)	−0.037 (0.056)	0.060 (0.036)	−0.011 (0.019)	−0.012 (0.036)
Wagegap, more than 45 years old (euro)	0.017 (0.062)	−0.008 (0.0415)	−0.002 (0.020)	−0.006 (0.041)
Spanish nationality	3.145*** (0.080)	−2.142*** (0.056)	−0.162*** (0.021)	−0.842*** (0.056)
Dummy temporary contract	−4.890*** (0.047)	2.696*** (0.035)	0.027** (0.013)	2.168*** (0.032)
Tenure in the firm (days)	0.003*** (2.5×10^{-5})	−0.001*** (1.7×10^{-5})	-1.53×10^{-4} *** (1.42×10^{-5})	−0.002*** (2.1×10^{-5})
Other family members, 0–6 years old	0.032 (0.044)	0.368*** (0.031)	0.058*** (0.011)	−0.458*** (0.033)
Other family members, 7–15 years old	0.769*** (0.051)	−0.626*** (0.037)	0.043*** (0.012)	−0.19*** (0.036)
Other family member, 16–65 years old	−0.122*** (0.021)	0.044*** (0.016)	−0.004 (0.006)	0.082*** (0.015)
Other family members, over 65 years old	−0.173*** (0.059)	0.272*** (0.042)	0.272*** (0.015)	−0.151*** (0.043)
N	1,948,383			
χ^2 (p-value)	1,497,944.84 (0.000)			

Notes: Other control variables: Year and month dummies, age group, multiple job-holding and the interaction between month and wagegap. ^aWagegap is only for workers who receive a salary lower than real minimum wage in $t + 12$. ***Significant at 1% level. **Significant at 5% level. *Significant at 10% level.

6 Conclusions

There was a strong increase in the real minimum wage in Spain between 2004 and 2010. We use it as a case study to estimate the impact of increases in real minimum wages on employment probabilities for affected workers, using administrative social security records. Our identification strategy compares a worker with real wage lower than the real minimum wage 12 months later (affected group) with a worker of similar characteristics but with a real wage high enough so that he is not affected by the increase and also with a worker of similar characteristics and same wage, but in a period in which the real minimum wage did not increase.

Across many different specifications, we find that an increase in the minimum wage induces a positive and significant impact on the probability of losing the employment for young and older workers. The magnitude of this effect in the case of older workers doubles that of young workers. A small part of these job losses for older workers actually comes from some of them becoming self-employed.

In high occupational categories (for which the increase was much lower) we only find some effects for young people.

The intuition of our results is that, from a macroeconomic point of view, one would expect the group of young workers to be more affected than other groups, because young workers receive a lower wage. From a microeconomic perspective, however, the picture can be different, because the effect of minimum wages on individual employment probabilities does not depend on the number of people affected, but rather on characteristics like functional mobility, learning or long-term productivity. All of these issues are against older people. This is of particular importance because the negative impact on employment probabilities might be very harmful in the case of older workers: They may be definitively expelled from the labour market if their productivity does not grow enough to overcome minimum wage increases, something that is likely to occur, as many of these people are in (or close to) the downward part of their life-cycle productivity profile. In contrast, young workers still have to enjoy the fastest part of their productivity profile, so they probably have greater chances of finding another job sooner or later, even if they are temporarily expelled from the labour market.

In summary, our work departs from other papers in the literature based on an aggregate or firm-level approach, by looking at the minimum wage problem from an individual perspective. Our results suggest that this individual approach is important, because an aggregate approach overlooks important individual

consequences for specific groups of workers. In particular, the effects on young people (where most of the previous studies have been focused) could be overwhelmed by the corresponding consequences for older people, once different effects by age are properly analysed.

Appendix: robustness checks and other estimations

In this section, we present the results of some specifications which, for several reasons, are less preferred than the benchmark estimations presented so far, but which nevertheless are useful to assess the robustness of our main results. They have some differences, but in all of them the increase in the minimum wage significantly reduced the probability of older people to keep their employment. Other age groups have also significant effects, but they are always of a smaller magnitude than in the case of older people. Hence, our main results are robust to these alternative specifications.

The first column of Table 10 presents a model equivalent to the one in the last column of Table 6. Results are very similar, and hence we do not comment them in detail. If any, differences across age groups become less apparent.

The second and third columns present the results of estimating random and fixed effects models, respectively. In a fixed effects model, identification comes from the comparison of the outcomes of the same individual in different moments in which he is affected or not affected. Consequently, we ignore the information provided by the comparison of the affected individual with people earning a slightly higher wage (and therefore not affected) in the same moment. Moreover, the specific situation at hand makes identification of a fixed effects model very weak, because if an individual is in the treatment group 1 year, he will probably lose his job, and hence he will not be observed again. Indeed, the average times an individual lose the job is 3.13, and this figure is reduced to 1.04 while in the treatment group.¹⁸ These criticisms more or less also apply for random effects estimation. Hence, most of our identification comes from comparing different individuals, and therefore models with individual non-observable effects are not best suited for our problem and database. Still, as

¹⁸ Note that, since we are looking at job losses 12 months later, these figures imply an average of 0.261 and 0.086 job losses per year, respectively.

can be seen in the table, we find significant effects for older people, although the effect for the youngest groups disappears. A new effect of the opposite sign appears in the intermediate age groups, which is against theory, and it is probably related to the problems with these type of models already commented.

The last column estimates a model similar to the first column of Table 6, but excluding observations older than 60. The purpose is to clear the result found for older people from early-retirement decisions. Table 6 is still the preferred model, because retirement may be a consequence of being expelled from the labour market, and hence it should be included in the estimation of minimum wage effects. Nevertheless, the main results do not change when we exclude those observations from the estimation, finding estimates of *wagegap* very close to those in the benchmark model in Table 6.

Table 10: Probability of losing employment

	24 months ^b	Random effects	Fixed effects	Retirement
Wage, 16–24 years old (euro)	–0.005*** (1.63×10^{-4})	–0.001*** (7.11×10^{-5})	–0.003*** (2.52×10^{-4})	–0.004*** (6.32×10^{-5})
Wage, 25–32 years old (euro)	–0.007*** (8.73×10^{-5})	–0.002*** (4.30×10^{-5})	–0.005*** (1.52×10^{-4})	–0.006*** (3.56×10^{-5})
Wage, 33–45 years old (euro)	–0.008*** (8.18×10^{-5})	–0.002*** (4.13×10^{-5})	–0.003*** (1.48×10^{-4})	–0.006*** (3.18×10^{-5})
Wage, more than 45 years old (euro)	–0.001*** (6.86×10^{-5})	3.05×10^{-4} *** (5.33×10^{-5})	–0.008*** (2.01×10^{-4})	–0.002*** (3.41×10^{-5})
Wagegap ^a , 16–24 years old (euro)	0.154*** (0.033)	6.39×10^{-4} (0.019)	–0.053 (0.067)	0.071*** (0.020)
Wagegap, 25–32 years old (euro)	0.113*** (0.032)	–0.042** (0.018)	–0.174** (0.064)	0.022 (0.019)
Wagegap, 33–45 years old (euro)	0.131*** (0.032)	–0.043** (0.018)	–0.164** (0.063)	0.048** (0.019)
Wagegap, more than 45 years old (euro)	0.171*** (0.033)	0.051*** (0.019)	0.170* (0.067)	0.138* (0.020)
<i>N</i>	3,276,657	16,898,400	9,411,070	16,587,057
χ^2 (<i>p</i> -value)	1,306,774.15 (0.000)	354,835.41 (0.000)	479,470.85 (0.000)	6,276,510.62 (0.000)

Notes: Marginal effects in percentage points for different specifications of logit model. Other control variables: Year and month dummies, age group, multiple job-holding and the interaction between month and wagegap. ^aWagegap is only for workers who receive a salary lower than real minimum wage in $t + 12$. ^bThis model is only estimated for 2002 and 2004 and the employment status 24 months later. ***Significant at 1% level. **Significant at 5% level. *Significant at 10% level.

Finally, we want to discuss a situation very important in the Spanish labour market, which is also indirectly related to minimum wages. Another possible wage floor in Spain is provided by collective bargaining, which determines a minimum wage for each occupational category, mandatory for all the workers in the sector or firm considered in the agreement. These bounds are higher than the mandatory minimum wage. The increase in the mandatory minimum wage may have been passed through to these bargained wages, at least in the case of those that were already close to the minimum, if the social agents that participate in the negotiations wanted to keep relative wages relatively constant. To study this possibility, we have considered another affected group of people. The model proposed is the same as our benchmark, but we have added a second affected group of workers who have a real wage that is less than 110%¹⁹ of the real minimum wage 12 months later, but also higher than the real minimum wage 12 months later (corresponding to people not directly affected, but maybe affected by a possible pass-through to bargained wages). We estimate different effects for these two groups by adding a new variable (*wagegap_2*) defined as:

$$wagegap_2_{i,t} = \max((1.1 \cdot m_{i,t+12} - wage_{i,t}) \cdot I(m_{i,t+12} < wage_{i,t}); 0) \quad [3]$$

where I is the indicator function that takes the value 1 if the condition is true. Tables 11 presents the estimation results for our benchmark model adding this second group of affected workers. The main result of our benchmark model is maintained. On top of that, we find that the *wagegap_2* for the second affected group has an effect for workers with a real wage that is lower than 110% of the real minimum wage 12 months later. This effect can be interpreted as a proxy for the effect of yearly increases in the real minimum wage on bargained wages, and sequentially on the probability of losing employment. This *wagegap_2* effect is positive and significantly different from zero for all age groups. In any case, the magnitude of the effect of this second wage gap is much lower than the original. This means that the pass-through of minimum wages to collectively bargained wages has some effect on the probability of losing employment, but is of secondary importance when compared to the minimum wage increase itself.²⁰

¹⁹ The number 110% is completely arbitrary. It is chosen to be very close to the minimum, so that it captures the mentioned pass through effect relatively clean of other possible movements in wages. It could have been better to directly use collective bargained wages. Unfortunately, these are easily available in growth terms, but not in levels, which are reported by very few agreements. The type of analysis developed here requires levels; hence, we needed to make the very imprecise approximation already mentioned as a first approach to the problem.

²⁰ This is true in terms of individual probabilities. The aggregate macroeconomic effect of bargained minimum wages on employment could be higher, because they affect more people.

Table 11: Probability of losing employment

	110%
Wage, 16–24 years old (euro)	–0.004*** (6.69×10^{-5})
Wage, 25–32 years old (euro)	–0.006*** (3.7×10^{-5})
Wage, 33–45 years old (euro)	–0.006*** (3.30×10^{-5})
Wage, more than 45 years old (euro)	–0.002*** (3.15×10^{-5})
Wagegap ^a , 16–24 years old (euro)	0.079*** (0.021)
Wagegap, 25–32 years old (euro)	0.027 (0.019)
Wagegap, 33–45 years old (euro)	0.053*** (0.020)
Wagegap, more than 45 years old (euro)	0.144*** (0.020)
Wagegap_2 ^b , 16–24 years old (euro)	0.016*** (0.003)
Wagegap_2, 25–32 years old (euro)	0.007*** (0.003)
Wagegap_2, 33–45 years old (euro)	0.017*** (0.002)
Wagegap_2, more than 45 years old (euro)	0.032*** (0.003)
<i>N</i>	16,898,400
χ^2 (<i>p</i> -value)	6,470,551.31 (0.000)

Notes: Marginal effects in percentage points. Other control variables: Year and month dummies, age group, multiple job-holding and the interaction between month and wagegap. ^aWagegap is only for workers who receive a salary lower than real minimum wage in $t + 12$. ^bWagegap_2 is only for workers who receive a salary between the minimum and 1.1 times the minimum in $t + 12$. ***Significant at 1% level. **Significant at 5% level. *Significant at 10% level.

Acknowledgement: We are grateful to the Spanish Ministerio de Empleo y Seguridad Social for providing us with the data needed to accomplish this study. In addition, we wish to thank all the seminar participants at Banco de España, Universidad Autónoma de Madrid and European Central Bank for discussions and suggestions, and in particular Mario Izquierdo, Pedro Portugal, Ernesto Villanueva and an anonymous referee for their very helpful comments

and suggestions. The views expressed here are those of the authors and do not necessarily reflect those of the Banco de España or the Eurosystem.

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