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The Impact of Minimum Wages on Wages and Employment: Evidence from Greece

Andreas Georgiadis, Ioannis Kaplanis, and Vassilis Monastiriotis

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The Impact of Minimum Wages on Wages and Employment: Evidence from Greece

Andreas Georgiadis[*], Ioannis Kaplanis[†] and Vassilis Monastiriotis[‡]

ABSTRACT

This paper investigates the impact of minimum wages on wages and employment in Greece between 2009 and 2017. Our main contribution is the examination of the effects of minimum wages under a dramatically changing context, as during this period Greece has experienced the deepest recession in its recent history, extensive labour market reforms, and several changes in the minimum wage, including a large decrease. Employing a unique administrative panel matched employer-employee data set and a range of estimators, such as difference-in-differences, fixed effects, and Instrumental Variables, we find that minimum wages have a positive and significant effect on individual and firm-level wages with significant positive wage spill-overs extending, sometimes, above the median wage, but no systematic employment effects.

Keywords: Minimum Wage, Wages, Employment

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[*] Brunel Business School, Brunel University London, Kingston Lane, London, UB8 3PH; and Said Business School, University of Oxford. E-mail: andreas.georgiadis@brunel.ac.uk.

[†] Panteion University, 136 Syggrou Ave., Athens, Greece; and SERC, LSE, Houghton Street, London WC2A 2AE

[‡] European Institute, Hellenic Observatory and Department of Geography and Environment, LSE, Houghton Street, London WC2A 2AE

1. Introduction

The literature on the employment effects of minimum wages is vast. The seminal work of Card and Krueger (1995) and a large number of subsequent studies (e.g., Machin et al., 2003) that produced evidence of no or even positive employment effects of minimum wages seemed to have dented the earlier consensus that higher minimum wages decrease employment (Brown et al., 1982). Despite this, there have been divergent views on whether the issue has been decisively settled and what could be the most fruitful areas for future research (Manning, 2016; Neumark, 2018).

On the one hand there are those who suggest that the employment effect of the minimum wage has been elusive, but acknowledge that there is a limit up to which minimum wages could be increased without reducing employment and thus the key policy question is to identify this limit (Manning, 2016). International organisations as well as several policy makers seem to share this view (e.g., see joint report by IMF, World Bank, OECD, and ILO, ILO (2012) and the Irish Low Pay Commission report, 2018).

On the other hand, there are those who point toward the more recent divergent evidence on the employment effects of minimum wages (e.g., Neumark, Salas, and Wascher, 2014; Allegreto et al., 2017) and suggest that future research should investigate the methodological/econometric as well as economic factors that could explain this (Neumark, 2018).

A point of convergence, however, of these views on future research priorities on minimum wages is that an investigation is warranted on whether the magnitude of employment effects of minimum wages may vary depending on a range of factors (Manning, 2016; Neumark, 2018). For example, a negative employment effect of minimum wages may be more likely to be detected in a context where the initial level of the minimum wage is relatively high, the magnitude of the change in the minimum wage is large, the level of aggregate economic activity is low, and labour market regulation is weak. Therefore, there are much to be learned from studies in such contexts.

A number of studies from Europe, such as Portugal (Pereira, 2003; Portugal and Cardoso, 2006), Ireland (O'Neill, Nolan and Williams, 2006), and Hungary (Harasztosi and Lindner, 2015) seem to suggest that, at best, large increases in minimum wages in countries where the level of minimum wages is relatively high have no or small negative employment effects. These studies, although informative, do not provide evidence of how results may vary depending on the point of the business cycle at which the change is enacted and the strength of labour market institutions. There is scarce evidence, mainly from cross-country studies, on the employment effects of the minimum wage during recessions and under different strictness of labour market regulation, and, in many cases, this evidence is rather mixed (Allegretto et al., 2011; Dolton and Bondibene, 2012; Addison et al., 2013; Christl et al., 2018).

Moreover, there is limited evidence on how minimum wages affected employment during the latest severe economic crisis in Europe. In particular, in some of the European countries hit the hardest from the crisis, there have been drastic decreases in minimum

wages (e.g., Ireland, Greece) in the face of wider and dramatic labour market deregulation. These decreases have been justified on the basis that they will help to mitigate the negative effects of the recession on the employment opportunities of the most affected groups, such as the youth and the low-skilled. This hypothesis, however, has not been rigorously investigated. It also hinges on the assumption that the employment effect of a decrease in the minimum wage is symmetric to that of an increase, as the neoclassical model of the labour market would predict. Nevertheless, this may not necessarily be the case due to asymmetry in behavioural responses to wage decreases relative to equivalent increases (Kahneman and Tversky, 1979; Tversky and Kahneman, 1991).

Finally, results of the few cross-country studies may be confounded by other differences across countries. Looking at a single country over time may abate this problem, but, to our knowledge, such study is missing.

This paper aims to present such a study and address the aforementioned gaps in the literature looking at the case of Greece during the period between 2009 and 2017. There are many reasons why Greece offers a fruitful ground for such an investigation. First, it is a country with a relatively high minimum wage, close to the average of OECD countries, that have been increased regularly and at different rates (OECD, 2014). Second, since the economic crisis of 2008 the country has experienced an unprecedented recession that deepened over time and led to a loss of more that 25 percent of per capita GDP by 2014 (Meghir et al., 2017). This, combined with other aspects of the Greek economy, triggered a debt crisis that led to the entry of the country to a structural adjustment program in May 2010 agreed between the Greek government on the one side and the IMF, the European Commission, and the European Central Bank on the other side. Third, as part of the structural adjustment program there has been a dramatic deregulation of labour market institutions, including a large reduction in the minimum wage in 2012 that was larger for those younger than 25 years of age, effectively introducing a youth subminimum.

Finally, unlike other European countries, there has been limited evidence on the effects of minimum wages on wages and employment in Greece. Earlier studies provide time-series evidence (Koutsogeorgopoulou, 1994; Karageorgiou, 2004), whereas a few more recent studies investigate the impact of the 2012 differential reduction in the minimum wage on employment dynamics among young individuals across the 25 years old threshold (Yannelis, 2014; Karakitsios, 2015; Kakoulidou et al., 2018). These studies, however, find conflicting evidence and do not provide evidence on how wages responded to the minimum wage reduction. This is possibly due to data limitations, as these studies use data from the Greek Labour Force Survey that does not include precise information on wages (up to 2015 wages were reported in bands). This is important, because examining wage responses to changes in the minimum wage is a pre-requisite of looking at effects of minimum wages on employment. Moreover, in contrast to minimum wage increases, in the case of a decrease it is not given that wages would change at all, and if so, if they would decline by more among low-wage workers. This is because the reduction in the minimum wage was combined with a decentralisation of collective bargaining, which was aimed at facilitating wage reductions across the wage distribution in the private sector.

We analyse the effects of minimum wages on wages and employment during the period between 2009 and 2017 in Greece using data from a random sample of employees in the private sector and their employers drawn from the Unified Social Security Authority (EFKA) records. This panel matched employer-employee data set has several advantages over other available data sources. First, it is the most precise source of information on individual wages that allows us to study the incidence and extent of wage spillovers that haven't been previously studied. Second, in contrast to other studies, it enables us to examine directly both employees' and employers' responses to changes in minimum wages.

We examine the effects of a range of changes in the minimum wage of different magnitudes, including two increases (one of 5.5 percent in 2009 and another one of 1.6 percent in 2011) as well as a dramatic reduction that differed for those above and below 25 years (22 and 32 percent respectively in 2012). These changes have been enacted at different points in the recession and under different strictness of labour market regulation.

We leverage on the different sources of variation in minimum wages during this period, employing a range of estimators, such as difference-in-differences (DID), fixed effects (FE), and fixed effects Instrumental Variables (FEIV). We find a significant and positive effect of minimum wages on individual and firm average wages, as well as significant positive wage spill-overs that may extend, depending on the period, beyond the median wage. Nevertheless, we find no systematic evidence of a significant employment effect of minimum wages at any given period. In particular, we fail to find evidence that employment increased or decreased by more in periods and groups of employees or employers who have experienced the largest wage increases or decreases as a result of the minimum wage. Moreover, in the case of 2012 decrease, FEIV estimates suggest that, after 2012, firms with a higher share of youth, and thus a lower effective minimum wage, had significantly lower wages and employment, a finding consistent with a significant positive relationship between the level of the minimum wage and firm employment.

The plan of the paper is as follows. In the next section we describe the data set and present descriptive statistics. The following section then presents our estimation strategy, whereas the fourth section presents our results. Finally, the last section concludes.

2. Data and Descriptive Statistics

The data used in our analysis were extracted from administrative records of the Unified Social Security Authority (EFKA) for the period between March 2009 and December 2017. EFKA includes social security records of all private sector employees and employers and was introduced in January 2017 through unifying all different private sector social security organisations. EFKA conducts a monthly census of all employers in the private sector collecting information on monthly gross wages of all individual employees at the firm as well as key employee and employer characteristics and social security contributions. This data provide the most reliable source of wage information

in Greece, as employers are required by law to return the information every month and gross monthly wages for each employee should be recorded with precision at two decimal places.

In our case, the sample included all employees in EFKA for whom the last two digits of the social security number matched a unique randomly selected two digit number. Records for these employees and their employers were drawn for the last month of every quarter, i.e., March, June, September, and December for the years between 2009 and 2017. Therefore, all employees in the sample at any given period appear in the sample in the following periods through December 2017, unless they have exited EFKA. In the case that an employee from the sample exits EFKA and there is no other employee in the sample from the same firm, the firm is also dropped from the sample. This results in a panel matched employer-employee data where, at any given period, for each individual employee there is also employer information and for each employer there is information on at least one employee at the firm.

Tables 1 and 2 report descriptive statistics of private sector employees and firms[4] respectively for the full period (see also Tables A.1 and A.2 in the Appendix for information on the occupation, industry, and region composition of the sample). The tables also present descriptive statistics separately for the months in the data that are just before and after the May 2009 and July 2011 minimum wage increases, as well as for the months just before and after the February 2012 minimum wage reduction, based on employees and firms in the balanced sample, i.e., those observed in the month before and after the change in the minimum wage.

According to Table 1, around half of the employees in the sample are male, the average employee age is around 38 years with around 10 percent of employees being younger than 25 years old, whereas 77 percent are full-time and the average employee gross monthly wage is around €1080 in the full period. Moreover, Table 2 reveals quite similar averages along these aspects across firms, with the difference that the share of full time employees at the firm is around 70 percent and the average wage bill per employee at the firm is around €1200, slightly higher than the average employee wage, as it this includes bonuses and arrears on top of basic pay.[5] Table 2 also indicates that the average firm in the sample during the full period has around 45 employees and that, on average, the share of employees with information on individual employee characteristics, including wages, at the firm is around 20 percent of total firm employment.[6]

[4] EFKA records include employees in the so-called "wider" public sector that includes mainly employees in public sector enterprises. These employees, however, are not covered by the minimum wage, as they are paid according to the unified public sector payroll for which the lowest wage or salary is always higher than the minimum wage.

[5] The data does not include information that would allow us to separately identify the monthly wage bill accounted by base pay, excluding bonuses and arrears.

[6] For 11 percent of firms in the sample there is information on individual characteristics and outcomes of all employees, whereas the share of employees with information is below 10 percent for half of the firms in the sample.

Table 1: Descriptive Statistics of Employee Characteristics in EFKA Data

	2009-2017	March 2009	June 2009	June 2011	September 2011	December 2011	March 2012
Male	0.53	0.55	0.55	0.53	0.53	0.53	0.53
	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)	(0.50)
Age	38.52	37.65	37.90	38.38	38.63	38.51	38.75
	(10.17)	(10.15)	(10.15)	(9.90)	(9.90)	(9.73)	(9.72)
Under 25 years	0.09	0.10	0.09	0.08	0.07	0.07	0.06
	(0.28)	(0.30)	(0.29)	(0.27)	(0.26)	(0.25)	(0.24)
Full-time	0.77	0.88	0.88	0.84	0.84	0.82	0.81
	(0.42)	(0.33)	(0.33)	(0.37)	(0.37)	(0.39)	(0.39)
Gross monthly base pay	1078.66	1268.95	1281.06	1277.80	1282.92	1286.13	1267.20
	(712.61)	(704.15)	(707.35)	(693.31)	(698.51)	(714.36)	(713.24)
Ratio of minimum to median wage	0.68	0.67	0.70	0.68	0.68	0.68	0.54
Number of employees	70,102	27,741	27,741	25,895	25,895	22,807	22,807
Number of observations	1,043,127	27,741	27,741	25,895	25,895	22,807	22,807

Notes: Figures are averages with standard deviations in parentheses. All samples are restricted to employees in the private sector. The samples in 2009, 2011, and 2012 are restricted to employees in the balanced panel, i.e., those who are present in both months of any given year. Gross monthly base pay is in Euros. The ratio of minimum to median wage is calculated using the minimum wage for not married employees with up to 3 years of working experience in each period before 2012 and the adult minimum wage in 2012.

Regarding the May 2009 minimum wage increase, when the minimum wage increased by 5.5 percent from €701.01 to €739.56 per month,[7] as suggested by Table 1, between March and June 2009 there was an increase in the minimum wage also as a share of the median wage from 67 to 70 percent, as well as a slight increase in the average employee gross monthly wage (around 1 percent). There is also a more noticeable increase in the firm average monthly wage bill and the average monthly wage bill per employee, as indicated by Table 2. Nevertheless, the latter may not be attributed necessarily to the increase in the minimum wage, as during the summer months, when several employees take holiday leave, there is an associated leave bonus.[8] Tables 1 and 2, however, suggest no noticeable change between June and September 2011, the months in the data just before and after July 2011 when the minimum wage increased by 1.6 percent from €739.56 to €751.39. This could be explained by the fact that this increase was rather small, as by then, the economic recession in Greece had deepened, and that, as suggested by Table 1, the minimum wage during this period seemed to have increased in line with median wages.

[7] In fact, this is the minimum wage for white collar private sector employees who are not married and with up to 3 years of working experience. Minimum wage rates vary with marital status and years of working experience, and are set at daily rates for blue collar workers (see Kanellopoulos, 2015 and Kakoulidou et al., 2018 for details).

[8] This is half of the monthly employee salary.

Table 2: Descriptive Statistics of Firm Characteristics in EFKA Data

	2009-2017	March 2009	June 2009	June 2011	September 2011	December 2011	March 2012
Share female	0.47	0.46	0.46	0.48	0.48	0.48	0.47
	(0.32)	(0.34)	(0.34)	(0.33)	(0.33)	(0.33)	(0.33)
Share under 25	0.08	0.09	0.08	0.07	0.07	0.06	0.06
	(0.16)	(0.17)	(0.17)	(0.15)	(0.15)	(0.14)	(0.14)
Share full-time	0.69	0.85	0.85	0.81	0.80	0.76	0.76
	(0.38)	(0.29)	(0.29)	(0.32)	(0.32)	(0.34)	(0.35)
Number of employees	46.14	49.87	51.14	50.69	50.69	58.79	50.15
	(269.54)	(294.11)	(295.19)	(279.45)	(278.99)	(313.33)	(287.24)
Share of employees with individual information	0.21	0.24	0.24	0.24	0.24	0.21	0.24
	(0.29)	(0.31)	(0.31)	(0.31)	(0.31)	(0.29)	(0.30)
Monthly wage bill	50736.49	45872.58	50063.70	54389.96	51785.57	93570.81	48680.80
	(132945.16)	(107823.94)	(119712.06)	(130007.7)	(120041.67)	(210641.16)	(120732.95)
Monthly wage bill per employee	1218.40	1151.97	1200.64	1235.95	1236.95	2110.42	1149.20
	(1124.40)	(859.36)	(723.22)	(959.63)	(696.43)	(1327.49)	(833.52)
Number of firms	80,426	16,437	16,437	15,457	15,457	13,778	13,778
Number of observations	698,001	16,437	16,437	15,457	15,457	13,778	13,778

Notes: Figures are averages with standard deviations in parentheses. All samples are restricted to firms in the private sector. The samples in 2009, 2011, and 2012 are restricted to firms in the balanced panel, i.e., firms that are present in both months of any given year. Monthly wage bill includes base pay, bonuses, and arrears. Monthly wage bill and monthly wage bill per employee are in Euros.

As far as the February 2012 reduction in the minimum wage, when the minimum wage decreased from €751.39 to €586.08 for those older than 25 and to €510.95 for those up to 25,[9] Table 1 indicates that this led to a marked decline in the (adult) minimum wage relative to median earnings from 68 percent to 54 percent between December 2011 and March 2012. Thus, although in the same period there was a noticeable reduction in the average employee monthly wage (around 1.5 percent), as presented in Table 1, overall wages across the distribution declined by much less than the floor afforded by the minimum wage. Moreover, Table 2 suggests a marked decline in both the number of employees and the firm average monthly wage bill and average monthly wage bill per employee. Nevertheless, again, the former could be well attributed to the economic downturn during this period, whereas the latter could be explained by the fact that in December all employers pay an additional salary to employees as a Christmas bonus.

[9] These two minima were the only two national minimum rates in place after February 2012, as the law through which the minimum wage reduction was enacted in 2012 also abolished the different minima based on marital status and working experience that were previously the case. The latter minima, however, were paid after 2012 by employers who were part of some of the major employers' associations that chose to sign the national general collective agreement.

3. Empirical Strategy

The key objectives of our analysis is to identify the impact of minimum wages on wages and employment. In order to achieve this, we employ two identification strategies. The first strategy is based on difference-in-differences (DID) estimation of the impact of the May 2009 and July 2011 increases in the minimum wage, as well as the February 2012 decrease. The second strategy relies on the fact that the 2012 reduction was higher among those 25 years old or younger introducing, in this way, a lower minimum wage for youths.

In particular, the first empirical strategy implements a differential trend adjusted DID estimator (Blundell and Costa Dias, 2009) through estimating the following specification:

$$\Delta O_{it} = \beta_0 + \beta_1 T_t + \beta_2 GAP_i + \beta_3 T_t * GAP_i + \boldsymbol{\beta_2' X_{it-1}} + u_{it} \quad (1)$$

where ΔO_{it} is the change in the outcome of individual employee or firm i between the initial period, $t-1$, and the following period, t, T_t is an indicator taking the value 1 for observations drawn before and after a period when the minimum wage changed and 0 for observations before and after a period when there was no change in the minimum wage, $\boldsymbol{X_{it-1}}$ is a vector of pre-treatment individual or firm characteristics, and u_{it} is an error term. The variable GAP_i is, the so called "wage gap", a measure of treatment intensity that is defined by previous literature (e.g., Machin et al., 2003; Stewart, 2004), as follows:

$$GAP_i = MW_t - W_i^* \quad (2)$$

where, MW_t is the log level of the minimum wage in period t (following period[10]) and W_i^* is the log level of the individual or firm wage in the absence of a (change in) minimum wage that aims to capture whether unit i is low- or high-wage. In this way, GAP_i provides a measure of the 'bite' of the minimum wage at the unit level.[11] There are several potential measures of W_i^*. For our purposes, we use the average individual wage across the different periods for which there is individual wage information or the mean firm-level average wage across periods, based on the wages of all firm employees across periods. This measure minimises measurement error in W_i^* that may afflict other potential measures of W_i^*, such as the individual wage or the average wage at the firm

[10] In fact, for 2009 and 2011, when there were several minima in place that varied with marital status and working experience, we use the lowest of the several minimum wages, covering employees who are not married and have up to 3 years of working experience. This is because there is no information on marital status and working experience in the EFKA data and thus we cannot identify which of the different levels of the minimum wage each individual is eligible to receive. This is expected to underestimate the share of those directly affected by the minimum wage and thus the impact of minimum wage increases. In the case of 2012, the calculation of the "wage gap" is based on the adult minimum wage.

[11] In contrast to Stewart (2004), we do not restrict the "wage gap" variable to be zero for individuals paid above the level of the (new) minimum wage. This is firstly because we are interested in examining the extent of wage spillovers among sub-samples of not directly affected units, and secondly, as discussed previously, because it is not clear what unit is directly affected in the case of a decrease in the minimum wage.

at the initial period $t-1$, W_{it-1}, that is expected to lead to biased estimates (Autor et al., 2016; Georgiadis and Manning, 2018).[12]

Equation (1) is suitable for estimating the impact of minimum wages on continuous outcomes. In the case of binary outcomes, such as the individual employment probability, the outcome of specification (1) can be denoted as $\Pr[E_{it+1}=1|E_{it}=1]$, that is the probability that the individual is employed in period $t+1$ conditional on being employed in period t. This suggests that in this case a linear probability model is estimated to assess the impact of the minimum wage on individual outcomes. A linear probability model was preferred due to its simplicity and straightforward interpretation (Blundell and Costa-Dias, 2009).

We can only, however, measure the individual conditional probability of employment imperfectly in our data. This is because, we only observe whether, at any given period, the individual is not employed in the private sector that does not only include unemployment, but also employment in the public sector and self-employment. We believe, however, that in the case of minimum wage increases, results of the impact of the minimum wage on the individual conditional probability of being employed in the private sector could be suggestive of employment effects of the minimum wage. This is likely to hold under the assumption that, given everything else the same, and given that an increase in the minimum wage increases pay in the private sector relative to alternative opportunities, it is less likely that a reduction in the probability of being employed in the private sector reflects voluntary quits and thus it is more likely to be attributed to involuntary separations. The same does not hold in the case of a minimum wage reduction that, on the one hand, may increase quits in the private sector and on the other hand may decrease involuntary separations. Therefore, given these two counteracting effects, analysis of the impact of the February 2012 minimum wage reduction on the individual conditional probability of remaining in the private sector is not expected to be informative of the employment effects of minimum wages arising from dismissals or job destruction.

Estimation of equation (1) requires data on individuals or firms at four points in time, before and after a period when the minimum wage changed and a period when it did not. This allows one to relax the common trends assumption on which the validity of the DID estimator rests and instead to implement a "differential trend adjusted DID estimator" (Blundell and Costa Dias, 2009). This further enables one to test explicitly the key identifying assumption of common trends of the DID method and control for differential trends in the treatment and control group in the case that the assumption does not hold.

The validity of the differential trend adjusted DID estimator, however, hinges on the assumption that trends in the control and treatment group in the period when the policy was not in place closely resemble differential trends in the two groups in the absence of the treatment. Following Blundell and Costa Dias (2009), we adjust for trends using the same period of the year, as that when the policy changed, in the most recent year when

[12] Measurement error in W_{it-1} is expected to lead to a positive bias in the OLS estimate of the coefficient of GAP_i when the outcome is ΔW_{it-1}, that is the change in the wage between $t-1$ and t.

there was no change in the minimum wage.[13] For example, in the case that the period straddling the change in the minimum wage considered is that between December 2011 and March 2012, the period between December 2010 and March 2011 is used to control for trends in the treatment and control group. Thus, the impact of the change in the minimum wage on the outcome is measured by β_3 in equation (1), whereas the inclusion of GAP_i allows to test, and control, for potential violation of the common trends assumption.

The second identification strategy uses the February 2012 differential reduction in the minimum wage of those 25 years old or younger and those older than 25 years. In particular, in this case, one can estimate the impact of the change in the minimum wage on individual outcomes using, instead of GAP_i, a binary indicator that is 1 if the individual is 25 years old or younger at the post-treatment period and 0 otherwise. This is the strategy implemented by several recent studies (Yannelis, 2014; Karakitsios, 2015; Kakoulidou et al., 2018) to identify the employment effects of the February 2012 minimum wage reduction in Greece.

Similarly, the impact of the minimum wage reduction on firm outcomes can be estimated by replacing GAP_i with a measure of the share of employees at the firm who are under 25 years old in the period before the change in the policy. This is expected to reflect the fact that the "effective" minimum wage across firms varies with the share of employees who are 25 years old or younger. One potential problem of this is that the share of those under the age of 25 at the firm prior to the change in the policy may respond to the change in the minimum wage if, for example, employers substitute youths for adults in anticipation of the change in the minimum wage. We believe, however, that this is unlikely to be a concern in the case of the February 2012 minimum wage reduction, as the change in the policy was not announced publicly in advance of becoming effective and thus there was not sufficient time for employers to adjust outcomes in anticipation of the change (see also Yannelis, 2014, for a list of other reasons ruling out an anticipation effect). Nevertheless, in our empirical analysis we also try to document whether this was indeed the case.

Another estimation strategy using the introduction of a lower subminimum wage in February 2012 is implemented employing the following specification:

$$W_{it} = \alpha_0 + \alpha_1 Agea25_{it} + \alpha_2 Post2012 * Agea25_{it} + \boldsymbol{\alpha_3'} \boldsymbol{X_{it}} + \gamma_i + \delta_t + \epsilon_{it} \quad (3)$$

where W_{it} is the outcome of individual i in period t, $Agea25_{it}$ is an indicator of whether the individual i is older than 25 years in period t, $Post2012$ is a binary indicator of whether the observation is drawn after February 2012, when the lower youth minimum has been in place, $\boldsymbol{X_{it}}$ is a vector of individual characteristics in period t, γ_i denotes time-invariant individual characteristics, δ_t stands for time effects, and ϵ_{it} is an error term. In this case, the effect of the treatment is captured by α_2, whereas the inclusion of term $Agea25_{it}$ aims to control for any systematic differences in the outcomes of

[13] Ideally one would like to adjust for differential trends using a recent period when no minimum wage is in place. This, however, is not possible, in our case, as minimum wages in Greece have been continuously in place since 1938 (Kanellopoulos, 2015).

those 25 or younger and those older than 25 in the absence of the treatment. Equation (3) is estimated using a fixed effects panel data estimator.

This approach aims to identify the effect of an increase in the minimum wage on individual outcomes using the change in the level of the effective minimum wage over time among individuals who cross the 25 years old threshold. The key identifying assumption is that the relationship between the outcome and factors other than the minimum wage that may change sharply around the 25 years old cut off has not shifted after 2012. This is likely to hold, as no other legislation in Greece influencing labour market outcomes changes sharply around this threshold[14] and none of the labour market reforms introduced after February 2012 determined differential provisions around the 25 years old cut off (Yannelis, 2012). Nevertheless, we also include a quadratic in age, also interacted with the indicator of whether the observation is drawn after February 2012, in the vector of controls, $\boldsymbol{X_{it}}$, to account for the fact that the outcome, e.g., individual wages, may change nonlinearly with age, and that this relationship may have shifted after February 2012. As above, the impact of the minimum wage on the probability of employment could be estimated by replacing W_{it} with $\Pr[E_{it+1} = 1 | E_{it} = 1]$.

Replacing individual with firm level outcomes and characteristics as well as $Agea25_{it}$ with the share of employees who are under 25 years in (3) and estimating the resulting equation using a fixed effects panel data estimator allows one to estimate the impact of the minimum wage on firms. A key concern, however, in this case, is that the share of those under 25 at the firm is endogenous, either due to measurement error or because it is expected to respond to transitory shocks affecting firm outcomes, such as wages. In order to address this, we estimate equation (3) for firm level outcomes using Instrumental Variables (IV) employing as instruments for the share of those under 25 at the firm the number of employees who were previously employed at the firm and cross the 25 years old threshold at any given point in time, expressed as a share of firm's total employment.[15] The latter is expected to be negatively correlated with the share of those below 25 years old and it is expected to be a valid instrument provided that it is plausibly exogenous and unanticipated by the employer. This hinges on the assumption that employers, particularly in larger firms, are unlikely to know their employees' birthdays. We provide a test of this assumption in the following section by looking at whether employers respond in anticipation of the fact that some of their employees may cross the 25 years old threshold at some future period and thus become eligible for a higher minimum wage.

[14] But even if there has been, this would be captured by $Agea25a_{it}$ in (3).

[15] This is based on the number of employees crossing the age threshold for whom there is individual age information in the data. Therefore, this is likely to underestimate the actual share of all those at the firm at any given period crossing the age threshold.

4. Results

3a. May 2009 and July 2011 Increase in the Minimum Wage

Tables 3 and 4 present differential trend adjusted DID estimates of the impact of the May 2009 and July 2011 increase in the minimum wage on individual and firm outcomes respectively. In particular, Table 3 includes results of the impact of the minimum wage increase on individual wages and the probability that the individual remains in the EFKA data that is interpreted, in our case, as remaining employed in the private sector, conditional on being employed in the private sector in the period before the minimum wage increase.

Results in Table 3 suggest a positive, but insignificant effect of the 2009 increase on individual wages in the full sample. This effect is larger in magnitude and significant for directly affected employees (those paid below the new minimum wage) and suggest that those with 1 percent lower initial wages relative to the average experienced a 0.092 percent higher wage growth as a result of the increase. There are also significant positive spill-over effects on the wages of those paid above the new minimum wage and below the median wage in March 2009, but no effects on the wages of employees paid above the median wage.

There is also some evidence that, among those directly affected, the probability of remaining in the private sector is significantly lower as a result of the 2009 minimum wage in employees whose wages had to increase by more to comply with the new minimum wage. In particular, estimates suggest that, as a result of the minimum wage increase, among those paid initially below the new minimum wage, those paid an initial wage that was relatively lower by 1 percent than the average had a 0.093 percent lower probability of remaining employed in the private sector compared to those paid initially a wage equal to the new minimum wage. There are no significant effects of the minimum wage increase, however, on the individual conditional probability of remaining employed in the private sector after the increase among employees who have experienced significant positive wage spill-overs as a result of the minimum wage increase. Results in Table 4, however, that presents effects of the 2009 minimum wage increase on firm level outcomes are not in line with effects on individual outcomes. In particular, estimates in Table 4 suggest no significant effects of the 2009 increase on firm average log wage and log number of employees. The former result could be explained by the fact that, in our case, the average firm wage measure is imprecise, as it is based on wage information of only a share of employees at the firm.

As far as the 2011 minimum wage increase is concerned, results in Table 3 show a weakly significant and positive effect on individual wages in the full sample of private sector employees, but no significant effects on the different sub-samples. There is some indication, however, that effects on individual wages, are larger in magnitude among directly affected employees. There is also a significant reduction in the probability that an individual paid above the 2011 minimum wage in June 2011 and below the level of the median wage in March 2011, before the increase becomes effective, remains employed in the private sector. On the other hand, as was the case for the 2009 policy change, results in Table 4 indicate no significant effects on firm wages and employment

from the 2011 increase in the minimum wage. These results could be partially explained by the fact that the 2011 increase was relatively small (1.6%) compared to previous years, such as that in 2009. Consistent with evidence presented in the previous section, the 'bite' of the minimum wage relative to the median wage remained unchanged during this period, and this is why it may be difficult to detect any effect on individual and firm outcomes.

Table 3: Differential Trend Adjusted Difference-in-Differences Estimates of the Impact of the May 2009 and July 2011 Increases in the Minimum Wage on Individual Employee Outcomes

	All	Paid below the New Minimum Wage in the Initial Period	Paid above the New Minimum Wage and below the Median Wage in the Initial Period	Paid above the Median Wage in the Initial Period
		Mar 2009-Jun 2009		
		Individual Log Monthly Wage		
Gap	0.005	0.092***	0.058***	0.006
	(0.005)	(0.028)	(0.021)	(0.007)
Observations	50,854	7,461	14,232	27,085
		Conditional Individual Probability of Remaining in the Private Sector		
Gap	-0.002	-0.093***	0.029	-0.007
	(0.005)	(0.019)	(0.020)	(0.006)
Observations	56,150	9,899	15,742	28,293
		Jun 2011-Sep 2011		
		Individual Log Monthly Wage		
Gap	0.010*	0.042	-0.039	0.009
	(0.005)	(0.027)	(0.024)	(0.008)
Observations	51,623	8,749	14,773	28,101
		Conditional Individual Probability of Remaining in the Private Sector		
Gap	0.0001	0.004	-0.047**	0.002
	(0.005)	(0.020)	(0.021)	(0.006)
Observations	56,492	11,157	16,136	29,199

Notes: Robust standard errors in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%. The Gap variable is the difference between the log minimum wage for those not married and with up to 3 years of working experience in the final period and the mean log wage of the individual employee based on all wages available for this employee between 2009 and 2017. In all specifications the sample is restricted to employees in the private sector. All specifications include controls for full-time vs part-time employment, employer's industry (1 digit) and region, and employees' occupation (1 digit), all measured in the initial period, but coefficients estimates are not reported. Differential trend adjusted Difference-in-Differences estimates are produced by pooling observations before and after the minimum wage increase and before and after the same period in the most recent year at which the minimum wage did not change. The latter include the period between March and June 2010 and between June and September 2010 for the 2009 and 2011 minimum wage increase respectively.

Overall, our results on the impact of minimum wage increases in 2009 and 2011 seem to show some significant positive effects on wages of low-wage workers, but no systematic effect on employment at both the individual and firm level. We also investigated whether employment adjustments to wage increases arising from the minimum wage may have taken more time to materialise by looking at longer-run impacts through the end of the year the minimum changed, but we fail to find either significantly larger wage increases or significant employment effects (these results are available from the authors upon request). Finally, results from all estimated

specifications are consistent with differential trends in wages and employment in low- and high-wage individuals and firms (not reported here), supporting our choice of the differential trend adjusted DID estimator as our preferred estimator.

Table 4: Differential Trend Adjusted Difference-in-Differences Estimates of the Impact of the May 2009 and July 2011 Increases in the Minimum Wage on Firm Level Outcomes

	All	Low-Wage (average wage in the initial period below median)	High-Wage (average wage in the initial period above median)
		Mar 2009-Jun 2009	
		Average Log Monthly Wage	
Gap	0.005	0.026	0.006
	(0.008)	(0.018)	(0.014)
Observations	29,185	11,376	17,809
		Log Number of Employees	
Gap	-0.003	-0.001	0.008
	(0.007)	(0.016)	(0.011)
Observations	29,669	11,693	17,976
		Jun 2011-Sep 2011	
		Average Log Monthly Wage	
Gap	0.003	0.002	0.013
	(0.008)	(0.019)	(0.013)
Observations	29,800	11,301	18,499
		Log Number of Employees	
Gap	0.008	0.019	-0.006
	(0.006)	(0.012)	(0.008)
Observations	30,204	13,380	16,824

Notes: Robust standard errors in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%. The Gap variable is the difference between the log minimum wage for those not married with up to 3 years of working experience in the final period and the mean log average firm wage calculated using the wages of all employees in the firm between 2009 and 2017. In all specifications the sample is restricted to firms in the private sector. All specifications include controls for the share of full-time, the share of employees under 25, and the share of female employees at the firm, industry (1 digit), and region, all measured in the initial period, but coefficients estimates are not reported. Differential trend adjusted Difference-in-Differences estimates are produced by pooling observations before and after the minimum wage increase and before and after the same period in the most recent year at which the minimum wage did not change. The latter include the period between March and June 2010 and between June and September 2010 for the 2009 and 2011 minimum wage increase respectively.

3b. February 2012 Reduction in the Minimum Wage and Introduction of a Youth Sub-Minimum

Estimation results of the effect of the 2012 minimum wage reduction on individual and firm level outcomes are presented in Tables 5 to 10. Table 5 presents differential trend adjusted DID estimation of equation (1) measuring the impact of the minimum wage reduction on individual wages in the short-run (March 2012) and the longer run (through to December 2012). This is done to account for the possibility that, in contrast to minimum wage increases, where employers are obliged by law to increase wages of those directly affected immediately after the increase becomes effective, in the case of a minimum wage reduction, employers may choose not to decrease wages at all or to decrease them at a later point.

Results presented in Table 5 suggest that there were significant reductions of wages of private sector employees as a result of the February 2012 minimum wage decrease and that these were larger among low-wage individuals, i.e., individuals with wages nearer to the level of the (adult) minimum wage in February 2012. However, as is clear in the results, the reduction in paid wages was not instantaneous and manifested with some hysteresis: between December 2011 and December 2012, i.e., 10 months after the policy change, the decline in individual wages was 8 times larger than that estimated immediately after the policy change (March 2012) and almost 1.5 times larger than that estimated for the period to September 2012.

Table 5: Differential Trend Adjusted Difference-in-Differences Estimates of the Impact of the February 2012 Decrease in the Minimum Wage on Individual Log Wage (Impact Measure-Gap)

	All	Paid the Old Minimum Wage or less in the Initial Period	Paid above the Old Minimum Wage and below Median Wage in the Initial Period	Paid above the Median Wage in the Initial Period
		Dec 2011-Mar 2012		
Gap	-0.008*	0.032	-0.074***	-0.019**
	(0.004)	(0.023)	(0.022)	(0.008)
Observations	45,535	8,191	12,958	24,386
		Dec 2011-Jun 2012		
Gap	-0.024***	0.064**	-0.092***	-0.061***
	(0.006)	(0.032)	(0.029)	(0.008)
Observations	41,592	6,565	11,724	23,303
		Dec 2011-Sep 2012		
Gap	-0.042***	0.114***	-0.215***	-0.083***
	(0.006)	(0.034)	(0.031)	(0.009)
Observations	38,867	5,644	10,818	22,405
		Dec 2011-Dec 2012		
Gap	-0.064***	0.020	-0.328***	-0.110***
	(0.007)	(0.039)	(0.032)	(0.010)
Observations	36,511	5,020	9,974	21,517

Notes: Robust standard errors in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%.

The Gap variable is the difference between the log minimum wage for those above 25 years old in the final period and the mean log wage of the individual employee based on all wage observations available for this employee between 2009 and 2017. In all specifications the sample is restricted to employees in the private sector. All specifications include controls for full-time vs part-time employment, employer's industry (1 digit) and region, and employees' occupation (1 digit), all measured in the initial period, but coefficients estimates are not reported. Differential trend adjusted Difference-in-Differences estimates are produced by pooling observations before and after before and after the 2012 reduction in the Minimum wage and before and after the same period one year before the change in policy occurred.

Estimates in Table 5 also indicate a significant effect of the minimum wage reduction on wages of higher-wage employees, i.e., those paid above the old level of the minimum wage that also becomes larger in magnitude over time. This effect reduces in magnitude as we move up the individual wage distribution in the private sector. In particular, results suggest that, among employees paid initially between the old minimum wage and the median wage, those with 1 percent lower wages relative to the average had, on average, a 0.074 percent higher wage reduction between December 2011 and March 2012 and a

0.328 percent higher wage reduction between December 2011 and December 2012. The same figures were 0.02 and 0.11 percent respectively among those paid above the median wage before the reform. We also find that, in the case of those paid the old minimum wage or below before the reduction,[16] the relationship between the gap and change in wages is insignificant or positive and significant, suggesting either similar reductions among relatively high- and low-paid employees in this range, or that there were higher reductions among those with wages nearer to the old MW before the minimum wage reduction becomes effective.

Table 6 presents results of the impact of the minimum wage reduction on individual wages using as a treatment indicator whether the individual is younger or older than 25 years. This aims to identify whether the differential reduction in the minimum wage for youths and adults resulted in significant differential wage reductions between the two groups.

Table 6: Differential Trend Adjusted Difference-in-Differences Estimates of the Impact of the February 2012 Decrease in the Minimum Wage on Individual Log Wage (Impact Measure-25 Years Old or Younger)

	All	Paid the Old Minimum Wage or less in the Initial Period	Paid above the Old Minimum Wage and below Median Wage in the Initial Period	Paid above the Median Wage in the Initial Period
		Dec 2011-Mar 2012		
25 years old or younger	-0.017	-0.039*	-0.003	0.010
	(0.012)	(0.022)	(0.014)	(0.036)
Observations	45,469	8,170	12,943	24,356
		Dec 2011-Jun 2012		
25 years old or younger	-0.015	-0.015	-0.007	-0.018
	(0.015)	(0.031)	(0.016)	(0.033)
Observations	41,529	6,543	11,711	23,275
		Dec 2011-Sep 2012		
25 years old or younger	-0.033*	-0.024	-0.035*	-0.019
	(0.018)	(0.035)	(0.021)	(0.046)
Observations	38,810	5,627	10,805	22,378
		Dec 2011-Dec 2012		
25 years old or younger	-0.055***	-0.092**	-0.032	0.042
	(0.019)	(0.038)	(0.021)	(0.069)
Observations	36,454	5,004	9,962	21,488

Notes: Robust standard errors in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%.

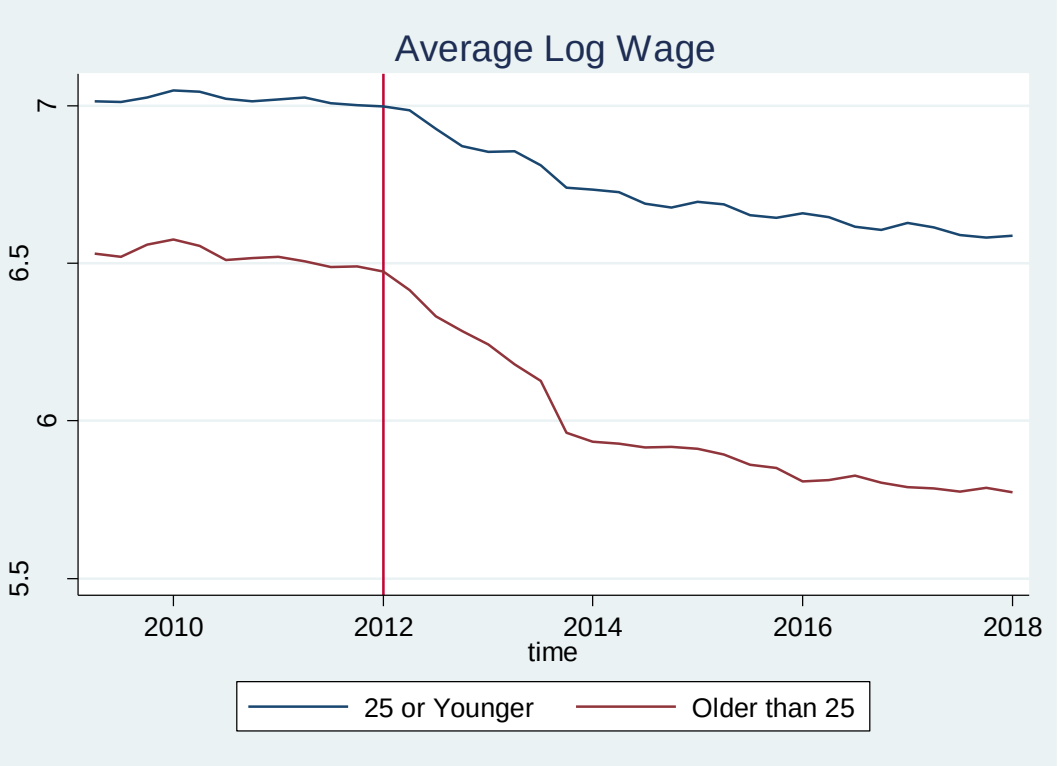
In all specifications the sample is restricted to employees in the private sector. All specifications include controls for full-time vs part-time employment, employer's industry (1 digit) and region, and employees' occupation (1 digit), all measured in the initial period, but coefficients estimates are not reported. Differential trend adjusted Difference-in-Differences estimates are produced by pooling observations before and after before and after the 2012 reduction in the Minimum wage and before and after the same period one year before the change in policy occurred.

[16] Wages below the old minimum wage may be explained by part-time employment, or by the fact that some full-time employees started work or leave the firm at some point during the month, or by non-compliance.

Figure 1 aims to provide a test of the common trends assumption in this case, by plotting average log wages of the treatment and control group between 2009 and 2017 using the EFKA data. The patterns in the figure suggest that the assumption of parallel trends is likely to be violated in this case. This provides further support to the choice of differential trend adjusted DID estimator implemented through OLS estimation of equation (1) as our preferred estimator.

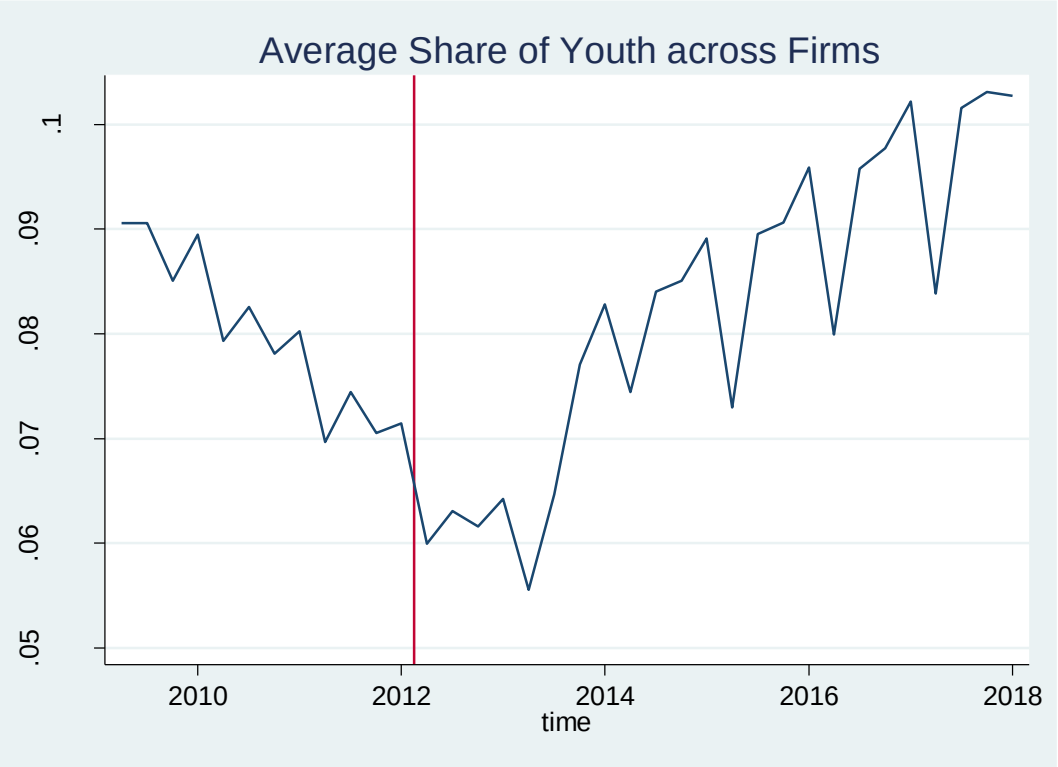
Results in Table 6 show that significant larger reductions in the wages of youth compared to those of adults, as a result of the differential reduction in the minimum wage for the two groups, materialised in the longer run, and are significant only among low-wage employees. In particular, estimates suggest that among employees paid initially at or below the old minimum wage, those 25 years old or younger experienced, on average, 9.2 percent higher wage reductions compared to older than 25 years between December 2011 and December 2012. These results suggest that the utilisation of the youth subminimum by employers became more prevalent over-time, but it did not lead to differential wage reductions between youths and adults among higher-wage employees.

Figure 1: Log Average Monthly Wage of Employees under 25 and 25 and Older, 2009-2017



Source: EFKA, 2009-2017, employees in the private sector.

Figure 2: The Average Share of Employees under 25 Years Old at the Firm, 2009-2017



Source: EFKA, 2009-2017, firms in the private sector.

Tables 7 and 8 present OLS estimation results of equation (1) measuring the impact of the minimum wage reduction and introduction of a lower minimum wage for youth on the firm level average log wage. Results in Table 7 reveal a similar pattern to those in Table 5 of the effects on individual wages. In particular, estimates suggest that there were significant reductions in firm level average wages in the private sector realised also among high-wage private sector employers, i.e., those with average log wage above the median, with higher reductions, in this group, among relatively lower-wage firms. Again, consistent with the results at the individual level, our results suggest that among low-wage firms, i.e., those with a log average wage below the median, reductions resulting from the decrease in the minimum wage did not differ across employers with different initial average wages.

Moreover, Table 8 suggests that there were no significantly different changes in wages among firms with different shares of employees who are under 25 years old. Nevertheless, the magnitude of these effects becomes larger in the longer-run that is in line with the pattern identified in the case of individual wages suggesting that employers are more likely to utilise the lower minimum wage for youth over time. In contrast, we find no support for the pattern that this was more likely among lower-wage employers. As discussed in the previous section, adjustments of the share of youth at the firm in anticipation of the larger reduction in the minimum wage for this age group would invalidate the differential trend adjusted DID estimator using the share of youth prior to the minimum wage reduction as a measure of the 'bite' of the minimum wage at the firm. Evidence whether this was the case is provided in Figure 2 that plots the average

share of those under 25 years old or younger at the firm between 2009 and 2017. The figure shows that the share of under 25, despite some seasonal variation, was systematically decreasing through to just after 2012, remained relatively stable from March 2012 to March 2013, when it fell slightly, and started increasing noticeably after this time and through to the end of 2017. This evidence does not support that employers may substitute youth for adult employees in anticipation of the introduction of a lower minimum wage for youth in February 2012.

Table 7: Differential Trend Adjusted Difference-in-Differences Estimates of the Impact of the February 2012 Minimum Wage Decrease on Firm Average Log Monthly Wages (Impact Measure-Gap)

	All	Low-Wage (below median in Dec 2011)	High-Wage (above median in Dec 2011)
		Dec 2011-Mar 2012	
Gap	-0.004	0.001	-0.033**
	(0.007)	(0.013)	(0.013)
Observations	25,975	11,734	14,241
		Dec 2011-Jun 2012	
Gap	-0.018**	0.013	-0.093***
	(0.009)	(0.019)	(0.015)
Observations	28,899	12,250	16,649
		Dec 2011-Sep 2012	
Gap	-0.029***	0.024	-0.138***
	(0.010)	(0.023)	(0.018)
Observations	21,072	8,447	12,625
		Dec 2011-Dec 2012	
Gap	-0.054***	-0.013	-0.182***
	(0.010)	(0.024)	(0.016)
Observations	19,487	7,596	11,891

Notes: Robust standard errors in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%. The Gap variable is the difference between the log minimum wage for those older than 25 years after in the final period and the mean log average firm wage calculated using the wages of all employees in the firm between 2009 and 2017. In all specifications the sample is restricted to firms in the private sector. All specifications include controls for the share of full-time, the share of employees under 25, and the share of female employees at the firm, industry (1 digit), and region, all measured in the initial period, but coefficients estimates are not reported. Differential trend adjusted Difference-in-Differences estimates are produced by pooling observations before and after before and after the 2012 reduction in the Minimum wage and before and after the same period one year before the change in policy occurred.

Tables 9 and 10 present results of the employment effects of the minimum wage reduction at the firm level.[17] Estimates in this case do not indicate a systematic relationship between firm employment and the minimum wage. In particular, there is no evidence that there were either significantly higher employment gains or losses in periods and among employers for whom wage reductions were the largest. The same holds for firms with relatively higher shares of youth in employment for which the 'effective' minimum wage after 2012 is lower. In Table 9, however, there is some

[17] Note that, for the reasons discussed in the previous sub-section, we refrain from estimating the impact of the minimum wage reduction on the individual conditional probability of remaining employed in the private sector.

indication that employment in the full sample increases in the long-run (between December 2011 and December 2012) among firms with higher share of youth and that this pattern is to the opposite direction of the pattern documented for the changes in wages in Table 8.

Table 8: Differential Trend Adjusted Difference-in-Differences Estimates of the Impact of the February 2012 Minimum Wage Decrease on Firm Average Log Monthly Wages (Impact Measure-Firm Share of Youth)

	All	Low-Wage (below median in Dec 2011)	High-Wage (above median in Dec 2011)
		Dec 2011-Mar 2012	
Share of employees under 25 years in Dec 2011	-0.011	-0.035	0.035
	(0.026)	(0.031)	(0.047)
Observations	25,975	11,734	14,241
		Dec 2011-Jun 2012	
Share of employees under 25 years in Dec 2011	-0.017	-0.034	-0.019
	(0.032)	(0.038)	(0.058)
Observations	22,941	9,611	13,330
		Dec 2011-Sep 2012	
Share of employees under 25 years in Dec 2011	-0.032	-0.032	-0.110
	(0.033)	(0.039)	(0.069)
Observations	21,072	8,447	12,625
		Dec 2011-Dec 2012	
Share of employees under 25 years in Dec 2011	-0.053	-0.059	-0.073
	(0.044)	(0.053)	(0.076)
Observations	23,760	9,693	14,067

Notes: Robust standard errors in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%. In all specifications the sample is restricted to firms in the private sector. All specifications include controls for the share of full-time and the share of female employees at the firm, industry (1 digit), and region, all measured in the initial period, but coefficients estimates are not reported. Differential trend adjusted Difference-in-Differences estimates are produced by pooling observations before and after before and after the 2012 reduction in the Minimum wage and before and after the same period one year before the change in policy occurred.

Tables 11 and 12 present fixed effects (FE) estimation results of equation (3) for individual and firm level outcomes respectively. Results presented in Table 11 are consistent with significantly higher wages among youth who cross the 25 years old threshold and become eligible for the (higher) adult minimum wage. In particular, estimates suggest that young employees who became 25 years old after 2012, had, on average, 5.4 percent higher wages compared than those younger than 25. Results are also consistent with significant effects among youth who are directly affected, i.e., those paid below the adult minimum wage, but also significant wage spill-overs extending to those with wages above the level of the median wage in December 2011.[18]

[18] We also extended the model to account for lead and lag effects of becoming eligible for the adult minimum wage among youth employees on wages in order to check whether wage increases take time to take effect and/or whether employers may provide increases in anticipation of this change in eligibility

Table 9: Differential Trend Adjusted Difference-in-Differences Estimates of the Impact of the February 2012 Minimum Wage Decrease on Firm Log Number of Employees (Impact Measure-Gap)

	All	Low-Wage (below median in Dec 2011)	High-Wage (above median in Dec 2011)
		Dec 2011-Mar 2012	
Gap	-0.009	0.001	0.011
	(0.007)	(0.012)	(0.015)
Observations	26,325	11,982	14,343
		Dec 2011-Jun 2012	
Gap	-0.001	0.012	0.002
	(0.010)	(0.019)	(0.016)
Observations	23,335	9,887	13,448
		Dec 2011-Sep 2012	
Gap	0.015	0.044**	0.012
	(0.011)	(0.022)	(0.017)
Observations	21,415	8,662	12,753
		Dec 2011-Dec 2012	
Gap	0.015	0.038*	0.012
	(0.010)	(0.020)	(0.016)
Observations	20,691	8,252	12,439

Notes: Robust standard errors in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%. The Gap variable is the difference between the log minimum wage for those older than 25 years after in the final period and the mean log average firm wage calculated using the wages of all employees in the firm between 2009 and 2017. In all specifications the sample is restricted to firms in the private sector. All specifications include controls for the share of full-time, the share of employees under 25, and the share of female employees at the firm, industry (1 digit), and region, all measured in the initial period, but coefficients estimates are not reported. Differential trend adjusted Difference-in-Differences estimates are produced by pooling observations before and after before and after the 2012 reduction in the Minimum wage and before and after the same period one year before the change in policy occurred.

Results of the effect of crossing the 25 years old threshold on the individual conditional probability of remaining employed in the private sector, show a significant and negative effect in the full sample, and negative, but insignificant effects in the different sub-samples of low- and high-wage employees. This may provide an indication that the youth subminimum introduction have promoted youth employment opportunities.[19]

Turning to the effects at the firm level presented in Table 12, fixed effects estimates suggest that a higher share of youth at the firm after February 2012 is associated with significantly lower firm average wages and significantly higher firm-level employment, as measured by the log number of employees. These effects, however, do not survive

(see Table A.3 in the Appendix for details). Results of the extended model suggest that wage increases are contemporaneous to the change in eligibility, but for higher-wage individuals take effect, on average, a year after these individuals cross the 25 years old threshold. A speculation here could be that these effects may suggest time consuming negotiations regarding a pay rise between these employees and their employers. We also find no systematic evidence that wages adjusted in anticipation of the change in eligibility.

[19] Extending the model to account for gradual adjustments or anticipation effects in the probability of remaining employed in the private sector produce insignificant estimated coefficients of contemporaneous, as well as lead and lag terms (see Table A.4 in the Appendix for details).

when we control for the possible endogeneity of the share of youth employment at the firm. In the fixed effects instrumental variables (FEIV) model, the relationship between the effective minimum wage at the firm (as measured by the share of youth in firm employment) and firm average wage after February 2012 remains negative but is now insignificant.[20] Moreover, FEIV estimates of the relationship between the share of youth at the firm and firm employment are now negative and significant suggesting that firms with 1 percent higher share of employees under age 25 than the average had 1.2 percent lower employment after 2012, as a result of a lower effective minimum wage.

Table 10: Differential Trend Adjusted Difference-in-Differences Estimates of the Impact of the February 2012 Minimum Wage Decrease on Firm Log Number of Employees (Impact Measure-Firm Share of Youth)

	All	Low-Wage (below median in Dec 2011)	High-Wage (above median in Dec 2011)
		Dec 2011-Mar 2012	
Share of employees under 25 years in Dec 2011	-0.011	0.033	-0.149
	(0.031)	(0.031)	(0.093)
Observations	26,325	11,982	14,343
		Dec 2011-Jun 2012	
Share of employees under 25 years in Dec 2011	0.009	0.052	-0.152*
	(0.035)	(0.039)	(0.085)
Observations	23,335	9,887	13,448
		Dec 2011-Sep 2012	
Share of employees under 25 years in Dec 2011	0.022	0.026	-0.012
	(0.041)	(0.045)	(0.091)
Observations	21,415	8,662	12,753
		Dec 2011-Dec 2012	
Share of employees under 25 years in Dec 2011	0.058	0.062	0.037
	(0.037)	(0.043)	(0.078)
Observations	20,691	8,252	12,439

Notes: Robust standard errors in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%. In all specifications the sample is restricted to firms in the private sector. All specifications include controls for the share of full-time and the share of female employees at the firm, industry (1 digit), and region, all measured in the initial period, but coefficients estimates are not reported. Differential trend adjusted Difference-in-Differences estimates are produced by pooling observations before and after before and after the 2012 reduction in the Minimum wage and before and after the same period one year before the change in policy occurred.

A comparison of FEIV and FE estimates suggest a large positive bias in the FE estimates that could imply that in the face of positive shocks to firm wages and employment the share of youth employees expands. The fourth and seventh column of Table 12 present FE estimation of the reduced form specification that estimates the relationship between

[20] Given the large magnitude of the FEIV estimated coefficient of the interaction of the share of youth at the firm and the indicator of whether the observation is drawn after 2012, it is likely that the lack of significance of the FEIV estimates is due to the large standard errors arising from the inefficiency of IV. This is despite the fact that the instruments strongly predict the endogenous variables, as indicated by a Kleibergen-Paap F-statistic of 50.

firm wages and employment and the instrument. Results, albeit insignificant, are consistent with higher average wages and lower employment in firms in which a higher share of employees turns 25 at any given period and for which the effective minimum wage is higher. On the whole, this is consistent with monopsony and related search models, in which, there is a range of wages in which employment is supply-determined, and thus higher wages allow firms to expand employment (Manning, 2003). Alternatively, this could also reconcile with efficiency wage models consistent with a wage-monitoring trade-off, where lower wages lead to increase in shirking and thus monitoring intensity should be increased, through reducing the size of workforce, to deter shirking (Georgiadis, 2013).

Table 11: Fixed Effects (FE) Estimates of the Effect of the Minimum Wage on Individual Outcomes, 2009-2017

	All	Wages at or below the Adult Minimum Wage after Feb 2012	Wages above the Adult Minimum Wage after Feb 2012 and below the Median Wage in Dec 2011	Wages above the Median Wage in Dec 2011
			Log Monthly Wage	
Older than 25 x	0.054***	0.039**	0.015***	0.063***
after Feb 2012	(0.009)	(0.018)	(0.004)	(0.010)
Older than 25	-0.007	-0.004	0.001	-0.025***
	(0.007)	(0.016)	(0.004)	(0.007)
Observations	938,434	236,058	330,559	371,817
			Conditional Individual Probability of Remaining in the Private Sector	
Older than 25 x	-0.022***	-0.010	-0.009	-0.019
after Feb 2012	(0.005)	(0.013)	(0.006)	(0.013)
Older than 25	0.027***	0.006	0.014***	-0.011*
	(0.004)	(0.012)	(0.005)	(0.007)
Observations	911,673	225,882	321,021	364,770

Notes: Standard errors clustered at the individual level in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%. In all specifications the sample is restricted to employees in the private sector. All specifications include a list of controls, but coefficients estimates for these are not reported. Controls in the specifications of log monthly wages include year/month dummies, a quadratic in age, employer's industry (1 digit) and region, and employee's occupation (1 digit), all measured contemporaneously to individual wages and interactions of all controls with whether the observation was drawn after 2012. Controls in the specifications of individual probability of remaining in the private sector are the same as those in the specifications for monthly wages, but controls for employer's industry (1 digit) and region, and employee's occupation (1 digit), are measured in the previous period (3 months).

As discussed in the previous section, the validity of the instruments hinges on the assumption that the share of employees turning 25 at any given period is exogenous and unanticipated by employers. In order to investigate this further, we also extended the reduced form model presented in Table 12 to include leads and lags of the key causing variable of interest.[21] Results of FE estimation indicate only a significant effect of the

[21] We only present estimation results of the reduced form mainly because, due to the endogeneity of the share of those under 25 at the firm, FE estimates of the structural equation are not expected to be valid. We also estimated the extended model with FEIV, but this did not produce valid results due to weak instruments potentially arising from the large number of endogenous variables (Shea, 1997).

lagged two periods measure of the share of those under 25 at the firm (see Table A.5 in the Appendix for details).[22]

Table 12: Fixed Effects (FE) and Fixed Effects Instrumental Variables (FEIV) Estimates of the Effect of Minimum Wage on Firm-Level Outcomes, 2009-2017

	Average Log Monthly Wage			Log Number of Employees		
	FE	FEIV	FE	FE	FEIV	FE
Share of employees under 25 x after Feb 2012	-0.121***	-0.613		0.496***	-1.221**	
	(0.017)	(0.393)		(0.025)	(0.482)	
Share of employees under 25	0.002	0.250		0.206***	1.321***	
	(0.013)	(0.190)		(0.022)	(0.239)	
Share of employees turning 25 x after Feb 2012			0.042			-0.023
			(0.029)			(0.028)
Share of employees turning 25			-0.026			-0.125***
			(0.019)			(0.021)
Kleibergen-Paap rk Wald F statistic		50.74			50.74	
Observations	572,380	572,380	572,380	572,380	572,380	572,380

Notes: Standard errors clustered at the firm level in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%. In all specifications the sample is restricted to firms in the private sector. All specifications include controls for time (year/month dummies), the share of share of full-time and the share of female employees at the firm, industry (1 digit), and region, and interactions of all controls with an indicator of whether the observation is drawn after 2012, but coefficients estimates are not reported. Instrumental variables estimation employs as instruments for the share of employees under 25 years in each period and its interaction with whether the observation is drawn after 2012, the share of employees at the firm turning 25 years in each period and its interaction with whether the observation is drawn after 2012.

Overall, our results of the impact of the change in minimum wage legislation in February 2012 support a positive and significant relationship between minimum wages and individual and firm-level wages, but no systematic relationship between the level of the minimum wage and employment. The latter is consistent with some of the recent evidence from Greece of no systematic and robust effect of the differential reduction of minimum wage for employees below and above 25 in February 2012 on the employment opportunities of youth just below and above this threshold (Karakitsios, 2015; Kakoulidou et al., 2018).

Closing, we should mention two possible limitations of our analysis, concerning possible employment adjustments that we cannot examine due to the nature of our data. First,

[22] This is also supported by the results in the Appendix that there is no anticipation effect of crossing the 25 years old threshold on individuals wages and the conditional probability of remaining employed in the private sector.

we were not able to investigate here the impact of minimum wages on hours in any of the periods we examine. Given that dismissals are costly[23], this could be an important margin of adjustment to changes in the minimum wage. Second, we were also not able to investigate whether there were employment effects resulting from exit or entry of firms in the long-run emanating from changes in the minimum wage. Indeed, using a different data source, Yannelis (2014) finds lower relative employment as a result of this change among youth just older than 25 years, realised entirely through a lower relative share among new hires in the first two years after the reform. We consider these two channels as possible avenues for future research.

5. Conclusion

The employment effect of minimum wages has been and remains a deeply controversial topic in the economics literature. The debate is mostly based on evidence from the USA and there is relatively less evidence from other contexts. Moreover, more recent studies seem to produce divergent results. A potential explanation of this, which has not been systematically investigated, is that the magnitude of the employment effects of minimum wages may vary with a range of factors. For example, a negative employment effect of minimum wages may be more likely to be detected in a context where the initial level of the minimum wage is relatively high, the magnitude of the change in the minimum wage is large, the level of aggregate economic activity is low, and labour market regulation is weak.

This paper addresses this gap in the literature by looking at the impact of minimum wage on wages and employment in Greece during the period between 2009 and 2017. During this period, Greece experienced an unprecedented recession and a dramatic deregulation of labour market institutions, as well as various changes in the minimum wage, including two increases, one reduction, and an introduction of a youth minimum wage enacted at different points of the recession and through different mechanisms.

Using a unique administrative panel matched employer-employee dataset and employing a range of estimators, such as difference-in-differences, fixed effects, and Instrumental Variables, we find that minimum wages have a positive and significant effect on individual and firm-level wages with significant positive wage spill-overs extending, sometimes, above the median wage, but no systematic employment effects. This is consistent with a number of empirical studies and reconciles with predictions of models of imperfect competition in the labour market.

[23] Dismissals, however, became must less costly, after the introduction of Greece in the structural adjustment program, as a result of a number of reforms related to employment protection.

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Appendix

Table A.1: Occupation, Industry, and Region Composition of Employees in the EFKA Data, 2009-2017

Occupation		Industry		Region	
Managers	0.68	Agriculture, hunting, forestry, and fishing	0.40	Attiki	60.60
Professionals	0.35	Mining, energy, and water	1.67	North Aegean	0.86
Technicians and associate professionals	8.05	Manufacturing	17.29	South Aegean	3.03
Clerical support workers	28.23	Construction	3.04	Crete	4.71
Services and sales workers	20.16	Whole and retail trade, hotels, and restaurants	37.60	East Macedonia and Thrace	2.78
Skilled agricultural, forestry, and fishing	0.36	Transport, storage, and communication	7.79	Central Macedonia	13.14
Craft and related trades	7.22	Banking, Finance, and Insurance	15.06	West Macedonia	1.19
Plant and machine operators	8.99	Public administration, education, and health	7.53	Epirus	1.55
Elementary occupations	14.88	Other services	5.46	Thessaly	3.20
Armed forces	0	No information	4.17	Ionian Islands	1.38
No information	5.19			Western Greece	2.67
				Central Greece	2.31
				Peloponnese	2.57
				No information	0
Number of observations	1,043,127	Number of observations	1,043,127	Number of observations	1,043,127

Notes: Figures are percentages. The sample is restricted to employees in the private sector.

Table A.2: Industry, and Region Composition of Firms in the EFKA Data, 2009-2017

Industry		Region	
Agriculture, hunting, forestry, and fishing	0.47	Attiki	49.36
Mining, energy, and water	0.67	North Aegean	1.25
Manufacturing	15.55	South Aegean	4.32
Construction	3.51	Crete	6.06
Whole and retail trade, hotels, and restaurants	43.18	East Macedonia and Thrace	3.62
Transport, storage, and communication	6.17	Central Macedonia	15.21
Banking, Finance, and Insurance	10.25	West Macedonia	1.55
Public administration, education, and health	8.60	Epirus	1.95
Other services	6.89	Thessaly	4.42
No information	4.7	Ionian Islands	2.17
		Western Greece	3.73
		Central Greece	3.00
		Peloponnese	3.27
		No information	0
Number of observations	698,001	Number of observations	698,001

Notes: Figures are percentages. The sample is restricted to firms in the private sector.

Table A.3: Fixed Effects (FE) Estimates of the Effect of the Minimum Wage on Individual Log Monthly Wage, 2009-2017

	All	Wages at or below the Adult Minimum Wage after Feb 2012	Wages above the Adult Minimum Wage after Feb 2012 and below the Median Wage in Dec 2011	Wages above the Median Wage in Dec 2011
Older than 25 x	0.039***	0.059	0.001	0.002
after Feb 2012	(0.014)	(0.056)	(0.007)	(0.012)
Older than 25 x	-0.022	-0.074	0.003	-0.012
after Feb 2012	(0.013)	(0.048)	(0.007)	(0.010)
lag 1				
Older than 25 x	0.002	-0.003	0.005	0.020
after Feb 2012	(0.013)	(0.039)	(0.007)	(0.012)
lead 1				
Older than 25 x	0.006	0.018	-0.005	-0.008
after Feb 2012	(0.012)	(0.030)	(0.006)	(0.010)
lag 2				
Older than 25 x	-0.005	-0.013	-0.006	-0.006
after Feb 2012	(0.015)	(0.035)	(0.007)	(0.025)
lead 2				
Older than 25 x	0.009	0.008	0.006	0.021
after Feb 2012	(0.013)	(0.037)	(0.006)	(0.013)
lag3				
Older than 25 x	-0.019	-0.023	-0.005	0.005
after Feb 2012	(0.017)	(0.035)	(0.008)	(0.025)
lead 3				
Older than 25 x	0.023*	0.032	0.014**	0.034***
after Feb 2012	(0.012)	(0.035)	(0.007)	(0.013)
lag 4				
Older than 25 x	0.019	0.029	-0.004	0.026
after Feb 2012	(0.016)	(0.032)	(0.009)	(0.020)
lead 4				
Observations	434,414	58,730	145,531	230,153

Notes: Standard errors clustered at the individual level in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%. In all specifications the sample is restricted to employees in the private sector. All specifications include a set of controls, but their coefficients are not reported. These include a contemporaneous measure and up to four lags and leads of the indicator for whether the individual is older than 25 years, as well as year/month dummies, a quadratic in age, controls for employer's industry (1 digit) and region, and employee's occupation (1 digit), and interactions of all these with whether the observation was drawn after 2012.

Table A.4: Fixed Effects (FE) Estimates of the Effect of the Minimum Wage on the Individual Conditional Probability of Remaining in the Private Sector, 2009-2017

	All	Wages at or below the Adult Minimum Wage after Feb 2012	Wages above the Adult Minimum Wage after Feb 2012 and below the Median Wage in Dec 2011	Wages above the Median Wage in Dec 2011
Older than 25 x	-0.023	0.006	-0.032*	-0.011
after Feb 2012	(0.016)	(0.041)	(0.019)	(0.040)
Older than 25 x	0.018	-0.023	0.031*	0.000
after Feb 2012	(0.015)	(0.038)	(0.018)	(0.040)
lag 1				
Older than 25 x	0.004	-0.006	0.006	0.004
after Feb 2012	(0.016)	(0.039)	(0.021)	(0.041)
lead 1				
Older than 25 x	-0.011	0.001	-0.005	-0.020
after Feb 2012	(0.015)	(0.036)	(0.018)	(0.035)
lag 2				
Older than 25 x	-0.006	-0.038	0.005	0.069
after Feb 2012	(0.017)	(0.040)	(0.021)	(0.049)
lead 2				
Older than 25 x	-0.011	0.027	-0.012	0.014
after Feb 2012	(0.014)	(0.037)	(0.017)	(0.028)
lag3				
Older than 25 x	0.016	0.023	0.004	-0.055
after Feb 2012	(0.017)	(0.040)	(0.022)	(0.053)
lead 3				
Older than 25 x	-0.006	-0.003	-0.005	-0.034*
after Feb 2012	(0.010)	(0.027)	(0.013)	(0.018)
lag 4				
Older than 25 x	-0.013	0.013	-0.013	-0.016
after Feb 2012	(0.014)	(0.031)	(0.017)	(0.044)
lead 4				
Observations	712,976	173,214	248,044	291,718

Notes: Standard errors clustered at the individual level in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%. In all specifications the sample is restricted to employees in the private sector. All specifications include a set of controls, but their coefficients are not reported. These include a contemporaneous measure and up to four lags and leads of the indicator for whether the individual is older than 25 years, year/month dummies, and a quadratic in age, as well as controls for employer's industry (1 digit) and region, and employee's occupation (1 digit) measured in the previous period (3 months), and interactions of all these with whether the observation was drawn after 2012.

Table A.5: Fixed Effects (FE) Estimates of the Effect of Minimum Wage on Firm-Level Outcomes, 2009-2017

	Average Log Monthly Wage	Log Number of Employees
Share of employees turning 25 x after Feb 2012	0.033	0.021
	(0.041)	(0.052)
Share of employees turning 25 x after Feb 2012 lag 1	0.026	0.083
	(0.040)	(0.052)
Share of employees turning 25 x after Feb 2012 lead 1	0.036	0.033
	(0.041)	(0.059)
Share of employees turning 25 x after Feb 2012 lag 2	0.028	0.136***
	(0.039)	(0.050)
Share of employees turning 25 x after Feb 2012 lead 2	0.023	0.045
	(0.043)	(0.065)
Share of employees turning 25 x after Feb 2012 lag 3	0.044	0.083*
	(0.033)	(0.047)
Share of employees turning 25 x after Feb 2012 lead 3	0.007	0.034
	(0.042)	(0.057)
Share of employees turning 25 x after Feb 2012 lag 4	0.022	0.066*
	(0.034)	(0.040)
Share of employees turning 25 x after Feb 2012 lead 4	0.010	0.111*
	(0.053)	(0.062)
Observations	215,005	215,005

Notes: Standard errors clustered at the firm level in parentheses, ***significant at 1%, **significant at 5%, *significant at 10%. In all specifications the sample is restricted to firms in the private sector. All specifications include a set of controls, but their coefficients are not reported. These include a contemporaneous measure and up to four lags and leads of the share of employees turning 25, year/month dummies, the share of share of full-time and the share of female employees at the firm, controls for industry (1 digit), and region, and interactions of all controls with an indicator of whether the observation is drawn after 2012.

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