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Short-term and long-term employment effects of minimum wage: evidence from Poland

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Short-term and long-term employment effects of minimum wage: evidence from Poland

Maciej Albinowski [#]

Abstract

I use the Polish anonymized tax data for 24 million individuals observed in the period 2004-2016 to analyse the employment effects of minimum wage. In contrast to most studies, the longitudinal dimension of the dataset allows me to control for unobserved characteristics of employees and to assess the long-term effects of minimum wage hikes. I find that minimum wage has a moderate impact on job separations in the long-run, while the short-term effects are negligible. Another important result is that young workers earning around the level of minimum wage have a significantly lower probability of returning to employment after a job loss than their peers from higher part of the income distribution. This effect has been in place since 2008, when there was a substantial increase in the minimum wage.

Keywords: minimum wage, unemployment, social exclusion

JEL: J21, J38, J63

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1. Introduction

Although the employment effect of minimum wage has already been examined in hundreds of analyses, the literature is far from being conclusive. The majority of these studies indicate that an increase in minimum wage reduces employment (see e.g. literature review by Neumark and Wascher 2007), which is consistent with the standard neo-classical model of the labour market. However, Doucouliagos and Stanley (2009) show that after filtering the research record from the publication selection bias,[1] there is no evidence of a meaningful adverse employment effect. Other meta-analyses tend to confirm that the employment effects of moderate increases in minimum wage are not substantial (Belman and Wolfson 2014, Nataraj et al. 2014, Schmitt 2013).

The empirical literature can be divided into two types of analyses: studies that analyse the effects on the employment variables at the aggregated level and microeconometric analyses that track situation of individual persons or firms. Studies of the former type aim to identify the overall impact of the regulation, which comprises the effects on job separations and on jobs creation. However, this strand of literature faces serious methodological challenges. First, the minimum wage may be endogenous with respect to the current and forecasted economic situation in a region or a country. Second, aggregate employment is also driven by factors such as demography, technology, global division of labour, or policies other than minimum wage. Unfortunately, it is often difficult to separate the effects of minimum wage from other factors that determined employment in a region (see e.g. Allegretto et al. 2017).

In contrast, the microeconometric research methodology is closer to that used in experiments, in which one aims at separating the effect of minimum wage from other factors that influence individual probability of being employed. However, such separation is also difficult as the level of wages is not assigned randomly, but may be correlated to some unobserved characteristics of individuals or firms.

The aim of the present paper is to provide new evidence on the employment effects of minimum wage that comes from a large micro dataset, in which every employee (taxpayer) is tracked for many years. An important advantage of this dataset is the possibility of controlling for unobserved characteristics of individuals. Furthermore, this paper contributes to the literature by analysing the long-term effects of minimum wage.

[1] In the research on minimum wage, the publication selection bias is reflected by a tendency to hide results that imply no negative employment effects.

An important criticism of the existing research is that it mostly focuses on the short-term impact of changes in minimum wage, whereas the adjustments of the labour demand may be more pronounced in the long-run, after firms modify their capital-labour ratios (Sorkin 2015). Meer and West (2016), using US employment data at the state level, show that the contemporaneous impact of an increase in minimum wage is insignificant, while this variable significantly reduces overall employment when lagged by one and two years. In contrast, Brochu and Green (2013) show that an increase in minimum wage lagged by one year does not explain much of the employment flows (quits, layoffs and hires) in Canada.

In the existing microeconometric studies, the focus on the short-term effects of minimum wage is often determined by the construction of the underlying surveys, which usually observe individuals for only two consecutive years. This may be sufficient to assess the employment effect of the minimum wage hike that takes place between the first and the second year. Such a sample selection can be found in, for example, the US Current Population Survey or the EU Labour Force Survey. Neumark et al. (2004) use the former data and introduce a lagged increase in minimum wage as a variable that explains individual employment. However, they admit that it would be worthwhile to know what the actual wage was of individuals in the year zero, before employees were surveyed. Although some person-level datasets do observe individuals for longer periods,[2] I am not aware of any study that would utilize this information to estimate the long-term employment effects of minimum wage.

Another issue related to the long-term consequences of minimum wage is its impact on social exclusion. I will compare the probabilities of remaining unemployed for people characterized by the different income levels. If employees displaced from jobs due to minimum wage increases had relatively lower chances of finding jobs in subsequent years, this would translate into higher welfare costs of the minimum wage regulation. Such a result would also indicate that minimum wage reduces creation of jobs for low-skilled employees.

The current analysis is set in the economic and institutional reality of Poland, that is, a country that has experienced a prolonged period of fast economic growth together with substantial increases in minimum wage as well as a rise in the ratio of the minimum wage to the average wage. Hence, it is an interesting case for studying the employment effects of minimum wage, and findings from this research may be interesting not only for the

[2] Examples in the US include the National Longitudinal Survey of Youth, the Panel Study of Income Dynamics or the Longitudinal Employer-Household Dynamics.

stakeholders in Poland. Nevertheless, there are some Poland-specific characteristics of the labour market (such as availability of civil law contracts which were not subject to the minimum wage regulation) that should be taken into account when drawing conclusions from this study. As Boockmann (2010) points out, the employment effects of minimum wage may depend on other country-specific labour market regulations.

The employment effects of minimum wage in Poland were previously analysed using the Labour Force Survey data. Baranowska-Rataj and Magda (2015) use a difference-in-differences matching estimator to assess the impact of minimum wage on employees aged 18-29. They find that an increase in minimum wage decreases the chances of affected individual to remain employed by almost 15 percentage points. Kamińska and Lewandowski (2015) follow up with a similar methodology, but with a larger sample and a focus on the population aged 15-54. They estimate an effect of the minimum wage increase on the probability of a job separation at 6 percentage points. Moreover, they identify that flows from permanent to temporary jobs (the latter includes civil law contracts which are not subject to minimum wage) may be attributed to minimum wage hikes. Both papers stress that workers with fixed-term contracts are significantly more exposed to the risk of job separation due to a minimum wage hike than are permanent workers.

An important assumption made in both papers is that employees directly affected by an increase in minimum wage (treated group) have similar unobserved characteristics to workers with somewhat higher wages (control group). Although propensity score matching combined with the difference-in-differences estimator may help to correct for unobserved factors, it is not the case for the analyses of job separations conducted in the above-mentioned papers. The reason is that every individual considered in those analyses is employed in the period t, and the only one observation on further employment history is in the period t+1.

Interestingly, the results from microeconometric studies on Poland are not backed up by the research that focuses on the aggregated variables. Ciżkowicz et al. (2015) find that the ratio of the minimum wage to the local average wage is insignificant in explaining local unemployment in Poland.

The rest of the paper is structured as follows. The second section describes the Polish labour market using both the publicly available data and the findings from the tax dataset. Section three explains the construction of the dataset and the empirical strategy. The fourth section reports empirical results, followed by section five, which contains the robustness analysis.

Section six summarizes the most important results and concludes. Detailed remarks about the data are provided in the appendix.

2. Main characteristics of the Polish labour market

The overall employment in Poland increased from 12.7 million people in 2004 (10.7 million in the non-agriculture sectors) to 15.3 million in 2016 (13.0 million outside agriculture). This was reflected by an increase of the employment rate (calculated for the age group 15-64) from 51.7% to 64.5% in the same period. Also, the unemployment rate declined from 19.1% to 6.2%. Despite this remarkable progress, the overall employment rate remains below the EU average.

Poland is characterized by a particularly low senior employment rate (age 55-64), which increased from 26.2% in 2004 to 46.2% in 2016, whereas the EU average in 2016 was at 55.3%. Low activity in this age group was related to the legacy of the communist economy, which had left many people unprepared to work in the market economy. As time passed, more and more people who had been educated before the economic transition exited the working age population. An additional factor contributing to the low senior employment rate is that the statutory retirement age for women is set at 60 (for men at 65) and there are some early retirement schemes for various occupational groups. Another regulation that influences senior employment is the law that prohibits laying off people who will be eligible for retirement within four years. Therefore women aged 56 and above as well as men aged 61 and above are covered by strong employment protection.

Young people (15-24) in Poland are also less active in the labour market than (on average) their peers in the EU, with the employment rates in 2016 amounting to, respectively, 28.4% and 33.9%. This is related to the fact that Poland has one of the highest ratios of students to population aged 20-24 in the EU.

There is also a large heterogeneity between regional markets in Poland, with the eastern part of the country recording significantly worse employment statistics. To some extent this is a result of a historically lower economic development of these regions. However, barriers to labour mobility (insufficient transport infrastructure, expensive housing to rent) also play a role in maintaining high local unemployment rates. Importantly, as the minimum wage is uniform for the whole country, the ratio of minimum to average wage is highest in the least developed regions, which may hamper employment. For example, in 2015 the ratio exceeded 48% in some of the NUTS 2 regions, while in the capital region it was at 34%.

In Poland there is a dual labour market, with a significant share of population being employed based on civil law contracts. These contracts are much less regulated than are job contracts, and they provide virtually no employment protection for the employees. They are also associated with lower non-wage costs. From a legal point of view, they are intended to be used for temporary jobs or when an employee is paid for accomplishing a specific task. However, the use of civil law contracts has become more widespread and also includes ordinary full-time jobs. An alternative, and also popular, way to evade taxes and labour market regulations is to register economic activity and sign a contract with the actual employer for providing services. Most importantly, civil law contracts were not subject to the minimum wage regulation until 2017.

Figure 1 Structure of employment as observed in the tax data, population below 60 years of age

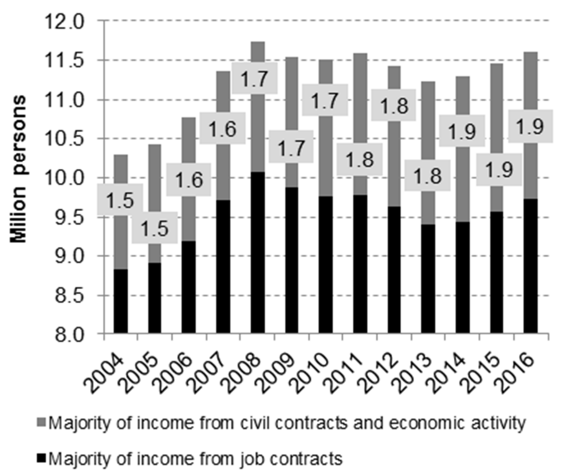
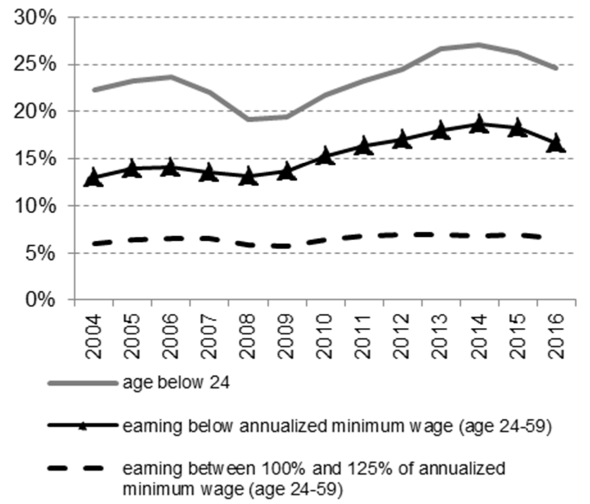


Figure 2 Share of people for whom income from civil law contracts and economic activity is higher than income from job contracts



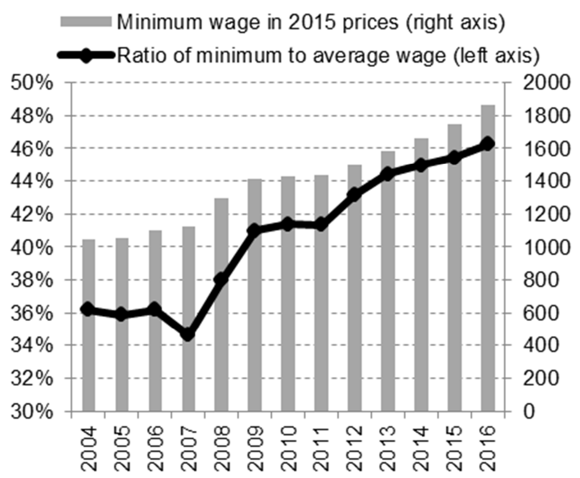
Source: Own calculations based on the tax dataset. The analysis includes only persons whose annual income was at least equal to the half of the annualized minimum wage.

Figure 2 depicts developments in the popularity of civil law contracts and economic activity. It seems that these types of contracts became a way to circumvent the minimum wage regulation, as they are particularly popular among people with an income lower than the annualized minimum wage. However, a sizable share of civil law contracts may actually be related to temporary jobs with monthly earnings above the minimum wage.

The minimum wage in Poland is set annually as a result of negotiations between government, employers and trade unions. However, if no consensus is reached, the government sets the level of minimum wage. Importantly, the law requires that as long as minimum wage is lower than 50% of the average wage, an increase in the minimum wage should be at least equal to the forecasted inflation plus 2/3 of the forecasted real GDP growth.

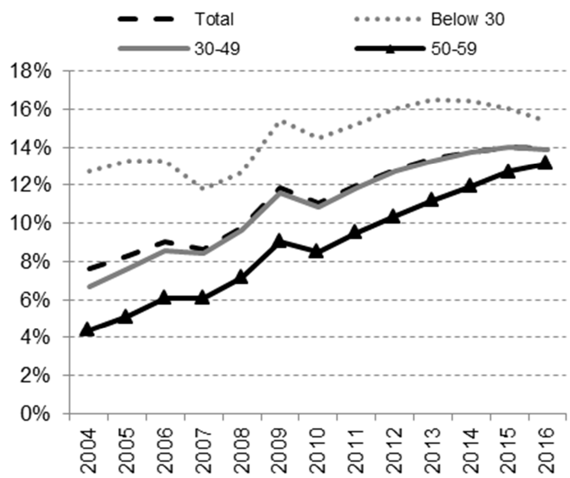
The minimum wage was relatively low until 2007. In 2008 and 2009 there were two substantial increases by, respectively, 20% and 13%. While in 2010 and 2011 the growth in minimum wage barely exceeded inflation, from 2012 onward there has been systematic increase in the real value of minimum wage, as well as in the ratio of minimum to average wage. These developments were accompanied by a significant increase in the share of employees (having job contracts) that earn the minimum wage, as evidenced in the Figure 4. Similarly to other countries, young people are relatively highly affected by the minimum wage. Regarding the situation of senior employees, the fact that the share of minimum wage earners is lowest in this group does not necessarily mean that they are the least affected by the regulation. It might be the case that people in pre-retirement age are more likely to be forced out of the labour market if their productivity becomes lower than the minimum wage.

Figure 3 Evolution of minimum wage in Poland



Source: Own elaboration based on official data

Figure 4 The shares of employees earning minimum wage in the selected age groups



Source: Own calculations based on the tax dataset; public sector employees excluded

3. Dataset and estimation strategy

The dataset was obtained from the Ministry of Finance of Poland internal tax registry. Its brief description in the next few paragraphs is complemented with more detailed remarks and descriptive statistics in the appendix.

The dataset reflects all the information that taxpayers submit in their annual tax returns. In particular, it contains an income from a job contract, which is essentially the sum of the wages and bonuses received during a year. I use this variable to approximate wages. Other categories of income include revenues from civil law contracts and economic activity. It is important to track them because people affected by labour market regulations may change the form of their contract without actually losing their job.

Another important variable is the cost of revenue related to a job contract. It is usually calculated as a flat sum multiplied by the number of months, in which a person was employed. I use this information to verify whether a person was employed for the whole year. If the cost of revenue implies that a taxpayer was not employed for the whole year, I do not use her income to approximate wages, because it might introduce more noise than valuable information. For example, someone employed from January 16th to March 15th would record the cost of revenue corresponding to 3 months, whereas her wage would reflect only two months of a full-time job.

Additionally, the dataset contains information on each taxpayer's age, sex, location of residence and year of death if appropriate. I also attribute to each taxpayer the ID number of her main employer in a given year.

The econometric analysis is conducted on the population that excludes employees from public sector. The main reason is that those people are entitled to a thirteen salary, which is not necessarily equal to the regular monthly wage. Therefore, it is more difficult to approximate monthly wages of those employees. Moreover, in the public sector minimum wage is expected to have lower impact on employment than in the private sector, as public entities are usually less concerned with cost minimization. Another large group excluded from the analysis comprises people of retirement age as well as those covered by the pre-retirement employment protection.

The tax dataset does not explicitly record events such as job separation or being unemployed. I define four dummy variables based on the changes in income, cost of revenue and employer's ID. The detailed definitions are provided in the appendix. The first variable is a job loss. It is intended to reflect the situation where somebody becomes unemployed for at least one month. The definition of this variable has been calibrated using the social security system database for 2015, which reports employment status of individuals on the monthly basis. Unfortunately, the social security data is not accessible for earlier years.

The second variable is a job separation. It reflects occurrence of either the job loss or a change in the main employer's ID. The third variable, a contract change, occurs when a taxpayer's income does not fall sufficiently to identify the job loss, but the source of income switches from a regular job contract to a civil law contract or economic activity. The last dependent variable, long-term unemployment, denotes a situation when an individual does not return to regular employment within three years from a job loss.

The explanatory variable of main interest is treatment by minimum wage. In the baseline specification it is coded as a binary variable that takes value of 1 when the annualized minimum wage for a given year is higher that the individual's income from job in the previous year.

Although the dependent variables are binary, I use linear probability models, as they provide good estimates of the partial effects for average values of the explanatory variables and the coefficients are easy to interpret (Wooldridge 2002). Moreover, a linear model is less computationally expensive than non-linear models, which makes it feasible to implement it for a large dataset.

As a first step of the analysis explaining the job loss, the job separation and the contract change, I run OLS estimations, which do not take into account individual effects. This approach is therefore analogous to the analyses that are based on datasets observing each individual only for two consecutive periods. I use the population composed of the two groups: the treatment group (people with the treatment variable equal to 1) and the control group. The control group consists of people earning in period t-1 between 100% and 125% of the minimum wage valid for the year t. The control group is smaller than the treatment group by, on average, 26%. Together they comprise 18% to 29% (the trend is increasing) of all employees having job contracts for a full year. The OLS specification is following:

$$y_{i,t} = \alpha_0 + \beta_1 * treated_{i,t} + \beta_2 * entr_{i,t} * \gamma * dem_{i,t} + \delta * reg_{i,t} + \epsilon_{i,t} \qquad (1)$$

where $entr$ denotes labour market entrants, that is, individuals who recorded income from work or economic activity for, at most, two years before a year t. This variable is defined from 2007 year, i.e. fourth year of data. The vector of demographic variables, dem, includes dummy variables for age groups and sex. In particular, the oldest age group covers women aged 55-56 and men aged 60-61. By including this variable, I aim to capture the idea that employers may be willing to lay off employees just before they enter the pre-retirement employment protection. The reg vector includes dummy variables that are created as the interaction of the NUTS 3 regions with years. Their purpose is to control for the local demand for low-skilled labour. There are 72 NUTS 3 regions in Poland and most of them may be considered as local labour markets. That is, employees are usually able to commute to work within the NUTS 3 region.

The crucial assumption that must hold for the specification (1) to provide unbiased estimation of β_1 parameter is the similarity between the control group and the treatment group in terms of unobserved characteristics of employees. The pooled OLS is a consistent estimator if the fixed unobserved characteristics of individuals are uncorrelated to the explanatory variables. Ideally, the treatment should be result of some random factors on the labour market. If, however, unobserved characteristics were correlated with the wage level, then the estimation of β_1 coefficient would be biased.

To get some insight whether an estimate of β_1 parameter is truly related to the minimum wage, I also run a placebo test for every dependent variable.[3] In each placebo test, I construct an artificial treatment variable, as if the minimum wage were 10% higher than the actual one. The treatment group is composed of people earning in the year t-1 below this artificial minimum wage in the period t. However, employees who are treated by an increase in the actual minimum wage are excluded from the placebo analysis. The control group is defined as previously, using the artificial minimum wage as a point of reference. Any value of the placebo treatment coefficient higher than zero would suggest that the OLS estimation of the minimum wage impact on job losses is biased upward.

Next, I turn to the analysis that is robust to the possible correlation between taxpayer's wage and her fixed unobserved characteristics. Namely, I use the fixed effects estimator. There are two important shortcomings of this estimator. First, it does not allow to estimate the effect of variables constant in time, e.g. some demographic variables. Second, the estimation of the impact of minimum wage is based only on those individuals who experienced variation in the treatment. That is, data on employees who were permanently affected by minimum wage is only utilized to estimate coefficients of other, less important, explanatory variables. The fixed effects specification is following:

$$y_{i,t} = \alpha_i + \sum_{p=0}^{P} \beta_{1,p} * treated_{i,t-p} + \sum_{p=0}^{P} \beta_{2,p} * irregular_{i,t-p} + \gamma * dem_{i,t} + \delta * reg_{i,t} + \epsilon_{i,t} \quad (2)$$

The analysis uses a categorical variable denoting one of the three possible statuses of taxpayers. First, an individual may be a regular employee (working for 12 months with earnings implying the full-time job) in the year t-1 and not being treated by the minimum wage increase. Such status is used as a point of reference. Second, an individual may be a

[3] I am grateful to Piotr Lewandowski for suggesting me to conduct such tests.

regular employee in the period t-1 who is treated by minimum wage increase of the period t. Third, a taxpayer may not be a regular employee in the year t-1. This category includes people with no income from job or with an income lower than 90% of annualized minimum wage as well as the employees whose cost of revenue implies working for less than 12 months.

In the static specification, the number of lagged values of treatment is set to 0, while in the dynamic specification the parameter P equals 3. I use lagged treatments to allow for the effects of minimum wage hike to materialize in the long-run.

For the static specification, inclusion of irregular employees does not change anything. The reason is that the dependent variables are not defined for people who were not classified as regular employees in the previous year. However, it has important benefits for the dynamic specification. By including variable denoting irregular employees, I can use the whole population. Otherwise, the sample in the dynamic specification would be largely reduced in a non-random way.

The region-year variables are constructed as in the specification (1). The only one demographic variable in the specification (2) is the age group composed of people just before entering pre-retirement protection. I exclude from the analysis people below 30 years of age as these individuals are relatively likely to experience changes in the educational attainment level and in other characteristics that are unobserved in the dataset. The population analysed in the fixed effects regressions consists of people who ever belonged to the treatment group or the control group, as defined in the specification (1).

Another analysis covered in this paper deals with the impact of the minimum wage on social exclusion. The question is whether the probability of prolonged unemployment after a job loss is higher for employees affected by the minimum wage than for people in the higher part of the income distribution. The regression takes the following form:

$$y_i = \alpha_0 + \sum_{j=1}^{j=3} \beta_j * D_{j,i} + \gamma * dem_i + \delta * reg_i + \epsilon_i \qquad (3)$$

where y_i is the long-term unemployment variable (defined as in the Table 7) and the vectors dem_i and reg_i are analogous to the specification (1). $D_{1,i}$ is the dummy variable, denoting that prior to a job loss a taxpayer belonged to the treatment group, $D_{2,i}$ stands for the control group and $D_{3,i}$ for the rest of employees (who earn more than 125% of minimum wage). The sample used for this estimation comprises all observations classified as the job loss events.

Hence, the dataset does not have a panel structure, because individuals are not expected to lose jobs repeatedly. The regression is also run separately for different demographic groups.

4. Empirical results

An initial glance at the evolution of the dependent variables is presented in figures 5-8. The figures compare the probabilities of the analysed events for different income groups. People affected by an increase in minimum wage record higher probability of losing a job or changing a type of contract than do employees in the control group, whose wage in the period t-1 is slightly above the minimum wage set for the period t. The average probability of remaining employed (i.e. not experiencing a job loss) is 81.5% among the treatment group and 84.6% in the control group. However, it is also apparent that both the treatment and the control group experience lower job security than the rest of population.

Figure 5 Probabilities of job loss

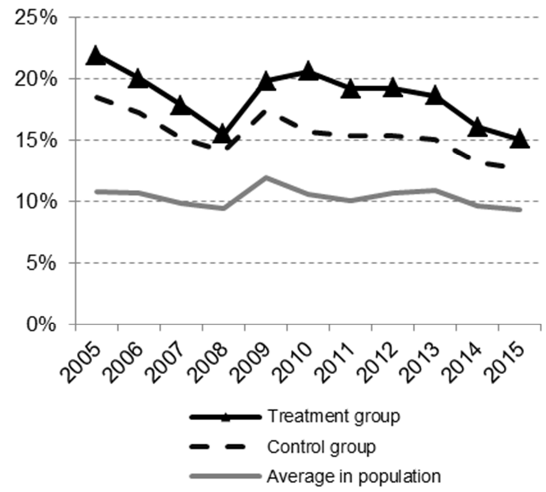


Figure 6 Probabilities of job separation

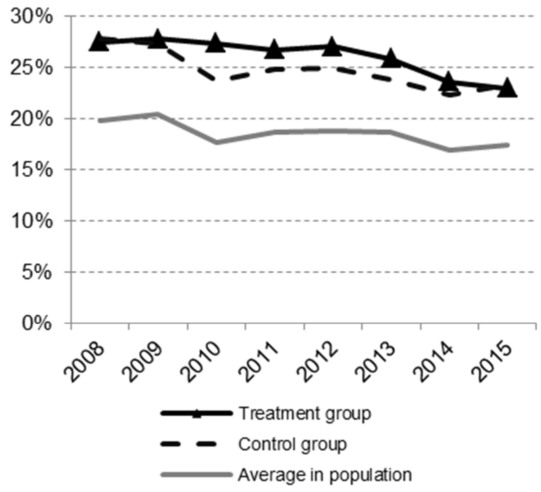


Figure 7 Probabilities of a contract change

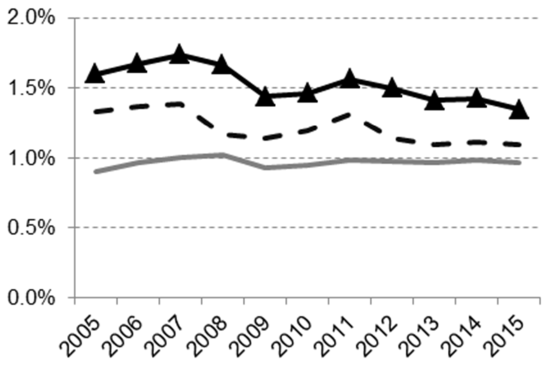
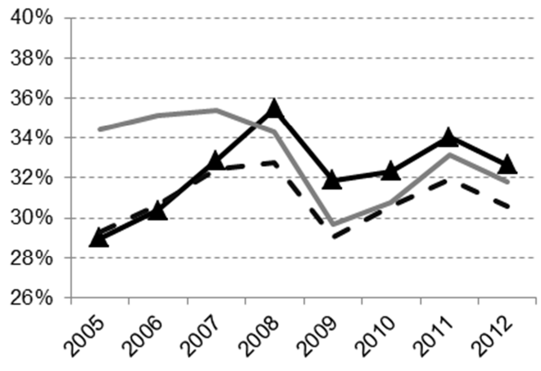


Figure 8 Probability of long-term unemployment, conditional on a job loss



Source: Own calculations based on the tax dataset

Figure 8 implies that the probability of long-term unemployment after a job loss has been quite similar in different income groups since 2008. Before 2008, however, people earning around the minimum wage recorded significantly lower probability of the long-term unemployment than the population average.

Table 1 Results of the OLS estimations

	Job loss, OLS	Job loss, OLS Placebo test	Job separation, OLS	Job separation, OLS Placebo test	Contract change, OLS	Contract change, OLS Placebo test
Treated	0.029^{***}	0.011^{***}	0.011^{***}	0.019^{***}	0.003^{***}	0.002^{***}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Entrants	0.086^{***}	0.062^{***}	0.091^{***}	0.071^{***}	0.001^{***}	0.000
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)
Age: below 25	0.077^{***}	0.093^{***}	0.111^{***}	0.138^{***}	0.008^{***}	0.007^{***}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Age: 25-30	0.060^{***}	0.071^{***}	0.091^{***}	0.117^{***}	0.008^{***}	0.007^{***}
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Age: 31-40	0.016^{***}	0.022^{***}	0.026^{***}	0.039^{***}	0.004^{***}	0.004^{***}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age: 41-50	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)
Age: 51+	0.034^{***}	0.028^{***}	0.024^{***}	0.013^{***}	-0.002^{***}	-0.002^{***}
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
Age: protection threshold#	0.119^{***}	0.103^{***}	0.095^{***}	0.073^{***}	0.002^{***}	0.002^{***}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
Woman	0.016^{***}	0.006^{***}	0.005^{***}	-0.012^{***}	-0.005^{***}	-0.006^{***}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.121^{***}	0.125^{***}	0.237^{***}	0.251^{***}	0.011^{***}	0.011^{***}
	(0.003)	(0.004)	(0.003)	(0.005)	(0.001)	(0.001)
Observations	1.31e+07	7.77e+06	1.12e+07	6.64e+06	1.24e+07	7.40e+06

The dependent variables are indicated in column headings and defined in Table 7. Robust standard errors in parentheses. # protection threshold includes women aged 55-56 and men aged 60-61. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1 reports the results of the OLS estimations. It turns out that people affected by an increase in minimum wage are more likely to experience the job loss, the job separation or the contract change than employees earning just above new minimum wage. The effects of being treated by minimum wage amount to, respectively for the three dependent variables, 2.9, 1.1 and 0.3 percentage points. These results, taken at face value, would suggest that each year around thirty thousand employees lost jobs due to a minimum wage increase. However, the outcome of the placebo regressions shows that the above-mentioned results do not have causal interpretation. The differences found between the treatment and the control group are also present when one compares the placebo group with people having a bit larger income.

An interesting issue presented in the Table 1 is the relation between demographic variables and probabilities of labour market events. As expected, young employees are much more likely to experience a job loss or a job separation than workers in their forties. The observation which is the most important from policy perspective is that many job contracts are terminated when employees are just about to be covered by pre-retirement protection.

Table 2 shows the results of the fixed effects estimations that may be interpreted in terms of causality. The conclusion from previous OLS estimations which is confirmed here is the positive effect of pre-retirement protection on the risk of terminating a job contract. When a person enters the last year before the start of pre-retirement protection, her probability of losing a job increases by 11 percentage points.

Table 2 Results of the fixed effects estimations

	Job loss, static version	Job loss, three lags	Job separation, static version	Job separation, three lags	Contract change, static version	Contract change, three lags
Treated	-0.010***	-0.005***	-0.000	0.008***	0.004***	0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Treated (-1)		0.008***		0.024***		0.002***
		(0.000)		(0.000)		(0.000)
Treated (-2)		0.007***		0.010***		0.001***
		(0.000)		(0.000)		(0.000)
Treated (-3)		0.005***		0.006***		0.001***
		(0.000)		(0.000)		(0.000)
Not a regular employee (-1)		-0.111*** (0.000)		-0.090*** (0.000)		-0.005*** (0.000)
Not a regular employee (-2)		-0.061*** (0.000)		-0.053*** (0.000)		-0.003*** (0.000)
Not a regular employee (-3)		-0.047*** (0.000)		-0.044*** (0.000)		-0.002*** (0.000)
Age: protection threshold#	0.125*** (0.001)	0.110*** (0.001)	0.111*** (0.001)	0.107*** (0.001)	0.001*** (0.000)	-0.001*** (0.000)
Constant	0.066***	0.123***	0.143***	0.209***	-0.002	0.001
	(0.010)	(0.013)	(0.018)	(0.018)	(0.004)	(0.004)
Observations	1.80e+07	1.42e+07	1.32e+07	1.32e+07	1.70e+07	1.34e+07
Individuals	3.86e+06	3.60e+06	3.49e+06	3.49e+06	3.76e+06	3.49e+06

The dependent variables are indicated in column headings and defined in Table 7. Robust standard errors in parentheses. # protection threshold includes women aged 55-56 and men aged 60-61. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

In contrary to the OLS results, minimum wage hikes are not conducive to job losses and job separations in the short-term. In the regression explaining the job loss, the coefficient of treatment is even slightly negative, which is counterintuitive. However, there is a significant positive effect on the probability of the contract change. The event of contract change is not very frequent itself, with the annual unconditional probability being close to 1%. Thus, the impact of treatment amounting to 0.4 percentage points should be considered as important.

The results on job losses and job separations change after including the lagged effects of treatment. Then, an increase in minimum wage has positive effect on the probabilities of these events. Being affected by minimum wage for four years increases the probability of job separation by 4.8 percentage points and the probability of job loss by 1.5 percentage points. Given the cumulative nature of the treatment, the latter effect may be considered as small, while the former seems to be economically significant. Long-term effects of minimum wage are also higher than the short-term effects in the case of the contract change.

It turns out that people who were not regular employees in previous years, but worked for a full year in t-1, have substantially lower probability of losing a job than those employees who were regular workers in previous years. There are two reasons that may explain this result. First, those are mostly employees who were recently hired, so it is likely that economic needs of employers continue to justify their employment. Second, the fact that a given person worked for a full year indicates that she acclimatized successfully in a new workplace.

The next part of the analysis is concerned with the long-term consequences of losing a job. Table 3 presents the results of separate estimations of the equation (3) for each year and for different age groups. The reason for this approach is that the results differ notably between years and various demographic groups. The only output reported in the table is the coefficient of the dummy variable that denotes being affected by the minimum wage increase. It represents an additional probability of remaining unemployed in comparison to the people earning more than 125% of the minimum wage.

Among people younger than 40 years, minimum wage earners have significantly worse chances of getting back to work after a job loss than the higher-income earners. In contrast, there is no substantial difference in terms of chances of return on labour market among population aged 41-50. The results are opposite for people older than 50 years, where employees earning around the level of minimum wage are actually more likely to return to employment than workers from higher parts of the income distribution. However, the results for people in their fifties and, to some extent, forties are influenced by the early retirement schemes. These schemes are dedicated to professional groups that earn more than the minimum wage. Hence, some of the job losses identified among employees with relatively high income may actually represent voluntary decision to take advantage of early retirement.

It turns out that before 2008, people earning around the level of minimum wage were not exposed to a relatively high probability of long-term unemployment after losing a job. In contrast, since 2008, this group of employees has significantly lower chances of returning to employment than people from the higher part of income distribution. In 2008 there was the biggest increase in minimum wage, which made the minimum wage binding for a larger share of the population. It also might have hampered the chances of low-skilled employees finding a job.

Table 3 Results of 50 regressions explaining long-term unemployment after a job loss

	All age groups	Age <31	Age: 31-40	Age: 41-50	Age: 51-61#
All years	0.016***	0.047***	0.050***	-0.019***	-0.090***
2005	-0.041***	-0.007***	-0.019***	-0.078***	-0.151***
2006	-0.041***	-0.008***	-0.020***	-0.079***	-0.139***
2007	-0.011***	0.008***	0.013***	-0.037***	-0.099***
2008	0.042***	0.072***	0.081***	0.021***	-0.077***
2009	0.049***	0.088***	0.083***	0.022***	-0.073***
2010	0.037***	0.070***	0.072***	-0.006*	-0.059***
2011	0.024***	0.059***	0.058***	-0.010***	-0.072***
2012	0.023***	0.059***	0.060***	-0.012***	-0.070***
2013	0.021***	0.053***	0.066***	-0.015***	-0.084***

The dependent variable is long-term unemployment. Table reports the effect of being affected by the minimum wage increase in comparison to being in the higher part of income distribution, that is to earn in year t-1 more than 125% of the minimum wage set for the year t; # excluding women above 56 years old due to employment protection;
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5. Robustness analysis

As a primary check, I rerun the dynamic version of specification (2), each time focusing on different subsamples. First, I verify whether the main results hold after changing the time frame of the analysis. Table 4 reports the output of regressions which exclude either last four years or initial five years of data. Although main findings hold in both subperiods, the impact of minimum wage on job losses is significantly larger in the later period. This may be related to the fact that minimum wage was on relatively low level until 2008. The results for job separation are presented only for the later subperiod, as data on employers' id is available from 2007.

Second, I change the population covered by the analysis. In one variant of regression, I include people below 30 years of age, who were excluded so far. In another regression, I consider only workers employed in large companies, that is with the number of employees exceeding 250. The rationale for the latter check is that there may be employees in small and medium firms who actually earn more than minimum wage but, for the purpose of tax evasion, declare that they receive only the minimum wage. Such practice is less feasible in large companies, because it would be more risky to have illegal agreement with hundreds of employees and also due to difficulties in managing illegal cash flows.

Table 5 shows that after including people below 30 years of age, the impact of minimum wage hikes on all the dependent variables is higher than in the baseline specification. The results on job losses and job separations remain mostly unchanged when considering only employees of large companies. However, among large firms the impact of minimum wage on the probability of contract change is significantly higher than for the whole population.

Table 4 Estimation results for different time periods

	Job loss, 2005-2011	Job loss, 2010-2015	Job separation, 2010-2015	Contract change, 2005-2011	Contract change, 2010-2015
Treated	-0.004***	-0.001	0.017***	0.004***	0.003***
Treated (-1)	0.008***	0.007***	0.023***	0.001***	0.002***
Treated (-2)	0.004***	0.015***	0.019***	0.001***	0.001***
Treated (-3)	0.005***	0.014***	0.014***	0.001***	0.001***

The dependent variables are indicated in column headings and defined in Table 7. Table reports only coefficients of the selected regressors. The full specification is given by equation (2). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5 Estimation results for modified coverage of population

	Job loss, people below 30 years included	Job loss, only employees of large firms	Job separation, people below 30 years included	Job separation, only employees of large firms	Contract change, people below 30 years included	Contract change, only employees of large firms
Treated	-0.004***	0.004***	0.013***	0.019***	0.005***	0.005***
Treated (-1)	0.010***	0.002**	0.028***	0.018***	0.002***	0.004***
Treated (-2)	0.008***	0.005***	0.012***	0.010***	0.001***	0.003***
Treated (-3)	0.005***	0.002***	0.008***	0.007***	0.001***	0.003***
Observations	1.83e+07	3.88e+06	1.71e+07	3.23e+06	1.74e+07	3.61e+06
Individuals	4.66e+06	1.37e+06	4.52e+06	1.04e+06	4.54e+06	1.30e+06

The dependent variables are indicated in column headings and defined in Table 7. Table reports only coefficients of the selected regressors. The full specification is given by equation (2). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Third, I run the main regressions for each of 16 NUTS 2 regions (voivodeships) separately. The results on job separation hold in every region, with the lowest impact of minimum wage hikes amounting to 3 percentage points over four years of treatment. In contrast, results on job loss are less robust. One voivodeship shows no positive effect of minimum wage on the risk of losing a job and another region has cumulated impact lower than one percentage point.

As another robustness check, I modify the explanatory variable. I express the treatment in terms of wage gap, which is defined as the percentage increase in employee's wage that is required to meet the new minimum wage.[4] Rather than using volatile one-year wage gaps, I construct cumulated wage gap as a product of one-year wage gaps from last four years. Wage gaps that are missing or equal to zero are not used when calculating the cumulated value.

Table 6 reports the results of fixed effects estimation. An increase in minimum wage by 10%, which happened over previous four years, is associated with probability of a job loss being higher by 1.9 percentage for an affected employee. In this approach, the impact of minimum wage on job separation is also higher than the impact on job losses, but the difference is much smaller than in the regressions using categorical treatment variable.

Table 6 Estimation results for the cumulated wage gap as explanatory variable

	Job loss	Job separation	Contract change
Cumulated wage gap	0.189***	0.237***	0.024***
	(0.001)	(0.002)	(0.000)
Entrants	-0.065***	-0.055***	-0.002***
	(0.001)	(0.001)	(0.000)
Age: protection threshold$^{\#}$	0.117***	0.109***	0.000
	(0.001)	(0.001)	(0.000)
Constant	0.043***	0.133***	-0.001
	(0.012)	(0.018)	(0.004)
Observations	1.56e+07	1.32e+07	1.47e+07
Individuals	3.70e+06	3.49e+06	3.59e+06

The dependent variables are indicated in column headings and defined in Table 7. Table reports all coefficients estimated in regressions, except for region-year dummy variables. $^{\#}$ protection threshold includes women aged 55-56 and men aged 60-61. Robust standard errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

I also check robustness of the finding that since 2008 young workers affected by minimum wage have had significantly higher probability of long-term unemployment following a job loss than their peers from higher part of income distribution. This result holds for each voivodeship separately and for modified definitions of the long-term unemployment variable.

[4] An analogous variable is used by, for example, Card and Krueger (1994) or Giuliano (2013).

6. Conclusions

In this paper, I evaluate the impact of minimum wage increases on unemployment, job separations (including job-to-job transitions) and on the outflows from the regulated labour market to other legal forms of employment.

The results of pooled OLS estimations, in which I compare the treatment group with the control group, point out to significant negative employment effects of minimum wage. However, as evidenced by the placebo analysis, these results do not have a causal interpretation. They simply show that people with lower wages are more likely to experience job separation.

In contrast, the outcome of fixed effects estimation indicates that minimum wage hikes do not have significant impact on job separations in the short-run. The adjustment that actually does happen in the short-run is the change in the legal form of employment. In this latter aspect, my results confirm findings from the previous study on the effects of minimum wage in Poland (Kamińska and Lewandowski 2015).

An important contribution of the present paper is to show that employment effects of minimum wage may materialize with a delay. I find that if an employee is affected by changes in minimum wage for four years, her probability of experiencing a job separation gets increased by almost 5 percentage points. This coefficient, though not very large, may be considered as economically significant. The results on job separations are robust to various changes in the specification, while the findings on the minimum wage impact on job losses (job separation followed by a period of unemployment) are not so clear. The baseline results suggest that minimum wage impact on job losses is very small. As Poland experienced relatively good labour market conditions in recent years, the possible explanation is that some job contracts were in fact terminated due to minimum wage hikes, but the employees were able to find new employment within a short period of time.

Another important finding which is enabled by the longitudinal character of the dataset is that young, low-income people face more difficulties in returning to employment after a job loss than their peers with higher salaries. It means that the welfare costs of minimum wage may include not only higher unemployment, but also long-term social exclusion among some of the negatively affected workers. This effect may be actually stronger in economies that experience slower economic growth and worse labour market conditions than Poland in the successful period after the EU accession in 2004.

As a by-product of the current study, I find that pre-retirement protection may be a counterproductive labour market policy. It turns out that employees that are about to enter the pre-retirement protection period are relatively likely to be fired.

It should be noted that the present paper is not a comprehensive assessment of the minimum wage impact on employment in Poland. Some of the effects of minimum wage are difficult to identify using person-level data. In particular, minimum wage may lead to lower levels of job creation, especially among firms that are about to enter the market or increase scale of their activity. They may choose to invest in technology which is less labour intensive, or to move the production to areas with cheaper labour. However, in the present paper, such effects are included in the exogenous measure of demand for low-skilled labour and are not distinguishable from other factors that influence aggregate economic activity in a region. Analogously, there may be unobserved positive employment effects of minimum wage, resulting from greater incentives for low-skilled people to enter the labour market. Future research may attempt to tackle these issues by analysing firm-level payroll data.

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Appendix

Identification of employment status

In order to precisely approximate the taxpayer's wage, it is essential to know the number of months in which a person was employed. As explained in the main text, I don't analyse individuals whose cost of revenue, related to a job contract, implies working for less than 12 months in a given year. There are two cases in which that variable may signal working for less than 12 months.

First, an employee may report costs that are lower than the annual flat rate for employees living in the town of their workplace. The second case is related to the fact that there is also a higher flat rate for employees commuting from distant areas. Hence, any linear combination of these two rates that uses less than 12 months implies that a person was working for less than a whole year. For example, when the monthly flat rates equal 111.25 and 139.06 PLN, the value of costs equalling 1418.42 PLN suggests that an employee worked in the town of her residence for 4 months and commuted from a distant location for 7 months. The switch may be due to a change in the employee's place of residence, so it is not necessarily a signal of a job-to-job transition.

However, when people report non-standard high costs of commuting to work, it may be impossible to tell if they were employed for the whole year or, for example, 10 months. About 7% of taxpayers, for whom the cost of revenue does not imply that they worked for less than 12 months, individually calculate their cost of commuting.

I verify accuracy of the cost of revenue in assessing the duration of employment by comparing calculations from the tax dataset with the social security database. The latter data is available only for year 2015. It comprises monthly information on the detailed source of income of each person, e.g. job contract, civil law contract or maternity leave. The minor inconvenience is that the employment status is based on the date of payment of salary. Hence, someone who quits a job in November, but receives the last salary on December 1st, would be classified as still being employed in December. However, in the case of regular job contracts salaries are often paid at the end of the corresponding month.

It turns out that the cost of revenue is a quite good indication of the employment duration. Among people for whom the cost of revenue implies working for 12 months, only 1.3% were employed for a shorter period according to the social security system. It is important to note that the cost of revenue is not assigned to employees who did not work at all in a given month due to a sick leave or a maternity leave. That is why almost 10% of people who figure in the social security database as being employed for 12 months are classified in the tax database as not working for a full year. This issue is not necessarily disrupting for the analysis, because people who are on various types of leaves receive only part (usually 80%) of their regular salary. Therefore, it would be difficult to precisely calculate their monthly wage.

Another limitation of the dataset is that it does not allow detection of persons employed on part-time contracts. Hence, someone earning above the minimum wage but working part-time may be mistakenly classified as being directly affected by the minimum wage regulation. Fortunately, part-time job contracts are not popular in Poland. The Eurostat data show that the share of part-time workers declined from 10% to 7% in the period 2004-2016. This indicator may actually overestimate the share of part-time workers in the population covered by the present analysis, as Eurostat data also includes employment based on civil law contracts, which are usually characterized by more flexible working hours than regular job contracts.

Definitions of dependent variables

Table 7 presents the way the four dependent variables are constructed. The definitions of job separation, contract change and long-term unemployment are to some extent related to the definition of job loss.

The job loss event was calibrated to match the situations, in which the social security database indicates that an employee became unemployed. I identify a job loss in the social security data when an employee who had been employed in 2014 for a full year (based on the cost of revenue available in the tax dataset), became unemployed, i.e. without any legal form of employment, for at least one month in the year 2015.

I compared several dozen definitions of the job loss that used only the variables that were available in the tax datasets: costs of revenue, income from job and total income from economic activity. The final definition (described in Table 7) was chosen to minimize weighted sum of the two types of errors. The error of first type is identifying a job loss against the evidence from the social security data, while the error of second type is not identifying a job loss when the social security data indicates that employment duration in 2015 was shorter than 12 months. I assigned higher weight to the second type of error, because the first type consists of situations, in which an employee experienced significant drop in annual earnings.

Thus, despite being officially employed for 12 months, the error of first type indicates some negative developments for an employee.

Table 7 Definitions of the dependent variables

<table>
<tr><th></th><th>Job loss</th><th>Job separation</th><th>Contract change</th><th>Long-term unemployment</th></tr>
<tr><td>Condition</td><td>Cost of revenue implies working for less than 12 months in year t
AND Total income* in year t is lower or equal to 85% of income from job in year t-1.</td><td>Job loss happened in year t</td><td>Income from job in year t constitutes less than 50% of total income in year t.
AND total income in year t is higher than 85% of income from job in year t-1.</td><td rowspan="2">Job loss happened in year t
AND in each of the years t+1, t+2, t+3 total income was lower than 30% of the annualized minimum wage multiplied by the ratio of individual wage to minimum wage in year t-1.</td></tr>
<tr><td>Alternative condition</td><td>Cost of revenue implies working for less than 12 months in year t
AND average of total income in years t and t+1 is lower or equal to 92.5% of income from job in year t-1.</td><td>The ID of main employer (the firm that paid the largest share of total salary related to a regular job contract) is different in year t than it was in year t-1.</td><td>The share of job related income in total income in year t is lower by at least 10% than in year t-1
AND the share of job income in year t+1 is lower than 50%
AND total income in year t is higher than 85% of income from job in year t-1.</td></tr>
<tr><td rowspan="2">Set to missing if</td><td></td><td>Data on employer's ID is missing in either year t-1 or year t.</td><td>Income from job in year t-1 constitutes less than 80% of total income</td><td>Taxpayer died in year t+4 or earlier.</td></tr>
<tr><td colspan="4">Income from job in t-1 is lower than 90% of annualized minimum wage (70% for workers with overall experience lower or equal to 2 years) [5]
OR cost of revenue implies work for less than 12 months in t-1
OR taxpayer died in year t+1 or earlier.</td></tr>
</table>

*The total income means the sum of income from job contracts, civil law contracts and economic activity.

Among 464 thousand job losses found in the social security data, the best definition of job loss used in the tax dataset captured 334 thousand of them, leaving 130 thousand mistakenly unidentified. It should be noted, though, that these 130 thousand cases consist of situations, in which an annual income of an employee did not fall substantially in the analysed year. There are also 253 thousand observations for which the definition used in the tax database identified a job loss in contrary to the evidence from social security system.

[5] Although it is not allowed for employers to pay wages lower than the minimum wage, there are some reasons why a person employed for the whole year might receive a lower amount of money. For example, an employee on sick leave receives 80% of her regular wage. Importantly, minimum wage is reduced to 80% of its normal level for the people with a history of overall employment shorter than 13 months.

To sum up, although the algorithm for identification of the job loss does not matches perfectly unemployment observed in the social security data, it is supposed to capture the most evident incidents of unemployment. Most of the remaining errors stem from the fact that the definition used within the social security data may actually underestimate the number of job losses. For example, the switch from full-time employment to a part-time civil-law contract would not be treated as becoming unemployed in the social security data, whereas it would correspond to a job loss according to the definition used in the tax dataset.

The job separation variable aims to cover both a change from employment to unemployment and a job-to-job transition. Regarding the latter, there may be a time shift of a few months in its identification. For example, if a taxpayer is employed in the firm X from January to August of the year t, and she starts working for firm Y from September, then the firm X would be her main employer in the year t (assuming comparable monthly wages in both firms), while the change of the main employer would be identified only in the year t+1. This inaccuracy is not necessarily wrong, as minimum wage for the year t+1 is usually announced at the beginning of the second half of the year. Hence, a job transition that happens in Autumn of year t may be a result of employer's adjustment to minimum wage set for the year t+1. It is important to note that the job separation is defined from 2008, as data on employers is available only from 2007.

The definitions of the contract change and long-term unemployment are somehow arbitrary. However, regression results are not very sensitive to the changes in the thresholds used in these definitions.

Descriptive statistics

Table 8 presents the summary on the number of taxpayers covered in the analysis. The first column shows the number of taxpayers that declared any income from job, civil-law contract or economic activity in a given year. There are over 24 million individuals observed in the dataset. The second column includes only those employees who obtained any income from regulated job contract. The third column provides number of employees having a job contract for a full year (as indicated by the cost of revenue variable). The difference between the second and the third column reflects the size of the population that cannot be analyzed in the current paper, due to the lack of information on the monthly basis. The fourth column is the subset of the population that is actually analysed. It excludes people whose age indicates that they are eligible for retirement or for pre-retirement employment protection. Public sector employees are also excluded. Moreover, people earning below 90% of annualized minimum wage are not taken into account, as they are probably part-time workers. The fifth column counts those taxpayers from the fourth column who earn minimum wage (their income from job is between 97% and 103% of annualized minimum wage). That number includes entrepreneurs that may be probably fictitiously employed in order to avoid paying social contributions related to their income from economic activity. Hence, in the econometric analysis I do not classify as being treated by minimum wage those entrepreneurs whose income from economic activity is higher than twice the annualized minimum wage.

Table 8 Summary on the population covered by the dataset, thousand persons

	(1)	(2)	(3)	(4)	(5)
Year	Active taxpayers	Having income from a job contract	Employed on a job contract for a full year	Covered by the analysis	Earning minimum wage
2004	12 980	10 852	7 371	6 774	419
2005	13 235	11 014	7 519	6 884	463
2006	13 720	11 405	7 665	7 025	511
2007	14 383	12 016	7 887	5 719	501
2008	14 860	12 420	8 283	6 013	593
2009	14 734	12 258	8 431	5 937	712
2010	14 769	12 124	8 478	5 985	670
2011	14 959	12 181	8 486	5 767	701
2012	14 892	12 016	8 489	5 630	732
2013	14 870	11 880	8 420	5 447	739
2014	15 088	12 008	8 497	5 432	759
2015	15 369	12 261	8 625	5 494	779
2016	15 573	12 517	8 806	5 620	790

Source: Own calculations based on the tax dataset