Education and Wage Inequalities under a Counterfactual Scenario of Minimum Wage

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Abstract: The main purpose of this paper consists in quantifying the impact of a minimum wage adjustment upon wage inequality in Romania. In general, rigorous minimum wage impact assessment upon wage distribution is quite difficult to conduct mainly because of data access limitations to longitudinal information available at individuals' level. In this paper an innovative approach is proposed for building a counterfactual scenario through the use of quarterly survey micro-data provided by the National Institute of Statistics. The period analysed in this paper regards the time-interval Q2 2014-Q3 2014. There are several reasons for this choice. First, it concerns data availability restrictions and second, the need to identify two consecutive periods corresponding to a window-frame right before a minimum wage adjustment and immediately after it took place. In order to check the impact on gender wage inequalities, a 1:1 matching procedure was applied for the construction of two distinct gender groups of individuals that were similar in observable characteristics. Both socio-demographic and economic factors are considered. When comparing the changes registered right after the minimum wage adjustment, we noticed a reduction in gender wage inequalities, as males' chances to earn more in comparison to females drop.

Keywords: wage inequalities; minimum wage; counterfactual scenario; education; wage distribution.

JEL Classification: J31; C82

1. Introduction

The main aim of this paper consists in assessing the impact of a minimum wage adjustment upon wage inequality in Romania. In general, minimum wage impact assessment on wage distribution is a rather difficult and challenging process, firstly because of data availability limitations regarding gross wage information at individuals' level in a longitudinal perspective. Secondly, there are methodological restrictions when conducting rigorous impact assessment on wage inequalities,

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such as the need for complex micro-simulations analysis under the assumption of a counterfactual scenario.

The main benefits of a counterfactual scenario analysis consist in the fact that it produces an estimation of what the net impact of a minimum wage adjustment would be noticed in the wage distribution, based on a comparison between the individuals' new wage level registered after the adjustment took place and the level of wages the individuals would have registered in the absence of the change in the minimum wage. Such a counterfactual outcome of what would have happened in the absence of the change in minimum wage is, however, never observed. So, specific statistical methods have to be applied in order to estimate the hypothetic situation.

In this paper we propose an innovative approach for building a counterfactual scenario through the use of quarterly survey micro-data. The Romanian Labour Force Survey (LFS) database provided by the National Institute of Statistics was used in the current study in order to investigate the impact of minimum wage adjustments on wage inequalities.

The period analysed in this paper regards the time-interval Q2 2014-Q3 2014. There are several reasons for this choice. First, there was the restriction on data availability, and second, we needed to find two consecutive quarters corresponding to a window-frame right before and immediately after a minimum wage adjustment. Actually, in case of the year 2014, there were two adjustments registered in the minimum wage level, as follows: a first change occurred in the beginning of 2014 when the gross minimum wage rate increased from 800 to 850 lei, while the second adjustment took place in July 2014, when the minimum wage increased up to the level of 900 lei.

Since the counterfactual scenario requires an assumption about what would have happened in the absence of the wage policy, we decided to rely on the available quarterly micro-data corresponding to the period Q2 2014 (right before the second change in minimum wage) and Q3 2014 (right after the change took place). Although there are several potential approaches on how to build the counterfactual scenario, because of the short time-horizon considered in this paper, we formulated the assumption that wages would have kept unchanged in the third quarter as compared to the previous one in the absence of the change in the minimum wage. The counterfactual assumption makes sense as empirical evidence show that, in general, on a short-term quarterly base and for the case of Romania, there is a rather high degree of stability in the wage distribution.[1].

In order to check the impact on gender wage inequalities in a robust manner, a 1:1 matching procedure was applied and two distinct gender groups of individuals

[1] See (Popescu & Miliaru, 2017).

similar in observable characteristics were built. Several socio-demographic and economic factors were considered in the analysis. The database has limited information on individuals' wages as it comprises only the net wage decile to which employees belong, instead of providing the effective net/gross wage at micro level. Under such data availability restrictions, the methodological approach for assessing minimum wage impact was limited to the estimation of an ordered logit model under a counterfactual scenario.

When comparing the changes registered right after the minimum wage adjustment, we noticed a reduction in gender wage inequalities, as the chances of males to earn more and move to higher wage decile than females drop by almost 46 percentage points. Our findings also suggest that educational attainment plays an important role in increasing the chances for higher wages, especially for the case of females.

2. Short Literature Review

Regarding the main factors that can explain wage inequalities through the use of micro-data, the Mincer model (1974) can be considered an effective tool that also captures the rate of return on education and work experience. It explains not only how wages depend on attributes such as years of schooling and work experience, but also on the rate of return on education – seen as an interest rate for investing in human capital. Several studies followed Mincer's approach (Ashenfelter & Rouse, 1998), while more recent studies have updated the list of attributes that could explain wage inequalities (Vasilescu et al., 2010).

The estimation of the effects of minimum wage adjustments on wage distribution has been approached in a number of distinct manners, that where based on one common element. It all involved estimating a counterfactual distribution, based on a hypothesis on what would have happened to the wage distribution in the absence of the policy change. In the difference-in-differences (DID) approach, for example, it involves a comparison between the treatment and the control group, followed by a comparison of pre- and post-treatment. The post-change counterfactual distribution of the treatment group is then estimated under certain assumptions using the treatment group pre-change distribution and the pre- and post-change distributions for the control group (Athey & Imbens, 2006).

According to international practice, there are several counterfactual approaches available, based on how the scenario assumptions are formulated. For instance, the simplest counterfactual scenario implies that, in the absence of a minimum wage increase, there would be no change in wages. The hypothesis is rather restrictive, as variations in wage distributions occur over a period of time, even in the absence of minimum wage adjustments. However, in our case study, the hypothesis could

work quite well as the time interval between the two moments (pre and post-change) is extremely short, being limited to one quarter.

Another possible counterfactual scenario could be based on a comparison of two parts of the same wage distribution (Stewart, 2011). The equivalent identification hypothesis used in this case assumes that the minimum wage policy only affects one part of the distribution, while leaving the other part of the distribution unaffected. This assumption could work as the net impact of the wage policy can be computed as a pre- and post- difference between a group of individuals that were affected by the policy and a control group that was not affected by the policy change, which may be true in some empirical situations for distinct parts of the same wage distribution. This hypothesis could be plausible especially because the employees at the top of the distribution tend not to be affected by the minimum wage increases. More precisely, most empirical studies have shown that employees above the median level tend not to feel the economic effects of the minimum wage increases.

Another counterfactual scenario assumes that in the absence of a change in the minimum wage, all wages would increase in line with the median level of wage earnings. Such a scenario was proposed by Lee (1999) and later used in many empirical studies (Autor et al., 2016; Teulings, 2003).

In general, there are two types of methodological approaches in estimating wage inequalities. On the one hand, there are OLS regressions applied for quantifying average wage inequalities, while on the other hand there are quantile regressions which can allow for unobservable factors to also be considered when explaining each individual's position in the wage distribution.

For instance, Pereira & Martins (2004) applied quantile regressions to study the impact of education on wage inequality in 16 countries during 1993-1995 and concluded that in most countries the dispersion of wage inequalities increases with schooling. In another study, Fournier & Koske (2012) quantified the effects of the following factors on a group of 32 countries through the use of quartile regressions: gender, age, number of hours worked and the highest degree of education obtained. Their findings suggested that women have less employment opportunities than men, and those who work earn less than men. Besides that, they brought empirical evidence to support the fact that policies aiming to increase graduation rate for upper secondary education tend to reduce wage inequalities.

Considering the empirically based international literature in the field, we conclude that finding proper means to estimate the ex-post impact of the minimum wage policy and to explain the role of the main determinants of wage inequalities could provide valuable support to policy makers in their attempt to reduce wage inequalities.

3. Research Methodological Framework

This chapter presents the research methodological framework, structured as it follows. We begin by presenting the main particularities of the micro-dataset and then we describe the statistical methodology used to assess the minimum wage impact on wage inequalities.

3.1. Datasets

For this study we used the LFS database provided by the Romanian National Institute of Statistics. The database provides national representative data collected on quarterly bases in households, at individual level. Information on both socio-demographic and economic characteristics concerning occupational status, work, occupation, main and secondary activity and hours worked of each individual aged over 15 were available.

Our study was conducted over the period Q2 2014 – Q3 2014 and focused only on employees. Therefore, all unemployed persons, as well as self-employed persons were excluded from the initial database. The sample used in our analysis comprised in the end a number of 15631 individuals for the second quarter and 15718 for third quarter of 2014.

Due to database specificity and econometric reasons the following information at individual level was considered in our analysis through the form of categorical variables, as presented in Table 1.

The data preparation implied building dummy variables for each variable's category. Thus, four dummy variables were generated for the age variable and the middle age group (*45-64 years*) was considered as a reference base and was therefore excluded from the estimation.

Table 1. Information available at individual level used in the study

Types of information	Individual characteristics	Sub-categories
Socio-demographic characteristics	Age	*age15-24, age25-44, age45-64, age over 65*
	Level of education	*EDUC0* for no education, *EDUC1* for primary or lower secondary education, *EDUC2* for upper secondary or non-tertiary secondary education *EDUC3* for higher education
	Gender	*Male* or *Female*
Economic variables	Economic sectors	*Industry, Constructions, Private services, Public services* and *Other sectors*

Source: Authors own computations using LFS database

Other four dummy variables were built in order to define the level of education, while the dummy variable corresponding to higher education (i.e. ISCED 5-8) was considered as reference base. The gender variable was assumed to take value 1 in case of *Males* and 0 in case of *Females*, while the dummy variables for the economic sectors implied a regrouping of the initial economic sectors into the following variables: *Industry*, *Constructions*, *Private services* (including Wholesale and retail trade, Transportation and storage, Accommodation and food service activities, Information and communication, Financial and insurance activities, Real estate activities, Professional, scientific and technical activities, Administrative and support service activities), *Public services* (including Public administration and defence, Education, Human health and social work activities, Arts, entertainment and recreation), and *other sectors* (including the rest of economic sectors) which was considered as reference base.

3.2. The Research Methodology

In this paper we propose an innovative approach for building a counterfactual scenario through the use of quarterly micro-data for the period Q2 2014 (right before a change in minimum wage) and Q3 2014 (right after the change took place). The counterfactual scenario was built on the assumption that wages would have kept unchanged in the third quarter as compared to the previous one in the absence of the change in the minimum wage.

In order to check the impact of minimum wage on gender wage inequalities we applied a 1:1 matching procedure that resulted into two distinct gender groups of individuals, similar in observable characteristics but with the difference that one group is made up entirely by males and a control group made up by females. For that, a probit model was first estimated using as covariates the variables described in section 3.1 and as dependent variable the gender binary one. The model also generated propensity scores for each individual that were later used in the matching algorithm.

The 1:1 matching procedure assumed applying a Nearest Neighbour matching algorithm (NN) which selects the comparison units with the propensity scores closest to a specific treated unit (Roman & Popescu, 2015). The same matching procedure was applied at both moments (Q2 and Q3 2014) so to consider both the pre- and the post-policy change moments.

Next, because the LFS database only provides information on the decile each employee's net earnings belong to, none of the most common empirically tested methodologies on distributional impact analysis could be applied. So, instead of using the classical OLS or the quartile regression methods, a distinct approach was proposed based on ordered logit models estimation.

In the logit model framework the estimates are based on a maximum likelihood function in order to determine the conditional probability of an individual to belong to a category (Y takes values 0 or 1) according to certain independent variables x_1, x_2,...,x_k. The logit model has the following general form:

$$ln\Omega(x) = \beta_0 + \sum_{j=1}^{k} \beta_i x_{i,j}.$$

where $\Omega(x) = \frac{Pr(y=1|x)}{Pr(y=0|x)} = \frac{Pr(y=1|x)}{1-Pr(y=1|x)}$ and $\Pr(y = 1|x) = x\beta + \varepsilon$ is a linear probability model, for which we restricted the probabilities to the interval [0,1] and obtained $\Omega(x)$.

In the case of an ordered logit model, the probability of an individual to belong to a category versus a smaller or a larger category is estimated, since the values of the dependent variable are ordered: $\Omega_{\leq m|>m}(x) = \frac{Pr(y \leq m|x)}{Pr(y>m|x)}$. Thus, in an ordered logit model the dependent variable is assumed to be equally spaced, while the ordering makes sense (i.e. it verifies the hypothesis of proportional chances).

4. Main Findings

As briefly presented in the previous section, the first step conducted in order to apply the impact assessment methodology consisted in estimating a probit model for each of the two moments considered: right before the change in minimum wage (Q2, 2014) and respectively, right after the change took place (Q3, 2014). The dependent variable consisted in the gender binary variable that took value 1 for Males and 0 for Females.

This step was required in order to estimate the propensity scores for each individual at both moments of time considered. The main results of the estimations are summarized in table 2.

According to the odds ratio resulted from the two probit models estimated on the entire initial data sample, we can draw a general profile of the male employees which tend to work especially in Constructions as compared to other economic sectors and have higher chances to have other than higher education level. On the other hand, females seem to have higher chances to work in the Industry sector, in private or public services as compared to other sectors.

Table 2. Probit models estimations explaining wage inequalities

	Q2 2014			**Q3 2014**		
Treatment: Male	*Coef.*	*Std. Err.*	*Odds ratio*	*Coef.*	*Std. Err.*	*Odds ratio*
Industry	-0.22	0.02	*0.80*	-0.18	0.02	*0.84*
Construction	0.17	0.03	*1.19*	0.23	0.02	*1.26*
Private servicies	-0.28	0.02	*0.76*	-0.24	0.02	*0.78*
Public Services	-0.42	0.02	*0.66*	-0.38	0.02	*0.68*
EDUC0	-0.10	0.17	*0.90*	0.09	0.26	*1.10*
EDUC1	0.03	0.02	*1.04*	0.04	0.02	*1.04*
EDUC2	0.03	0.01	*1.03*	0.03	0.01	*1.03*
age15_24	-0.03	0.02	*0.97*	0.00	0.02	*1.00*
age25_44	-0.05	0.01	*0.95*	-0.04	0.01	*0.96*
age65+	0.30	0.06	*1.35*	0.16	0.08	*1.17*
No. obs.=	15631			15718		
Pseudo R2=	0.0646			0.067		
LR chi2(10)=	1388.72			1448.1		
Prob>chi2=	0.00			0.00		

Source: Authors' own computations

Based on the Probit model, the propensity scores for each individual of the two groups of males and females were generated and then plotted in order to see the degree of similarities between the two groups (males versus females). One can clearly see that there is no symmetrical correspondence of the propensity scores distributions between the treated and the untreated groups, meaning that a matching technique is required in order to obtain a more similar distribution. The distributions of the propensity scores before matching are plotted in figure 1.

In order to apply the matching algorithms, the balancing property of the model was first tested and confirmed (Becker & Ichino, 2002). Using the *psmatch2* command in STATA 14 the common support was automatically included, in order to identify the range of probability that contains the observations with enough common features to be taken into consideration. A 1:1 matching procedure was applied and resulted into two distinct gender groups of individuals similar in observable characteristics but with the difference that one group is made up entirely by males and a control group made up by females.

Then two ordered logit models were estimated corresponding to the two quarters under analysis (see Table 3). Although the Pseudo R^2 test values are rather small in both cases, we accept such biases due to the current data limitations. The dependent variable considered was a categorical one, taking values from 1 to 10 according to the correspondent decile.

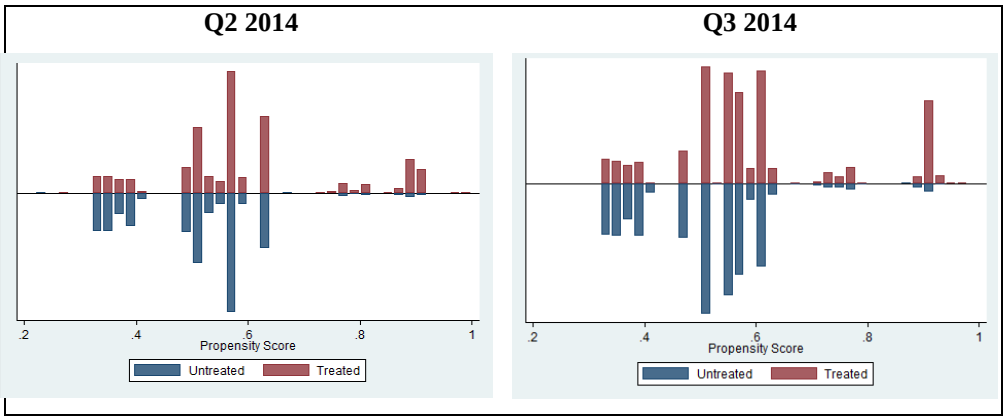

Figure 1. The propensity scores of the treated and the control groups before matching
Source: Authors' own computations

Based on these models we were able to estimate the importance of several wage determinants upon the individuals odds of getting higher earnings and moving towards a higher wage decile.

Table 3. Ordered logit model estimations explaining wage inequalities

	Q2 2014		Q3 2014	
Dependent: Wage decile	*Odds ratio*	*Std. Err.*	*Odds ratio*	*Std. Err.*
Male	***2.41***	0.07	***1.95***	0.06
Industry	0.50	0.10	0.44	0.07
Construction	0.56	0.14	0.81	0.19
Private Services	0.39	0.08	0.35	0.06
Public Services	0.49	0.10	0.44	0.07
EDUC0	0.06	0.04	0.00	0.00
EDUC1	0.10	0.01	0.11	0.01
EDUC2	0.26	0.01	0.27	0.01
age15_24	0.47	0.04	0.41	0.03
age25_44	0.84	0.03	0.85	0.03
age65+	0.33	0.24	1.17	0.50
No. obs.=	13978		14050	
Pseudo R2=	0.04		0.0353	
LR chi2(10)=	2713.15		2281.26	
Prob. > chi2=	0.00		0.00	

Source: Authors' own computations

Regarding the wage inequalities issues, the most notable finding suggest that the chances of male employees to earn more and move forward to a higher wage decile drop from 2.41 to 1.95 times higher than female employees, during the two

analysed quarters. These results indicate that the minimum wage impact on gender wage inequalities corresponds to a reduction with almost 46 percentage points in males' chances to earn more than females.

Among the socio-demographic characteristics that could explain wage differentials, it seems that the level of education plays an important role in increasing the chances of an individual to earn more. The findings suggest that individuals with low or medium level of education have lower chances to earn more as compared with those with higher education. The logistic output confirms the human capital theory sustaining that education contributes to higher labour remuneration. In this case the lowest chances in having higher earnings correspond to those with no education (EDUC0), followed by the graduates of primary or lower secondary education level (EDUC1) and up to the graduates of secondary or non-tertiary secondary education (EDUC2), for which chances are approximately 74% less than that of highly educated employees.

5. Conclusions

The main purpose of this paper consisted in quantifying the impact of a minimum wage adjustment upon wage inequality in Romania. In general, rigorous minimum wage impact assessment upon wage distribution is quite difficult to conduct mainly because of data access limitations in a longitudinal framework at individuals level.

In this paper an innovative approach was proposed for building a counterfactual scenario through the use of quarterly survey micro-data provided by the National Institute of Statistics. The period analysed in this paper regards the time-interval Q2 2014-Q3 2014. The reasons for this choice was based, on the one hand, in data availability restrictions and on the other hand, in the necessity to identify two consecutive periods corresponding to a window-frame right before a minimum wage adjustment and immediately after it took place. In order to check the impact on gender wage inequalities in a robust manner, a 1:1 matching procedure was applied and two distinct gender groups of individuals that are similar in observable characteristics were built. Both socio-demographic and economic factors are considered. When comparing the changes registered right after the minimum wage adjustment, we noticed a reduction in gender wage inequalities, as males chances to earn more and move forward to higher wage deciles than females drop with almost 46 percentage points. Our findings also suggest that the level of education plays an important role in employees chances of getting higher wages, especially for the case of females.

As a limitation to the study we are aware of the fact that because of data unavailability we had to study the minimum wage impact on wage inequalities using information on wage decile groups instead of the effective gross wage levels.

Thus, our findings could only partially explain the changes in wage inequalities, by assessing how the individuals' chances of earning more and move forward to a higher wage decile can differ between males and females under a minimum wage counterfactual scenario. Further research on the matter is therefore required, through the use of other micro-databases that could allow applying micro-simulations on individuals' gross/net wages in order to estimate the distributional effect of a minimum wage adjustment as well as its other economic and social implications.

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