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Effect of employment tax incentives: the case of disability quota in Hungary

by

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Abstract

This paper evaluates the effect of the Hungarian disability quota - levy system on disabled employment and firm behavior, and also aims to shed light on factors influencing the effectiveness of employment tax incentives. According to the quota rule, firms above a certain size threshold have to employ at least five percent disabled employees or pay a levy in case of non-compliance. The special feature of the Hungarian quota system is the uniquely high levy, which is accompanied by poor labor market integration of the disabled. The estimation exploits two significant policy changes: the drastic raise of the levy in 2010 and the increase of the firm size threshold from 20 to 25 employees in 2012. The policy effect on disabled employment is estimated on firm level data with regression discontinuity design. The baseline RDD results are adjusted to account for the potential bias arising from non-random firm selection, as many firms adjust their size to avoid the quota. The estimated disabled employment effect is high in international comparison, however, almost three-quarter of the quota is not fulfilled. I find evidence that the ratio of disabled population influences the disabled employment effect of the quota. This suggests that low effective labor supply and high (perceived) non-wage costs of hiring disabled are factors behind low quota fulfillment.

JEL: J14,J21,J22,J23,J78,H32

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1 Introduction

The labor market integration of disabled population is a great challenge in all countries. In labor market context, the concept of disability refers to a long term physical or mental health problem that causes serious work limitation, and employment rates of the disabled are usually well below the non-disabled population. Developed countries usually apply an arsenal of different, supply and demand side policies to boost the labor market integration of disabled individuals. Disability quota system is a commonly used element of the toolkit that concentrates on the demand side. Firms, usually above a certain size threshold have an obligation to employ a certain number of disabled employees or pay a tax in case on non-compliance. Thus, the aim of quota-levy systems is to enhance the labor market demand by increasing the relative cost of employing non-disabled employees.

This paper evaluates the effects of the Hungarian disability quota-levy system on employment of disabled persons and firm behavior. In addition, exploiting the special features of the Hungarian quota-levy system, the paper also aims to reveal factors influencing the effectiveness of the policy. The Hungarian quota-levy system is peculiar in terms of the amount of levy compared to wages, which has become one of the highest in the world after a dramatic, 454 percent increase in the middle of the financial crisis in 2010. A unique feature of the system is that the levy is higher than the minimum wage cost of fulfilling the quota. Nevertheless, the quota fulfillment can be considered rather low: more than 70 percent of firms above the threshold chooses paying the levy instead of hiring a disabled employee. This paper aims to shed light on the roots of this contradiction.

In addition to the drastical levy hike in 2010, the identification of the quota employment effect exploits another policy change: the increase of the firm size threshold from 20 to 25 employees in 2012. Similarly to Lalive et al. (2013), Mori and Sakamoto (2017), Malo and Pagán (2014), in the first step the employment effect of the quota was estimated by applying regression discontinuity design (RDD), focusing on the years before and after the two reforms. I find that firms react quickly and intensively to the policy changes. Basic sharp RDD estimations show no significant discontinuity before the levy hike. However, in 2010, when the increase came into effect, more than quarter of the quota is fulfilled thanks to the regulation. A similarly large discontinuity is estimated in 2012 at the increased, 25-employee threshold, while the discontinuity at the old threshold disappears within a single year.

However, probably attributable to the exceptionally high levy, Hungarian firms are more inclined to change the size of their workforce in order to avoid the regulation than in other countries, resulting in a solid bunching in firms' distribution below the quota threshold. The bunching shifts upward with increasing the firm size threshold, confirming that the observed discontinuity in firms' distribution is related to the disabled quota. As the assumption of random firm selection around the quota threshold is violated, baseline RDD might produce an upward biased estimation of the treatment effect. Firm size manipulation was also detected in the Austrian case by Lalive et al. (2013), and they apply a back-of-the envelope method to calculate lower and upper bounds for the treatment effect. For the Hungarian case, where bunching is more spectacular, I estimate the potential magnitude of the bias using a simulation method, using an estimated counterfactual distribution to calculate the mass of firms that keep their size below the threshold on account of the levy. The basic idea is based on the method Lalive et al. (2013), and the estimation consists of the following steps. First a counterfactual distribution is constructed by fitting a power law on firm distribution, omitting observations near the threshold, where the bunching takes place. The number of firms that keep their size below in order to avoid the regulation ("bunchers") are calculated by comparing the counterfactual and the actual firm distribution. In the following step, the calculated number of randomly selected firms are moved above the threshold, that is a simulated sample is constructed such that the resulting firm distribution is smooth. The lower bound of the quota's disabled employment effect is the average of treatment effects of re-estimated RD from a simulation of 100 draws.

Results show that the bias caused by the bunching accounts for at most 40% of the estimated disabled employment effect, the quota strongly increases disabled employment even after controlling for the potential endogeneity bias. The estimated elasticity of substitution between disabled and non-disabled employees is also much higher than found in other countries, suggesting that firms react very sensitively to financial incentives. Regression discontinuity estimations on firm characteristic and the composite covariate index indicates that selection of firms between the treatment and control groups is based on non-observable firm characteristics. However, RD estimations on different subgroups of firms indicate that the disabled employment effect at the threshold strongly depends on firm characteristics. Specifically, firms with lower average wages are more inclined to hire disabled as an effect of the quota, confirming that the level of the levy compared to the average wages influences the reaction of firms. I also find evidence that the employment effect of the quota is stronger in regions where the ratio of disabled population is higher.

This shows that low effective labor supply and high adjustment costs of hiring disabled might be factors behind low quota fulfillment. The effective labor supply of disabled is constrained by many factors, for example lack of capacity in rehabilitation services or high opportunity cost of working. High adjustment costs (cost of recruiting, workplace and job accommodation, integration) and discrimination by employers also might play a role.

The few papers in the literature that study the effects of disabled employment quota usually find positive, but moderate or insignificant effect on disabled employment around the threshold, however, in these cases, the levy is also moderate. The quota system is found to significantly increase disabled employment in Austria (Lalive et al. (2013), Wuellrich (2010)) and Japan (Mori and Sakamoto (2017)). Malo and Pagán (2014) find small positive employment effect for Spain that is significant only at 10 % level,[1] and Nazarov et al. (2015) conclude that changes in the quota system in South-Korea (decrease in employment threshold and increase in fine) have increased labor market participation of disabled, but after controlling for selection into the labor market, had only a limited impact on probability of being employed.

This paper primarily contributes to the quota literature by analyzing the effects of a disabled quota, when the financial incentive is particularly strong. In addition to the significant increase in the levy, I can exploit another significant policy change, the increase in the firm size threshold from 20 to 25. The second policy change serves as a robustness check and strengthen the main findings, as the policy effect changes along with the shift in the threshold.

The paper is also related to the literature that analyzes the effects of demand side employment policies, for example employer-side wage subsidies and other tax incentives, as the basic mechanism of quota-levy systems is similar. Specifically, all these policies operate by decreasing the relative wage cost of disadvantaged groups, thus the quota-levy system can be regarded as a negative subsidy or tax incentive. Empirical evidence on wage subsidies is mixed: there is some evidence that wage subsidies can be effective in enhancing employment of disabled (Datta Gupta et al. (2015)) and disadvantaged unemployed (Kluve (2010)), other papers find that wage subsidies have modest (Katz (1996), Hamersma (2008) or no effect(Baert (2016)). Katz (1996) highlights that elasticity of labor supply and other factors, such as administration costs, stigmatization effect and employer awareness also influence employment and wage effects of wage subsidies. However, little is known about the relevance of the different factors empirically. This paper contributes by showing that other factors beyond labor demand elasticity, such as labor

[1] However, there is no levy accompanied to the quota in the Spain case.

supply constraints and labor market frictions might have a great influence on employment outcomes. The example of Hungarian quota-levy suggests that applying strong financial incentives is not sufficient for achieving policy goals even if firms react sensitively to changes in relative wage costs. Without addressing the underlying frictions on disabled labor market, the quota-levy rather behaves like a size-related tax that puts a disproportional burden on low-wage firms.

The remaining of the paper is structured as follows. The second section describes the institutional setup and mechanism of quota-levy system in Hungary. Section 3 describes the data that are used for the empirical analysis. Section 4 shows the empirical strategy and results of regression discontinuity design. Section 5 shows firm heterogeneity in employment effect and provides evidence for the role of labor supply in the disabled employment effect. Section 6 concludes.

2 Institutional background

The labor market position of disabled individuals (in Hungarian terminology: individuals with changed working capacity) in Hungary seems to be particularly poor in international comparison.[2] The employment rate of disabled in Hungary is one of the lowest in the EU, and the employment rate is only one third of that of the total working age population (see Appendix D, Figure 12).[3] The large discrepancy with other EU countries mainly comes from the very low disabled activity rate, though the disabled unemployment rate is also excessive (see Appendix D, Figure 13).

2.1 Disabled quota system in Hungary

Similarly to other countries, the Hungarian disabled employment policy applies a set of different tools: sheltered and subsidized employment, education, rehabilitation services (for a detailed review, see for example Scharle and Varadi (2013), Scharle and Csillag (2016)). Disabled employment quota is one of the most common tools, which is applied in about one third of OECD countries. OECD (2010). The aim of quota-levy systems is to enhance the labor demand for disabled by increasing the relative cost of employing non-disabled employees. Firms, usually above a certain size threshold have an obligation to employ a certain number of disabled employees

[2]International data are not completely comparable with data of our econometric analysis. Eurostat data are based on the Labor Force Survey and the disabled status is assessed on the basis of self assessment and does not imply official qualification automatically. However, these data give a picture about the magnitude of the problem.

[3]The employment rate is very low even after controlling for age and education differences between disabled and non-disabled (source:Central Statistical Office).

or pay a levy in case on non-compliance. The details - size threshold, levy compared to wages, quota - differ across the countries.

Employment quota has been in force in Hungary since 1991. According to the regulation, practically all employers, firms and public institutions above a size threshold are obliged to employ 5 percent of their average statistical headcount with a certificate of changed working capacity.[4] The status of changed working capacity is attained through a complex assessment process implemented by the rehabilitation authority (National Office for Rehabilitation and Social Affairs, previously Institute of National Rehabilitation and Social Experts).[5] If the number of employed disabled is lower than the quota requirement, the firm is obliged to pay a levy (in Hungarian terminology: rehabilitation contribution) for the missing persons from the quota.

The quota is 5 percent of the yearly average statistical headcount (for details of the yearly average statistical headcount calculation, see Appendix A). The rehabilitation contribution has to be paid for the difference between the number of disabled employees at the firm and the obligatory employment level implied by the quota, that is 5 percent of the average headcount.

Working time of disabled employees must reach or exceed 20 hours per week to be considered in the quota. However,once this minimum is attained, the working time is not relevant: a half-time disabled employee is treated in a same way as a full-time disabled, that is regarded as a full person in the quota.[6]

A specialty of the Hungarian regulation is that the quota is not rounded to an integer number, but it is rounded to one decimal digit. (The same applies for data both in the denominator and the numerator in the quota: the average headcount and the average number of disabled are rounded to one decimal digit.) Thus, if the threshold is 20 employees, a firm with 25 employees that employs one disabled still has to pay the levy for a quarter missing person, has to overfill the quota if wants to avoid paying the levy. This rule implies that we can expect discontinuity in the number of disabled workers only at the threshold (20 employees up to 2012 and 25 employees

[4]There are only a few exemptions, for example the organizations of Armed Forces. Additionally those who employed in some special forms of communal and temporary employment also do not count toward the headcount of the company, that is the base of the rehabilitation contribution. First, the rehabilitation contribution was regulated in the ACT IV. of 1991 on Job Assistance and Unemployment Benefits. Since 2011, the quota rules are encoded in Act CXCI of 2011 on Allowances for Persons with Disabilities and the Amendment of Certain Legislation.
The threshold was 30 employees up to 1997, then it was reduced to 20 employees from 1997. In 2012, the threshold was increased again to 25 employees. Number of employees is considered as yearly average headcount.

[5]A person is qualified with changed working capacity if her overall health status does not exceed 60 percent, that is, the overall health impairment at least 40 percent, or her working capacity is reduced at least by 50 percent. The status also implies eligibility to official rehabilitation and disability benefits.

[6]Note the discrepancy in recognition of part-time between total staff and disabled workers: a disabled employee is counted in the quota only if her contractual working time is minimum 20 hours per week, that is roughly 80 hours per month, compared to the 60 hours/month lower limit in case of average headcount.

afterwards). Firms have to declare and pay their obligation to the national tax authority on a quarterly basis.

2.2 Policy changes

There were two major changes in the quota regulation in the last decade.

1. Starting from 2010, the amount of the levy was increased dramatically, by 454 percent, from HUF 174 thousand per year per missing employee from the quota to 964 thousand HUF. In 2010 the levy amounted to 86 percent of the total labor cost (gross wage plus employer's contributions) of a full-time non-disabled minimum wage earner, and 31 percent of the labor cost of an employee with average wage.

   After the 2010 increase Hungary became one of the top OECD countries in terms of the amount of levy compared to average wages. In 2010, the levy amounted to about 2 percent of average payroll, in contrast with the typical 0,25-1 percent in OECD countries (OECD (2003)). What makes the Hungarian system really unique is not the high levy/average wage but that it is higher than the minimum cost of the quota fulfillment. Note that this increase, which put a significant burden on firms, came into effect in the middle of the financial crisis, after a more than 6 percent GDP loss in 2009.

   The first announcement about the increase was made in February 2009, and the law was signed in June of 2009. As a consequence, some firms already reacted in 2009, therefore the effects of the policy change are partly reflected in the 2009 data.

2. In 2012, the employment threshold was increased from 20 to 25 persons, while the amount of the levy remained unchanged.[7]

In this paper, I focus on these two policy changes in order to reveal the effects of the disabled employment quota in Hungary.

3 Data

The empirical analysis is based on the corporate tax data set of Hungarian double-entry book-keeping firms. The database contains administrative tax files data collected by the National Tax and Customs Administration (NAV) of all double-keeping Hungarian firms from 2006-2013.

[7] see Act CXCI of 2011 on allowances for persons with disabilities

Tax files comprise detailed balance sheet and income statement data of firms as well as firm characteristics, such as industry, location, number of employees, ownership structure.

The corporate tax database does not contain information on the actual levy payment, as the rehabilitation contribution is filed in a different tax form on a quarterly basis. However, corporate tax files also contain number of disabled employees.As both tax statements are gathered and stored by the NAV, the reliability of the data can be considered high. For firms, for which data for number of disabled workers is missing, but there is data on total employment, I replace missing data to zero disabled employee. The imputation concerns large number of observations. However, tax database after the imputation and aggregate information about the levy revenues yields very similar results for the number of missing persons from the quota (for details, see Appendix B). This implies that the reliability of the data on the number of disabled persons is very high, and the imputations do not threaten the validity of the results. The correspondence of levy revenue and disabled employment data also suggests that the enforcement of the regulation is high; firms do in fact pay the levy if they do not meet the quota requirements.[8]

In the corporate tax database, the number of total employees of the firm is expressed with the yearly average statistical headcount, however, average yearly headcount of employees is rounded to an integer number due to the general rules of rounding. In contrast, the quota requirement is computed using average yearly headcount that is rounded to one decimal digit, and the quota itself is expressed as a number with one decimal digit (see Section 2). Due to discrepancy in rounding rules, the calculated quota requirement based on NAV database data might differ from the actual quota requirement that is prescribed by the law. Implications of differences in rounding rules to the estimation are discussed in Section 4).

Basic descriptive statistics from the corporate tax database are summarized in Appendix F, Table 17. The total number of disabled employees at firms does not exhibit much increase in 2010, after the significant increase in the levy. However, it seems that majority of disabled employees is employed in sheltered employment, at special accredited firms. Firms where the share of disabled employees reaches 40 percent of total work force, have the possibility to apply for a special status that implies wage and other subsidies. This status can be achieved through a process of accreditation, in which the firms have to meet some criteria to prove that they are able to rehabilitate disabled employees. As the analysis focuses on the open labor market, I excluded

[8]However, consistency of disabled employment and levy revenue data does not exclude the possibility that firms try to escape paying the levy by falsely reporting disabled employment. However, high cost of being found in fault in case of labor inspections is a serious disincentive, and internationally high levy revenues also suggest compliance,therefore I disregard this possibility in the estimation.

firms from the estimations where the share of disabled employees exceeded 40 percent.

In 2010, the levy amounted to 86% of total labor cost of a full-time minimum wage earner, 170% of a half time minimum wage earner, and 31% of a full-time average wage earner. As the quota can be fulfilled also with a part-time (minimum half-time) worker, hiring a disabled minimum wage earner even with zero productivity would incur lower cost by 70 % than paying the levy, if we disregard adjustment costs of employment and assume that and firms are able to hire disabled employees on this wage level. Despite the strong financial incentive, majority of firms chose not to employ disabled workers but pay the non-compliance levy instead. The quota fulfillment, that is the ratio of the quota that is filled with disabled employees is less than 30 % even after the levy hike (see Table 17).[9] The quota fulfillment can be assessed as low in international comparison, as usually 50-90% of the quota is filled with disabled employees.[10]

The low quota fulfillment is also reflected in the high aggregate levy revenue which increased from 0,06 percent of GDP in 2009 to 0,24 percent of GDP in 2011, around 65 billion HUF. As a comparison: total revenue from corporate tax was approximately 2 percent of GDP in 2011, thus the revenue from non-compliance levy can be considered as substantial. One of the main questions of the following analysis is whether the low performance is due to the fact that firms are not sensitive to the strong financial incentive,or other factors impede disabled employment.

4 Empirical strategy

4.1 Firms' options

Firms that are subject the regulation and do not employ enough disabled workers to fill the quota face the following choices:

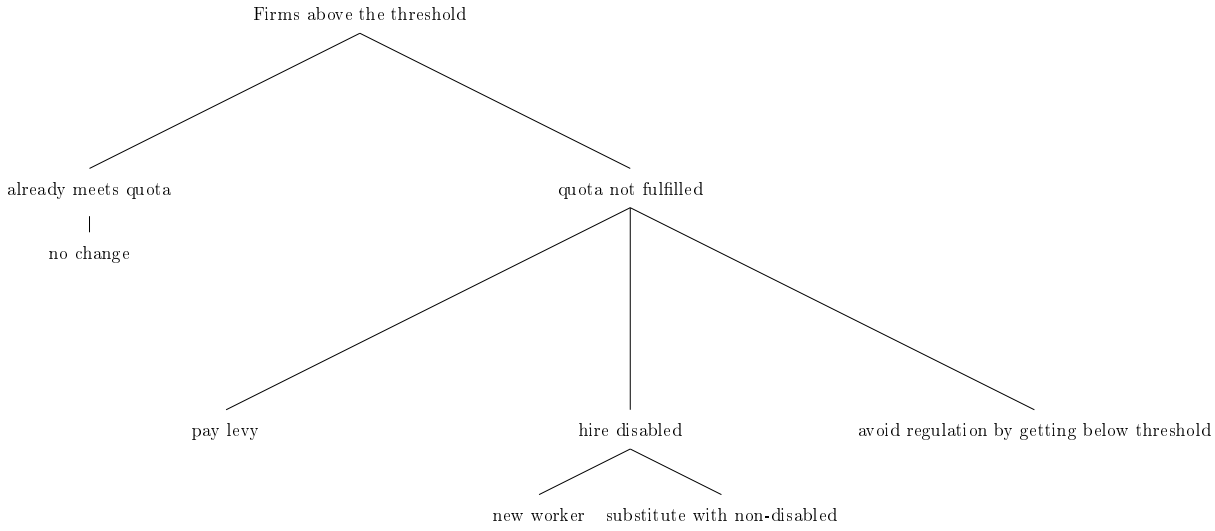
- Hire additional disabled worker(s)
- Substitute non-disabled employees with a disabled worker

[9]The quota fulfillent can be measured in different ways, depending on the assessment of overfilling the quota. The lowest estimation for quota fulfillment is given by comparing empty positions to the quota: (1-missing employees from the/quota)as this method disregards number of disabled employees who are employed above the quota requirement (11. and 15. row in table 17. Relating the number of employees in non-special firms to the quota yields a somewhat higher quota fulfillment, as disabled employees in firms that employ more disabled that required by the quota also are taken into consideration in this case (12-16. rows in the table).

[10]In OECD (2003), the quota fulfillment was estimated to 64% in Austria, at least 50%in Italy, 46-72% in Korea, 57% in Germany, 64% in France. Close to 90% of the quota is fulfilled in Japan Mori and Sakamoto (2017). The most similar case to Hungary is Poland, where quota fulfillment was similarly low at around 30% and the levy was relatively high above 2% of average payroll. citeoecd2006)

- Pay the levy
- Avoid regulation by reducing or keeping employment below the threshold.

A firm might indeed reduce its labor demand and run with less employees to avoid the regulation, but this category also includes firms that manipulate their official size while the true employment remains the same. This can happen for example by contracting out employees, employing unreported workers or increasing the working time, that is decrease employment on the extensive margin while increase it in the intensive margin.



Firms' choice first of all depends on the amount of the levy compared to labor costs of disabled and nondisabled employees, the substitutability between disabled and non-disabled employees and the marginal revenue product of disabled and nondisabled. A firm of which optimal size without the quota is above the threshold, will choose its size below the threshold if the loss from employing less than optimal employees is lower than both the cost of hiring a disabled (either as a new hire or subsitution) and the levy. Clearly, this choice is relevant only for firms for which the non-quota optimum is not far above the threshold. A firm will choose paying the levy instead of employing a disabled, if the profit loss of employing a disabled worker (either with or without substitution) is higher than the levy. The lower is the levy compared to nondisabled wages, the labor costs of hiring disabled compared to labor costs of nondisabled, and the lower is the relative (percieved) productivity of disabled compared to nondisabled employees, the more probable is that a firm will choose paying the levy. Regarding the labor costs of disabled employees, both wages and non-wage costs might differ from those of nondisabled employees.

Following from the potential responses of firms, I analyze the effect of the quota - levy system on the employment of disabled persons, and as the quota-levy poses non-negligible burden on firms, I also analyze the effect on firm behavior. I also aim to reveal the factors influencing the effectiveness of the effectiveness of the policy by analyzing the contradiction between low quota fulfillment and high levy.

4.2 Disabled employment effect with sharp discontinuity design

As a starting point, I estimate the effect of the quota-levy system on disabled employment using sharp regression discontinuity design framework (RDD). The RDD is estimated separately for every single year from 2007 to 2012. These regressions show how the effect of the policy changes year to year around the threshold.

Firms with at least 40 % of share of disabled employee ratio are presumably special accredited firms (for the details see Section 3), hence these firms are excluded from econometric analysis.

In the sharp regression discontinuity design, the observed outcome is:

$$Y_{it} = \begin{cases} Y_{it}(1), & \text{if } emp_{it} >= c_t \\ Y_{it}(0), & \text{if } emp_{it} < c_t \end{cases}$$

$Y_{it}(1)$ = outcome for a randomly chosen population unit if treatment is imposed exogenously $Y_{it}(0)$ = outcome for a randomly chosen population unit if excluded from treatment exogenously.

Where *emp* is the variable that divides the population into treated and control groups (running variable), in our case the number of employees at the firm), and c is a cutoff value of emp_{it}, so firms with number of employees above the cutoff belong to the treated group. For assessing the effect of the regulation on disabled employment, the outcome variable Y is the number of disabled employees (*disemp*), but I also look for discontinuities in variables of firm performance, such a wages, productivity, profitability at the quota threshold.

We are looking for the treatment effect at the threshold, that is:

$$\tau = E(Y_i(1) - Y_i(0)|X_i = c)$$

$$\tau = \mu_+ - \mu_-$$

where

$\mu_+ = \lim_{x \downarrow c}$, $\mu_- = \lim_{x \uparrow c}$, $\mu(x) = E(Y_i | X_i = c)$

A crucial identifying assumption of the RDD is the exogeneity of selection into the treatment group. However, firms with employees close to the threshold employment level have an incentive to stay or get below the threshold, that is to keep their employment under 20 and under 25 employees after 2012 and avoid the regulation completely. Thus the firm size is endogenous, as firms close to the cutoff might self-select themselves between the treatment and control groups. Non-random firm selection might distort the estimated treatment effect. In the following, I am going to present the results from the baseline (naive) specification, then I am going to adjust the results to account for the potential bias arising from the firm size manipulation.

Figure 1 and 2 show average number of disabled employees in firms by number of employees in different years and the fitted 4th order polynomial on both sides of the cutoff using the optimal plotting method of Calonico et al. (2015). Figure 1 suggest that the most striking increase in disabled employment is not between firms with 19 and 20 employees, but between firms with 20 and 21 employees in 2010. Similarly, in 2012, when the threshold was increased to 25 employees, sharp increase can be detected also between firms with 25 and 26 employees in addition to discontinuity between 24 and 25 employees.

Differences in rounding rules between employment data in the database and in computation of mandatory quota might explain this "double" discontinuity. Namely, the average headcount is rounded to an integer number in the NAV database, while the quota regulation is based on the average headcount that is rounded to one decimal digit (for details, see Section 2). Consequently, the category of firms with exactly 20 employees in the database is a mixture of treated and non-treated firms.[11] Therefore I omitted firms with exactly 20 employees from the RDD regressions as those firms might be both above and below the legal threshold.

The treatment effect is identified nonparametrically by using the method of Calonico et al.

[11] This group contains firms with average size between 19.5 and 20.4 employees. These firms show up with 20 employees in the database as their size is rounded to an integer number. However, firms with average number of employees between 19.5 and 19.9 are not subject of the quota regulation, as rounded to one decimal digit, their headcount is below 20 employees, that is these firms are below the legal threshold. However, firms between 20.0 and 20.4 employees are already required to meet the quota or pay the levy.

Figure 1: Average number of disabled employees by firm size, 2008-2010

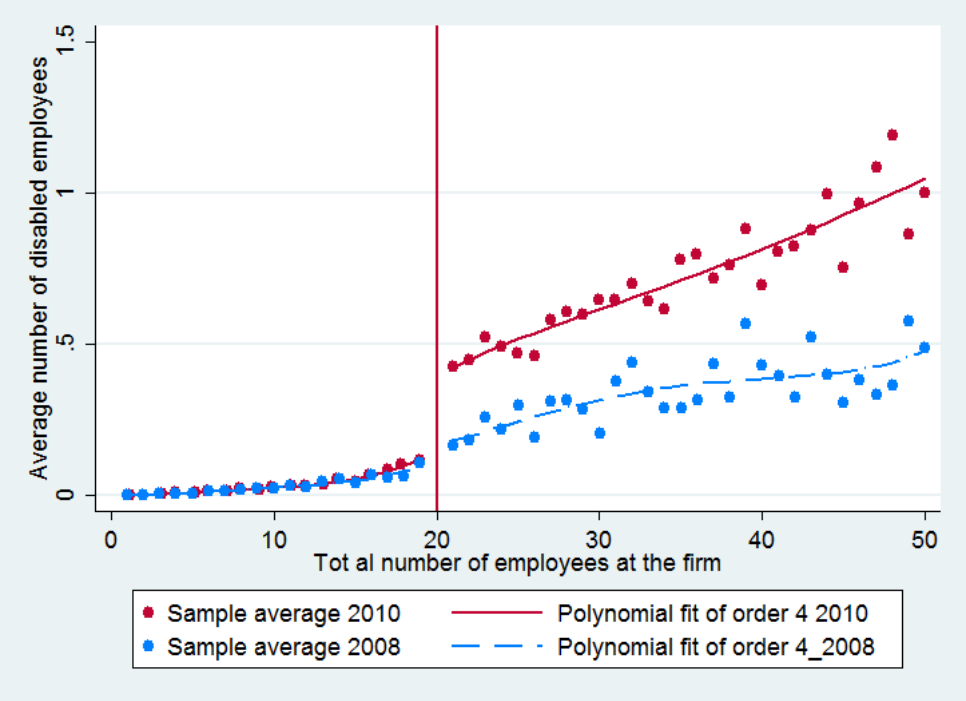
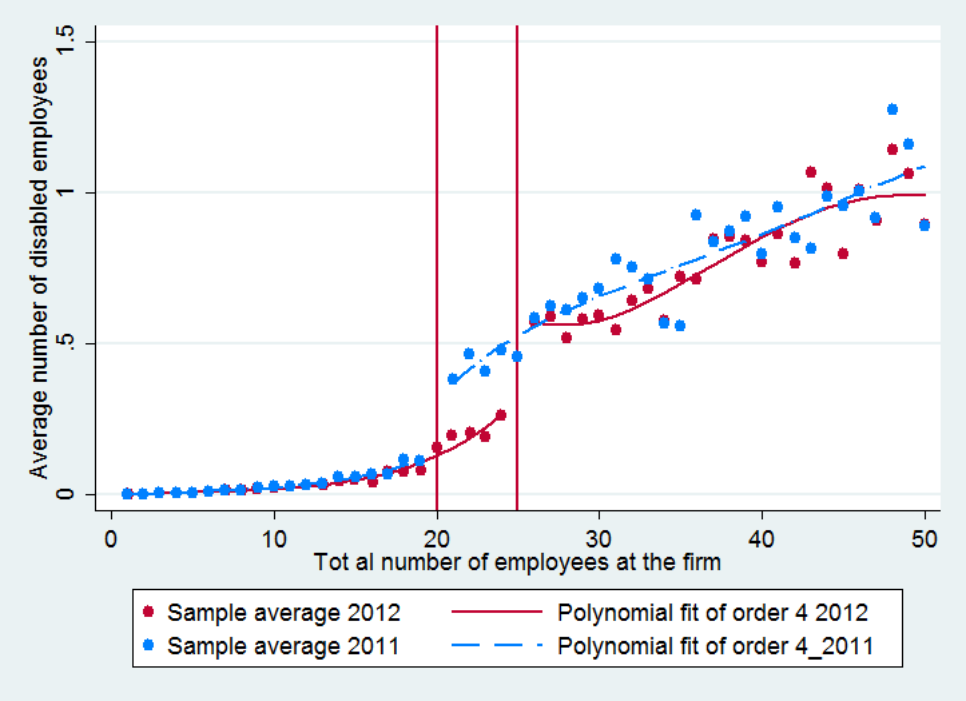


Figure 2: Average number of disabled employees by firm size, 2011-2012



(2014) that applies kernel-based local polynomials on both sides of the threshold. Specifically,

$$\hat{\tau_p} = \hat{\mu}_{p,+}(h_n) - \hat{\mu_{p,-}}(h_n)$$

Table 1: Rdrobust results, c=20

	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
τ **robust**	0.086	0.079	0.017	0.099	0.285	0.244	0.063
robust SE	0.034	0.042	0.041	0.04	0.046	0.043	0.035
adj SE robust	0.044	0.052	0.061	0.05	0.056	0.053	0.055
τ **conventional**	0.084	0.068	0.028	0.106	0.288	0.245	0.068
conventional SE	0.03	0.036	0.036	0.035	0.039	0.037	0.031
adj conv SE	0.039	0.047	0.055	0.045	0.05	0.042	0.044
bandwidth	6.55	3.365	5.135	6.144	7.086	6.788	5.668
eff. # of obs(l)	7563	3004	5294	6672	8819	8188	5663
eff. # of obs(r)	3137	1711	2545	2766	2815	2733	2572
order of p	1	1	1	1	1	1	1

Where $\hat{\mu}_{p,+}(h_n) = \mathbf{e}_0^{'}\hat{\beta}_{p,+}(h_n)$ and $\hat{\mu}_{p,-}(h_n) = \mathbf{e}_0^{'}\hat{\beta}_{p,-}(h_n)$.

with:

$$\hat{\beta}_{p,+}(h_n) = argmin \sum_{i=1}^{n} \mathbb{1}(emp_i >= c)(Y_i - \mathbf{r}_p(emp_i - c)^{'}\beta)^2 \mathbf{K}_{h_n}((emp_i - c)$$

and

$$\hat{\beta}_{p,-}(h_n) = argmin \sum_{i=1}^{n} \mathbb{1}(emp_i < c)(Y_i - \mathbf{r}_p(emp_i - c)^{'}\beta)^2 \mathbf{K}_{h_n}((emp_i - c)$$

Where $\mathbf{r}_p = (1, x, ...x^p)$, $\mathbf{e}_0 = (1, 0, ..0) \in \mathbb{R}$, $K()$ is a kernel function, h_n is the bandwidth.

The advantage of this method compared to the OLS is its flexibility: it allows for non-linear relationship between the running and the dependent variables and the bandwidth is also estimated by minimizing mean squared error instead of an arbitrary choice.(The specification and the results of the OLS model can be found in the Appendix C.)

As the method of computing optimal bandwidth (see Calonico et al. (2014) does not work because of discrete running variable, I make the running variable continuous by adding a uniformly distributed random number $u \sim [-0.5, 0.5]$ to the number of employees *emp* and estimated the RDD with this created running variable. I simulate the running variable 100 times and present the τ as an average of the 100 estimations. In the table I present the average of standard errors and adjusted standard errors, which were computed by adding the standard deviation of the simulation to the average standard error of the simulations.

Table 2: Rdrobust results, c=25

	2010	2011	2012
τ **robust**	-0.145	0.034	0.289
robust SE	0.092	0.088	0.057
adj SE robust	0.122	0.118	0.067
τ **conventional**	-0.115	0.063	0.284
conventional SE	0.083	0.078	0.049
adj conv SE	0.112	0.104	0.06
bandwidth	4.792	5.203	8.163
eff. # of obs(l)	2000	2344	5461
eff. # of obs(r)	1501	1570	2269
order of p	1	1	1

The results (Table 1 and 2) show very strong firm reaction to changes in the levy and the quota threshold. There is no significant discontinuity in disabled employment in 2008, when the levy was very low. The treatment effect is already significant in 2009, denoting that the expected number of employed disabled is higher above the quota threshold as firms have already started adjustment in 2009. The estimated treatment parameter is much higher in 2010, after the dramatic hike in the non-compliance levy that came into effect in 2010. Strikingly, in 2012, when the threshold was increased to 25 from 20 employees, the discontinuity at the old threshold disappears, but a new discontinuity of similar magnitude emerges above the new threshold, 25 employees, that was missing in 2011.

The parameter can be interpreted as firms just above the threshold employ 0.244-0.285 additional disabled worker on account of the quota-levy regulation in 2010 -2011, that is roughly 24.4-28.9 percent of the quota is fulfilled because of the levy. Important to note that this number can be regarded large compared to the few estimations in the literature, for example Lalive et al. (2013) estimate that 4 percent of the quota is fulfilled thanks to the regulation.

4.3 Endogeneity of firm size

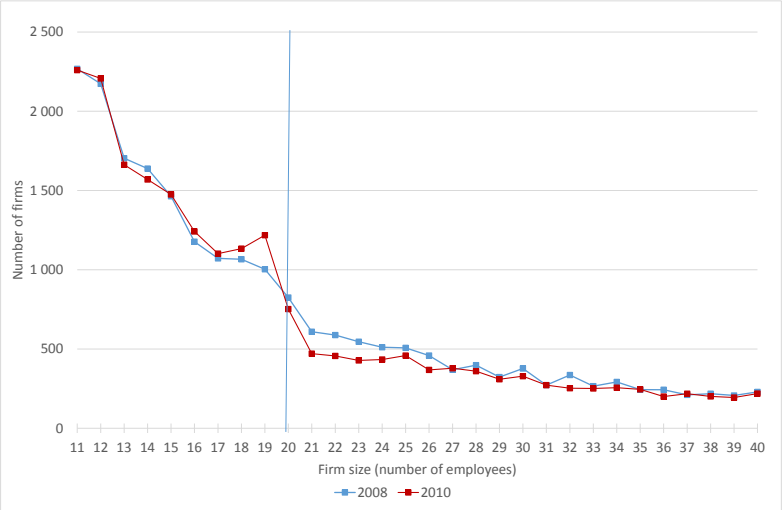
Given the firms' incentive to avoid the quota-levy by keeping their size below the threshold, assumption of random firm selection between treatment and control groups might be violated.

Malo and Pagán (2014) and Mori and Sakamoto (2017) do not find evidence for significant firm size manipulation around the disability quota threshold in Spain and Japan. However, as Garicano et al. (2016) shows, size-related regulations might have strong distorting effect around the threshold, if the regulation poses substantial costs to firms. In France, labor costs increase considerably above 50 employees due to various administrative requirements. This huge jump in

marginal labor costs prevent many firms from growing, resulting in a bunching in the distribution of firms below the threshold.

In Hungarian data, distribution of firms around the threshold shows the effort of firms to keep their size below 20 employees in 2010, that is reflected in a noteworthy, though not a huge bunching (see Figure 3).

Figure 3: Distribution of firms by number of employees, 2008-2010



However, as the new threshold increases from 20 to 25 persons in 2012, a new bunching emerges at the old threshold, while the old bunching below 20 employees disappears (Figure 4).

To study more closely the effect of the policy change on firm behavior, I also look at the distribution of firms around the threshold, with 15-25 employees before the levy hike. First, I compare the distribution of these firms with the firm distribution around a placebo threshold, 35 employees.

Figure 5 and 6 show that the distribution around the real threshold is more skewed, and the probability that the number of employees of a given firm is below the threshold is much higher than in case of the placebo threshold.

A similar conclusion arises from comparison of firms near the threshold with no disabled employees before the policy change with firms that already had employed disabled ex-ante, thus

Figure 4: Distribution of firms by number of employees, 2011-2013

already fulfilled the quota. The firms in the latter group do not have to pay the levy, thus practically not affected by levy increase. The probability that the number of employees is below the threshold after the levy increase is much higher in case of affected than in case of non-affected firms. However, no significant difference can be observed between distribution of firms with and without disabled employees at the placebo threshold (35 employees). Table 3 summarizes the relevant probabilities.

Table 3: Distribution of firms in 2010

$$Prob(emp_{2010} < c | emp_{2008} \in [c-h, c+h]) \tag{1}$$

		employment in 2008:15-24 (c=20)	employment in 2008: 30-39 (c=35)
P(emp_2010<20 ‖15≤emp_2008≤24)	no disabled workers in 2008	74.8	65.7
	disabled workers in 2008	63.3	64.5

Nonrandom firm selection was investigated formally using a nonparametric manipulation

Figure 5: Distribution of firms in 2010 around the real threshold (20 employees), with 15-24 employees in 2008

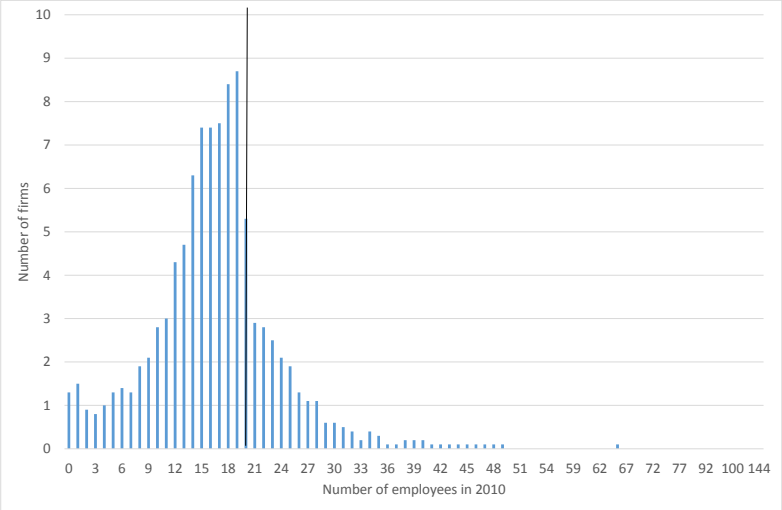
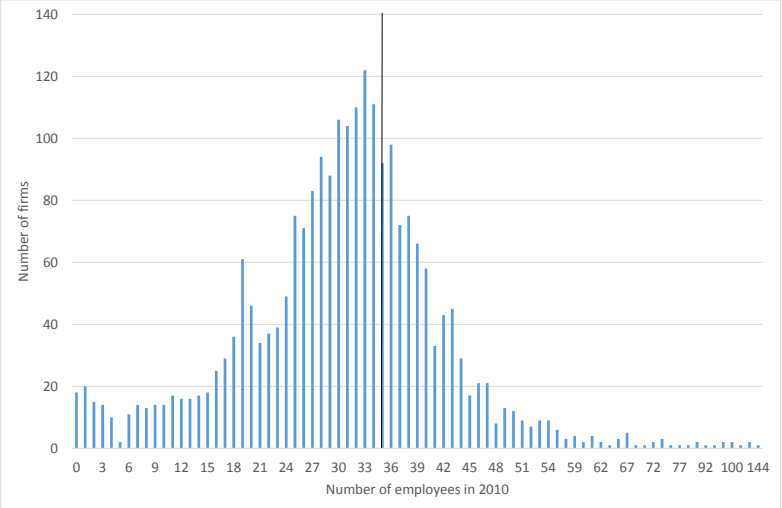


Figure 6: Distribution of firms in 2010 around a placebo threshold (35 employees), with 30-39 employees in 2008



test of Cattaneo et al. (2018). The test is based on the consideraton that manipulation of the the running variable might be captured by a discontinuity in the distribution of the running variable around the cutoff. The test uses local polynomial distribution estimators and based on a Wald-type statistic where the null hypothesis is the continuity of the running variable at the cutoff:

Ho:$\lim_{emp\downarrow c} f(emp) = lim_{emp\uparrow c} f(emp)$, vs H1: $\lim_{emp\downarrow c} f(emp) \neq lim_{emp\uparrow c} f(emp)$

The test statistic is the following:

$$T_p(h) = \frac{\hat{f}_{+,p}(h) - \hat{f}_{-,p}(h)}{\hat{V}_p(h)}$$

Where:

$$V_p^2(h) = V[\hat{f}_{+,p}(h) - \hat{f}_{-,p}(h)];$$

The test rejects H_0 at α level iff $T_p^2 > \chi^2_{\alpha-1}$

The authors emphasize that the test can be also used for discrete running variables. The results of the density test are summarized in Table 4. [12] The density test suggests manipulation of the running variable at $c = 20$ in 2010 and 2011 after increasing the threshold. However, in 2012, the test statistics looses significance at $c = 20$ and becomes significant at 5 % significance level at $c = 25$ in line with the increase of the threshold. As a robustness check, the test is implemented for placebo thresholds for 2010 and the test shows size manipulation only at the quota threshold, $c = 20$.

Table 4: Results of manipulation test *rddensity* for different years and placebo cutoffs

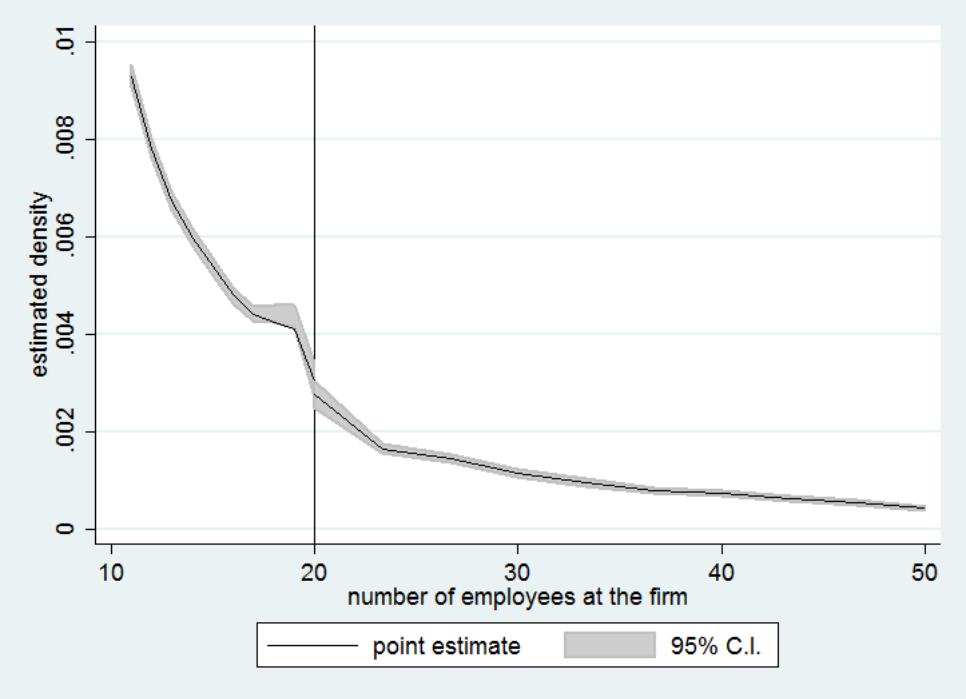
c=20			c=25			2010		
	T	P>|T |		T	P>|T|	c	T	P>|T|
2007	-2.447	.014	2007	-.032	.974	15	1.373	.17
2008	-1.837	.066	2008	.447	.655	20	-4.989***	0.00
2009	-1.969	.049	2009	-.628	.53	25	-.693	.488
2010	-4.989***	0.00	2010	-.693	.488	30	-.465	.642
2011	-3.69***	0.00	2011	-.101	.919			
2012	-1.726	.084	2012	-2.301**	.021			

Restriction: equal c.d.f. and higher order derivatives assumed on the two sides of the cutoff.
Bandwidth selection is based on MSE of difference and sum of densities,assuming
one common bandwidth.Optimal bandwidth is selected as the lower of the two above criteria

[12] I also run the test with predefined bandwidth $h = 5$, with no restrictions imposed on the shape of the c.d.f and it yielded similar results.

Figure 7 shows the estimated density function on the two sides of the cutoff. In 2010, discontinuity is observed at $c = 20$, while in 2013, at $c = 25$

Figure 7: Estimated firm density by *rddensity* and discontinuity at the threshold,2010

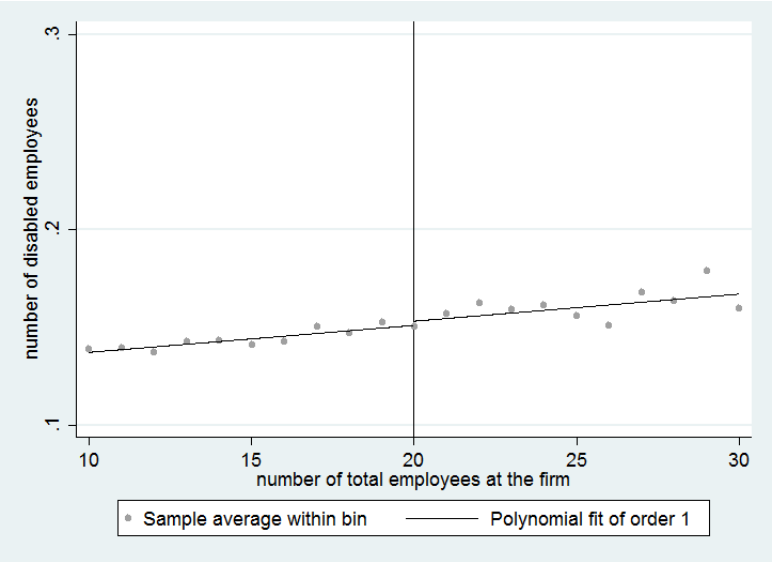


4.4 Discontinuity in firm characteristics

The sectoral and regional composition of the the firms below and above the cutoff is very similar on the two sides of the threshold (see Appendix E). I check the total effect of all potential covariates on firm size manipulation with the composite covariate index (see Card et al. (2007)). The number of disabled employees in 2010 are regressed on a set of covariates and the predicted value from this regression is plotted against the firm size (Figure 8). The following covariates are added as right hand side variables: firm age, dummy for state and foreign ownership, sectoral and regional dummies, lagged values of productivity, average wages, profit ratio, change in the total employment in the two years before the levy increase (2007-2009). The lack of discontinuity in the predicted value around the threshold shows the lack of relationship between firm characteristics and firm size manipulation. For the variables of firm's performance (productivity, average wages, profit ratio, change in the total employment) lagged values show up in the composite covariate index, as the contemporaneous values already include effects of the regulation, and the aim of

the exercise is to find factors determining firm's choice to keep their size below the threshold.The results suggest that bunching is not systematic, firms' selection into the treatment group is based on unobserved firm characteristics.

Figure 8: Composite covariate index, 2010



I also investigate discontinuity in the contemporenous values of firm performance. As Garicano et al. (2016) shows, if many firms choose to avoid the size related regulation by keeping its size below the threshold, we can expect a spike in the productivity distribution of firms at the threshold, and he finds empirical support for these predictions in the case of French firms. I test congestion in productivity and other firm specific variables by running an RD on these variables.

I test the following outcome variables. $profitratio$: profit ratio (pretax profit/number of employees), $lnaverwage$: logarithm of total wage bill/number of employees, $lnprod$: logarithm of sales/number of employees $lnprod\_gdp$: logarithm of labor productivity (value added/number of employees) $lnsales$: logarithm of sales $lnprod$: logarithm of sales/number of employees $firmage$: firm age (in years), $foreign$: dummy variable for foreign owned firms (if share of foreign ownership is greater than 50%.), $state$: dummy variable for foreign owned firms (if share of state ownership is greater than 50%).

I look for discontinuity in the deviations of the above variables from the industry average.

The results for 2010 are summarized in Table 5. While disabled employment effect is significant in magnitude after the levy hike, the RD regressions show no discontinuity in the variables

that capture firm characteristics.[13].

Results confirm that while a non-negligible fraction of firms chooses to avoid the regulation, this decision is not reflected in difference in firm characteristics and performance just below and above the threshold neither before nor after the policy change.

Table 5: Rdrobust results on firm characteristics (2010, c=20)

	profitratio	lnaverwage	lnprod	lnprod_gdp	lnsales	firmage	foreign	state
τ **robust**	0.012	0.011	0.051	0.025	0.092	0.806	0.016	0.004
robust SE	0.011	0.046	0.084	0.069	0.092	0.753	0.021	0.009
adj SE robust	0.011	0.056	0.114	0.089	0.122	1.157	0.021	0.009
τ **conventional**	0.01	0.018	0.052	0.032	0.08	0.62	0.018	0.004
conventional SE	0.009	0.039	0.07	0.058	0.077	0.647	0.018	0.008
adj conv SE	0.012	0.049	0.092	0.07	0.099	1.028	0.021	0.01
bandwidth	4.847	5.349	6.155	6.175	5.534	4.149	6.927	6.243
eff. # of obs(l)	5223	5903	7063	6749	6113	4257	8482	7342
eff. # of obs(r)	1931	2159	2436	2320	2206	1631	2763	2509
order of p	1	1	1	1	1	1	1	1

4.5 Bunching and estimation of the treatment effect

The number of employees is not exogenous as it might be a choice of an optimizing firm that can react to the regulation, and the bunching below the threshold suggests that the assumption of random firm selection between treatment and control groups is indeed violated. Therefore, even if firm choice is based on unobserved characteristics, using the firm size as a running variable might produce a biased estimation of the treatment effect. The direction of the bias is not straightforward a priori. In our case we can assume that "bunchers" have on average lower propensity to employ disabled than firms that do not manipulate their size, so the baseline RD estimations might produce an upward biased treatment effect.

The bias from manipulation is sometimes treated with the so-called doughnut-hole method, that is by dropping observations in the close neighborhood to the cutoff. However, by ignoring data close to the cutoff we lose important information. Another approach is implemented by Lalive et al. (2013) who calculate the bias arising from bunching with a back-of-the-envelope calculation. The basic idea is a thought experiment: what would be the difference in mean of disabled employees just above and just below the threshold if there were no bunching, that is firms simply would not have the possibility to avoid the regulation with size manipulation. Lalive et al. (2013) move calculated number of bunchers from just below to just above the threshold,

[13]No discontinuity can be detected for 2011, for pooled estimation for 2010-2011 with a time dummy for 2011 and 2012 with c=25

and recalculate the raw unconditional mean of disabled employees assuming that they continue to employ disabled .[14] Gerard et al. (2016) estimate lower and upper bounds by truncating the distribution of the outcome variable above the cutoff, where some units assumed to manipulate the running variable. In both applications, the share of manipulators is calculated using a non-parametric density test. I provide a lower bound to the treatment by reestimating the RD on a simulated sample with a novel method, that is related to the main idea of the Lalive et al. (2013) method.

The estimation consists of the following steps:

1. Construction a counterfactual distribution by fitting a power law on firm distribution by size, omitting observations with number of employees $c+/-5$.

2. Calculating number of firms that are below the threshold to avoid the regulation ("bunchers") and missing firms from above the threshold by comparing actual and the counterfactual distribution in the $c+/-5$ range. (A similar method is used for example in Harasztosi and Lindner (2015)).

3. Constructing a simulated sample such that the resulting firm distribution is smooth by moving calculated number of randomly selected firms above the threshold into the $c+5$ range, while leaving the number of disabled employees unchanged.

4. Re-estimating RD on the simulated sample and repeat this exercise many times.

The lower bound is the average of treatment effects of re-estimated RD from a simulation of 100 draws.

This method is similar in its approach to the method of Lalive et al. (2013). However, I use observations not only just above and just below the cutoff, but in a wider range, and give an RD estimation of the treatment effect on the simulated sample.

Graph 9 shows the estimated counterfactual distribution and the firm distribution of the simulated sample after moving randomly selected firms from below to above the cutoff in 2010. Results of RD estimation with the simulated sample are summarized in Table 6. The results show that the lower bound treatment effect is lower than the simple RD estimation by more than

[14] Lalive et al. (2013) calculate also an upper bound in addition to the lower bound. However, in contrast to the Hungarian case, the quota threshold concerns the number of nondisabled employees in Austria. Consequently, there are firms which choose nondisabled employment below the threshold, but employ a disabled worker if this worker increases the profit. As the running variable in Lalive et al. (2013) is the number of nondisabled employees, this group of firms create a downward bias in the treatment effect estimated with baseline RD. In Hungary, the threshold refers the size of the total workforce, hence this downward bias is not relevant.

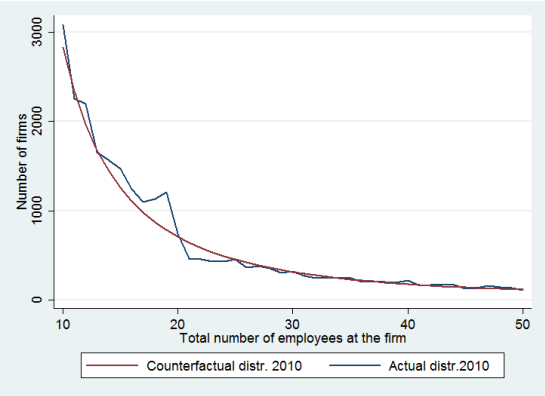


Figure 9: Counterfactual distribution (fitted power law)

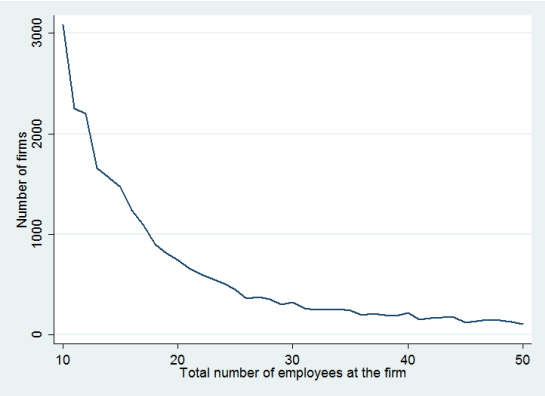


Figure 10: Firm size distribution in the simulated sample distribution

Table 6: Rdrobust results for lower bound

	2008(c=20)	**2010** (c=20)	**2012** (c=25)
τ **robust naive**	0.017	0.285***	0.289***
τ **robust simulated**	0.008	0.163***	0.259***
SE robust simulated	(0.063)	(0.051)	(0.077)

40%, but it remains significantly high. However, in 2012, where the size of the bunching is much smaller, the lower bound is much closer to the simple RD disabled employment effect.

The reaction of firms is strong even if the magnitude of the levy compared to the wages is taken into account. The elasticity of substitution between disabled workers and non-disable workers, that is the percentage change in relative employment of disabled to non-disabled divided by percentage change of relative disabled/nondisabled relative labor cost, is the highest in Hungary among comparable estimations, even if the bias arising from the bunching is taken into account (see Table 7)[15] However,the baseline (below threshold) ratio of disabled is the lowest in Hungary.

Table 7: Comparison of disabled employment effect estimations across countries

	coeff.	threshold	quota	change in dis /nondis. emp.	dis.emp. below thr.	quota fulf. below threshold	%change in dis/non emp	levy/average labor cost	% change in dis/nondis rel. wage	elast. of substitution
Japan*	1.42	300	2%	0.5%	1.6%	87%	30%	11%	-10.2%	-2.97
Austria**	0.04	25	5%	0.2%	1.3%	25%	12%	6%	-5.9%	-2.01
Hun,baseline,2010***,	0.29	20	5%	1.5%	0.6%	11%	264%	31%	-23.8%	-11.06
Hun, lower bound,2010	0.18	20	5%	0.9%	0.6%	11%	164%	31%	-23.8%	-6.86
Hun(by 2008 to 2010)	0.27	20	5%	1.3%	0.7%	13%	206%	31%	-19.4%	-10.64

*based on Mori and Sakamoto (2017) and own calculation.The source of average non-disabled wage is DIDA.
**based on Lalive et al. (2013) and own calculation.
The elasticity of substitution differs from that of Lalive et al. (2013), as I added obligatory employer social contributions to the nominal wage.
The Source of the employer contributions data is the OECD Taxing Wages database.
***Average labor cost is calculated as average gross earnings plus employer contributions.

[15]Note that the elasticity of substitution can also be calculated by comparing the above-threshold employment before and after the levy increase. This is shown in the last row in Table 7. This calculation yields similar elasticity of substitution than the baseline RD estimations for 2010.

5 Firm heterogeneity in disabled employment effect

The above section concluded that firms' decision to stay below the threshold is not systematic: while the bunching clearly shows that a fraction of firms chooses keeping its size below the threshold, selection of firms between the treatment and control groups is based on unobservable firm characteristics. However, the disabled employment effect of the quota-levy regulation in the neighborhood to the threshold is influenced by observable firm characteristics. As firm selection between control and treatment groups does not depend on firm characteristics, the comparison of the treatment effect in RD regressions estimated on different subgroups captures well the heterogeneity in firms' reaction to the quota.

5.1 Effect of firm size

Note that the total quota fulfillment that considers all non-special firms above the threshold exhibit a much less favorable picture than the estimated treatment effect around the threshold plus the quota fulfillment below the threshold. However, this discrepancy arises from the fact that the ratio of disabled employees at the firm decreases with firm size (see Table 8).

Table 8: Ratio of disabled employees and average wages by firm size

		disabled ratio%		wage cost (million HUF)	
firm size	N	mean	sd	mean	sd
0-19	249981	0.09%	1.38%	1186	1620
20-25	2983	1.82%	3.59%	1833	1657
26-49	5383	2.05%	3.54%	1979	1765
50-99	2857	1.93%	3.23%	2256	1903
100-499	2090	1.66%	2.92%	2591	1828
500-999	222	0.92%	1.77%	2963	1616
1000-	160	0.83%	1.42%	3076	1709

It is in part attributable to the much higher average wage level of larger firms, however, firm size remains significant in explaining the ratio of disabled employees at the firm even after controlling for the wage level (see Table 9). However, one might expect opposite effect of firm size. One-off costs of hiring disabled (for example accommodation of the workplace) per disabled worker are lower for larger firms with more disabled employees and the probability that a disabled employee can fulfill a given job might be higher a larger firm with larger variety of jobs. The fact that quota fulfillment is worse for larger firms indicates that there are other significant barriers to employing disabled.

Table 9: Regression for ratio of disabled employment above the threshold, 2010-2013

	(1)	(2)	(3)
VARIABLES	disemp_percent	disemp_percent	disemp_percent
lnemp	-0.248***	-0.134***	-0.137***
	(0.0204)	(0.0203)	(0.0208)
lnaverwage		-0.815***	-0.650***
		(0.0322)	(0.0392)
lnprod			-0.157***
			(0.0233)
d2011	0.097***	0.127***	0.132***
	(0.0278)	(0.0282)	(0.0289)
d2012	0.000504	0.122***	0.110***
	(0.0311)	(0.0318)	(0.0326)
d2013	-0.102***	0.0398	0.0261
	(0.0334)	(0.0340)	(0.0348)
Constant	2.919***	8.541***	8.826***
	(0.0916)	(0.245)	(0.259)
Observations	46,372	46,276	44,952
R-squared	0.006	0.033	0.034

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.2 Role of disabled labor supply and adjustment costs

The fact that majority of firms choose paying the levy instead of hiring disabled workers might be explained by the following reasons:

- High (perceived) adjustment (hiring and firing) costs
- Labor supply shortage of disabled

One can argue that both hiring and firing costs might be higher in case of non-disabled workers. Accommodation of the workplace to be able to receive disabled workers might be costly. Searching costs are probably also much higher in case of disabled workers (see e.g. Silva and Vall-Castelló (2017)).[16]

However, labor supply shortage is probably a major obstacle to substantial rise in disabled employment. According to the labor force survey, the share of disabled population is roughly in line with European average, but the activity rate of disabled is quite low, only around 25%.

[16]There are basically two organizations that mediate demand and supply of disabled. The local agencies of National Office of Rehabilitation and Social Affairs, and the alternative suppliers. Additionally, public employment services (PES) also had matching role. However, operation of these agencies can be characterized by uneven territorial distribution and scarcity.

There were 48 thousand disabled unemployed in 2011, and additional 30-40 thousand can be assessed as discouraged workers.[17] Meanwhile, in 2010 the levy was paid after 57 thousand, in 2011 63.5 thousand employees from the quota.[18] Assuming that the probability of matching is much lower in case of disabled, the magnitude of these numbers suggest that perhaps there are simply not enough disabled jobseekers who would accept a job at the offered wage in the given regions, industries, jobs.

The low effective labor supply might be related to the institutional environment of other disability policies. Around 2010, most disabled workers were employed in sheltered workplaces - at accredited special institutions and firms - and the empirical evidence suggests that sheltered employment does not facilitate integration into the open labor market. However, availability of personalized rehabilitation services and supported work, that is, comprehensive support for working in the open labor market that proved to be much more effective, is quite limited (Scharle and Váradi (2015), Scharle and Csillag (2016) Adamecz-Völgyi and Scharle (2017)).

Lack of support in getting to the workplace also might impede jobseeking of disabled. Opportunity costs of working might also constrain labor supply. Up to 2014, earning activity terminated eligibility to disability and rehabilitation benefits above a certain, relatively low earning level.[19]

I use regional variation in disabled employment and population to test the role of disabled labor supply and high adjustment costs in firms' reaction. Due to anecdotal evidence, firms in Central Hungary and Western Transdanubia face with disabled labor shortage, while less developed regions - such as South Transdanubia and regions of Great Plain - have excess disabled supply.[20]

Table 10 shows that the share of disabled in total working age population is indeed lower in

[17] source:Central Statistical Office

[18] The data from the database are not comparable in one to one with the unemployed data from the labor force survey.

[19] The amount of rehabilitation and disability benefits has changed many times since 2010, it was linked to the previous income and depended on degree of health impairment. In case of the disability pension (for disabled with high capacity loss and no expected gain from rehabilitation) the eligibility terminated after 6 month of work, if the wage exceeded 70% of previous net wage or the minimum wage. The temporary rehabilitation allowance (for disabled whose working capacity can be restored or improved by rehabilitation, with capacity loss 50-79%) was linked to the previous wage and was relatively generous (50-61% of previous wage, but in average close to the minimum wage), and the eligibility has terminated after 3 month if the wage exceeded 90% of previous wage. Disabled with low, 40-50% capacity loss are entitled to the regular social allowance, what was flat and amounted about one third of the minimum wage. In case of the regular social allowance, the eligibility terminated after 6 month if the wage exceeded 80 % of the minimum wage. Between 2014 and 2016, eligibility to rehabilitation benefit is terminated above 20 working hours per week, regardless the earned amount. Since 2016, eligibility is linked to the earnings again in case of both rehabilitation and disabled benefits. Specifically, eligibility terminates if earnings exceed 150% of the minimum wage for 3 consecutive month.

[20] for example see the analysis of a HR company, Trenkwalder. https://www.hrportal.hu/hr/megvaltozott-munkakepesseguek-foglalkoztatasa-ketteszakadt-az-orszag-20160203.html

the central and western regions[21].

Table 10: Share of disabled population in regions

region code	Hungarian name	English name	% of disabled in the working age pop.
1	Közép-Magyarország	Central Hungary	7.3
2	Közép-Dunántúl	Central Transdanubia	9.2
3	Nyugat-Dunántúl	Western Transdanubia	9.2
4	Dél-Dunántúl	South Transdanubia	16.8
5	Észak-Magyarország	North Hungary	14.1
6	Észak-Alföld	North Great Plain	14.7
7	Dél-Alföld	South Great Plain	14.8

Source:Labor force survey 2011, Central Statistical Office

However, Hungarian regions differ in many other important aspects, for example average productivity and general wage level. Underdeveloped Eastern regions can be characterized with generally lower wage and less productive firms, and presumably ratio of wages to the levy might also influence the reaction of firms.

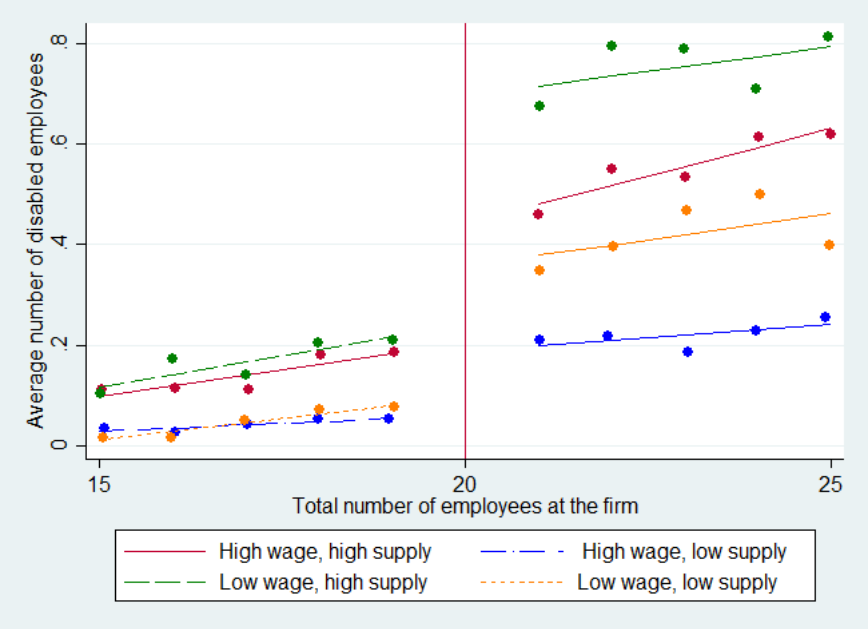
Against this background, I estimate the treatment effect within four subgroups. I divided the regions into two groups, the low supply regions (Central Hungary, Central Transdanubia and western Transdanubia) and high supply regions (South Transdanubia, North Great Plain, South Great Plain and North Hungary). Within each of the two groups, firms are divided into a low wage (below average wage of firms between 15-25 employees in 2010-2011) and a high wage group (above average wage). Figure 11 indicates that both firm wage level and ratio of the disabled influences reaction of firms. Firms in low supply regions employ less disabled in average even under the threshold and react less to the quota regulation. Wage level of firms also affects the reaction of firm. Results suggest that firms with lower average wage are more inclined to react to the quota in both low supply and high supply regions. Stronger reaction of low-wage firms was also found at Lalive et al. (2013) for Austrian firms. Given that the levy is flat, the levy compared to the average wage level is lower for firms with higher average wages, hence the levy poses lower burden relative to other costs. Note that the wage does not influence disabled employment below the threshold, where the levy is negligible, indicating that wage level matters as it determines the relative burden the levy poses on the firm. Heterogeneity in the treatment effect is also reflected in RD estimates implemented on the four different subgroups by wage level and regional supply of disabled (Table 11).

[21]2011 LFS data are based on a survey, so number of disabled does not coincide with the number of people with official status of changed working capacity, but can be used as an indicator.

Table 11: RD robust estimation for different subgroups, 2010-2011

supply	low	low	high	high
wage	low	high	low	high
mean_tau_robust	.151	.101	.628	.314
mean_se_robust	.136	.029	.284	.073
adjusted_se_robust*	.156	.029	.304	.073
mean_tau_conventional	.248	.135	.469	.388
mean_se_conventional	.086	.021	.143	.047
adjusted_se_conventional*	.093	.023	.15	.052
mean_bandwidth	4.268	21.071	6.779	27.965
eff_number_of_obs_l	1566	29213	1420	16150
eff_number_of_obs_r	499	3240	497	2367
order_of_polinomial	1	1	1	1

Figure 11: Average number of disabled employees by firm size and first order polynomial in subgroups, 2010-2011



Results suggest that firms face - or perceive - difficulties in hiring disabled employees, however, the effect of disabled ratio on firms' reaction may capture multiple problems both on the employee and on the employer side. The supply is constrained by low capacity of rehabilitation services, disincentive scheme of disabled allowances, lack of support in transportation.

On the demand side, high one-off costs of hiring (for example high searching, accommodating, training costs) and discrimination on the employers' side might be the most important barriers to employing disabled employees. Where the ratio of disabled is lower, the above problems gain momentum and might hinder disabled employment excessively. My results suggest that efficiency of quota-levy regulation could be improved significantly by addressing the above frictions on

disabled labor market. The relative importance of the above factors is a subject of further research.

Table 12: Number of firm in different regions in the NAV database (2010)

Region NUTS2	Freq (thousand)	Percent	Cum
1.	204	51.3	51.3
2.	34	8.7	60.0
3.	31	8.0	67.9
4.	27	6.9	74.9
5.	28	7.1	81.9
6.	36	9.1	91.0
7.	36	9.1	100
Total	398	100	

6 Conclusion

This paper demonstrates intense reaction of Hungarian firms to the increased levy accompanied to the disability quota. In 2010, the Hungarian levy was increased drastically, by 454 percent, reaching an exceptionally high level compared to average wages. This measure posed a significant burden on firms in the middle of the financial crisis. There are a few papers in the literature that analyze the effect of the disability quota with a moderate levy and usually find small or insignificant effect. The Hungarian case demonstrates how firms can cope with the quota if the accompanied levy is really substantial and creates a strong financial incentive. Many firms near the threshold clearly make an effort to avoid the regulation by keeping the size of their workforce below the quota threshold. This attempt results in a remarkable bunching in firms' distribution below the threshold employment level. Firm size endogeneity might compromise baseline regression discontinuity estimations as the random assignment of firms between treated and control groups is violated. However, I could not detect any discontinuity in firm specific variables and these variables do not seem to influence firms' choice to stay below above the threshold, suggesting that selection between treatment and control groups is based on unobservable firm characteristics. I add a lower band to the disabled employment effect by re-estimating the RD on a simulated sample. The results suggest that disabled employment effect of the quota-levy system is very high in international comparison even after controlling for the potential bias caused by the bunching.

However, the effectiveness of the policy is questionable. Though the disabled employment

policy effect and the estimated elasticity of substitution can be considered high, majority of affected firms pays the levy instead of hiring a disabled, resulting in a low fulfillment of the quota less than 30 percent. Taking into consideration the exceptionally high level of the levy, the low fulfillment of the quota is somewhat surprising, as firms would incur lower wage cost if hired a part-time, low wage disabled employee even with zero productivity than paying the levy. This contradiction suggests that there are important factors beyond relative productivity that constrain hiring disabled employees. Specifically, it seems that the main barrier to employing disabled persons is the low effective labor supply and/or high (perceived) non-wage costs of employing disabled. Exploiting regional differences in the ratio of disabled population, I find evidence that disabled employment effect of the quota regulation varies with the share of disabled population in the region. This implies that effectiveness of the policy might be hampered by the the shortage of effective supply of disabled and/or high adjustment costs of hiring disabled persons. As firms are not able to fulfill the quota, the regulation behaves like a tax that primarily hits low-wage firms. My results suggest that efficiency of the quota-levy system could be enhanced significantly by addressing the frictions on disabled labor market.

7 Appendix

7.1 Appendix A: Details of the quota rules

In average headcount, part-time employees and employees that work only in a part of the year are treated differently. Part-time employees are considered as a full person (not as a full-time equivalent), but they are counted only if their working time due to their contract is minimum 15 hours per week (about 60 hours per month).If the person is employed only for a half month, she will be counted if the number of her actual working hours exceeds 30 hours. However, employees that are employed only in a part of the year, are counted proportionally with the ratio of their time of employed status in the year.For example, an employee that was employed for 6 months at a company, is counted as 0,5 employee in average headcount, regardless that she is a part-time or full-time worker. A half-time (4 hours a day) employee employed in the whole year is considered as one person in the average headcount.The average headcount of a firm that applies 20 full-time employees and 2 part-time employees throughout the year is 22, while the average headcount of a firm with 20 full-time employees and two employees that quit the firm mid-year is 21.

Other changes in the quota regulation in 2011 and 2012:

- From January 2011, employee leasing companies, that were exempt the regulation until 2010, are also required to pay the rehabilitation contribution. It implies that this policy change might have also contributed to the increase in aggregate disabled employment in 2011. Beyond its direct effect (45 out of the 519 employee leaser companies were between 15 and 25 employees this the regulation also might have influenced the behavior of smaller firms in general. The exemption until 2011 allowed smaller firms to exempt the regulation by working with leased workers instead of employees with employment contract, that count for the average headcount. However, the regulation probably increased the price of leased employees and decreased the relative advantage of leasing employees. (About the potential effect of this policy change, see Data section)

- Since 2012, employers might get allowance from employer social contribution for two years, if they employ disabled employees.[22] The allowance is 27 percent of the gross wage, but maximum 27 percent of double of the minimum wage. The regulation implies that the

[22]Persons with changed working capacity are eligible for the rehabilitation card, that qualifies employers to the allowance in case of employing card owners.

Table 13: Variable: number of disabled employees at firms. Original and filled with imputed zeros.

	Variable	Obs	Mean	Std. Dev.	Min	Max
disabled employees	original	5404	0.80	2.07	0	29
disabled employees	with imputations	21710	0.20	1.09	0	29

relative labor cost of employing disabled employment has decreased further. However, in 2012, only 6400 rehabilitation cards were demanded.

7.2 Appendix B: Data imputations

The firm tax database contains a variable of number of disabled employees. However for majority of firms which have data for number of total employees, this information is missing. Based on the assumption that firms who employ disabled and reduce their levy obligation do not leave this part empty, I replaced missing data with zeros. As the share of imputed data are very high, the imputation need to be addressed.

I have data on the total levy revenues for every year and for the share of revenues paid by business organizations (that are in the tax database) for 2015 and 2016. Moreover, for 2015 I have firm size breakdown of the revenues paid by firms. Using the 2015 composition of revenues for 2013 data, the levy is paid after 47.9 employees, while the calculations from tax database data show that 49.1 persons are missing from the quota, the deviation is less than 2%. Regarding the firms below 50 employees, the number of missing disabled employees estimated from revenues are 6.33 thousand , while the tax database shows 6.56 thousand, the difference is 3.5%. The two data are not comparable one-by-one because potential differences caused by rounding, but the less than 2% deviation suggest that the imputation probably does not threaten the validity of results.

7.3 Appendix C: Parametric RD results

The treatment rule is the following:

$$D = \begin{cases} 1, & \text{if } emp_{it} >= c \\ 0, & \text{if } emp_{it} < c \end{cases} \tag{2}$$

(3)

Where D is the treatment indicator, in our case, the firm that is subject of the quota-levy regulation.

The following equation is estimated: specification:

$$disabled_i = \beta_0 + \beta_1 \widetilde{emp_i} + \delta D_i + \gamma D\widetilde{emp_i} + u_i$$

where $disabled_i$:number of disabled employees,emp_i:total number of employees, $\widetilde{emp_i} = emp_i - c$

The model is estimated in the neighborhood of the cutoff value: $emp_{it} \in [c-h, c+h]$, in baseline specification: $h = 5$, $c = 20, 25$. [23]

Table 14: Parametric RDD on disabled employment 2008-2012, c=20

	(1)	(2)	(3)	(4)	(5)
VARIABLES	disemp	disemp	disemp	disemp	disemp
YEARS	2008	2009	2010	2011	2012
D	0.0264	0.109***	0.294***	0.255***	0.0170
	(0.0281)	(0.0307)	(0.0324)	(0.0307)	(0.0252)
$\widetilde{emp}$	0.0128***	0.0161***	0.0172***	0.0157***	0.00974**
	(0.00477)	(0.00513)	(0.00495)	(0.00479)	(0.00423)
$D\widetilde{emp}$	0.0178**	0.000170	-0.00325	0.00128	0.0376***
	(0.00847)	(0.00931)	(0.00971)	(0.00921)	(0.00765)
Constant	0.106***	0.136***	0.135***	0.131***	0.0935***
	(0.0166)	(0.0177)	(0.0170)	(0.0164)	(0.0149)
Observations	8,506	8,154	8,381	8,368	7,947
R-squared	0.022	0.030	0.086	0.080	0.043

$D = 1$ if $emp_t > 20$ sample: $15 <= emp_t <= 25$ and $emp_{it} \neq 20$

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

[23] Second order polynomial and and cross term of the of the treatment dummy with the the running variable to capture potential heterogeneous treatment effect proved to be insignificant perhaps thanks to the relatively narrow band

Table 15: parametric RDD on disabled employment 2008-2012, c=25

VARIABLES	(1) disemp	(2) disemp
YEARS	2011	2012
D	0.0187	0.298***
	(0.0638)	(0.0526)
$\widetilde{emp}$	0.0494***	0.0206**
	(0.0117)	(0.00908)
$D\widetilde{emp}$	-0.0272	-0.0170
	(0.0190)	(0.0156)
Constant	0.545***	0.263***
	(0.0422)	(0.0320)
Observations	4,204	4,503
R-squared	0.024	0.059

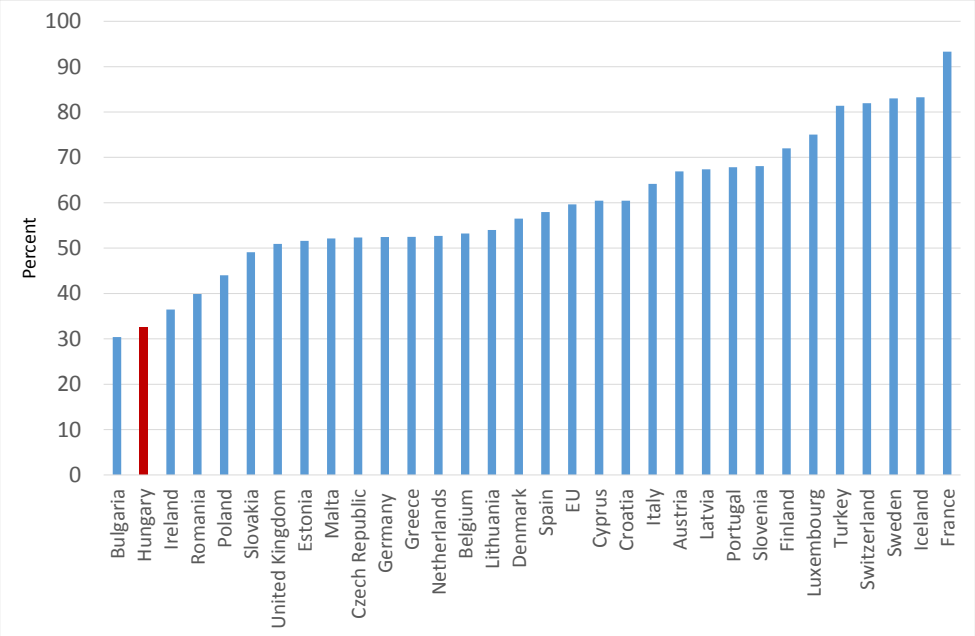
$D = 1$ if $emp_t >= 25$ sample: $20 <= emp_t <= 30$ and $emp_{it} \neq 25$

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

7.4 Appendix D:Disabled employment in international comparison

Figure 12: Employment rate of disabled/employment of total working age population,2011



Source:Eurostat

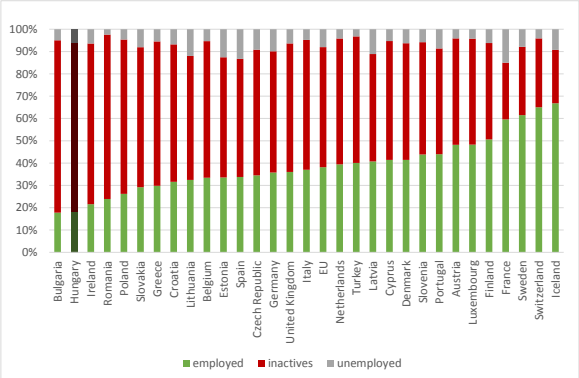


Figure 13: Decomposition of disabled,2011

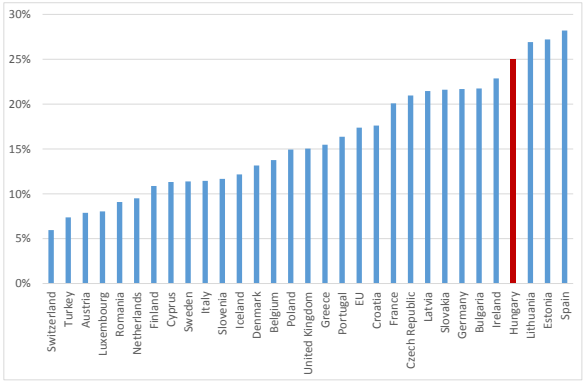


Figure 14: Unemployment rate of disabled,2011 Source:Eurostat

7.5 Appendix E:Regional and sectoral structure of firms

Table 16: Regional and sectoral composition of firms

Regions	$15 <= emp < 20$	$20 < emp < 25$	**Sectors**	$15 <= emp < 20$	$20 < emp < 25$
1.	45.6	43.77	**A**	4.5	6.1
2.	9.7	9.07	**B**	0.1	0.1
3.	8.9	8.45	**C**	0.2	0.4
4.	7.8	8.32	**D**	21.1	23.8
5.	6.8	6.81	**E**	0.5	0.7
6.	10.2	11.61	**F**	12.7	10.3
7.	11.0	11.97	**G**	24.9	22.6
			H	7.6	5.3
			I	5.6	6.5
			J	1.2	1.3
			K	16.8	17.0
			L	0.0	0.0
			M	0.8	0.6
			N	1.4	1.8
			O	2.6	3.6

7.6 Appendix F:Descriptive statistics

Table 17: Descriptive statistics - firms with at least 20 employees

	2006	2007	2008	2009	2010	2011	2012	2013
1. Total number of employed disabled in all firms	50 921	46 919	44 871	44 325	45 928	49 520	48 203	45 241
Firms with at least 20 employees								
2. number of employed disabled in firms above 20 employees	47 358	43 294	41 233	40 609	42 118	45 532	44 926	42 654
3. as a % of total disabled emplyment (2./1.)	93.0%	92.3%	91.9%	91.6%	91.7%	91.9%	93.2%	94.3%
4. in firms with disabled ratio less than 40%	11 801	11 921	11 509	12 287	19 325	22 220	20 949	18 470
5. ratio of disabled employment in firms below 40% dis. ratio (4./2.)	25%	28%	28%	30%	46%	49%	47%	43%
6. in firms with disabled ratio at least 40%	35 557	31 373	29 724	28 322	22 793	23 312	23 977	24 184
7.share of disabled employees in all firms	2.9%	2.7%	2.5%	2.7%	2.8%	3.1%	3.0%	3.1%
8. share of disabled employees excluding special firms	0.8%	0.8%	0.8%	0.9%	1.4%	1.6%	1.5%	1.4%
***THRESHOLD=20								
9.quota (threshold=20)	80 394	79 296	81 162	75 234	75 020	74 158	75 698	69 824
10. missing employees from the quota (threshold=20)	69 360	68 887	70 810	64 063	57 417	53 533	55 856	52 040
11. quota fulfillment, 1-missing employees/quota (1-10./9.)	14%	13%	13%	15%	23%	28%	26%	25%
12. quota fulfillment, excluding special firms)	16%	16%	15%	17%	27%	32%	29%	28%
THRESHOLD=25								
13.quota (threshold=25)							72492	66441
14. missing employees from the quota (threshold=25)							53106	49066
15.quota fulfillment, 1-missing employees/quota (threshold=25) (1-14./13.)							27%	26%
16. quota fulfillment (threshold=25, exluding specials)							29%	28%

7.7 Appendix G: Treatment effect heterogeneity, parametric RD results with interaction terms

The heterogeneity of the treatment effect and was also investigated parametrically, by extending the naive RD with interaction term of disabled population ratio with the treatment indicator.

Using the labor force survey data (see Table 10), regional dummies were replaced by one region- specific variable that captures the share of disabled in total working age population. The variable is normalized to zero:

$dis\_popratio_r = \frac{DP_r}{TP_r} - \frac{\overline{DP}}{\overline{TP}}$, where DP_r is working age (15-64 years) disabled population in a given region and TP_r is regional total working age population. I also added average wage and productivity of the firm to separate the effect of disabled population ratio from the development of regions.

The results show that if the share of disabled population ratio is lower, firms on average employ less to the quota regulation (see Table 18). The cross-product of the disabled population ratio with the treatment dummy is significantly positive, even after controlling for wage and productivity differences, which shows that higher share of disabled population yields higher disabled employment effect of the quota regulation on firms. The magnitude of the coefficient is large: it shows that if the ratio of disabled population is higher by 1 percentage point, the employment effect is larger by around 0.03. Consequently, the higher disabled population alone implies more than double treatment effect in the Eastern regions compared to the most developed Central-Hungary.

Table 18: RD extended with disabled population ratio(2010 and 2011, firms with 15-25 employees)

Table 19: RDD for number of disabled employees (firms with 15-25 employees)

	(1)	(2)
YEARS	2010	2011
VARIABLES	disemp	disemp
D	0.316***	0.273***
	(0.0327)	(0.0317)
emp-c	0.0160***	0.0166***
	(0.00499)	(0.00491)
D*(emp-c)	0.00447	0.00592
	(0.00980)	(0.00949)
lnaverwage	-0.0129	0.00531
	(0.0171)	(0.0160)
lnprod_gdp	-0.000925	-0.00976
	(0.0101)	(0.00989)
D*lnprod_gdp	-0.0447**	-0.0119
	(0.0202)	(0.0199)
D*lnaverwage	-0.0927***	-0.0852***
	(0.0328)	(0.0310)
disabled pop.ratio	0.0159***	0.0150***
	(0.00204)	(0.00198)
D*disabled pop._ratio	0.0343***	0.0280***
	(0.00392)	(0.00379)
Constant	0.249***	0.191**
	(0.0953)	(0.0882)
Observations	7,841	7,888
R-squared	0.131	0.117

h=5

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

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