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ISSN: 2365-9793

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ABSTRACT

The Effects of a Disability Employment Quota When Compliance Is Cheaper than Defiance*

This paper evaluates the effects of the Hungarian disability employment quota, which requires firms over a certain size to employ people with disabilities or pay a noncompliance tax. We employ a regression discontinuity design on firm-level data to estimate the effect on the quota on the employment of persons with disabilities, when the tax increased from very low levels to 170 percent of the lowest wage cost required to meet the quota. We estimate a lower bound of the effect that takes into account the bias resulting from bunching of firms below the threshold. Firms hire 0.24–0.29 additional disabled workers on average when the tax increased, with a lower bound of 0.16. When the threshold is raised from 20 to 25 employees, bunching of firms and the estimated effect disappears around the old threshold. The policy effect is weaker in regions with few disabled individuals, implying that the policy outcomes are hampered by low labor supply, materializing in high fixed costs of hiring, as predicted by our model.

JEL Classification: J14, H32, J23

Keywords: disability employment quota, labor demand, regression discontinuity, Hungary

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* We are grateful to Gábor Kézdi, Andrea Weber, Anna Adamecz, Anikó Bíró, Cristian Pop-Eleches, Róbert Lieli, László Mátyás, Zhuan Pei, Daniel Prinz, Balázs Reizer, Ágota Scharle, Ágnes Szabó-Morvai, Ádám Zawadowski and participants of the CEU PhD research seminar, EEA-ESEM, EALE and ERMAS Cluj conferences for valuable comments. Krekó was supported by the "Lendület" program of the Hungarian Academy of Sciences (grant number: LP2018-2/2018). We thank Trenkwalder Hungary for sharing information on disabled employment. CEU Microdata provided access to the data- base and we thank András Vereckei for assistance with the data. All errors are our own.

1 Introduction

Integration of people with disabilities into the labor market is a great challenge for all governments around the world, and many countries apply an arsenal of policies to boost their employment. The disability employment quota is among the most common policy tools used to enhance the demand for disabled individuals, and is applied in about one-third of the OECD countries (OECD 2010). The policy increases the cost of nondisabled workers, hereby enhancing the demand for employees with disabilities: firms above a size threshold are subject to a noncompliance tax if they do not employ disabled employees in a certain proportion. The details of the regulation, such as the threshold, the amount of tax, and size of quota, vary across countries. Research demonstrates that the quota system increases the employment of disabled people in Austria (Lalive et al. 2013, Wuellrich 2010) and Japan (Mori & Sakamoto 2018). Malo & Pagán (2014) finds a small positive, marginally significant effect for Spain and Nazarov et al. (2015) conclude that the policy has only a limited impact on the employment of disabled individuals in South Korea.

This article evaluates the effects of the disability quota system in Hungary, which is an excellent laboratory for the analysis of this question. The position of individuals with disabilities in the Hungarian labor market is particularly poor in international comparison.[1] Initially, the quota was levied on firms with at least 20 employees and the value of the tax was very low. The poor employment rate was probably among the factors that prompted the government to increase the noncompliance tax by a factor of five in 2010, while leaving other features of the program unchanged.

This provision raised the tax rate from very low levels to 1.7 times the minimum cost to fulfill the quota (one person employed half-time at the minimum wage). We use this policy to provide a causal estimate of the quota on employment of disabled persons. To this end, we employ a regression discontinuity design (RDD) and study firms on the two sides of the quota threshold before and after the policy change. In addition to establishing the average effect of the policy, we also study two factors that influence its success: the labor supply of disabled people and the wage level of firms.

We show that firms reacted to the tax increase, and those right above the size threshold disproportionately reduced their size to avoid the regulation, and this behavior is more prevalent among firms those which did not have a disabled employee in their workforce. To address the potential bias of the estimation arising from this behavior, we build on Lalive et al. (2013), but we also extend their method by creating counterfactual distributions and estimate the effect on a simulated sample to correct for the additional mass of firms

[1] According to the ad-hoc module of the Labour Force Survey (Eurostat), the relative employment rate of people with disabilities compared to the total working age population in Hungary at the time of this analysis (2011) was the second lowest at 33 percent and the unemployment rate among the highest at 25 percent in the European Union (EU). At the same time, the share of people with disabilities in the working-age population was similar to the average in the EU (11 percent).

under the threshold. We randomly move the firms from below to above the threshold and rerun the RD estimation on the simulated sample.

We find that the firms' reaction is quick and intensive to the tax increase. In the years prior to the high-tax regime, there is no discontinuity at the quota threshold in the number of employees with disabilities. When the high tax came into effect, firms under the quota regulation raised the employment of disabled workers by 0.24-0.29 persons, with a lower bound estimate of 0.16 workers. The implied elasticity of substitution between disabled and nondisabled employees ranges between -6.1 and -10.6, much higher than in other countries where the tax was lower. We take this as evidence that firms are sensitive to financial incentives.

Two years after the tax increase the threshold was increased to 25 employees and the discontinuity disappeared around the old threshold, and a discontinuity developed at the new threshold suggesting that it was indeed the quota policy that induced the discontinuity.

Despite the large estimated elasticity of substitution, it is puzzling that the majority of employers did not hire any person with disabilities, although the noncompliance tax was much higher than the variable cost of a worker hired at the minimum wage and hiring a low wage person even with zero productivity would have resulted in a lower wage cost than the noncompliance tax. To answer this apparent puzzle, we constructed a simple model to predict factors that lead firms to one of the following three possible outcomes: fulfilling the quota, decreasing firm size to avoid regulation, or paying the tax. The model suggests that the decision to hire a worker with disabilities depends on the relative productivity and wage cost (fixed and variable) between the two types of workers and the level of wages relative to the tax. It is a natural assumption that the fixed cost of labor – especially search costs – depend on the labor supply of individuals with disabilities, and labor supply shortages can also drive up wages. We test the heterogeneity of the quota effect empirically by capturing search costs and the labor supply of disabled workers with the share of individuals with disabilities in the working age population across Hungarian regions. The model also predicts that firms paying high average wages are more likely to pay the tax than hire persons with disabilities.[2] This is because the tax burden relative to the total wage bill decreases with the level of average wages and thus firms are less motivated to hire workers with disabilities. As high-wage firms are not distributed evenly in Hungary, we take this into account in our analysis of the effects of disabled labor supply.

As predicted by the model, in counties with a high proportion of persons with disabilities in the working age population, the quota has greater effects than in regions with a low ratio. This heterogeneity is exacerbated by firm wages, as low wage firms react to the tax increase more strongly than high wage businesses. Therefore, our results show that one reason for the low quota fulfillment is the low level of labor supply of people

[2] Lalive et al. (2013) also analyze this heterogeneity.

with disabilities, which materializes in high search costs and higher wages. This finding is important for policy because it demonstrates that financial incentives themselves (even if they are really large) cannot guarantee the success of the quota policy if other frictions are present in the labor market of persons with disabilities. Therefore, the promotion of the participation of people with disabilities in the labor market is crucial to the success of the quota policy.

This paper is primarily related to studies on the effects of financial incentives on the labor demand for people with disabilities, which usually find positive, but moderate, effects (presented at the beginning of this section). Our paper builds on this research, but it also extends it in several dimensions. It has the novelty of analyzing a policy where the noncompliance tax is much higher than the minimum wage cost of hiring a person with disabilities. The institutional framework changed twice during the studied period, which strengthens the identification strategy: in addition to comparing firms below and above the size threshold, we can also assess how firm behavior changes when the new regulation becomes effective. Our results show that many firms do not meet the quota even though the tax burden is larger than the minimum wage cost, demonstrating that other factors, such as the supply of people with disabilities, play a crucial role. We reinforce the finding of Lalive et al. (2013), that firms with a high wage bill are less sensitive to financial incentives than firms that pay lower average wages. We take a step further in analyzing the heterogeneity of the response of firms to the policy and look for frictions hampering the effectiveness of the policy. We uncover one such friction, which is the lack of labor supply of persons with disabilities: if there are only few people with disabilities available for work, search costs related to hiring will skyrocket, and so the optimal choice of firms will be paying the tax. This finding suggests that demand-side financial incentives alone cannot solve the employment of persons with disabilities – even if they are very strong – but they should be accompanied by measures which enable individuals with disabilities to enter the labor market, facilitate the matching of supply and demand, and resolve demand-side barriers, such as high expected accommodation costs and discrimination. Without addressing underlying frictions in the labor market of persons with disabilities, the quota system cannot achieve its primary goal, but instead behaves like a size-related tax.

Our research is also related to the literature analyzing the effects of other demand-side employment policies, such as wage subsidies and other tax incentives. Contrary to the quota system which punishes noncompliance, all these policies operate by decreasing the relative wage cost of disadvantaged groups. Empirical evidence on wage subsidies is mixed: while there is some evidence that wage subsidies can be effective in enhancing the employment rate of people with disabilities (Datta Gupta et al. 2015) and disadvantaged unemployed (Kluve 2010), other papers find that wage subsidies have modest effects (Katz 1998, Hamersma 2008), or no effect at all (Baert 2016). This paper contributes by showing

that other factors beyond labor demand elasticity, such as labor supply constraints and labor market frictions might have a great influence on employment outcomes.

The remainder of the paper is structured as follows. Section 2 describes the institutional setup, followed by a conceptual framework for the mechanisms of the quota system in Section 3. Section 4 describes the data and the empirical strategy. Next, we present the estimation results in Section 5, while Section 6 concludes.

2 Institutional Framework

2.1 The Disability Quota Policy

The disability quota system is one of the policy tools that promote the labor demand for employees with disabilities in Hungary.[3] It was introduced in 1991 and obliged all employers, including firms, public, and civil organizations with more than 20 employees, to have disabled employees on board in a proportion of at least 5 percent of the workforce. In case of noncompliance they were levied a tax on the number of missing disabled employees, which equals the difference between the number of disabled employees implied by the quota and the actual number of workers with disabilities on payroll. A peculiarity of the Hungarian regulation is that the quota is rounded to one decimal digit, instead of an integer.[4] This rule implies that once the threshold is reached, the quota increases proportionately with firm size and the tax payment obligation has a discontinuity only at the threshold. To meet the quota, the person with disabilities must be employed for at least 20 hours per week. Above this limit, the number of working hours is not relevant for the fulfillment of the quota: the minimum of 20 hours is treated equally to full-time work.[5]

The most peculiar feature of Hungarian regulation is the amount of tax levied on firms. Before 2010, one missing employee with disabilities from the quota cost the firm HUF 174 thousand yearly (approximately USD 840/EUR 632). This tax was radically increased to HUF 964 thousand (USD 4635/EUR 3505), which represents an increase of 454 percent[6] The government announced the tax increase in February 2009, the law was signed in June and came into effect on 1 January 2010. Some firms already reacted in

[3]The Hungarian disability employment policy also applies other tools, including sheltered and subsidized employment, educational programs and rehabilitation services. For a detailed review, see Kreko & Scharle (2021).

[4]According to this rule, a firm with 25 employees has to hire 1.3 disabled individuals, so it either overfills the quota or it pays the tax after one-third of person.

[5]Cheating with the number of workers with disabilities is probably not a serious concern here, as the firm must present the certificate of disability status of employees and so it is easy to detect fraud. The resulting tax revenues were also high, suggesting low levels of cheating.

[6]The drastic change was probably motivated by the dismal employment rate of individuals with disabilities (discussed in the Introduction) and also to comply with EU guidelines on enhancing the open labor market employment of disabled individuals (European Commission 2006, 2009).

2009 and so the effects of the policy change are partly reflected in the 2009 data. The other features of the policy were left unchanged: neither the employment size threshold nor the regulation regarding disability status was affected. Hence, our analysis quantifies exclusively the effects of the tax increase.

Under the new regulation, the tax was among the highest in the OECD countries. It amounted to approximately 2 percent of the average payroll, in stark contrast to the typical 0.25 to 1 percent in other countries (OECD (2003)). The tax was equal to 86 percent of the total labor cost of a full-time minimum wage earner, 170 percent of a half-time minimum wage earner, and 31 percent of a full-time average wage earner. As the quota can be fulfilled with a half-time employee, hiring a disabled minimum wage earner even with zero productivity would generate a 70 percent lower cost relative to the tax payment (not taking into account the fixed cost associated with hiring and firing and assuming that firms are able to hire people with disabilities at this wage level).

Despite the strong financial incentive, the majority of the firms chose not to employ workers with disabilities but instead paid the non-compliance tax: among companies under the quota legislation, the quota fulfillment was 26 percent, which is low in international comparison.[7] The low quota fulfillment is also reflected in the high aggregate tax revenue, which increased from 0.06 percent of GDP in 2009 to 0.24 percent in 2011. To provide a comparison, overall income after corporate tax was about 2 percent of GDP in 2011, and therefore noncompliance tax revenues are fairly significant.

The tax increase was followed by another policy change in 2012, when the quota threshold was increased from 20 to 25 employees. The other features of the quota regulation remained unchanged, but a broad reform took place which affected the minimum wage policy, the tax system, and disability benefits. The government introduced a new income tax system which replaced the progressive income tax with a flat rate of 16 percent and also abolished the basic tax allowance for low-wage earners. The minimum wage also increased by 19 percent. To cushion the radical increase of the wage bill, the government provided subsidies to firms employing low-wage workers, but this last only for one year. As part of the reform of the disability benefit system, the government tightened the entry conditions and prescribed a health audit to nearly 200 thousand incumbent beneficiaries, leading to a significant decrease in people with approved disability status. These changes attenuated the cost of the noncompliance tax relative to the wage cost of employees with disabilities and also decreased the number of people who could fill up the disability quota.

[7]Quota fulfillment was between 50 and 64 percent in a number of Western European countries, and even higher in East Asia (OECD 2003, **?**). The most similar case to Hungary is Poland, where the fulfillment of quota was also low at around 30 percent and the tax relatively high at 2 percent of the average payroll (OECD 2010).

2.2 People with Disabilities in Hungary

According to the Hungarian regulation, the disability status and degree of disability of persons with impaired health are proven by the *certificate of changed working capacity*. Individuals with a degree of health impairment greater than 40 percent qualify for the disability quota.[8] Employees with disabilities are subject to the same labor code as people without a disability, except that they are entitled to 5 additional days of paid annual leave. In fact, if the worker receives a disability pension, it can be more easily laid off than a nondisabled employee.[9] Hiring costs, however, are likely to be high for disabled employees. Physical adjustments to receive disabled workers can be costly, and search costs associated with disabled individuals are probably also higher (Silva & Vall-Castelló 2017), especially if there are few such individuals willing to work.

Table 1 presents the main characteristics of the disabled and nondisabled populations in 2011.[10] There were almost 800 thousand disabled Hungarian individuals of working age (15–64 years), which makes up 11.5 percent of the total population in the same age category. As expected, young people are underrepresented in the disabled population, as 70 percent of them are older than 50 years: people with disabilities make up more than one-quarter of the total population of this age category. The highest completed education of disabled individuals is much lower than of nondisabled: over 70 percent of the disabled persons did not graduate from high school, which is a much higher proportion than the 47 percent of the nondisabled. Only 23 percent graduated from high school and a mere 6 percent finished college (the corresponding numbers for nondisabled individuals are 34 and 19 percent, respectively). The regional distribution of disabled individuals is uneven: their proportion in the population ranges from 7 to 15 percent. Finally, only 18 percent of people with disabilities were employed (compared to the 61 percent employment rate of people without disabilities) and the unemployment rate was 25 percent, 2.5 times higher that of the nondisabled population. The vast majority (76 percent) were out of the labor force, which is a much larger proportion than the corresponding number of 32 percent of nondisabled individuals.

Besides the quota regulation, the government applied several other policies to promote the employment of disabled individuals. Perhaps the most important is the existence of sheltered workplaces. Firms with at least 40 percent of disabled employees in their workforce can apply for a special status that entitles them to substantial wage subsidies. This

[8]The official disability status is also required for the eligibility to disability benefits which depend on the degree and type of disability, working history and the prospect for rehabilitation.

[9]Disability pension recipients, akin to other pensioners, could be laid off without justification. The disability pension was the main disability benefit in Hungary at the time of the analysis.

[10]This information is not from our firm-level database but from the Ad-Hoc Module of the Labor Force Survey in 2011 and is based on self-assessment. As some of the people who consider themselves disabled may not have a disability certificate, the numbers in the table are upper bounds for people who qualify to fulfill the quota. The number of individuals with a disability certificate is not available.

status can be achieved through a process of accreditation when firms have to prove that they can rehabilitate disabled employees. These workplaces employ about 30 thousand disabled workers and further reduce the supply of disabled workers in the open labor market even in the long run, as empirical evidence provided by Scharle & Csillag (2016) suggests that sheltered employment does not facilitate the integration of disabled individuals into the open labor market.[11] There are also agencies that mediate between firms and disabled job seekers, and also provide rehabilitation services. However, these are distributed unevenly throughout Hungary and their capacity is rather limited.[12]

The activity rate of people with disabilities was very low in Hungary, which may be partly caused by individual preferences or the inability of people to work, but several policies – or the lack of them – further aggravated it. The existence of sheltered workplaces decreased the number of workers with disabilities available to work in the open labor market. The lack of mobility support and the low capacity of rehabilitation services inhibit people with disabilities from entering the labor market. In addition, the large proportion of low-skilled individuals among persons with disabilities suggests higher probability of skill mismatch. Finally, disability beneficiaries lost their transfers if their earnings passed a threshold. As their labor supply is sensitive to financial incentives (Fevang et al. 2017, Kostol & Mogstad 2014), the opportunity cost of working could have further reduced the number of active individuals.[13]

To avoid paying the noncompliance tax, firms should have employed about 74 thousand disabled employees.[14] The real number instead was lower than 19.5 thousand.

3 Conceptual Framework and Testable Hypotheses

The disability quota policy is essentially a negative wage subsidy levied on firms with respect to disabled worker employment.[15] A firm faces the following choices. First, it can comply with the policy and employ persons with disabilities or not comply. In the latter case, it also has two choices: it can either pay the tax or reduce/keep its employment

[11] Our analysis focuses on the open labor market and we excluded these firms from the analysis.

[12] Adamecz-Völgyi et al. (2017) and Koenig et al. (2019) show that efficient rehabilitation service and placement systems targeting disabled individuals improve their employment prospects.

[13] In the period we study, eligibility of the disability pension (given to individuals with strong health impairment) terminated after 6 months of work, if the wage exceeded 70 percent of the previous net wage or the minimum wage. The temporary rehabilitation allowance (given to those with health impairment between 50 and 79 percent) was similar to the minimum wage and terminated after 3 months if the recipient's wage exceeded 90 percent of her previous wage. Individuals with moderate, 40-50 percent health impairment were entitled to the regular social allowance, which was about one-third of the minimum wage. The eligibility of this allowance terminated after 6 months if the recipient's wage exceeded 80 percent of the minimum wage.

[14] This number equals the number of employees in firms with at least 20 employees multiplied with 0.05 and rounded up to the next integer.

[15] Such policy may be more effective than positive wage subsidies (at least in the short run), if the managers and owners of firms weight money loss more than gaining extra funds (e.g., Tversky & Kahneman (1991)).

below the threshold even if this size is lower than the no-quota optimum (this latter choice is relevant only for firms with employment size close to the threshold). This last case includes a decline in the workforce or a lack of growth of firms under the threshold.[16]

These choices depend on the following: a firm with its optimal size above the threshold will choose to reduce its size below the threshold if the loss from employing fewer workers is lower than both the cost of hiring an individual with disabilities and the tax. A firm will choose to pay the tax instead of employing a disabled worker if the loss from employing a disabled worker is greater than the tax. The higher the cost of hiring a disabled compared to a nondisabled person, and the lower the relative productivity of disabled compared to nondisabled employees, the more probable is that a firm will choose to pay the tax. In fact, the employer will compare the expected productivity of disabled and nondisabled workers.[17] Regarding the labor cost of disabled employees, both variable and fixed costs can differ from those of nondisabled employees.

We formalize these insights in a simple model of firms' choices when a disability quota is present. Firms use two inputs, disabled and nondisabled workers (D and N, respectively), and profits depend on the production function $f(N, D)$, the wages of disabled and nondisabled employees (w_D, w_N), and the expected fixed hiring cost which is F for disabled workers (expressed in annual equivalent) and normalized to zero for nondisabled workers, and the noncompliance tax (T).

The model has two key parameters. The first is the relative productivity of workers with and without disabilities (δ). We assume that the marginal product of disabled and nondisabled employees is proportional, $f_D^{'} = \delta f_N^{'}$. As disability means a loss of work capacity, we can safely assume that $\delta \leq 1$. The second parameter is the wage gap between disabled and nondisabled workers ($w_D = d \cdot w_N$). If the firm can enforce the productivity differential when setting wages, or even impose wage discrimination, then $d \leq \delta \leq 1$. But in the presence of the minimum wage regulation, for low-skilled workers $d = 1$, and d can even exceed unity in case of supply shortage of persons with disabilities. We allow w_N, d, F, and δ to vary between firms.

The firm chooses N and D to maximize its profit under the quota regulation:

$$\begin{aligned} \pi(N, D) = p \cdot f(N, D) - d \cdot w_N \cdot D - w_N \cdot N - F \cdot D \\ - \mathbb{1}(N + D \geq c) \cdot max((N + D)q - D, 0) \cdot T, \end{aligned} \tag{1}$$

where $\mathbb{1}()$ denotes the indicator function, q is the quota (expressed as a share of the total workforce), T is the value of the noncompliance tax and c is the threshold employment

[16] It also includes the manipulation of reported employment numbers, such as contracting out employees or increasing the working time instead of employing additional workers. Unfortunately, we have no way to detect cheating or the adjustment of the working time, but nonetheless these all are deviations from the previous optimum, thus they involve extra costs.

[17] The expected and actual productivity of disabled workers may differ, if employers statistically discriminate against disabled workers.

level. In the following we normalize output prices to unity ($p = 1$).

We analyze the effect of the noncompliance tax through the simplest case: the optimization problem of a firm that does not have disabled employees and has its employment size equal to the threshold in the no-quota optimum: $D^* = 0, N^* = c$, where D^* and N^* denote the optimal labor choice without the quota. By construction, the firm has to hire one disabled employee to satisfy the quota ($N \cdot q = 1$)[18]

The profit change from hiring one disabled employee at the no-quota optimum is the following:

$$\Delta\pi = \delta f_N^{'} - d \cdot w_N - F < 0 \tag{2}$$

As the firm's labor choice was optimal in absence of the quota, the marginal revenue product from hiring a disabled employee is lower than its marginal labor cost. In the no-quota optimum, hiring a disabled employee will generate a profit loss.

When the disability quota is introduced, the firm must hire one disabled employee to meet the quota requirement. The firm will choose hiring a disabled employee instead of paying the tax, if the profit loss from hiring a disabled worker is lower than the tax:

$$-\Delta\pi = d \cdot w_N + F - \delta f_N^{'} \leq T \tag{3}$$

The firm hires a disabled person if the total labor cost (the wage and the unitary fixed cost) is lower than its benefit (the marginal product of the disabled worker and the relief from the noncompliance tax):

$$w_N d + F \leq \delta f_N^{'} + T \tag{4}$$

Figure 1 displays the effect of the quota graphically. The x and y axes show the marginal cost and marginal product of hiring one person with disabilities. Before the tax increase, all firms are at their optimum and are therefore on the 45 percent line, which represents $MC_{disabled} = MP_{disabled}$. Firms on this line (point A on the graph) hire disabled employees even in the absence of the tax. The introduction of the quota shifts the indifference line to the right by the size of the tax (T). Firms will respond by hiring disabled workers between the new and old maximum profit lines (point B) to meet the quota. Note that in the presence of the quota, even a disabled worker with negative productivity may be worth hiring (point C).[19] This is because the minimum wage cost of employing a person with disabilities is lower than the noncompliance tax. However, a set of firms will not hire people with disabilities even after the introduction of the quota. Some have a too high marginal cost relative to their marginal productivity (point D). This could happen

[18]For the sake of simplicity, we do not study the case when the firm can replace an incumbent nondisabled employee with a disabled worker. This simplification does not affect the outcomes of the model.

[19]The expected $_{disabled}$ can be negative, for example, if managers expect that hiring a person with disabilities will cause disruptions in the production process.

if a high average wage of the firm w_N, or adjustment costs F, or supply problems (high d) push the actual labor cost of employing a disabled person above the levy to such an extent that the marginal product of the disabled employee does not counterweight it. Other firms expect largely negative productivity (point E), (for example, as a result of statistical discrimination), that even at the smallest wage cost, they will not hire a disabled employee.

A firm close to the threshold c may also opt to avoid the regulation altogether by decreasing its size. In our example, this would result in firing of one worker.[20] This strategy is chosen if both the net marginal cost of the disabled worker and the value of the tax are higher than the profit loss resulting from the dismissal of one employee:

$$min(w_N d + F - \delta f_N^{'}, T) \geq w_N - f_N^{'} \tag{5}$$

Firms with a production function with a low curvature (low second derivative) are not sensitive to changes in the number of workers, thus such firms will be more likely to choose this option and keep their employment below the threshold at the quota optimum.

This simple model offers several hypotheses about the ways the policy alters firm behavior, some of them testable with our data. The most obvious is that a large non-compliance tax imposed on companies increases the demand for people with disabilities. However, the strength of this effect depends on several factors, as Equation 4 shows. The firm will rather pay the tax than hire a disabled person if the wage of disabled employees is high relative to the wage of nondisabled employees (d close to or even higher than 1). Note that d is endogenous in the sense that the noncompliance tax may alter its value: the tax increases the demand for disabled workers; hence the new equilibrium wage may also increase in the presence of supply constraints (which is the case in Hungary). A high fixed cost of hiring a disabled person (F) will also decrease the effectiveness of the policy. F also varies with the labor supply of disabled people, as search costs associated with hiring will increase if demand increases. We test these hypotheses by estimating separate effects in regions with low and high proportions of the disabled population separately.

The high average wages (w_N) at the firm level also decrease the chances of hiring a disabled person. The intuition behind this model outcome is the following: first, in a high-wage firm the value of the tax is small relative to the total wage bill, and consequently, the cost of not hiring a disabled person will be relatively low. Second, if wages are correlated within the firm (Barth et al. 2016, Song et al. 2019), high-wage firms are likely to pay higher wages to disabled employees regardless of their productivity (in the model, the wedge between the wages of disabled and nondisabled workers (d) does not vary much with the average wage of the firm). We test this insight by analyzing the heterogeneity

[20] By construction, this firm will not have a disabled worker, as we assumed that in the optimum its workforce is made up only of nondisabled employees.

of the differences in the policy response by the average wage of the firm.[21]

In the Hungarian context, a firm may hire a disabled worker and not give him/her any task at all, as the minimum wage cost is lower than the value of the noncompliance tax. Our framework provides insight into the apparent puzzle that the majority of firms choose to pay the tax instead to meet the quota. It is also possible that considerations of fairness and fear from demotivated employees without disabilities, who compare their level of effort with that of a worker who does not have to work for its salary, will make this strategy unpopular among employers (Card et al. 2012, Cohn et al. 2014).

In addition to empirically testable predictions from our data, our model can also capture other frictions and demand side factors that can play an important role in the low employment rate of people with disabilities. The larger the difference between the marginal productivity of disabled and nondisabled employees (low δ), the less likely the firm will obey the quota. A small δ can reflect the actual productivity difference between the two groups of workers, but employers' expectations about the marginal productivity of workers with disabilities can also decrease δ relative to the true productivity differential, if expectations are based on incomplete information. The lack of experience with workers with disabilities can also increase the expected fixed cost of hiring (F) if employers believe that it is very costly to refurbish the company to meet the needs of workers with disabilities.[22] This type of statistical discrimination is represented by low (δ) and high (F) in the framework. High (expected) accommodation costs and the high search costs are captured by the high F.[23]

4 Data and Empirical Strategy

4.1 Data Description

The empirical analysis is based on annual corporate tax data of all Hungarian double-entry bookkeeping firms, an administrative data set collected by the National Tax and Customs Administration. Double-entry bookkeeping was compulsory for firms with sales above HUF 50 million (about Euro 200,000), so almost all firms with employment close

[21] High wage firms are also likely to have a high share of jobs that require high skills, and Hungarian individuals with disabilities are predominantly low skilled, as shown in Table 1. This further increases search costs and implies that in such firms the probability of skill mismatch is higher, which is reflected in low productivity due to inadequate skills (δ is small).

[22] Misinformation and negative attitudes toward disability contribute to lower employment rates among people with disabilities (Phillips et al. (2016)). In Hungary, according to the 2015 Labor Force Survey, almost two-thirds of employees with reduced work capacity reported that they had experienced discriminatory practices during the job search.

[23] Hiring, training and accommodation costs tend to be high for employees with disabilities, although they are usually lower than the expectation of firms (Hendricks et al. (2005)). Based on a Hungarian firm survey, Szellő et al. (2013) finds that the lack of up-to-date information on the real costs and benefits of hiring people with disabilities among firms is a major barrier to hiring people with disabilities.

to the quota threshold of 20 employees are present in the data. We use the waves between 2006 and 2014. Tax files comprise balance sheet and income statement information, as well as several other firm characteristics, such as industry, region, and number of employees. Firms have to report the number of disabled employees each year and we use this as our outcome variable. As in many other datasets, firms leave the cell blank if they do not have disabled employees, which shows up in the data as missing. We replaced these cells with zeros.[24]

The average employment is rounded to the closest integer in the data, while in the disability employment quota regulation both firm employment and the employment quota are rounded to one decimal place.[25] This discrepancy has two consequences. First, firms with their average employment between 19.5 and 19.9 will be shown up in the data as having 20 employees (and being subject to the quota regulation), but they will actually not be subject to it. Consequently, firms with employment equal to the size threshold of the quota constitute a mixture of treated and untreated firms. We deal with this in the regression analysis by dropping firms with an employment size equal to the quota threshold. Second, we can expect discontinuity in the disability employment numbers only at the threshold.[26]

As discussed in Section 2, in exchange for wage subsidies, accredited firms hire large numbers of workers with disabilities and provide them with training and rehabilitation services. We do not have a variable in the data indicating whether a firm provides "sheltered jobs," and in line with the legal requirement of gaining accreditation, we define a firm to be in this category if the proportion of employees with disabilities in their workforce exceeds 40 percent. We remove these companies from the data because we focus the analysis on the open labor market.

4.2 Empirical Strategy

To estimate the effect of the quota on the employment of people with disabilities, we employ a sharp regression discontinuity design (RDD) in various years. The main outcome variable is the number of disabled employees ($Disemp$), but we also estimate the effect of the policy on average wages, the value of sales, labor productivity and profitability. The running variable is the number of employees in the firm (emp) and the variable of interest is $Quota$, indicating whether $emp \geq c$.

[24] To check whether this reflects reality, we obtained aggregate data from the Tax Authority on total revenues from the noncompliance tax from the corporate sector for 2013. The comparison of this information with the number of employees with disabilities in our data shows that this imputation is justified: in the aggregate data, the tax in the corporate sector is paid after 47.9 thousand employees, while calculations based on our data suggest that 49.1 thousand persons are coded as missing in 2013.

[25] The average employment equals the average of the monthly employment figures.

[26] As we discuss in Section 2, the regulation requires a firm with 39 employees to employ 1.95 employees with disabilities and a firm with 40 employees to employ 2.

We follow the literature and identify the effect nonparametrically with the method of Calonico et al. (2014*a*,*b*). This procedure applies kernel-based local polynomials on the two sides of the threshold. The advantage of this method compared to parametric RD estimation is its flexibility: it allows for a nonlinear relationship between the running and the dependent variables, and the bandwidth is estimated by minimizing the mean square error (MSE) of the estimation instead of an arbitrary choice.[27] The estimation equation for firms with $emp < c$ ("controls") is

$$Disemp_i = \gamma_c + f_c(emp_i) + \epsilon_c, \tag{6}$$

while for firms with $emp > c$ ("treated") is the following:[28]

$$Disemp_i = \gamma_t + f_t(emp_i) + \epsilon_t. \tag{7}$$

The estimated effect of the quota policy is the difference between the two intercepts:

$$\tau = \hat{\gamma}_t - \hat{\gamma}_c \tag{8}$$

The side effect of the quota regulation can be a discontinuity in the size distribution of firms at the threshold, and this is indeed the case in Hungary (as we show in Section 5.1 below). This behavior of firms is crucial for our estimation strategy: if those firms manipulate their size which have difficulties employing disabled workers, traditional RD estimates will be upward biased: firms that squeeze down their size below the threshold would probably not employ disabled individuals anyway. In the absence of firm size manipulation, the estimated effect of the quota would be smaller. We estimate a lower bound by constructing a simulated sample where we smooth the distribution of firms by employment size by moving firms from below to above the threshold and run our regression on this sample. We construct the simulated sample with the following procedure:

1. Construct a counterfactual distribution without the quota by fitting a power law function on the firm size distribution, omitting observations close to the threshold ($c \pm 5$);

2. Compute the number of firms that keep their size below the threshold to avoid the quota regulation ("bunching firms") and the number of firms that are missing from above the threshold;[29]

3. Construct a simulated sample by moving the number of excess firms randomly from

[27] We also estimated standard parametric RD models, which yield very similar results.

[28] As discussed in Section 4, we do not include $c = 20$ in the regression because both control and treated firms can have this size in the data.

[29] A similar method is used, for example, by Harasztosi & Lindner (2019), who estimate the effect of the minimum wage on employment.

the size range of $[c-5, c-1]$ to $[c, c+4]$, while we leave the number of disabled employees unchanged. We do this 10 times and run the baseline regression on each resulting sample. The average of these estimated coefficients is the lower bound of the estimate.

This method is a natural way to create a lower bound of the estimation because, in reality, bunching also forms because firms change their employment to end up below the threshold. By moving firms above the threshold, we simply inverse this procedure.[30]

This procedure builds on the idea of Lalive et al. (2013), who estimate the number of bunching firms right below the cut-off employment size $(c-1)$ and move them to c and recalculate the unconditional mean of disabled employees. Our method uses observations not only just above and just below the cut-off, but in a wider range, and gives an RD estimation of the treatment effect on the simulated sample. They also calculate an upper bound because the quota threshold is set in terms of the number of nondisabled employees in Austria, so the quota rule obliges firms to hire one disabled worker per 25 nondisabled workers. Firms at the threshold will comply with the regulation by replacing a nondisabled worker with a disabled employee, and so will also go below the threshold. As the running variable in Lalive et al. (2013) is the number of nondisabled employees, this group of firms may also create a downward bias in the treatment effect. In Hungary, the threshold refers to the size of the total workforce, hence this downward bias is not relevant.

5 Results

In this section, we first show the bunching of firms below the threshold, and construct the counterfactual sample used in the estimation of the lower bound of the quota effect (Section 5.1). Then we present the estimated effect of the quota on the number of employees with disabilities and on firm performance (Section 5.2). Finally, we analyze how the effect varies by the supply of people with disabilities and firm wages (Section 5.3).

5.1 Bunching of Firms Under the Threshold

The undesirable side effect of the regulation is that some firms close to the quota threshold keep their size below it to avoid regulation, even if their optimal size without the quota would be above the threshold.[31] In this section, we quantify the size of bunching below

[30] We argue that this method is more adequate in the Hungarian case than trimming the data to establish bounds of the estimator (Horowitz & Manski 1995, Lee 2009, Gerard et al. 2020) because very few firms have disabled employees below the threshold (about 8 percent). Dropping a relatively small proportion of firms without disabled employment will not change the estimated coefficient.

[31] Size-related regulations can have a strong distorting effect on the firm size distribution, as Garicano et al. (2016) shows for France and Amirapu & Gechter (2020) for India. In the context of the disability quota regulation, Lalive et al. (2013) finds evidence for this behavior in Austria, but Malo & Pagán (2014) and **?** do not uncover such behavior in Spain and Japan, respectively.

the quota threshold and construct the simulated samples that are used to estimate the lower bounds of the quota effect.

Figure 2 presents the size distribution of firms between 10 and 40 employees before and after the tax increase. The figure demonstrates that bunching below the threshold of 20 was shallow in 2008 and it expanded after the tax increase. As a consequence of the excess mass of firms under the threshold, there are fewer firms in the immediate vicinity above it in 2010, relative to 2008.[32]

We formally investigate non-random firm selection in the neighborhood of the threshold using the non-parametric manipulation test developed by Cattaneo et al. (2020).[33] The results of the test are summarized in Table 2 and clearly indicate the manipulation of the running variable at $c = 20$ in 2010 and 2011 after increasing the tax, while they are statistically insignificant in 2008 and 2009. In 2012 the threshold is raised to 25, and the test statistic loses significance.[34]

To further investigate how bunching forms under the threshold, we compute the transition probabilities between firm size categories before and after the policy changes. For this, we construct two size categories in 2008 representing firms right below and right above the threshold (15-19 and 20-24), and compute the transition probabilities into the size categories of 10-14, 15-19, 20-24, and 25-29 in 2010. Comparing the transition probabilities of firms from the size categories right below and right above the threshold helps to assess how the quota affects the growth of firms.[35] To provide a comparison group that has similar firms in terms of size, we also calculated the transition probabilities between 2006 and 2008 between the same size categories.

Figure 3 shows that 37 percent of firms right above the threshold decrease their size and end up right below the threshold after the tax increase. The proportion of firms right below the threshold that enter the size category of 10-14 is 27 percentage points. For growing firms, the differences are much smaller: 10 percent of firms right above the threshold grow into the next size category, while 8 percent of firms right under the threshold grow right above it. Thus, bunching below the threshold of 20 is, indeed, predominantly made up of firms that were just above it before the policy change. Contrary to this pattern, the transition probabilities between 2006 and 2008 around the placebo threshold are very similar for the size categories of 15-19 and 20-24 (25 and 27 percent, respectively) (see Appendix Figure A1).

[32] The distribution of firms in 2011 is very similar to that in 2010.

[33] The test is based on the hypothesis that bunching under the threshold results in a discontinuity of the size distribution around the cutoff. It uses local polynomial distribution estimators and is based on a Wald-type statistic, where the null hypothesis is the continuity of the running variable at the cutoff.

[34] As a robustness check, the test is implemented for placebo thresholds (c = 15, 25) in 2010 and 2011, which do not provide statistically significant test scores.

[35] This exercise will reflect the effect of the new regulation on firm size if firms in the size categories of 15-19 and 20-24 react to other factors than the quota regulation (such as the macroeconomic environment) in similar ways.

To assess whether changes in firm size are correlated with the presence of disabled employees on the firm payroll before the policy change, we computed the probability that companies with an employment size between 15-25 in 2008 were under the quota threshold after the tax increase for firms that had/did not have disabled employees on payroll in 2008. For comparison, we computed the same probability for firms in the 30-40 size category. With the help of these probabilities, we can compute a simple difference-in-differences estimate that shows how firm employment after the tax increase is correlated with having disabled employees before the policy change.

Table 3 shows the results of this exercise. In 2010, 73 percent of firms without disabled employment in 2008 were under the quota threshold in 2010, while this proportion is 57 percent of firms with at least one disabled employee in 2008. The proportion of firms that were below the placebo threshold of 35 varies little by disabled employment (63 and 60 percent). The difference-in-differences estimate is 12 percent. Therefore, firms that did not have disabled employees were more likely to shrink their size (or remain below the threshold) to avoid the quota regulation.

To test whether the bunching of firms under the threshold produces differences in observable firm characteristics (other than the number of disabled workers) between the groups below and above the threshold, we look at the covariate balance between these two groups for the following variables: employment change between 2007 and 2009, logarithm of average wage (total wage bill/number of employees), logarithm of output (value of sales), return on employment (value of pretax profit/number of employees), logarithm of labor productivity (value added/number of employees), and regional and industrial dummy variables.[36] The average values of the variables below and above the threshold in the range of +/- 5 employees, the normalized difference between them, and the discontinuity (as measured by our RDD regression), are summarized in Table 4. The normalized difference is small for most of the variables,[37] and even for variables with higher normalized difference, the regression coefficient measuring the discontinuity at the threshold is always small and statistically insignificant.

Although a non-negligible fraction of firms chose to avoid the regulation, this decision is not reflected in differences in observable firm characteristics, despite that size-related regulations can have a strong distorting effect around the threshold. In France, as Garicano et al. (2016) shows, labor costs increase considerably for firms above 50 employees due to various administrative requirements. The jump in the marginal labor costs prevents many firms from growing, resulting in a bunching in the distribution of firms below the threshold. This causes a spike in the productivity distribution of firms at the threshold. Unlike the French regulation, the Hungarian quota system does not affect any firm out-

[36] Defining the firm performance variables as deviations from industry averages does not change the results.

[37] As a rule of thumb, values under 25 percent are acceptable (Imbens & Wooldridge 2009).

comes other than the number of employees with disabilities.

Furthermore, to assess whether the observable firm characteristics jointly predict any discontinuity in disabled employment, we estimate the overall effect of all covariates (except size), including pre-treatment firm outcomes, on number of employees with disabilities at the firm. For this purpose, we follow Card et al. (2007) and compute the composite covariate index as follows. The number of disabled employees in 2010 is regressed on a set of lagged firm characteristics and the predicted value of this regression is plotted against firm size.[38] The graph is presented in Figure 4, and does not find discontinuity in the predicted disabled employment around the threshold. This shows that there is no relationship between hiring disabled employees and firm characteristics around the threshold other than the size threshold itself, indicating that firms' selection into the treatment group is based on firm characteristics that we do not observe.

Finally, we follow the method described in Section 4.2 to compute a lower bound of our estimates and also to assess the proportion of bunching firms. The left panel of Figure 5 shows the original and counterfactual distributions in 2010, while the right panel presents a simulated employment size distribution of firms after moving randomly selected firms from below to above the threshold.[39] To provide an estimate of the magnitude of bunching, we calculate the share of bunching firms relative to the total number of firms in the size range of 15-25. The number of bunching firms is calculated by subtracting the estimated counterfactual number of firms from the actual number of firms in the range of 15-25 employees. In 2010, 1152 firms kept their size below the threshold relative to the counterfactual distribution, which amounts to 12 percent of the firms between 15-25 employees.

5.2 The Effect of the Quota Regulation on Disabled Employment

Figure 6 shows the average number of disabled employees by employer size and the fitted polynomial in the vicinity of the threshold before and after the tax increase. The average number of disabled employees is continuous in employment size before the tax increase (blue line). When the tax is raised, the number of disabled employees does not change under the threshold but it increases above it, forming a distinct discontinuity at the threshold of 20 (red line). The estimation results from the baseline RD method are summarized in the upper panel of Table 5. The estimations confirm the pattern observed in Figure 6. Before the tax increase (in 2008), the estimated coefficient is very small and statistically insignificantly different from zero. The estimated effect equals 0.11 and is statistically significant already in 2009, when the regulation was not in effect, but

[38] The following covariates are added as right-hand side variables: firm age, dummies for state and foreign ownership, industrial sector and regional dummies, lagged values of productivity, average wages, profit ratio, change in the total employment in the two years before the tax increase.

[39] As discussed in Section 4.2, we construct 10 such samples.

became known to firms. Firms above the threshold increased the number of disabled employees by 0.25-0.29 on average in 2010 and 2011. The average number of disabled workers is about 0.082 in firms below the threshold (with size between 15 and 19), so the quota increased the number of workers with disabilities 3-3.5 times. When the threshold shifted from 20 to 25 employees in 2012, the discontinuity at the old threshold disappears. The disappearance of the discontinuity around the old threshold serves as a placebo test and provides further evidence that the estimated discontinuity is indeed related to the disability regulation.[40]

Estimates for the lower bound of the quota effect are presented in the bottom panel of Table 5.[41] In 2010 and 2011, the lower bound is 0.16-0.17, which is lower by 30-40 percent than the baseline estimate, but still quite large and statistically highly significant.

The quota threshold changed to 25 employees in 2012, as we discussed in Section 2. We use this policy change to test its effect on bunching and the discontinuity in the number of disabled employees around the old threshold of 20, when it is no longer a threshold. The left panel of Figure 7 shows the number of disabled employees in 2011 (blue line) and 2012 (red line). In 2011 the figure is practically identical to Figure 6 and shows a discontinuity in the number of disabled employees at the threshold, but in 2012 this discontinuity disappears and a new one emerges above 25 employees. The right panel of the figure shows the distribution of firms by employment and also shows that bunching under the old threshold of 20 disappears in 2012 and only little bunching forms under the new threshold of 25.[42] These pseudo-outcome tests provide further evidence that the bunching and discontinuity in disabled employment is indeed the result of the quota regulation.

The estimated effects of the quota in 2012, 2013 and 2014 are presented in Table 6.[43] In the first year of the threshold shift, the effect is comparable to the effects measured in 2010 and 2011 (0.29), but in 2013 and 2014 it decreases to 0.12-0.15. This decline may be explained by the tightened disability rules that decreased the number of eligible people for the quota and the significant increase in the minimum wage. This compressed the wedge between the wages of high- and low-wage workers and decreased the ratio of the noncompliance tax to wages. Meanwhile, the net minimum wage did not increase, because the government abolished the basic tax allowance on minimum wage earnings. This measure counterbalanced the positive supply effects of minimum wage increase. [44] Additionally, the share of the tax in the wage bill of firms in the data with 25 employees is

[40] Similar placebo tests were carried out in 2010 and 2011 at the pseudo-threshold of $c = 25$. Neither of these found any effect.

[41] We computed the lower bounds only in the two years when sizable bunching occurs (2010 and 2011).

[42] Our simulations show that the excess mass of firms under 25 employees is about 3 percent of all firms with 20-29 employees.

[43] As bunching is very small in this case, the lower bounds are very close to the estimated coefficients.

[44] In 2012, the government gave subsidies to companies to ease the high burden of the increased minimum wage. As subsidies were terminated in 2013, the estimated effect of the quota regulation declined.

30 percent higher than that of 20 employees, so non-compliance taxes are a relative lower burden. As we discussed in the model, the labor cost of a disabled person and the relative size of the tax are factors affecting the decision of firms obeying the quota regulation.

To assess the magnitude of the estimated effect of the quota in Hungary and also to facilitate comparison with the results of other countries with enough information (Austria and Japan), we calculate the elasticity of substitution (σ_{DN}) between disabled and nondisabled workers. This equals the percentage change in the relative employment of disabled to nondisabled workers at the quota threshold, divided by the percentage change in the relative labor cost of disabled and nondisabled workers.[45] We compute σ_{DN} with the RDD estimate and also with the lower bound. We also used two figures of average wages: one is the average wage of all corporations, which was also used in Austria and Japan, and the other is taken from the sample over which the RDD regression was estimated (firms with 15-25 employees. The value of σ_{DN} are shown in Table 7 and are much higher in Hungary than in the other two countries, even when the basis of the calculation is the lower bound of the estimated effect.[46]

In Hungary, the success of the quota regulation is controversial: the elasticity of substitution is very high, suggesting a large effect. According to our most conservative estimate, a 10 percent increase of the relative labor cost of disabled and nondisabled employees at average wages induced a 47 percent increase of disabled relative to nondisabled employment. On the other hand, the fulfillment of the quota was 41 percent among firms between 20-25 employees.[47] This is a rather low value, especially in light of the fact that the noncompliance tax was higher than the minimum wage cost necessary to fulfill the quota.

In fact, the large σ_{DN} may not fully reflect the economic effect of the regulation for three reasons. First, its large size is partly the consequence of the low levels of disabled employment below the threshold. As the 4$^{\text{th}}$ column of Table 7 shows, only 11 percent of the quota was fulfilled in Hungary at firms with 19 employees (just below the threshold), which is in stark contrast to the same statistic of 25 percent in Austria and 87 percent in Japan. Second, when computing the elasticity of substitution, the change in the wage cost of disabled relative to nondisabled workers is proxied by the noncompliance tax itself. However, it is possible that the fixed cost of hiring a disabled worker also increased: as labor supply is limited, search costs were likely to increase, which may have offset part of the financial incentives induced by the tax. Taking into account the increase in fixed

[45] The numerator of σ_{DN} is calculated as the estimated disabled employment effect divided by the average number of disabled employees below the threshold. The denominator is the change in the relative disabled/nondisabled labor cost relative to the average cost of labor (wages and employer contributions, evaluated at the average national wage level at the threshold).

[46] As a robustness check, we computed σ_{DN} by comparing firms above the quota threshold before the tax increase (2008) and after it (2010). This calculation yields a similar value for the elasticity of substitution (-10.6).

[47] This figure is 26 percent among all firms above the threshold.

cost in the calculation of σ_{DN} would probably decrease its magnitude. Furthermore, we compared two countries with small levels of noncompliance taxes with Hungary, where the tax was large. To do this comparison, we have to assume that σ_{DN} is independent of the value of the tax, which is unlikely. Actually, it is possible that comparable tax levels in Hungary to those of other countries would have resulted in lower σ_{DN}. Finally, and perhaps most importantly, is that even this large elasticity dwarfs in the light of the tax being much higher than the minimum wage cost to fulfill the quota.[48] In the light of this fact, one could have expected a complete fulfillment of the quota and a huge σ_{DN} that would correspond with such behavior.

5.3 The Role of Labor Supply

The Hungarian noncompliance tax was so high that it more than covered the variable cost of a half-time minimum wage earner, thus firms would have been better off even if they had hired a disabled worker with zero productivity than paying the tax. Why did the majority of firms pay the tax instead? As discussed in Section 3, this can be explained by the high expected adjustment costs, the shortage of labor supply, the size of the wage bill, or discrimination. In this section, we examine the variation of the effect of the policy by the labor supply of disabled workers and the average wages of firms.

We use geographical variation in the share of disabled individuals in the working-age population to test the role of labor supply of people with disabilities in the effectiveness of the quota policy. Table 1 from Section 2 demonstrated that the share of people people with disabilities in the total working-age population varies between regions. Against this background, we estimate the effect of the quota policy for regions with a high and low share of the disabled population separately. To group the regions into these categories, we use data from 20 counties (NUTS3 level) and group them according to whether the share of people with disabilities in the working-age population is lower or higher than the country average.[49]

High-wage firms experience a lower tax burden relative to the size of their wage bill; therefore, they can more easily lean toward paying the tax instead of hiring a person with disabilities.[50] Because high-wage firms are more likely to be present in more developed counties with a low share of disabled individuals, this may bias our analysis of the labor supply of disabled persons. To attenuate this bias, we construct four separate samples,

[48] σ_{DN} does not reflect the fact that the wage cost to fulfill the quota is lower than the noncompliance tax itself.

[49] Average low share = 7.2 percent; high share = 15 percent. Counties with a low proportion of disabled population are Budapest, Győr-Moson-Sopron, Fejér, Pest, Vas, Veszprém, Zala, and with a high proportion are Baranya, Bács-Kiskun, Békés, Borsod-Abaúj-Zemplén, Csongrád, Hajdú-Bihar, Heves, Jász-Nagykun-Szolnok, Komárom-Esztergom, Nógrád, Szabolcs-Szatmár-Bereg, Somogy, Tolna. This information come from the 2011 Labor Force Survey.

[50] In the sample of firms with 20 employees in 2008, the share of the tax in the total wage bill of the firm at the 25^{th} (75^{th}) percentile of the wage bill distribution was 3.4 (1.8) percent.

defined by the wage level of the firm (below/above the average wage of firms between 15-24 employees in 2010-2011) and counties with a low/high proportion of disabled individuals), and run the RD regression on these samples.

Figure 8 plots the average number of disabled employees around the threshold for the four samples. Firm reactions to the high tax depend both on the proportion of disabled population and the wage of the firm. As expected, the proportion of workers with disabilities is positively correlated with the proportion of disabled individuals in the working age population in the county: a larger share of individuals with disabilities results in high numbers of job applicants with disabilities and some will end up being employed eventually. Firms in high supply counties employ more people with disabilities in average even under the threshold and also react more intensively to the quota. In low supply regions, the treatment effect is lower than in high supply regions at both low wage and high wage firms.

Within high- and low-supply regions, the share of disabled workers is very similar in low- and high-wage firms below the threshold, perhaps suggesting that the willingness to hire people with disabilities does not depend on the type of firm.[51] In contrast, firms with low wages are more inclined to react to the quota, regardless of supply. This is probably because the tax relative the wage level is higher for firms with lower average wages. Therefore, the average wage of the firm does not influence the employment of people with disabilities below the threshold, where the quota rule does not apply, but it interacts with the policy. This indicates that the only channel through which the wage level affects the demand for people with disabilities is that it determines the relative burden the tax poses on the firm.

To assess the heterogeneity of the quota effect more formally, we first estimate our RD regressions in high- and low-supply regions and high- and low-wage firms separately.[52] As the first two columns of Table 8 demonstrate, in low-supply regions firms above the threshold employ 0.18 additional disabled employees after the tax increase, while this figure is 0.4 in high-supply regions. Similar differences are uncovered for low- and high-wage firms in columns 3 and 4 of the table: low-wage firms have a stronger reaction and employ 0.39 additional disabled workers, while high-wage firms employ only 0.15.

The joint effects of the supply of disabled workers and firm wage are presented in

[51] Besides the relatively lower tax burden of high wage firms, they may also have fewer jobs suitable for disabled individuals, at least in the Hungarian context. As Table 1 demonstrated, the share of people with basic education is higher among people with disabilities, and high-wage firms probably have fewer such positions. However, the similar share of disabled employment in high- and low-wage firms within regions of high and low supply of disabled persons under the threshold makes this potential constraint unlikely.

[52] To calculate the lower bound of the estimation, we keep the same sample over which we defined high- and low-wage firms. Therefore, we do not estimate the bandwidth but set it to the range of ± 5. For this, we cannot use an estimated power law distribution as a counterfactual because we use only a fraction of the employment distribution of firms (between 15-25 employees). Instead, we use the 2008 distribution of firms as a counterfactual. The size distribution of firms of the four subgroups is shown in A2

Columns 5-8 of the table. As expected, the policy effect is the weakest for high-wage firms in low-supply regions (13 percent) and the largest in low-wage firms in high-supply regions (56 percent). Low-wage firms in low-supply regions have a very similar probability of employing disabled individuals as high-wage firms in high-supply regions (about 25 percent).

The table also presents the lower bounds of the estimates. These are quite similar to the estimates themselves for high-wage firms (the lower bound is 10-15 percent lower than the baseline estimate) and smaller for low-wage firms (by 25-40 percent).

These results are consistent with the predictions of our model and provide an explanation for the apparent contradiction that the majority of firms pay the tax instead of hiring individuals with disabilities, even though the latter would incur a lower wage cost. Without sufficient labor supply of people with disabilities, even in the presence of strong financial incentives, companies are less likely to meet the quota, as hiring a person with disabilities suitable for their needs is very expensive or even impossible.

6 Conclusion

This article analyzed a disability quota policy, when the government increased the non-compliance tax to be higher than the lowest wage cost associated with fulfilling the quota. We apply a regression discontinuity design and provide a lower bound of the estimates, which takes into account the bunching of firms under the threshold. We find substantial effects of the policy. When the tax is raised from low to very high levels, the estimate jumps from zero to 0.24-0.29 with a lower bound of 0.16. When the size threshold is moved from 20 to 25 employees, the discontinuity of disabled employment disappears at the old threshold, and a new discontinuity emerges at 25 employees.

Although these effects are larger than those found in other studies, it is surprising that around 74 percent of firms under the quota regulation do not hire any disabled employees to lower their costs, when hiring a minimum wage worker even with zero productivity would incur a lower wage cost than paying the tax. We build a simple framework to show that several factors, among them labor supply shortage and the resulting high adjustment costs, can explain this apparent contradiction. To examine this behavior, we look into the heterogeneity of the effect by the regional supply of disabled persons. We find that the compliance rate is higher if the proportion of disabled individuals is high in the region, and this effect is stronger if the firm pays low wages. Our results, therefore, indicate that even such strong financial incentives cannot meet their target if other frictions, such as the low activity rate of people with disabilities, are not addressed with adequate policy measures.

A closer look at the Hungarian disability policies suggests that labor supply is constrained by the lack of mediation between workers and firms, which increases search costs

both on the demand and supply side. The low capacity of rehabilitation services and insufficient accessibility to public transport, the dominance of sheltered workplaces, and disincentives to work associated with the loss of disability allowances further decrease the participation rate of disabled persons. Addressing these problems would not only promote the employment chances of people with disabilities but also increase the efficiency of the quota system.

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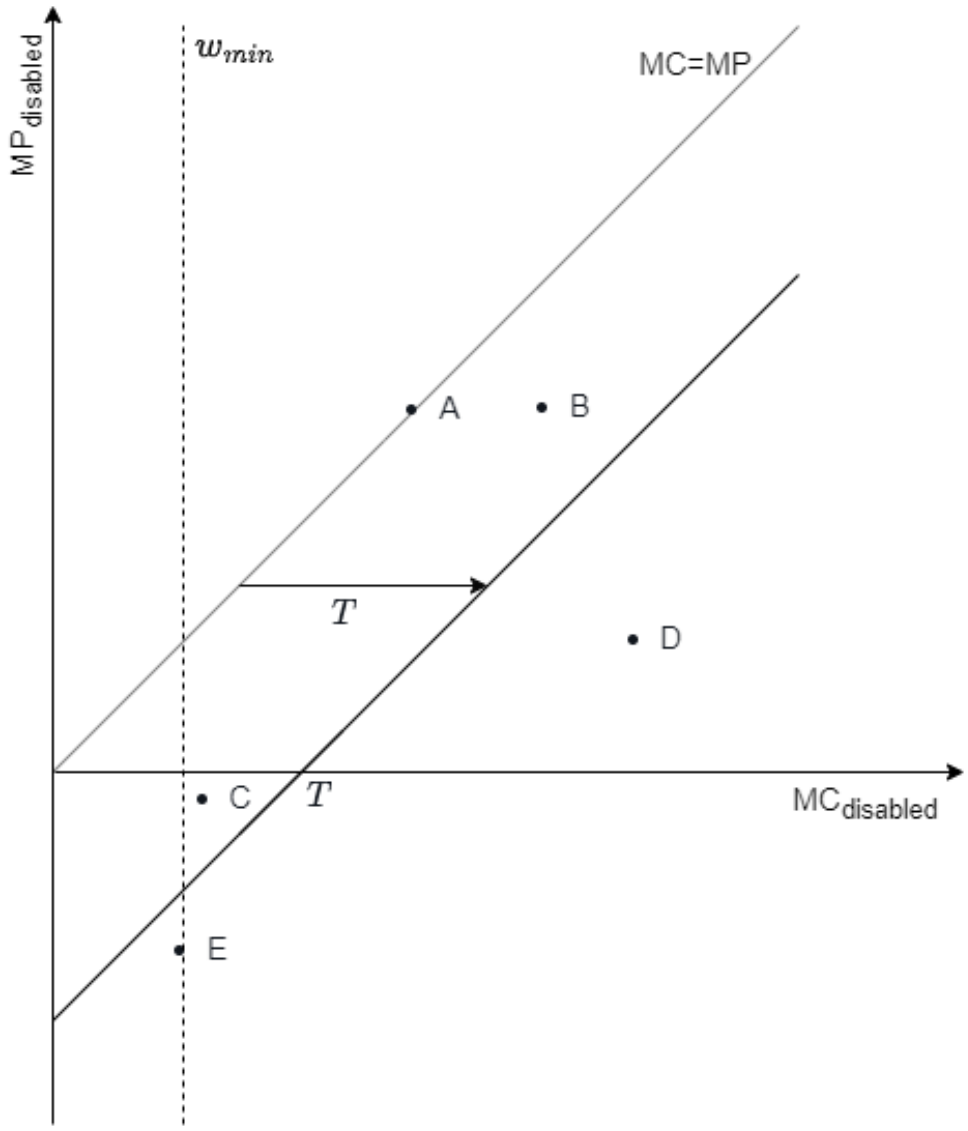
Tables and Figures

Figure 1: Demand for Disabled Workers



Notes: This figure presents a firm's decision to employ disabled workers with and without the quota regulation. $MC_{disabled} = w_N d + F$; $MP_{disabled} = \delta f'_N$ (see Equation (4)). w_{min} = minimum wage cost to fulfill the quota. Point A: the firm hires a disabled worker without the quota; point B: the firm hires a disabled worker in presence of the quota; point C: the firm hires a disabled worker in presence of the quota even if the marginal product of the worker is negative; point D: the firm does not hire a disabled worker even in the presence of the quota ($MC_{disabled}$ too high); point E: the firm does not hire even if the worker gets the smallest wage possible ($MP_{disabled}$ too low).

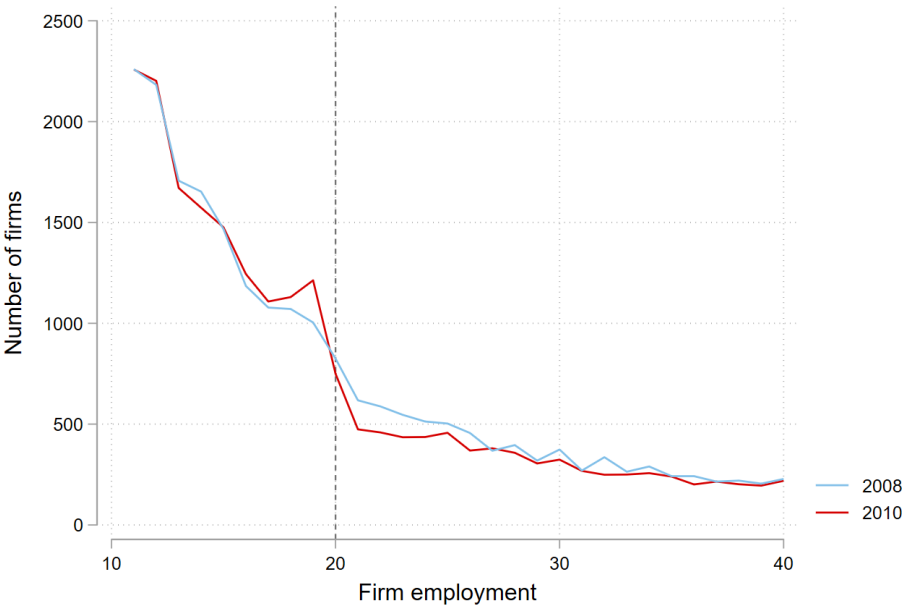
Table 1: Comparison of Disabled and Nondisabled Populations

	Disabled		Not Disabled		Perc. disabled
	Number	Percent	Number	Percent	
Total	766823	100.0	5925684	100.0	11.5
Age					
15-29	39658	5.2	1810493	30.6	2.1
30-50	179542	23.4	2642178	44.6	6.4
50-64	547624	71.4	1473013	24.9	27.1
Education					
Basic	292758	38.2	1317416	22.2	18.2
Vocational	252626	32.9	1471797	24.8	14.6
High School	177734	23.2	1986067	33.5	8.2
College	43705	5.7	1150404	19.4	3.7
Region					
Central Hungary	146020	19.0	1851170	31.2	7.3
Central Transdanubia	68012	8.9	670770	11.3	9.2
Western Transdanubia	61739	8.1	611981	10.3	9.2
Southern Transdanubia	105144	13.7	522540	8.8	16.8
North Hungary	110894	14.5	675397	11.4	14.1
North Great Plain	146290	19.1	850635	14.4	14.7
South Great Plain	128723	16.8	743190	12.5	14.8
Labor Force Status					
Employed	139035	18.1	3605637	60.8	3.7
Unemployed	42976	24.8	409500	10.0	9.5
OLF	581811	75.9	1910546	32.2	23.3

Source: Central Statistical Office, based on the Ad-Hoc Module of the Labor Force Survey 2011.

Notes: Population: individuals aged 15-64 years. "Number" presents the number of individuals in the given group; "Percent" presents the column percent of disabled/nondisabled population in the given group; "Perc. disabled" presents the row percent of disabled individuals in the given group. Percent unemployed is related to the active disabled/nondisabled population. Basic = 8 classes or less; Vocational = 10-11 classes; High school = high school diploma; College = completed college or more.

Figure 2: Distribution of Firms by Employment Size



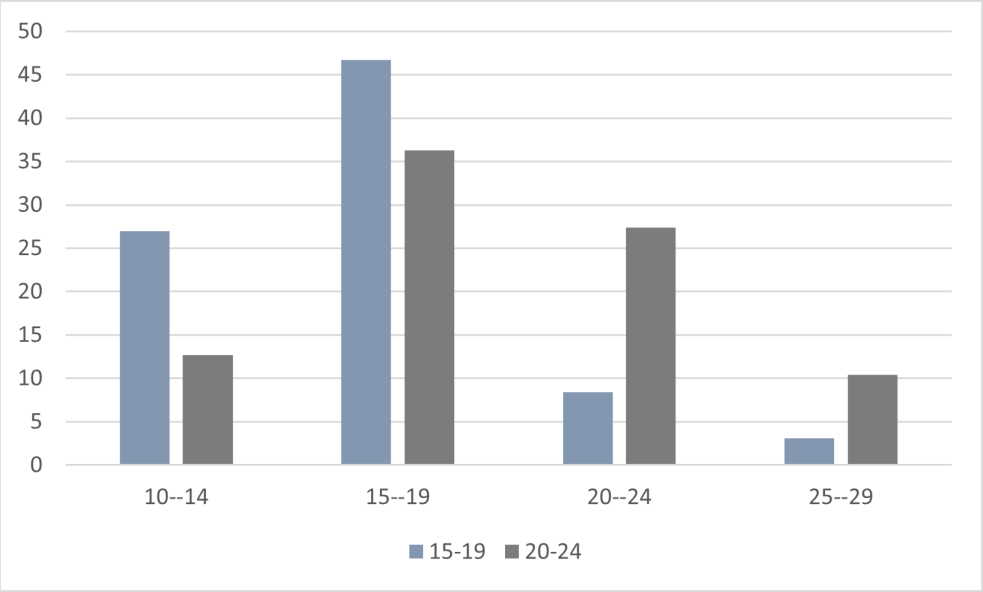
Notes: N= 25,059 (2008), 24,126 (2010). The figure presents the distribution of firms by employment size around the disability quota threshold before (2008) and after (2010) the noncompliance tax increase. 2009 is not included because the quota regulation was signed in June and firms started adjustment.

Table 2: Discontinuity in Employment Density at 20 Employees

Year	Threshold	Tax	T	P>|T|
2008	20	Low	-0.693	0.489
2009	20	Low	-0.762	0.446
2010	20	High	-3.999***	0.000
2011	20	High	-1.775*	0.076
2012	25	High	-1.283	0.199

Notes: the table presents the results of the nonparametric manipulation test for the quota threshold of c=20 in 2008-2010, and the pseudo threshold of c=20 in 2012, for low- and high-tax regimes. The test statistic T measures discontinuity in the distribution of firm employment size at the threshold. Identical 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. *** = p<0.01, ** = p<0.05, * = p<0.1.

Figure 3: Transition of Firms across Size Categories



Notes: N= 89,052. This figure presents the transition probabilites of firms from the size categories right below (15-19) and right above (20-24) the quota threshold into size categories of 10-14, 15-19, 20-24 and 25-29 between the years of 2008 (before the tax increase) and 2010 (after the tax increase).

Table 3: Size Adjustment of Firms With and Without Disabled Employees

Threshold	20	35	Diff.
Without Disabled Worker in 2008	0.73	0.63	
	(0.01)	(0.01)	
With Disabled Worker in 2008	0.57	0.60	
	(0.02)	(0.02)	
Difference	0.15***	0.03	0.12***
	(0.09)	(0.23)	(0.03)
N	8230	2523	

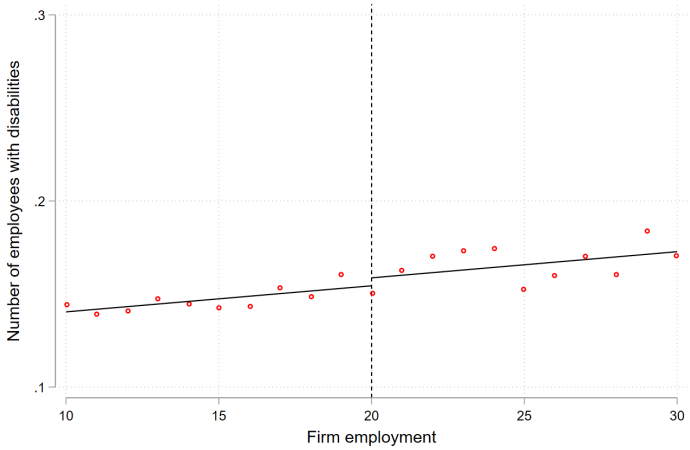
Notes: column 1 of this table shows the fraction of firms between 15-24 employees in 2008 (before the tax increase), which stay below the disability quota threshold in 2010 (after the tax increase) for firms that had and firms that did not have disabled employment in 2008. Column 2 shows the same figures for firms with 30-39 employees in 2008 (before the tax increase), which stay below the pseudo-threshold of 35 in 2010 (after the tax increase) for firms that had and firms that did not have disabled employment in 2008. The number if column 3 is the difference-in-differences estimate.

Table 4: Descriptive Statistics Around the Quota Threshold

Variable	Below Threshold	Above Threshold	Normalized Difference	Discontinuity
Emp. Change 2007-2009	1.063	1.23	1.1	0.798
Wage	7.43	7.52	15.4	0.018
Profit/Sales	-0.001	-0.322	0.2	-0.001
Value added/Emp.	8.102	8.171	7.2	0.043
Regions				
Central Transdanubia	0.086	0.102	5.3	-0.007
Western Transdanubia	0.087	0.097	-3.4	-0.008
South Transdanubia	0.081	0.073	3	0.025
North Hungary	0.069	0.058	-3	-0.163
North Great Plain	0.108	0.117	2.8	0.011
South Great Plain	0.115	0.130	4.4	-0.010
Industries				
Industry	0.345	0.359	2.9	-0.050
Retail	0.231	0.220	-2.8	0.032
Tourism	0.069	0.065	-1.5	0.017
Other Services	0.368	0.350	-3.8	0.047

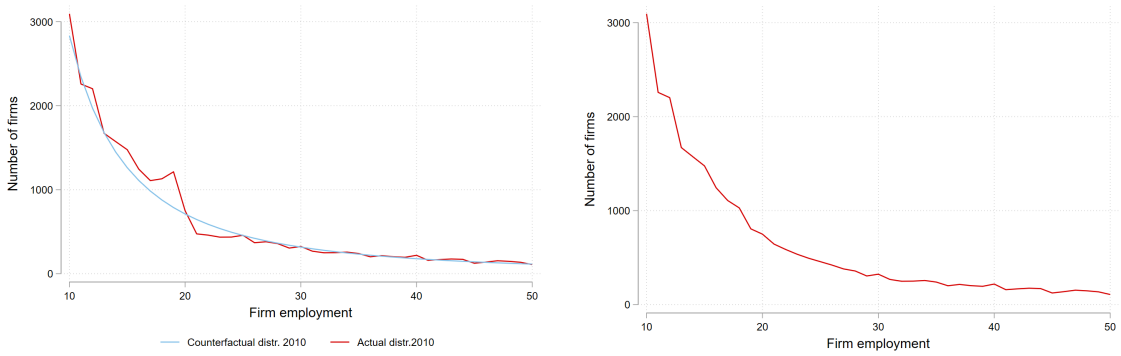
Notes: the table shows the means of firm covariates in a +/- 5 employees range under and above the quota threshold of 20 employees in 2010 and the normalized percentage difference between them. The last column contains non-parametric RD estimation results. Running variable: firm employment; threshold = 20 employees. The order of the local polynomial is 1. Wage = average firm wage. Value added/Emp and Sales are logged. *** p<0.01, ** p<0.05, * p<0.1.

Figure 4: Selection on Observable Company Characteristics



N=15590. The figure displays predicted values from a linear regression where the number of disabled employees of firms between 10 and 30 employees in 2010 are regressed on the following covariates: firm age, dummy for state and foreign ownership, sectoral and county dummies, lagged values of productivity, average wages, profit ratio, change in the total employment in the two years before the noncompliance tax increase (2007-2009). The dots on the chart are the predicted values. The line is a polynomial on order 1 fitted on the two sides of the cutoff.

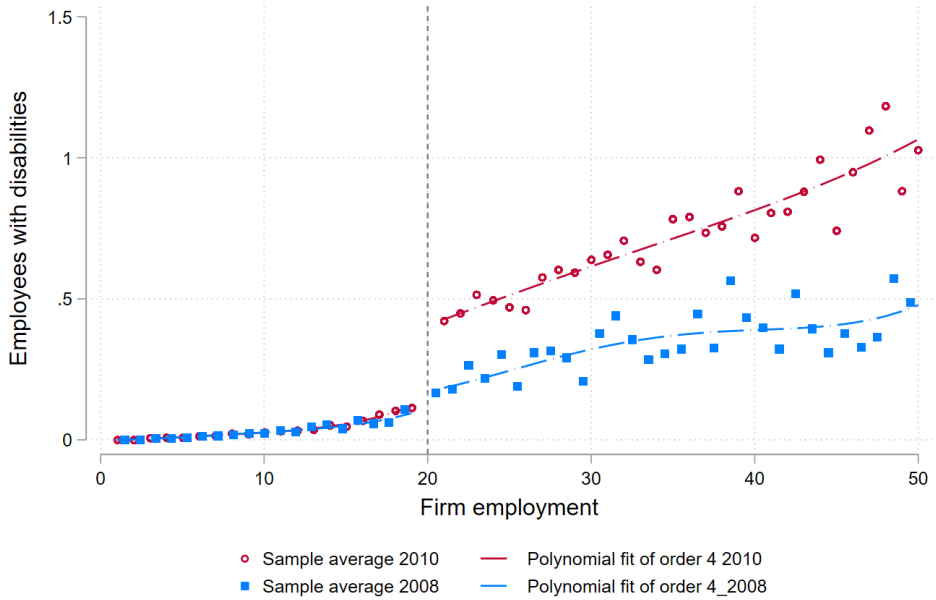
Figure 5: Simulated Distribution of Firm Employment



(a) Counterfactual Distribution (b) Simulated Distribution

Notes: N= 25,619. Panel A presents the actual and counterfactual distributions of firm employment in 2010, Panel B present one (out of the 10) simulated distribution used to estimate the lower bound of the quota effect.

Figure 6: Disabled Employment by Firm Size Before and After the Policy Change



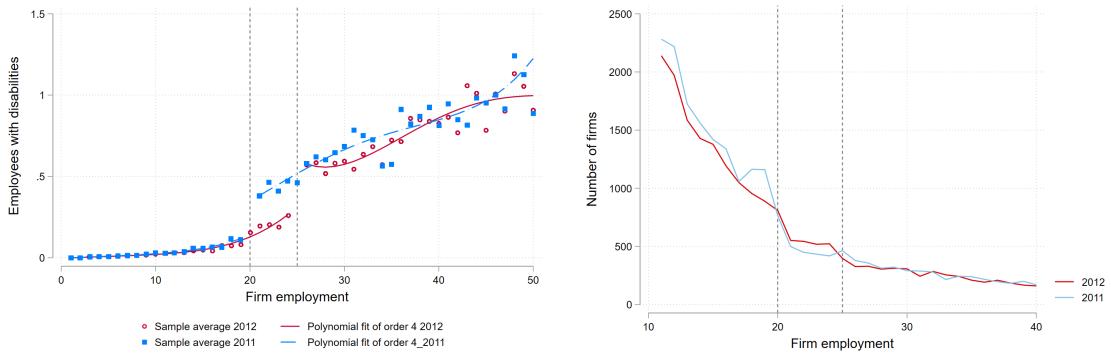
Notes: N= 511,257. The blue/red dots present the average number of disabled employees in firms in 2008 (before the tax increase) and 2010 (after the tax increase). The blue/red lines are fitted fourth order polynomials before/after the tax increase. The red vertical line represents the quota threshold at 20 employees.

Table 5: The Effect of the Disability Quota on Disabled Employment

	2008	2009	2010	2011	2012
Quota Effect	-0.012	0.112***	0.287***	0.237***	0.038
	(0.048)	(0.031)	(0.041)	(0.035)	(0.028)
Bandwidth	3.5	7.5	6.6	7.6	6.3
N	4905	12096	10374	12430	9756
Lower Bound	NA.	NA.	0.171***	0.161***	NA.
			(0.065)	(0.063)	
Bandwidth			6.3	6.7	
N			9944	10600	

The table contains nonparametric RD estimation results and their lower bounds, which takes into account bunching of firms below the threshold. Standard errors in parentheses. NA. = not applicable (no bunching under the threshold). Outcome variable: number of disabled employees at the firm; running variable: total firm employment; threshold = 20 employees (2008-2011), 25 employees (2012). The order of the local polynomial is 1. *** p<0.01, ** p<0.05, * p<0.1.

Figure 7: Pseudo-Outcome Tests: Disabled Employment and Size Distribution of Firms when the Threshold Changed to 25



Notes: N = 543,349. The blue/red dots in the left panel present the average number of disabled employees in firms in 2011 (when the threshold was at 20 employees) and 2012 (when the threshold was at 25 employees). The blue/red lines are fitted fourth order polynomials before/after the tax increase. The red vertical lines represent the quota thresholds at 20 and 25 employees. The right figure presents the employment distributions of firms in 2011 (when the threshold was at 20 employees) and 2012 (when the threshold was at 25 employees).

Table 6: The Effect of the Disability Quota on Disabled Employment (c=25)

	2012	2013	2014
Quota Effect	0.285***	0.116*	0.145**
	(0.051)	(0.070)	(0.052)
Bandwidth	7.83	4.90	5.51
N	6905	3566	5039

The table contains nonparametric RD estimation. Standard errors in parentheses. Outcome variable: number of disabled employees at the firm; running variable: total firm employment; threshold = 25 employees. The order of the local polynomial is 1. *** p<0.01, ** p<0.05, * p<0.1.

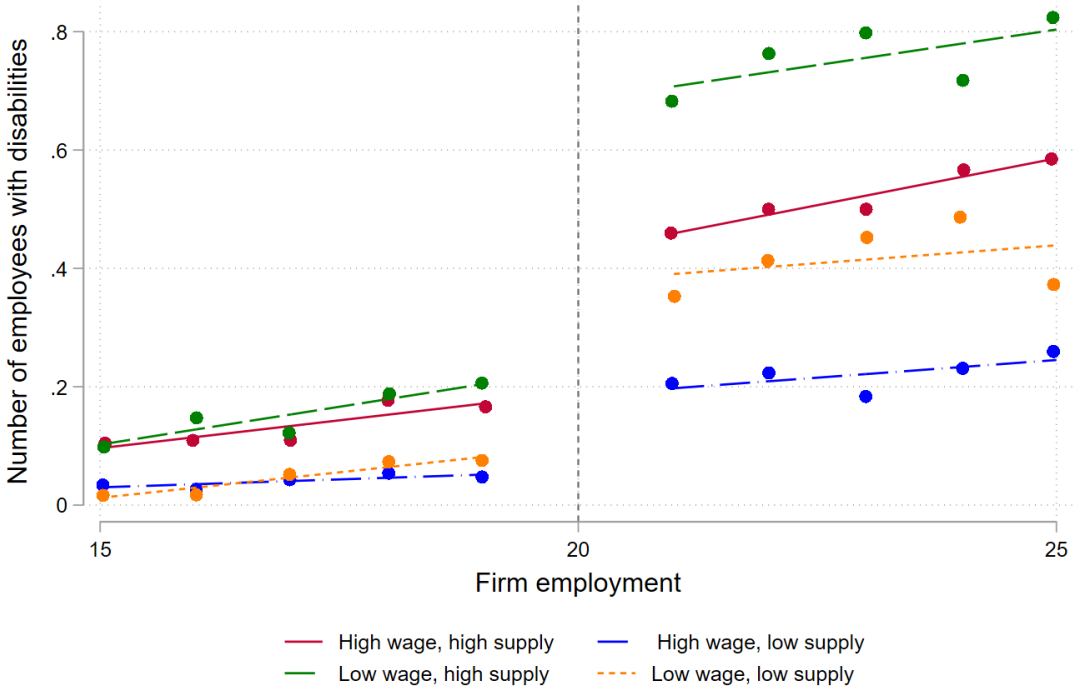
Table 7: Elasticity of Substitution Between Disabled and Nondisabled Workers

	Est. Coeff.	Thres. (emp.)	Quota	Quota Fulfill. below Thres.	σ_{DN}
Hungary					
Baseline	0.29	20	0.05	0.11	-10.6/-8.3
Lower bound	0.16	20	0.05	0.11	-6.1/-4.7
Other countries					
Japan	1.42	300	0.018	0.87	-2.97
Austria	0.04	25	0.05	0.25	-2.01

Source: Japan: based on Mori & Sakamoto (2018) and own calculation; Austria: based on Lalive et al. (2013) and own calculations. Source for average nondisabled wage: Central Statistical Office (Hungary); Annual Salary Survey done by DODA (a Japanese job-search website) (Japan). Source of employer contribution information: OECD Taxing Wages database (Austria).

Notes: Estimated coefficient: the estimated effect of the quota on disabled employment; Threshold: the firm employment above which the quota is effective; Quota: the proportion of firm employment to be filled with disabled workers; Quota fulfillment below threshold: the proportion of the quota fulfilled in absence of the quota, at firm size of 19 employees in Hungary, 24 nondisabled employees in Austria and 169-300 employees in Japan. σ_{DN}: first number computed with the average wage of all corporations (comparable with the other countries); the second number computed with the average wage of firms with size between 15-25 employees. The calculation of σ_{DN} for Austria differs from that of Lalive et al. (2013), as the wage cost contains the employer's contribution.

Figure 8: Disability Employment for Subsamples of Firms



Notes: The dots present the average number of disabled employees in firms around the quota threshold in 2010. The lines are fitted first order polynomials. High wage firms: firm average wage is above the average wage of all firms between 15 and 25 employees. Counties with low/high proportion of disabled people are in Footnote 47.

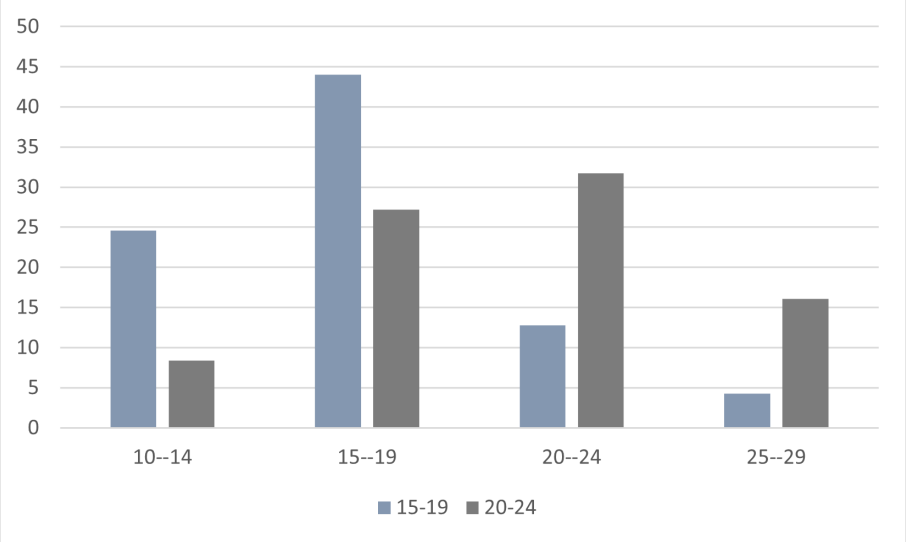
Table 8: Effect of the Disability Quota by Labor Supply of Disabled Individuals and Firm Wage

	Supply		Wage		Low Supply		High Supply	
	Low	High	Low	High	Low Wage	High Wage	Low Wage	High Wage
Quota Effect	0.175***	0.413***	0.386***	0.158***	0.254***	0.128***	0.565***	0.249**
	(0.046)	(0.109)	(0.089)	(0.052)	(0.083)	(0.048)	(0.172)	(0.117)
N	3861	2436	3550	6224	5543	2,366	4573	2725
Quota Effect	0.101**	0.278***	0.229***	0.135***	0.169**	0.105**	0.437**	0.221
	(0.046)	(0.138)	(0.096)	(0.056)	(0.078)	(0.051)	(0.195)	(0.139)
N	5057	3115	4766	3,632	2004	1875	1478	949

The table contains nonparametric RD estimation results and lower bounds of the estimation for subsamples by low/high supply of disabled employees and low/high wage firms. Standard errors in parentheses. High wage firms: firm average wage is above the average wage of all firms between 15 and 25 employees. The outcome variable is the number of disabled employees at the firm, the running variable is total firm employment. The threshold (c) is 20 employees. The order of the local polynomial is 1. *** p<0.01, ** p<0.05, * p<0.1.

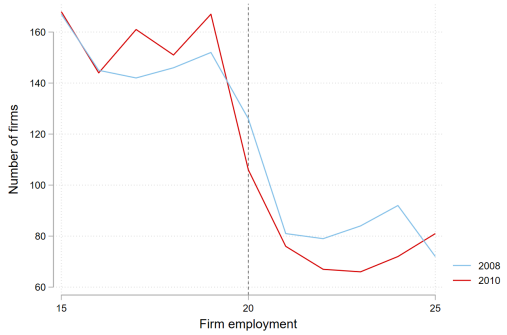
Appendix: Additional Figures and Tables

Figure A1: Transition of Firms Across Size Categories around a Placebo Threshold

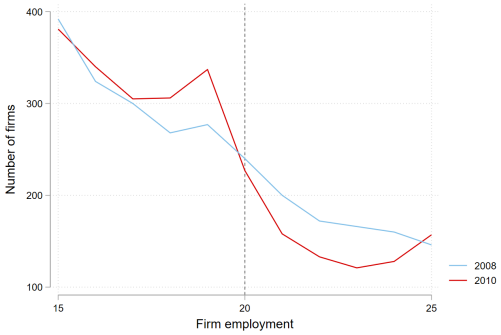


Notes: N= 87,836. This figure presents the transition probabilites of firms from the size categories right below (15-19) and right above (20-24) the quota threshold into size categories of 10-14, 15-19, 20-24 and 25-29 between the years of 2006 and 2008. Both years are under the low-tax regime.

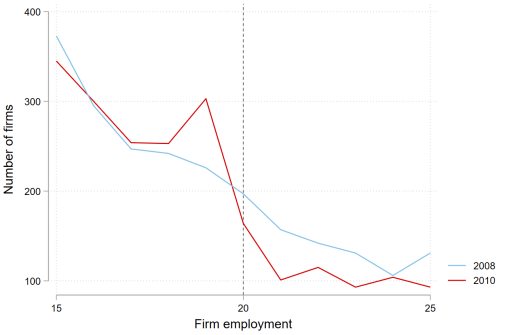
Figure A2: Firm size distribution by supply and wage



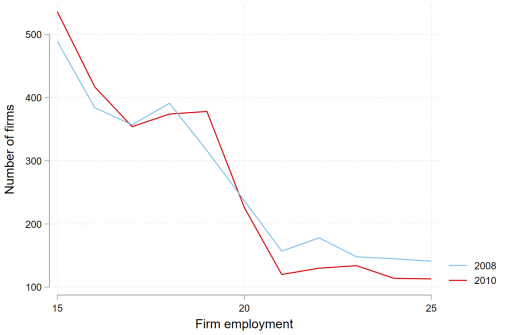
(a) High supply, high wage



(b) Low supply, high wage



(c) High supply, low wage



(d) Low supply, low wage

Notes: The figure presents the employment distributions of firms in 2008 and 2010 in the four subgroups by proportion of disabled individuals in the county and average of the firm, the vertical line shows the quota threshold (20 employees)) High wage firms: firm average wage is above the average wage of all firms between 15 and 25 employees. Counties with low/high proportion of disabled people are in Footnote 47.