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Economic consequences of employment quota system for disabled people: Evidence from a regression discontinuity design in Japan

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ABSTRACT

This study examines the effect of Japanese employment quota system for disabled people on their employment. By using administrative data from Japan, we show that a levy-grant scheme increases the employment of disabled workers in Japan's manufacturing industry. In addition, we find that small-sized firms hire disabled workers when increasing firm size, although they are not obligated to pay levies. Finally, we use the number of disabled workers assigned by the quota system as an instrumental variable (IV) to evaluate the impact of disability employment on a firm's profit rate. The results of the fuzzy regression discontinuity design (RDD) suggest that an increase in the number of disabled workers does not necessarily decrease a firm's profit rate, which is in contrast to the results of the ordinary least squares (OLS) regression that suggest a negative relationship between the profit rate and disability employment.

1. Introduction

Since the mid-twentieth century, many developed countries such as UK, France, and Germany have constructed and maintained support systems of education and employment for disabled people. Despite decades of efforts for achieving normalization and mainstreaming, many surveys have indicated that disabled people have been faced with difficult situations in their employment and education. For example, OECD (2003; 2010) reported that disabled people were at twice the risk of unemployment and poverty compared to non-handicapped people. In order to lessen the severity of these problems, some western European and eastern Asian countries have adopted employment quota systems that require public and private firms to employ disabled people above a certain targeted level.

In general, employment quota systems can be classified in terms of levy-grant schemes. The simplest quota system requires only moral responsibility for firms to employ disabled people above a certain level. However, this system has been criticized as very few firms achieve their quotas. The other quota system requires firms to pay levies if they are not able to achieve their quotas. Moreover, it gives firms grants if they are able to achieve some targeted levels on disability employment. This system has also been criticized since employers often prefer to pay levies rather than achieve their quotas (Waddington, 1995; National Institute of Vocational Rehabilitation, 2002). Therefore, there have been considerable interests and concerns about how much levy will be a reasonable amount for achieving a targeted level of disability employment. In this study, we examine whether a levy-grant scheme could actually promote employment of disabled people by using administrative data from Japan. Moreover, we use the number of employed disabled people assigned by the quota system as an instrumental variable (IV) to investigate the causal effect of disability employment on a firm's profit and efficiency.

The Japanese disability employment system was established in 1960.[1] In the initial system, there was no levy-grant scheme. That is, a moral responsibility only drove private firms to employ disabled people. In 1976, a levy-grant scheme was introduced and private firms were strictly requested to achieve their quotas. If they were not able to meet their *levy quotas*, the employers were required to pay levies. In addition, if they could hire disabled work-

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[1] See Matsui (1998) and Hasegawa (2010) for the historical background of Japan's disability employment system.

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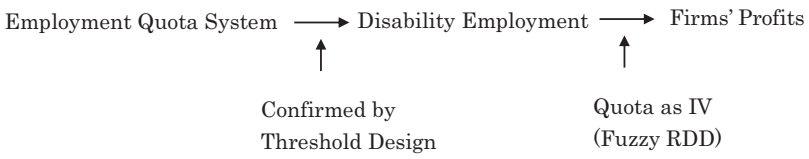


Fig. 1. Empirical strategy for estimating the effects of disability employment on firms' profits.

ers above a certain level (hereafter, *grant quotas*), then they had rights to receive grants. This disability employment system was slightly modified several times but adhered fundamentally to the levy-grant scheme. The system, which this paper focuses on, stipulates 1.8% as the legal targeted level for private firms and requires employers to pay a monthly amount of 50,000 yen per person short of the levy quotas if they are not able to achieve their quotas.[2] However, since its inception, the legal targeted level has never been satisfied, and the proportion of disabled people in the entire workforce has always been approximately 0.2% points below the targeted level. Therefore, some administrators and specialists criticize that the levy is too low to motivate employers to employ the required number of disabled people.[3]

The purpose of this study is to investigate the effect of the Japanese levy-grant scheme on the employment of disabled workers by using Japanese administrative data in 2008. According to the 2008 disability employment policies in Japan, private firms with 301 regular workers or more were required to pay levies if they could not achieve their levy quotas. On the contrary, private firms with 300 regular workers or less had no obligation to pay levies. We consider baselines of the levy-grant scheme, where each baseline equals each levy quota if a firm has 301 regular workers or more, and equals zero otherwise. If a firm was unable to employ disabled workers beyond the baseline defined above, then it must pay a levy. By focusing on the effect of these baselines on the employment of disabled people, we investigate the employment effect of the levy-grant scheme. In addition, we use the number of disabled workers assigned by the quota system as an instrumental variable (IV) to examine whether disability employment decreases firms' profit rates. Employers often consider disabled workers as an economic burden in maximizing their profits. Therefore, firms that are less driven to earn profits are more willing to hire disabled workers.[4] As a result, simple regression overestimates the negative effect of disability employment on a firm's profit.[5] In this study, we identify the causal effect of disability employment on a firm's profit rate by using the increase in the number of disabled workers due to the quota system as an IV. In sum, as shown in Fig. 1, we investigate an impact of disability employment on firms' productivity by using fuzzy RDD strategy as follows: For the first step, our empirical strategy exploits a discontinuous change of the number of disabled workers in each quota threshold. For the second step, we estimate an effect of disability employment on firms' profits by using the quota system as an IV.[6]

Our main results show that a levy can promote disability employment in Japan's manufacturing industry. Moreover, we also find that small-sized firms have an incentive to hire disabled workers with increasing firm size. Finally, we show that there is no clear relationship between the number of disabled workers and the firm's profit rate, although results of the ordinary least squares (OLS) regression indicate a negative relationship between them. This fact suggests that the effect of disability employment on profits or efficiency has a negative bias and could be non-negative.

Although there are many studies on the economics of disability,[7] very few have focused on the employment quota systems for disabled people. This is because US and UK disability employment policies do not adopt employment quota systems.[8] Consequently, the majority of studies focused on the problems faced by US and UK institutions and examined the economic effects of the disability discrimination law on the employment rate of disabled people (DeLeire, 2000; Schumacher and Baldwin, 2000; Acemoglu and Angrist, 2001; Beegle and Stock, 2003; Kruse and Schur, 2003; Jolls and Prescott, 2004), disincentive effects of disability benefits on their labor supply (Chen and van der Klaauw, 2008), and the reasons for the wage gap between non-disabled and disabled people (Johnson and Lambrinos, 1985; Gunderson and Hyatt, 1996; DeLeire, 2001). Notably, Lalive et al. (2013) examined the effect of the quota system on disability employment in Austria, where a firm must hire one disabled worker per 25 non-disabled workers or pay a tax otherwise. Then, Lalive et al. (2013) showed that a firm with 25 non-disabled workers employed more disabled workers than without the tax.[9] Our study makes three contributions to the existing literature. First, our study uses administrative data from the Japanese government. Fortunately, we use the complete survey of firms and disabled workers in 2008, which was originally constructed by the Ministry of Health, Labor, and Welfare. Hence, our analysis does not face with the sample selection bias. Second, we analyze the "threshold design" of disability employment *à la* Lalive et al. (2013). Therefore, this paper can be interpreted as a further review of quota systems for disability employment in the context of the threshold design analysis. Third, our study investigates the causal effects of disability employment on firms' profits and efficiency using the fuzzy regression discontinuity design (RDD). As usual, firms' managers believe that disabled workers have lower productivity and usefulness in terms of improving firms' profits. Our results suggest that under current systems for disabled workers, such a belief is wrong. We believe that the economic analysis of employment quota systems for disabled people is as important as other economic analysis concerning disabled people, because many countries have maintained the quota

[2] The legal targeted level for private firms increased from 1.8% to 2.0% in 2013.

[3] Makoto Hata, one of the most influential specialists in the field of Japanese disability employment, said that the levy should be tripled in order to achieve the targeted level of disability employment (http://www.nhk.or.jp/baribara/lineup/130419.html).

[4] Examples of such firms are non-profit firms, social enterprises, companies that prefer corporate social responsibility management, and firms in less competitive industries. We call such firms *welfare-oriented* firms.

[5] Nagae (2014) regressed a firm's operating income margin on a dummy variable that indicates whether firms meet their levy quotas. Then, he showed that firms achieving their levy quotas have lower operating income margins than the other firms. However, as our paper shows, his result lacked robustness since he did not consider problems of endogeneity.

[6] If all firms satisfied their quotas, we could use sharp RDD to estimate a causal effect of disability employment on profits. However, since some firms pay levies and do not follow their quotas, we use fuzzy RDD.

[7] See Bound and Burkhauser (1999) and Haveman and Wolfe (2000).

[8] By 1996, the UK adopted the quota system for disabled people. Since there were few registered disabled people and the targeted employment level was too high, the quota system was abolished.

[9] Economists have been paying considerable attention to the economic effects of the quota system as an affirmative action for protecting the interests of disadvantaged groups such as women and ethnic minorities (Holzer and Neumark, 2000). In the context of elections, Pande (2003) evaluated the effects of the Indian quota system for disadvantaged groups on redistribution policies. Mori and Kurosaki (2011) evaluated the effects of the Indian quota system for disadvantaged groups on voting behaviors.

system as an affirmative action for protecting the interests of disabled people.[10]

The remainder of this paper is organized in the following manner. The next section explains the Japan's employment system for disabled people in 2008. Section 3 provides details of our data and methods. Section 4 examines the effect of Japan's levy-grant scheme on disability employment. Section 5 discusses the impact of hiring disabled people on firms' profits by comparing the results of the OLS with those of the fuzzy RDD. Finally, Section 6 concludes our analysis.

2. Japan's disability employment system

This section provides an overview of Japan's disability employment system. The Japanese disability employment system is administrated by Japan Organization for Employment of the Elderly, Persons with Disabilities and Job Seekers. Firms must report the monthly number of disabled employment to this agency.[11] After checking the firms' reports, they are forced to pay levies whenever they could not meet their levy quotas.[12] In the 2008 system, the levy quota for private firms was set to be 1.8% of the entire regular workforce.[13] In calculating the levy quota, regular workers were defined as workers who used more than 30 h of labor per week.[14] The levy quota was rounded down to the closest integer. For example, the levy quota of a firm with 600 regular workers would be 10 because 600 multiplied by 0.018 equals 10.8. The quota system required employers with 301 regular workers or more to pay a monthly amount of 50,000 yen per person short of their levy quotas if they were unable to achieve the quotas.[15] On the contrary, there was no legal obligation for firms with 300 regular workers or less to pay levies even if they were unable to achieve their levy quotas. Moreover, in certain industries that seemed to have more difficulties with disability employment than other industries, the levy quotas were adjusted downward. For example, the adjustment rate for medical services was set at 40%. Then, the levy quota of a medical service company was calculated to be 1.8% of the adjusted regular workforce that equaled the number of total workers multiplied by (1 - 0.4). In general, we can calculate the levy quota of firm i in the following manner:

$$Levy\ Quota_i = \lfloor 0.018 \times (1 - a_i)L_i \rfloor, \quad (1)$$

where for all real numbers x, $\lfloor x \rfloor$ is the largest integer not greater than x, a_i is the adjustment rate of firm i, and L_i is the number of regular workers in firm i. Hereafter, we refer to $(1 - a_i)L_i$ as the "*adjusted firm size*." Fig. 2 shows the relationship between adjusted firm sizes and levy quotas. The levy quota changes discontinuously at each levy quota threshold. For example, the levy quota is 5 when the adjusted firm size ranges from 278 to 333. However, if the adjusted firm size is 334, the levy quota changes from 5 to 6.

Next, a firm could receive a grant for disability employment if the firm employed disabled people beyond the targeted level. Firms with 301 regular workers or more could receive a monthly amount of 27,000 yen per person above their *levy* quotas if they employ disabled people over their quotas. On the other hand, firms with 300 regular workers or less could receive a monthly amount of 21,000 yen per person above their *grant* quotas if they employed disabled people over their quotas, which would be calculated in the following manner. Basically, the grant quota was calculated to be 4% of the entire regular workforce. However, the grant quota was limited to a ceiling 6, that is, the grant quota was 6 whenever the value of firm size multiplied by 0.04 was greater than 6. Then, the grant baseline for firm i can be expressed as follows:

$$Grant\ Quota_i = \begin{cases} \min\{\lfloor 0.04 \times L_i \rfloor,\ 6\} & if\ \ L_i \le 300, \\ Levy\ Quota_i & otherwise. \end{cases} \quad (2)$$

By the definition of a grant baseline, if firm i hired disabled workers beyond the grant baseline, then the firm would have the right to receive the grant.

Apart from the levy-grant scheme discussed above, there are the other support systems for disability employment that play a central role in decreasing the costs accruing to firms for hiring disabled people. First, firms employing disabled workers are eligible to receive two-thirds of the total cost for improving their workplaces. This subsidy system permits the firms to receive this amount up to a maximum of 4.5 million yen per disabled worker. Second, firms have the option of establishing a special subsidiary company (*tokurei-kogaisya*). Under the special subsidiary company system, a parent company can add the number of disabled workers employed in the subsidiary company to the number of disabled workers in the parent company. Then, a large-sized company with large levy quotas can save the costs of disability employment by just concentrating disabled workers in the subsidiary company. Third, there is a double count system that permits firms to count employing one person with *severe disabilities* as employing two disabled persons. In Japan, the grades of disabilities are not relevant to labor productivity of disabled workers but to their physical conditions. Hence, in the double count system, employers can save the cost of disability employment by hiring one person with *severe disabilities* who is more productive than one person with *disabilities*.[16] Fourth, if the labor productivity of disabled workers is much lower than that of regular workers, then firms can employ them at less than the minimum wage. However, since firms

[10] More than a third of OECD countries, such as Austria, Belgium, France, Germany, Italy, Japan, Korea, Poland, and Spain, etc., adopt the quota system.

[11] All firms know that their obligated quotas are set to be 1.8% of the number of whole regular workers and they can easily calculate their quotas in advance of sending their reports. Moreover, they must apply an administrative report on disability employment to the agency every year, so they must be aware of their quotas as long as they would not drastically change their employment plan of regular workers. In addition, firms can download an administrative report form from website of the agency throughout the year, which is an excel file that automatically calculates firms' quotas by macros. Therefore, we think all firms be aware of their quotas before they send the administrative reports to the agency.

[12] After firms report their disability employment, they are informed about their own levy quotas and the total amount of levies the agency imposed. In this system, the threshold each firm faces with is not informed. Of course, each firm can calculate its threshold by using information provided by the agency. However, we don't think that firms manipulate the number of regular workers because of our results obtained by manipulation tests.

[13] Japan's level at 1.8% was the lowest of all OECD countries. The levy quota of OECD countries was calculated to be in the range of 2% to 7% of the entire workforce. Of course, Japan's definition of disabled people is very different from that in other countries. In fact, the proportion of disabled people among the entire population in Japan was approximately 4% or 5%, but the range of those in other European countries was from 7% to 20% (OECD, 2010). In general, Japan's definition is narrower than that in other countries. Hence, it must be noted that Japan's levy quota may not be necessarily small as compared to those of other countries.

[14] In 2008, part-time workers were not counted as regular workers. Since 2010, however, one part-time worker, who uses 20-30 h of labor, has been equivalent to 0.5 regular worker.

[15] The Japanese cabinet office reported that the average wage of non-disabled regular workers was ¥270,000 per month, and those of regular workers with physical disabilities, mental illness, and intellectual disabilities were respectively ¥254,000, ¥129,000, and ¥118,000 per month in 2008 (Annual Report on Government Measures for Persons with Disabilities 2011), available from http://www8.cao.go.jp/shougai/whitepaper/h23hakusho/zenbun/pdf/h1/2_07.pdf. Therefore, the levy costs about 20% or 40% as much as hiring one disabled workers.

[16] Disabled people are classified according to the Japanese official criteria. The grades of disabilities are specified by an ordinance of the Ministry of Health, Labor, and Welfare. This criteria focuses on the physical functions of disabled persons that are independent of their labor productivity. For example, a person with paraplegia is classified as a person with severe disabilities, but while working in an office, she/he could be more productive than a person with mental illness or intellectual disabilities. Hence, people with severe disabilities are not necessary less productive than people with disabilities.

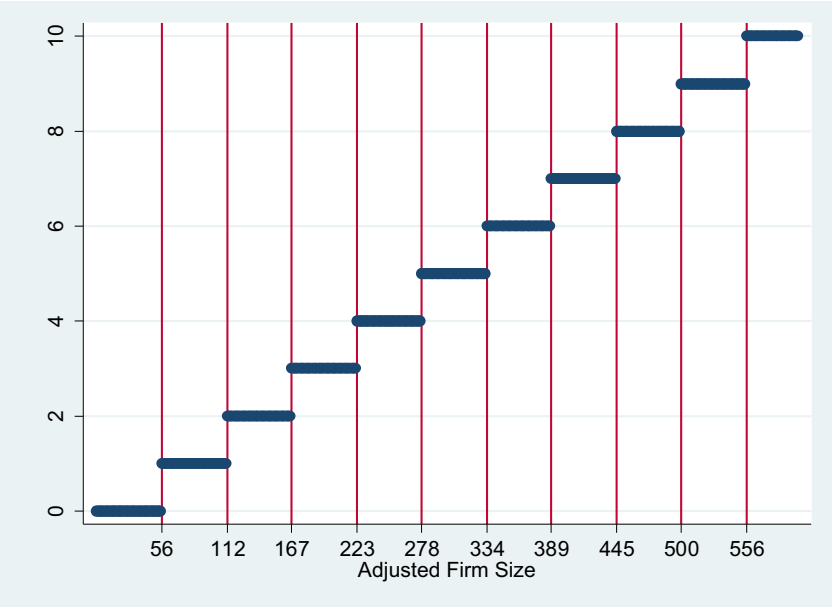


Fig. 2. Adjusted firm size and levy quota.

have to undergo complicated processing with administrative institutions, not too many firms are approved for the minimum wage exemption. Finally, some programs for decreasing job search costs are provided, such as job coaching services and trial employment support. These programs have been considered to reduce the number of mismatch problems between firms and disabled workers.

Although there are numerous support systems for disability employment in Japan, the targeted disability employment level of 1.8% for private firms has never been satisfied. The proportion of disabled workers among the entire workforce has always hovered at approximately 0.2% less than the targeted level.[17] In 2008, the aggregate rate of disability employment was 1.59%. Half the total number of employers did not achieve their levy quotas and seemed to prefer to pay levies than employ disabled workers at or beyond their levy quotas.[18] Hence, some administrators and specialists insist that a levy is insufficient to ensure employment of disabled workers beyond the targeted level. The following sections investigate the effect of the levy-grant scheme on disability employment in Japan's manufacturing industry.

3. Data and method

3.1. Data

In this study, we use two data originally obtained from official surveys in Japan. The first source, "The 2008 Firm's Employment of People with Disabilities," is available from the website of *Japan National Assembly of Disabled Peoples' International* (DPI Japan). The data are obtained from the 2008 annual survey conducted by the Ministry of Health, Labor, and Welfare. In general, the data set is unavailable, but the DPI Japan makes this data available for the promotion of empirical studies on disability employment. The data contain information such as firms' names, addresses, phone numbers, the numbers of regular workers, and the actual rates of disability employment. Since the agency actually calculates firms' levies and grants by using the numbers of regular workers in the data, there is no difference in timings to evaluate the number of employees between data and law, which implies any measurement errors cannot be occurred in our analysis. The second source, "Basic Survey of Japanese Business Structure and Activities (BSJ, hereafter)" compiled by the Ministry of Economy, Trade and Industry from 2004 to 2009, contains varied information on firms' financial statuses and the Japan Standardized Industrial Classification code. The BSJ examines financial data of firms with 50 regular workers or more and whose paid-up capital or investment fund is greater than 30 million yen.[19] We merge these micro data by using the firm's name and its phone number and construct the data set for our analysis.[20] Then, we use the financial data and the Japan Standardized Industrial Classification code from the BSJ in order to calculate firms' profit rates, adjusted firm sizes, and levy quotas. All the adjustment rates are calculated by using classification codes of the Japan Standard Industrial Classification. However, the BSJ assigns a classification code to a firm according to the section that

[17] Some people believe that disability benefits decrease the work incentives of disabled people. See Section 4.2 in Haveman and Wolfe (2000). In Japan, with few exceptions, a person with *severe disabilities* receives ¥800,000–1,000,000 per year as a public disability pension.

[18] The Ministry of Health, Labor, and Welfare reported that the number of active job seekers with disabilities was 143,533 and the number of disabled workers newly employed was 44,463 in 2008. Hence, in the Japanese labor market, the quantity of labor supplied by disabled workers is much larger than the quantity of labor demanded by employers. The fact that half of firms fail to satisfy their levy quotas can be explained by demand side of disability workers.

[19] The period of datasets that two surveys examine is as follows. The DPI Japan's data used the number of disability employment of June 2008. On the other hand, the BSJ conducts a survey on March 31 that equals to the accounting term of typical Japanese firms.

[20] We merge the different datasets in the following manner. First, when both the firm's name and its phone number from one data set correspond to those from the other data set, we merge these datasets into one. Second, when both the firm's name and its area code of phone number from one data set correspond to those from the other data set, we merge these datasets. Third, we remove abbreviated expressions such as "Co., Ltd." or "Inc." from the firm's original names and merge the datasets whenever both the revised firm's name and its phone number from one data set correspond to those from the other data set. Fourth, we merge the datasets whenever both the revised firm's name and its area code from one data set correspond to those from the other data set. As a result, we can succeed in merging 11,776 manufacturing firms' data from the BSJ into that of DPI Japan. The BSJ contains 13,394 manufacturing firms but 1,618 firms hire 55 regular workers or less. Hence, the rate of merge is 92.0% because the DPI Japan's data focuses on firms that hire 56 regular workers or more. In addition, the correlation of number of regular workers, which both datasets contain, is 0.958. Hence, missing variables are 8.0% of entire data and sufficiently small. Since the main causes of missing variables are errors in firm's names or phone numbers, we think they are randomly occurred.

Table 1
Descriptive statistics.

	Observation	Mean	Std. dev.	Min	Max
Firm size < 301					
Adjusted firm size	5965	155.97	57.27	85	300
Number of disabled workers	5965	2.43	2.57	0	48
Fraction of disabled workers (%)	5965	1.57	1.82	0	35.56
Firm size ≥ 301					
Adjusted firm size	2453	1158	2006	210	73,149
Number of disabled workers	2453	20.64	55.84	0	1368
Fraction of disabled workers (%)	2453	1.68	0.82	0	18.33
Profit rate	2452	0.18	0.15	−1.25	0.89
Amount of sales	2452	75,969	306,526	578	9,278,483
Cost of sales	2452	64,322	274,182	330	8,332,566

earns the highest sales in the firm's businesses. Therefore, for a firm with diversified businesses, the adjusted firm size can be either overestimated or underestimated. For example, if the adjustment rate of the section earning the highest sales in a firm is 0%, then we assign 0% to this firm as its adjustment rate. In this case, the adjusted firm size is overestimated compared to the true value whenever the firm has the other sections that are assigned positive values as their adjustment rates. On the contrary, the adjusted firm size is underestimated whenever the adjustment rate of the section with the highest sales has a positive value, and the adjustment rates of the other sections are 0%. However, these problems are not serious, since aggregated data from the 2008 annual report of the Ministry of Health, Labor, and Welfare provides approximately the same value as our estimations. Moreover, even though our analysis focuses on middle or small sized firms that are considered to run less auxiliary businesses than large sized firms, we have the similar results. Due to the availability of the Japan Standardized Industrial Classification code and sample-size of industries from the BSJ, this paper focuses on the manufacturing industry's analysis.[21] However, this does not at all diminish the value of our research, since the manufacturing industry is the biggest vehicle to provide jobs to disabled workers. In 2008, the manufacturing industry provided a place of employment for 35.3% of entire disabled workers. Therefore, focusing on the manufacturing industry is not limited contribution to considering for Japanese disability employment policies.

3.2. Method

Next, we explain the methodology used in this paper. As explained in Section 2, the levy quota changes discontinuously. Therefore, according to classical strategies in the fuzzy RDD (Angrist and Lavy, 1999), we investigate whether firms decide the number of disabled workers in response to discontinuous changes in their levy quotas.

To examine the effect of a levy quota on the employment of disabled people, we estimate the following model[22]:

$$Disabled_i = \beta_0 + \beta_1 Levy\_Quota_i + f\left(\tilde{L}_i\right) + \epsilon_i, \tag{3}$$

where $Disabled_i$ is the number of disabled workers in firm i, $Levy\_Quota_i$ corresponds to Eq. (1), and $\tilde{L}_i$ is the adjusted firm size.[23] We use the linear and fourth-order polynomial function for $\tilde{L}_i$. As mentioned in Section 2, under Japan's 2008 legislation, firms with 300 regular workers or less were not subject to the levies, while firms with 301 regular workers or more were subject. To examine the effect of a quota system with and without the levy component, this model is separately estimated for firms with 300 regular workers or less and for firms with 301 regular workers or more.[24] Since the DPI Japan's data covers firms with 56 regular workers or more, we exclude firms with 85 adjusted firm size or less.[25]

It is most common in the RDD literature (Lee and Lemieux, 2010) to allow the function of adjusted firm size to differ between the right- and the left-hand sides of the threshold. Therefore, to conduct a robustness check, we use an alternative model.[26] First, we define $threshold_i$ as the closest levy quota threshold for firm i. Second, we classify firms into groups g, according to the closest threshold for each firm. Third, we calculate the normalized adjusted firm size for firm i, which is defined as the adjusted firm size minus the closest threshold for firm i. Finally, we pool the data from all groups and estimate the following model (hereafter, pooled quota thresholds model):

$$Disabled_i = \alpha_0 + \alpha_1 T_i + \delta_0 NL_i + \delta_1 T_i NL_i + G_g + u_i, \tag{4}$$

where $T_i = 1(\tilde{L}_i \geq threshold_i)$ is a dummy variable for a treatment that indicates whether the adjusted firm size is more than $threshold_i$, $NL_i = \tilde{L}_i - threshold_i \in [-27, 27]$ denotes the normalized adjusted firm size, and G_i is the fixed effect of group g. To consider the different functions of adjusted firm size for firms under the threshold and above the threshold, we add the interaction terms T and NL. Since we pool all thresholds, α_1 is interpreted as the weighted average of the treatment effect at each threshold.

The descriptive statistics are reported in Table 1. While the fraction of disabled workers among entire workforces of firms with 300 regular workers or less is 1.57%, that of firms with 301 regular workers or more is 1.68%. Therefore, the fraction of disabled

[21] The BSJ covers all the firms in the following industries: mining and quarrying of stone, manufacturing, and wholesale and retail trade. In addition, it covers a part of the firms in the following industries: electricity, gas, heat supply and water; information and communications; finance and insurance; real estate lessors and managers; scientific research, professional and technical services; accommodations, eating and drinking services; living-related and personal services and amusement services; and services n.e.c. When the other industries are included into our analysis, the effect of a levy quota on employment of disabled people is insignificant. Hence, our analysis suggests that firms in the manufacturing industry would respond the levy-grant scheme but the others would not.

[22] Due to the limited number of observations, we cannot estimate the treatment effect of levy quota at each threshold.

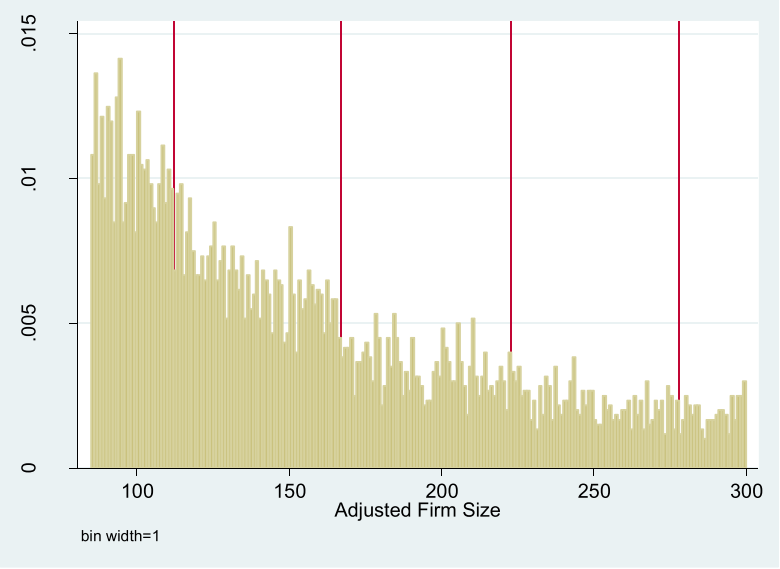
[23] Imbens and Lemieux (2008) recommended that potential covariates should be included in order to eliminate small sample bias and reduce the variance. However, when we include potential covariates in our equations, the number of observations decreases from 8418 to 6375 due to missing variables. Thus, Eqs. (3)–(5) do not include potential covariates. For the robustness check, we performed statistical analysis of Eqs. (3)–(5) including potential covariates such as physical asset, firm age, employment stability and growth rate of employment. As a result, all estimates are similar one on the sample size 8418, which confirm the robustness of our findings.

[24] We also use non-separated analysis by including all sizes of firms and estimate the difference of the coefficients of levy quota between firms with and without levy obligations. The results are same as that of separated analysis.

[25] By the definitions of thresholds and normalized adjusted firm sizes in the Eq. (4), 85 (=112-27) is the minimum bound of firm size with threshold of 112.

[26] Lalive et al. (2013) used a similar model.

Panel (a): Adjusted firm size ≦ 300



Panel (b): 301 ≦ Adjusted firm size ≦ 550

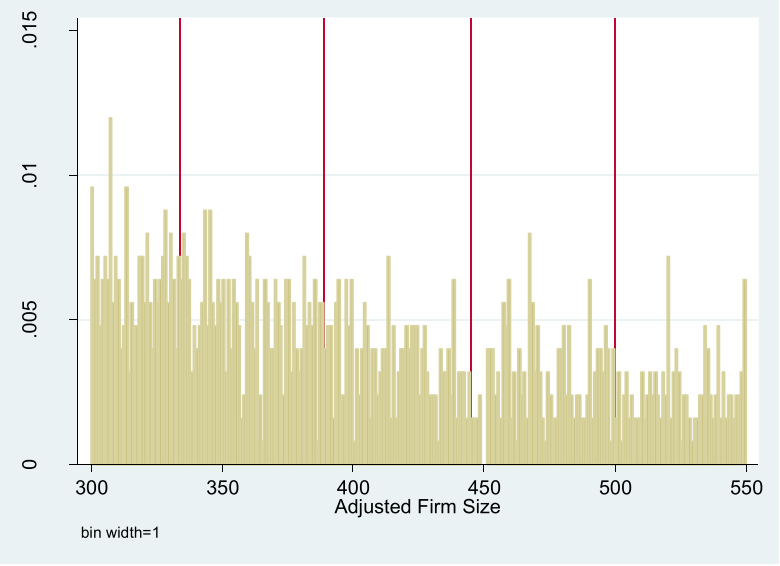


Fig. 3. Density of adjusted firm sizes.
Note: The density of each adjusted firm size is reported in Fig. 2. Bin width are 1. The vertical line represents threshold of levy quota.

workers is not largely different between firms with and without the levy component.

3.3. Manipulation checks

For our estimation method to be valid, we have to check whether firms manipulate their adjusted firm sizes at the levy quota thresholds. Lalive et al. (2013) noted that if firms manipulate firm sizes to avoid the payment of levies, the estimate of the quota effects will be biased. For example, consider a firm that would pay a levy rather than hire disabled workers. This firm might restrain the number of non-disabled workers to avoid crossing the threshold. In this case, the estimate of the "jump" at the threshold has an upward bias.[27]

Under Japanese quota system, firms are informed about their own levy quotas and the total amount of levies the agency imposed, after they report their disability employment. In this system, the levy quota threshold each firm faces with is not informed. Therefore, it may safely be assumed that firms are less likely to manipulate the number of regular workers since adjusted firm size is not obvious for firms.

[27] Lalive et al. (2013) theoretically showed that since the levy quotas were based on the number of non-disabled workers in Austria, there were two possibilities for bias: upward bias and downward bias. However, the levy quotas in Japan are based on the entire work force, including both disabled and non-disabled workers. Thus, in Japan's case, only the upward bias is considered.

Table 2
McCrary's discontinuity test.

Threshold	(1) 112	(2) 167	(3) 223	(4) 278	(5) 334	(6) 389	(7) 445	(8) 500
Log difference in height	−0.13	−0.15	0.05	0.12	0.11	0.05	0.08	−0.0004
	(0.05)	(0.07)	(0.08)	(0.10)	(0.10)	(0.11)	(0.13)	(0.14)

Note: Observation is 8418. Standard error is reported in parenthesis.

In addition, following Lee and Lemieux (2010), we test whether the density of adjusted firm sizes and potential covariates are continuous at thresholds. To consider this matter, we check the density of the adjusted firm sizes. Panel (a) in Fig. 3 illustrates the density of adjusted firm sizes for firms with 300 regular workers or less. Around the thresholds 112 and 167, the density seems to fall downwards. Discontinuity estimates based on McCrary (2008) test are reported in Table 2. The difference in the densities between adjusted firm sizes barely below and above the threshold are statistically significant around the thresholds 112 and 167. Since the possibility of manipulation at the thresholds 112 and 167 cannot be rejected, we estimate the effects of the levy quota both with and without the firms around these two thresholds.[28] On the other hand, Panel (b) in Fig. 3 shows the density of adjusted firm sizes for firms with 301–550 regular workers. Although it is not clear whether there are discontinuous changes at the thresholds, the results of the estimates, as shown in columns (5)–(8) of Table 2, confirm that there are no statistically significant estimates of the difference in the density at the thresholds.[29]

Next, we test the continuity of potential covariates such as physical fixed assets, firm age, employment stability, employment growth and the number of part-time workers.[30] Employment stability indicates the coefficient of variation of the entire workforce from 2004 to 2008. Employment growth is the growth rate of the workforce from 2007 to 2008. As for the number of part-time workers, firms might have manipulated their firm sizes by replacing regular workers with part-time workers since the adjusted firm size did not include part-time workers in 2008. Panels (a)–(e) in Fig. 4 plot the average of each variable for a band width of 2. These figures confirm there are no significant discontinuities at all thresholds. To confirm the continuities based on the regression, we use Eq. (3) by replacing the dependent variable for each potential covariate. As shown in Table 3, there are no significant "jumps" at the thresholds.

Table 3
Continuity of potential covariates.

Variables	Firm size	Observations	Coefficient of levy quota
Physical fixed asset (×1000)	85–300	5932	0.142
			(0.122)
	301	2466	−6.102
			(4.112)
Firm age (×1000)	85–300	5965	1.170
			(0.822)
	301	2481	−1.323
			(1.452)
Employment stability ($\times 10^6$)	85–300	4430	−3.662
			(4.379)
	301	1995	−3.865
			(7.466)
Employment growth (×1000)	85–300	5475	1.263
			(0.763)
	301	2327	1.373
			(0.990)
The number of part-time worker (×100)	85–300	5965	0.277
			(0.258)
	301	2453	3.710
			(3.598)

Note: Standard errors clustered at adjusted firm sizes are given in parentheses. All regression include fourth-order polynomial function for adjusted firm size.

4. The effect of a levy-grant scheme

4.1. The effect of the quota on disability employment

The relationship between the adjusted firm size and the number of disabled workers is reported in Fig. 5. The straight line represents 1.8% of adjusted firm size. Notably, whether or not the firm is subject to the levy component, the number of disabled workers increases approximately linearly along with adjusted firm sizes, and the slope is close to 1.8%. This implies that although firms with 300 regular workers or less have no obligation to pay levies, they respond to their levy quotas.[31] Panel (a) in Fig. 6 plots the average number of disabled workers by each adjusted firm size with 300 regular workers or less. The solid line represents the levy quota, although there is no obligation to pay levies. This figure shows that while the number of disabled workers increases approximately linearly with adjusted firm sizes, it does not increase discontinuously at the levy quota threshold. Panel (b) in Fig. 6 focuses on firms with sizes ranging from 301 regular workers or more, up to firms with adjusted firm size of 445 regular workers or less. Although the number of disabled workers increases along with adjusted firm sizes, it appears to hover around the corresponding levy quota. This implies that a levy is effective for firms with 301 regular workers or more.

Table 4 presents the results for firms with 300 regular workers or less using Eq. (3). Column (1) includes the levy quota and the linear function of adjusted firm sizes. While the coefficient of levy quota is small and statistically insignificant, that of adjusted firm size is 13.289 and statistically significant. This result indicates that, for every adjusted firm size increases by 100, there is an associated increase in the number of disabled workers by 0.013, which is not too different from the levy quota of 1.8%. In column (2), we use the

[28] Regarding the problem of manipulation at thresholds 112 and 167, we are not sure why such manipulation seems to occur. It may be occurred by chance. Or it might be occurred by other legislations establishing thresholds around 112 and 167. Traditionally, small-sized firms have been supported by various public policies such as preferential treatments for financing and tax payment, and some thresholds of these public support systems have been set to 100 and 150. Hence, the systems for small-sized firms may cause the discontinuity of distribution among adjusted firm size at 112 and 167. Indeed, we find the discontinuity of adjusted firm size at 100 is also statistically significant.

[29] Regarding the other thresholds, we also estimate the continuity of the density using McCrary's test and confirm the discontinuity of the density at all thresholds.

[30] All variables are sourced from the BSJ.

[31] While small firms with fewer than 300 employees are not obligated to pay a levy, they are required to meet their quotas. Indeed, they have to report the number of disabled workers to the administrative agency every year. Thus, we use firms with fewer than 300 employees and try to estimate the effect of the quota system without the levy on hiring disabled workers.

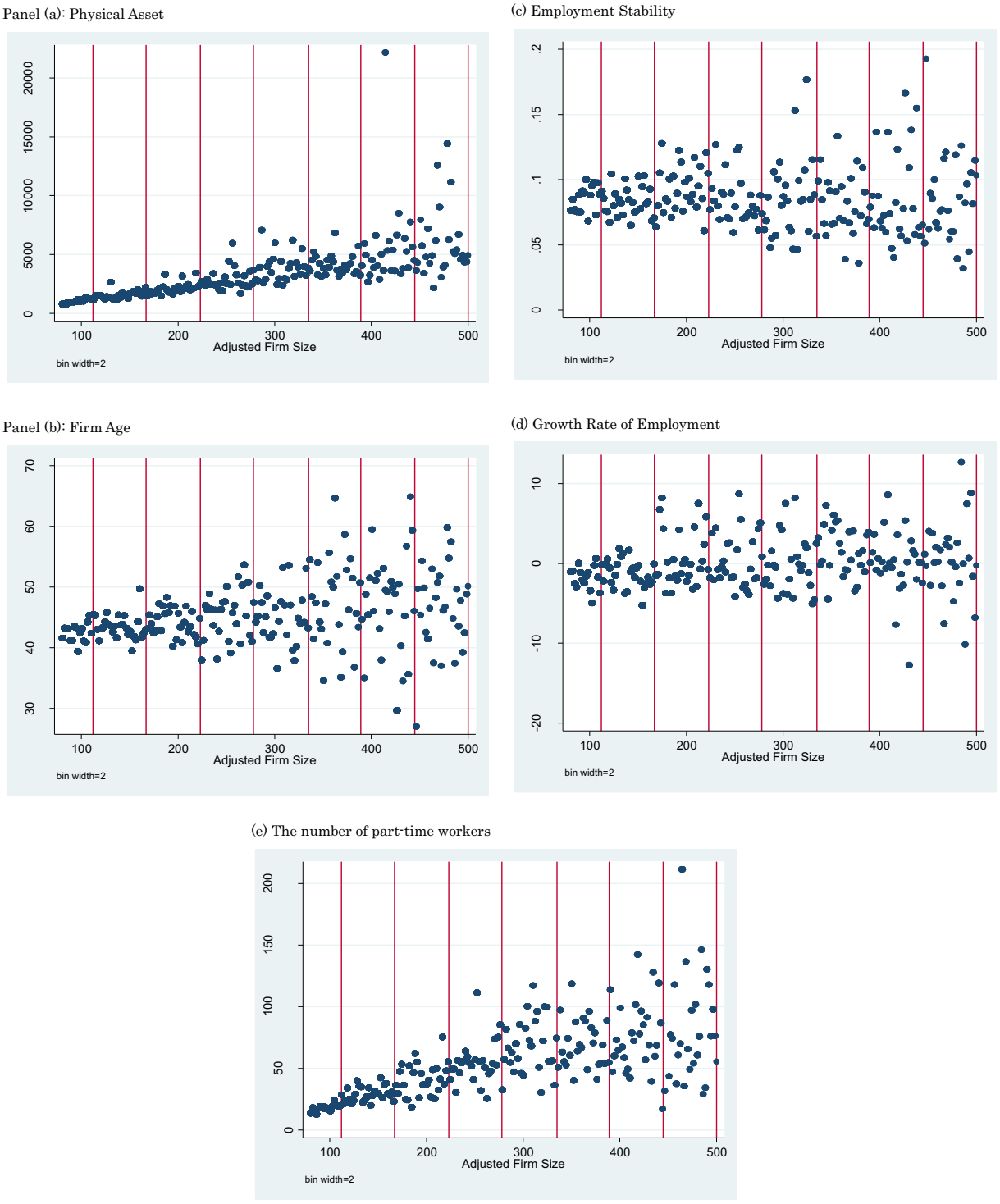


Fig. 4. Continuity of potential covariates.
Notes: A bandwidth of 2 is used to calculate binned averages. Each circle represents the average value of a baseline covariate for each bin. The vertical line represents each threshold of levy quota.

fourth-order polynomial function of adjusted firm sizes. Here too, the coefficient of quota is small and statistically insignificant. Since there is a possibility of manipulation at thresholds 112 and 167, we exclude firms around these thresholds for the robustness check. As shown in columns (3) and (4), the coefficients of levy quota are small and statistically insignificant. In addition, the coefficient of linear adjusted firm size is 17.527, which is also close to 1.8%. In column (5), we conduct another check for robustness ±3 points around the quota cut-off. The coefficient of levy quota is small and statistically insignificant. We add the interaction term between the adjusted firm size and a dummy for thresholds in column (6) to consider if the function of the adjusted firm size is different below and above the thresholds. The coefficient of levy quota is also statistically insignificant.

Table 4
Levy quota and disability employment, firm size ≦ 300.

Sample	All		196–300		196–300 and +/−3	
	(1)	(2)	(3)	(4)	(5)	(6)
Levy quota	0.051	0.060	−0.071	−0.149	−0.339	1.068
	(0.117)	(0.117)	(0.279)	(0.286)	(0.469)	(4.113)
Adjusted firm size (/1000)	13.289	101.468	17.527	−1580.350	13.394	−9.021
	(2.281)	(71.839)	(6.432)	(6604.767)	(15.312)	(64.957)
Adjusted firm size* dummy for threshold						−0.005
						(0.016)
Polynomial order in $\tilde{L}_i$	1	4	1	4	1	1
Observations	5965	5965	1497	1497	205	205
R-squared	0.101	0.101	0.034	0.035	0.007	0.007

Note: Standard errors clustered at adjusted firm sizes are given in parentheses.

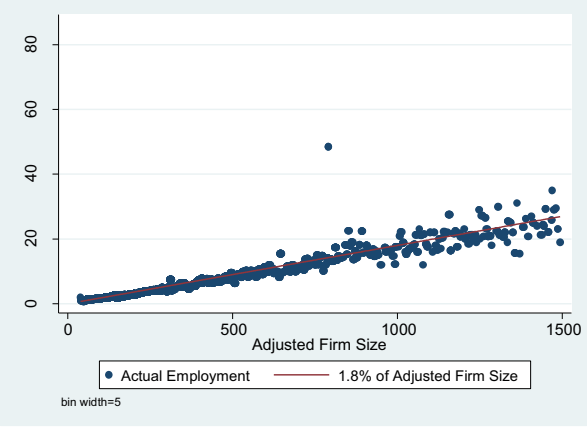


Fig. 5. Adjusted firm size and number of disabled workers.
Note: The bin width is 5. Each circle is the average number of disabled workers of each bin. The straight line represents 1.8% of adjusted firm size.

Table 5
Grant quota and disability employment, firm size ≦ 300.

	(1)	(2)	(3)
Grant quota	−0.070	0.039	0.060
	(0.051)	(0.122)	(0.125)
Levy quota			0.073
			(0.119)
Polynomial order in $\tilde{L}_i$	1	4	4
Polynomial order in L_i	–	–	4
Observations	5965	5965	5965
R-squared	0.098	0.099	0.101

Note: Standard errors clustered at adjusted firm sizes are given in parentheses.

As explained in Section 2, the government offers a grant to firms that hire disabled workers beyond their grant quotas. Then, we check the effect of the grant on the employment of disabled workers.[32] Firms with 300 regular workers or less can receive a monthly amount of 21,000 yen per person above their grant quotas when they hire disabled workers over the rate of 4% of the entire workforce or when they hire more than 6 disabled workers. This means that the threshold for the grant is different from that of the quota. By replacing *Levy Quota* with *Grant Quota* in Eq. (3), we estimate the effect of the grant quota on disability employment. The result is reported in Table 5. Column (1) includes only the linear estimation of adjusted firm size, while column (2) includes the fourth-order polynomial estimation. The coefficients of grant quota are small and statistically insignificant. When we control both grant quotas and levy quotas in column (3), both coefficients are small and statistically insignificant. This implies that the amount of the grant for firms with 300 regular workers or less is not a sufficiently large incentive for them to hire disabled workers.

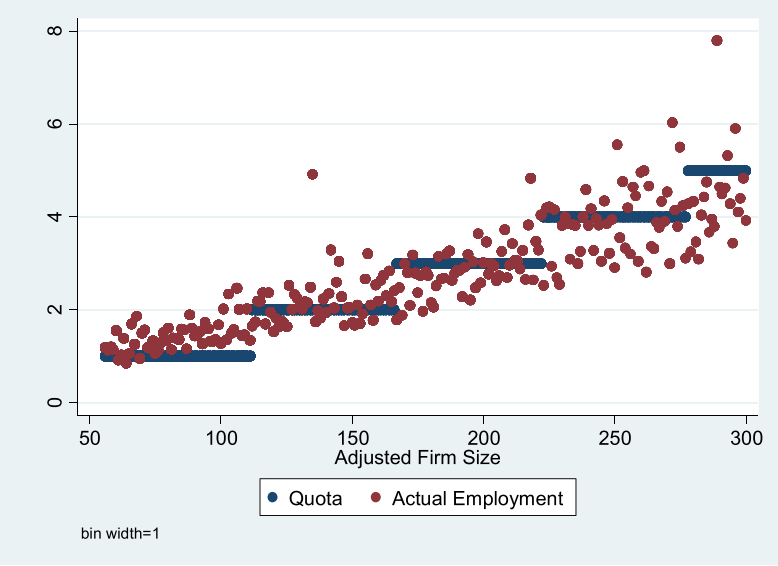
Next, Table 6 demonstrates the results for firms with 301 regular workers or more. As shown in column (1), the coefficient of levy quota is 0.878 and statistically significant while that of adjusted firm size is small and statistically insignificant, which is contrary to the results for firms with 300 regular workers or less. When we use the fourth-order polynomial function of adjusted firm size in column (2), the estimate of the quota is 0.914 and statistically significant. As discussed in Section 3.1, the adjusted firm sizes of large sized firms may have measurement errors, and thus, we restrict our observations in columns (3) and (4) to firms with 1000 adjusted firm size or less. Although the coefficients of levy quota are smaller than those in columns (1) and (2), they are still statistically significant. In columns (5) and (6), only the observations of ±3 around the levy quota thresholds are used to identify the effect of the levy quota. While the coefficients of levy quota are positive and statistically significant, they are quite large compared to the results from column (1) to (4). One interpretation of this effect is that firms just marginally exceeding the levy quota threshold hire extra disabled workers by way of precaution since the turnover rate of disabled workers is high.

To check the robustness further, we estimate Eq. (4) to consider the different functions of adjusted firm sizes for firms under the threshold and above the threshold. Table 7 shows that the quota system successfully influenced firms with 301 regular workers or more to hire disabled workers to meet the levy quotas. In column (1), the coefficients of the normalized adjusted firm size are the same among all threshold groups. The coefficient of the dummy for the threshold is larger than the results in Table 6 and statistically significant. Column (2) adds the interaction term between the normalized adjusted firm sizes and dummy variables for threshold groups to consider the different slopes of normalized adjusted firm sizes. The coefficient is 1.422, which is close to the results in Table 6. Therefore, we confirm the positive effect of levy quota for firms with the levy component.

Thus, the analysis conducted in this section reveals that if there is an obligation to pay levies, firms respond by meeting or exceeding the levy quotas. Compared to the estimates of Lalive et al. (2013), who found that the effect of the levy was 0.04, our estimates are large. However, Lalive et al.'s (2013) study is different from this study in that they focused on only the first threshold, included all industries, and the amount of levy in Austria is 200

[32] For firms with 301 regular workers or more, the threshold of the grant is almost similar to that of the levy. The difference is that while the provision of the grant is based on the *firm size*, which is not adjusted, the imposition of the levy is based on the *adjusted firm size*. Since the number of firms with different thresholds for the grant and levy is limited, we do not estimate the effect of grant for large sized firms.

Panel (a): Firm Size ≦ 300



Panel (b): 300 ≦ Firm Size and Adjusted firm size ≦ 445

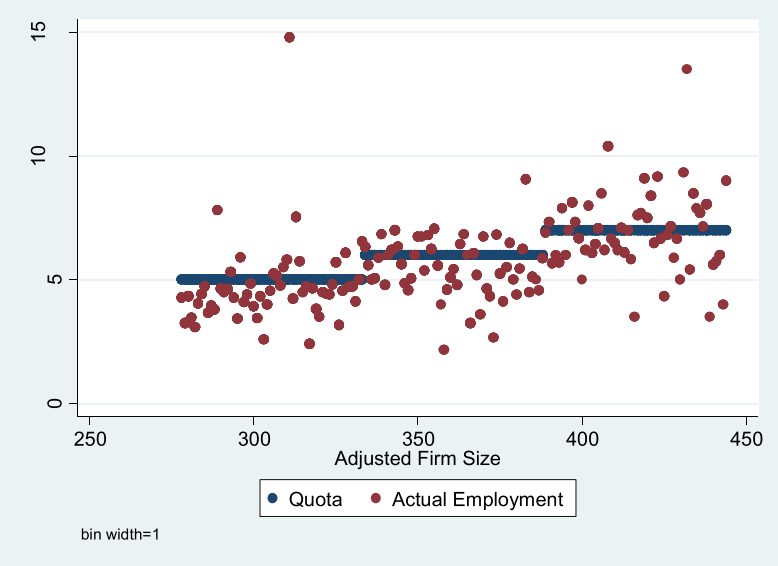


Fig. 6. Adjusted firm size and number of disabled workers by firm size.
Note: Each circle is the average the number of disabled workers of each adjusted firm size. Solid line represents levy quota.

Table 6
Levy quota and disability employment, firm size ≧ 301.

Sample	All		$300 \leqq L_i \leqq 1000$		+/−3	
	(1)	(2)	(3)	(4)	(5)	(6)
Levy quota	0.878	0.914	0.816	0.794	1.563	2.455
	(0.426)	(0.418)	(0.335)	(0.335)	(0.655)	(0.691)
Adjusted firm size (/1000)	3.306	1.893	4.359	107.972	−9.112	−25.044
	(7.654)	(7.608)	(5.824)	(51.534)	(11.799)	(12.348)
Adjusted firm size* dummy for threshold						−0.001
						(0.000)
Polynomial order in $\tilde{L}_i$	1	4	1	4	1	1
Observations	2453	2453	1876	1876	303	303
R-squared	0.988	0.989	0.376	0.380	0.989	0.989

Note: Standard errors clustered at adjusted firm sizes are given in parentheses.

Table 7
Levy quota and disability employment based on the pooled quota thresholds analysis, firm size ≧ 301.

	(1)	(2)
Threshold	1.855	1.422
dummy	(0.436)	(0.413)
NL	Yes	Yes
NL*Threshold	Yes	Yes
Group Dummy (G)	Yes	Yes
NL*G	No	Yes
NL*Threshold*G	No	Yes
Polynomial order in NL	1	1
Observations	2338	2338
R-squared	0.990	0.992

Note: Standard errors clustered at adjusted firm sizes are given in parentheses.

euro (about half the levy in Japan). Moreover, the differences in the results may be attributed to the existence of sufficient support offered by the Japanese government; the various support systems described in Section 2 may contribute toward improving the productivity of disabled workers.

On the other hand, even among small firms which have no obligation to pay levies, disability employment increases with firm size. This fact suggests that the productivity of disabled workers is not so low as usually thought.[33] Also, this may imply the effectiveness of social norms for employing disabled people.[34] In Japan, firms give the considerable importance to activities promoting corporate social responsibility.[35] In addition, the results can be partially attributed to the Japanese government's success in pressuring Japanese firms to meet their levy quotas through policy requirements. In fact, administrative institutions monitor all firms to check whether they achieve their levy quotas and require firms that cannot satisfy their levy quotas for several years to submit annual documents on their disability employment schedules so that they may hire disabled people beyond the targeted level.[36] In the next section, we discuss relationships between employing disabled workers and firms' profits in order to consider the productivity of disabled workers in more detail.

5. The effect of disability employment on firms' profits

Although Japan's quota system for disabled workers is often criticized for enforcing a low levy and providing a low grant, the results in the previous section demonstrate the positive effect of the levy quota and social norms on disability employment. This may be partially because the employment of disabled people does not always adversely affect firms' profits, although the disability employment is often considered to decrease firms' profits. However, if firms employed disabled workers in suitable posts, the productivity of disabled workers would not be necessarily low. In addition, to improve the working condition of disabled workers, the government offers subsidies to firms for providing barrier-free facilities. This support can contribute to improving the productivity of disabled workers. In this section, therefore, we examine the effect of disability employment on firms' profit rates.

When we investigate the effect of hiring disabled workers on firms' profit rates, a potential concern is the existence of an omitted variable that is correlated with the number of disabled workers and affects firms' profit rates. For example, firms that hire many disabled workers may be welfare-oriented companies with less incentive to maximize their profits. On the other hand, if there is the discrimination against disabled workers in labor markets, then firms under greater competitive pressure (with lower profit rates) may be more likely to hire disabled workers who are paid less than their productivity. In both cases, the coefficient of disability employment will be biased downward. Another possibility is that firms that hire many disabled workers may have higher profits and can afford to hire disabled workers.[37] In this case, the coefficient of disability employment will be biased upward. To deal with these endogeneity problems, we use the levy quota as an IV. This identification strategy is based on the fuzzy RDD. We exploit discontinuities in an expected number of disabled workers conditional on adjusted firm sizes. There is no clear difference in firms' characteristics between firms with barely more regular workers than the threshold and firms with barely less regular workers than the threshold. Using the external variation of disability employment implied by the levy quota, we estimate the causal effect of disability employment on firms' profit rates.

For the first-stage regression, we use the same specification as that of Eq. (3). Since we only use the information on firms that respond to levies for the IV regression, this section focuses on firms with 301 regular workers or more. The second-stage regression is expressed in the following manner:

$$y_i = \delta_0 + \delta_1 Disabled_i + g(\tilde{L}_i) + u_i, \tag{5}$$

where y_i is the profit rate of firm i. Descriptive statistics of amount of sales, cost of sales, and profit rates are reported in Table 1.[38] In calculating firms' profit rates, we use the firms' gross incomes on sales, which do not include both the levy and the grant.[39] Based

[33] The fact that small firms do hire disabled workers is consistent with the empirical result that disability employment have no negative impact on firms' profits in the next section. In general, the reasons why private firms hire disabled workers below their levy quotas are as follows: 1. Firms cannot find productive disabled workers because of their scarcity; 2. There are quite few suitable positions for disabled workers among firms' jobs; 3. Firms do not know the best way to make disabled workers productive since they have never hired disabled workers before. Since nearly half of firms that do not satisfy their levy quotas have no disabled workers, the third reason seems to be the strongest one.

[34] We think social norms are one of the factors promoting disability employment. Before 1970s, small firms had employed the most disabled workers because they had been asked to hire disabled persons by their parents and school teachers. Traditionally, small Japanese firms have had strong ties to their local communities and have not necessarily behaved to maximize their *short-run* profits. If small firms deeply connected with communities behaved aggressively in maximizing their profits, they would be ostracized by their neighborhoods. Hence, we think social norms pressure small firms to hire disabled workers in order to maintain positive relations with local communities and maximize their *long-run* profits.

[35] Endo (2013) showed that firms' activities for corporate social responsibilities did not have any negative impact on their stock prices in Japan. Generally speaking, the CSR oriented management is positively correlated with a firm's stock value or profit rate.

[36] For large firms that had achieved substantially below their levy quotas for several years, the Ministry of Health, Labor, and Welfare can publish their names as a punishment. However, this penalty is quite rare. The number of published firms' names have hovered between 0 and 7 for the last 10 years. On the other hand, the administrative agency also monitors levy quotas for small firms because all firms must send administrative reports on disabled workers to the agency. In addition, the agency recommends even small firms with 300 regular workers or less should hire disabled workers whenever possible.

[37] Aoki (1990) and Iwai (2005) pointed out that Japanese firms seemed to have different motivations for business operations from U.S. and U.K. firms. Japanese firms often behave as if they prefer maximizing their *stakeholder*'s benefits to maximizing their *stockholder*'s profits. Stakeholders include almost all of society's members such as stockholders, managers, workers, business partners, consumers, and the future generations.

[38] Since just one firms' profit rate is missing, the observations of profit rates are 2480. In addition, there is a just 1 outlier whose profit rate is less than -1. We exclude this firm from sample and reran regressions. Then, all results are not sensitive to the outlier. Moreover, we reexamine similar regressions by using the firms whose profits are within 2 standard deviations of the mean and confirm the robustness.

[39] We also investigate the relationship between the disability employment and the other profit indices such as operating income margin and recurring profit margin, and we arrive at results similar to those shown in Tables 8 and 9. Note that both the operating income margin and the recurring profit margin include the cost of levies as taxes and dues in the firm's financial statement, whereas only the latter includes the benefits from rewards and subsidies as miscellaneous income. In

Table 8
Disability employment and firms' profit, firm size ≧ 301.

Sample	All				$L_i \leq 1000$		+/−3	
Method	(1) OLS	(2) IV	(3) OLS	(4) IV	(5) OLS	(6) IV	(7) OLS	(8) IV
Number of disabled workers (/100)	−0.138	0.140	−0.124	0.0658	−0.166	−0.0670	−0.186	−0.159
	(0.0486)	(1.135)	(0.0498)	(1.072)	(0.0789)	(1.346)	(0.0945)	(0.561)
Polynomial order in $\tilde{L}_i$	2	2	4	4	4	4	1	1
First stage F value	–	4.20	–	4.80		5.64	–	6.52
J test (*P* value)	–	–	–	–	–	–	–	0.51
Observations	2452	2452	2452	2452	1875	1875	303	303
R-squared	0.005	−0.008	0.008	0.002	0.007	0.006	0.008	0.006

Note: Standard errors clustered at adjusted firm sizes are given in parentheses.

on IV regression, δ_1 captures the causal effect of disability employment on the firm's profit rate. For the robustness check, we also use the pooled quota thresholds model.

Table 8 reports the estimates of the second-stage regression based on Eq. (5). As shown in column (1), the coefficient of the number of disabled workers based on the OLS regression is negative and statistically significant. Column (2) presents the results based on the IV regression. The effect of the number of disabled workers is positive but statistically insignificant. This suggests that the OLS estimate of hiring disabled workers has a negative bias. When we use a more flexible fourth-order polynomial function, the estimates based on both the OLS and the IV regressions in columns (3) and (4) are similar to the results in columns (1) and (2), respectively. Since the effect of one disabled worker on the sales for large firms is quite small, it may be difficult to get statistically significant estimates of hiring disabled workers. We, therefore, restrict our sample to firms with 1000 regular workers or less. As shown in columns (5) and (6), the results are similar to the estimates in columns (1) and (2). Although the number of observations decreases, we estimate the same specification using the ±3 discontinuity sample. The coefficient of the number of disabled workers based on the IV regression is insignificant and smaller than that based on the OLS regression.[40]

The results based on the pooled quota thresholds model are reported in Table 9.[41] While columns (1) and (3) include only the linear regression of normalized adjusted firm size, columns (4) and (6) include the second-order regressions of normalized adjusted firm size. Columns (3) and (6) allow the function of normalized adjusted firm size to differ between the right- and the left-hand sides of the threshold at the first stage. The coefficients of the number of disabled workers based on OLS are all negative and statistically significant. On the other hand, those based on the IV are statistically insignificant, and the F statistics of the first stage are larger than those reported in Table 8. Therefore, these results also imply that the estimate based on OLS has a negative bias, and the disability employment does not have a negative effect on firms' profits.

In sum, this section demonstrates that the employment of disabled workers does not necessarily decrease firms' profit rates. In addition, in the OLS regression, the coefficient of disability employment has a downward bias. This implies that firms that employ a higher proportion of disabled people place greater importance on their welfare or corporate social responsibility rather than pursuing their profits. That is, firms that meet just their levy quotas prefer to employ disabled workers who have high productivities, but firms that have disabled workers far beyond their levy quotas may do not care about productivities of disabled workers.[42] Generally speaking, in white collar jobs such as dealing with accounts, the productivity of persons with paralysis of the lower half of the body is not lower than that of non-handicapped persons. Also in various jobs of manufacturing's assembly lines, the productivity of persons with hearing impairment is as high as that of non-handicapped persons. It seems to be rational for firms sufficiently care their profits to hire productive disabled workers at just their levy quotas and avoid the payment of levies. Moreover, decreasing profits by disability employment would happen only if disabled workers were paid more than they produce. Like many countries, the average wage of disabled workers has been lower than that of normal workers in Japan.[43] This may be partly due to the discrimination against disabled workers. Then, profit-making firms do hire

addition to our analysis of the indices of firms' profits, we try to examine the impact of the disability employment on typical efficiency indices such as labor productivity and the Solow residual. However, we cannot construct these efficiency indices, since almost all the relevant variables are missing in the BSJ.

[40] We calculate the optimal bandwidths based on Imbens and Kalyanaraman (2012), Ludwig and Miller (2007), and Calonico et al. (2014). In practice, we get the optimal bandwidth by each threshold and calculate the weighted average of optimal bandwidths. As a result, the optimal bandwidths are 13.5, 21.0 and 7.9 based on Imbens and Kalyanaraman (2012), Ludwig and Miller (2007), and Calonico et al. (2014), respectively. Thus, all of the optimal bandwidths are wider than the bandwidths of regression in columns (7) and (8) of Table 8. In addition, the coefficient of the number of disabled workers based on IV with each optimal bandwidth is statistically insignificant, which confirms the robustness of our results.

[41] The pooled quota thresholds model includes some singleton dummy variables; as a result, the matrix estimator from clustering the robust standard errors is actually less than full rank. To deal with this problem, we use the Frisch–Waugh–Lovell theorem and partialed out the exogenous regressors from the explanatory variables (Baum et al., 2010).

[42] We can construct a simple example where some firms employ disabled workers far beyond their levy quotas and their productivities are low even if all firms do maximize their profits. Suppose that there are two goods Q_D and Q_H: Q_D is a good made by only disabled workers in a welfare-oriented workplace and Q_H is a good made by normal firms. Let consumers' utility functions be given by $U(Q_D, Q_H) = aQ_D^{0.5} + (1\text{-}a)Q_H^{0.5}$ where $0<a<1$. By definition of the utility functions, the consumer's demand for the good made in welfare-oriented firms is greater than zero. There are three types of labor forces: L_D is the labor level of disabled workers who have low productivities b_D; L_{D^*} is the labor level of disabled workers who have high productivities b_{D^*}; L_H is the labor level of non-handicapped workers who have high productivities b_H. Then, we assume $b_D < w^m < b_{D^*} \leq b_H$, where w^m is the minimum wage in this model. Suppose production functions of two type goods be given by $Q_D = b_D L_D + b_{D^*} L_{D^*}$ and $Q_H = b_D L_D + b_{D^*} L_{D^*} + b_H L_H$, respectively. For simplicity, we assume each type's labor supply is fixed and each type's labor market is competitive. Hence, wages of type D^* or H workers equal to b_i / P_j where P_j is a price of a good j ($i = D^*, H$; $j = D, H$). Due to the minimum wage, type D workers receive w^m/P_j. In addition, we assume that fixed labor supply of high-skilled disabled workers is smaller than labor demand for them. Then, if two goods markets are in Cournot competitions, there are combinations of parameters where some welfare-oriented firms employ both high-skilled and low-skilled disabled workers and their productivities are smaller than those of normal firms. With the levy-grant scheme, we can show similar results of the above model.

[43] The Ministry of Health, Labor and Welfare reported that, in 2013, the average wage of non-disabled regular workers was ¥261,000 per month, and those of regular workers with physical disabilities, mental illness, and intellectual disabilities were respectively ¥223,000, ¥159,000, and ¥108,000 per month (Survey on the Employment Situation of Persons with Disabilities 2013), available from http://www.mhlw.go.jp/file/04-Houdouhappyou-11704000-Shokugyouanteikyokukoureishougaikoyoutaisakubushougaishakoyoutaisakuka/gaiyou.pdf.

Table 9
Disability employment and firms' profit at pooled thresholds, firm size ≧ 301.

Method	(1) OLS	(2) IV	(3) IV	(4) OLS	(5) IV	(6) IV
Number of disabled workers	−0.195	−0.00938	−0.0495	−0.195	0.00272	0.0910
	(0.0615)	(0.600)	(0.600)	(0.0614)	(0.601)	(0.601)
Instrumental variable						
Threshold	–	Yes	Yes	–	Yes	Yes
NL*Threshold	–	No	Yes	–	No	Yes
NL^2*Threshold		No	No		No	Yes
Group dummy (G)	Yes	Yes	Yes	Yes	Yes	Yes
Polynomial order in NL	1	1	1	2	2	2
First stage F value	–	20.98	10.49	–	20.78	7.73
J-test (*P* value)	–	–	0.52	–	–	0.20
Observations	2337	2337	2337	2337	2337	2337
R-squared	0.076	0.0004	0.0021	0.076	0.0004	−0.0055

Note: Standard errors clustered at adjusted firm sizes are given in parentheses. Columns (1)–(3) include the normalized adjusted firm size. Columns (4)–(6) include the first and the second order of normalized adjusted firm size.

disabled workers as long as their productivity is higher than minimum wage.[44] On the other hand, the reason why low productive firms can survive in the market economy might be explained by several support policies for disabled workers such as grants for wages of disabled peopled, subsidies for barrier-free facilities, and priority review systems in public biddings.[45]

6. Conclusion

In this study, we examine the economic effects of the quota system for the employment of disabled people in the Japanese manufacturing industry. Using the baselines of the levy-grant scheme, we show that the levy-grant scheme helps to increase the employment of disabled people. Moreover, our results suggest that social norms may be one of the most important factors in promoting the disability employment, because half the total number of firms in the industry achieved their levy quotas without the legal obligation of paying the levies. Undoubtedly, the employment effect of the levy-grant scheme or social norms are influenced by the existence of other support systems for disabled people in Japan. Without these support systems, such as subsidies for ensuring barrier-free workplaces and job training services, the levies would have to be increased in order to make firms achieve their levy quotas. Hence, these support systems can be interpreted as the hidden aspects of the levy-grant scheme.

In response to the employment effects of the levy-grant scheme, we use an increase in the number of disabled workers through the policy channel as an IV to investigate the causal effect of disability employment on firms' profit rates. Our results reveal that there is no clear relationship between firms' profit rates and disability employment in fuzzy RDD, whereas the OLS regression results suggest a negative relationship between them. Hence, thus far, the negative effects of disability employment on firms' profits are smaller than expected. This finding suggests that there is room for both firms and administrative institutions to create productive jobs for disabled people.[46] We strongly hope that our study will enable Japanese policymakers to understand the problems of achieving the levy quotas efficiently.

This study has several limitations. First, our study cannot estimate appropriate levels or ranges for levies and grants, since both levies and grants were fixed in the Japanese disability employment system. Therefore, note that our estimations simply observe responses to disability employment mandates among firms under the fixed levy-grant scheme of 2008. Second, we need to investigate the overall effects of the levy-grant scheme on disability employment in other industries. This paper focus on the Japanese manufacturing industry, since available industrial codes and financial data are restricted in the BSJ data.[47] However, the cost of hiring disabled workers would vary considerably by industry and area. We hope further studies refine estimations of prefecture- and industry-wide effects of Japanese disability policies on their economic situations.[48] Third, our IV regression strategy estimates an effect of *complier* firms that increase the number of disabled workers in response to their quotas. This means the IV estimates do not include an effect of *never-taker* firms that have never hired disabled workers, nor *always-taker* firms that have hired disabled workers regardless of their quotas. Then, never-takers might lose

[44] If there was the discrimination, then for-profit firms hiring disabled workers would be getting higher profits as disabled workers being underpaid. Unfortunately, we do not have any information on wages and incomes of disabled workers, and cannot examine the above hypothesis. This problem was pointed by the referee. We thank a lot for helpful comments.

[45] Almost all of local governments have their priority review systems in public biddings. In these systems, a firm that employs many disabled workers could have a high evaluation and gain a local government contract.

[46] In entire industries, half of firms that fail to satisfy their levy quotas hire no disabled workers. Even in the manufacturing industry that offers the largest number of jobs for disabled workers, more than 30% of firms that fail to satisfy their levy quotas hire no disabled workers. Since disability employment have no negative impact on firms' profits, the government could improve the employment opportunity for disabled persons by promoting *the right person with disabilities in the right job*. Recently, work fields of disabled workers have been expanded through various efforts by specialists. For example, although persons with intellectual disabilities are said to be inadequate for jobs of customer service, some firms succeed to hire them as waiters in fashionable cafes. In order to decrease the opportunity costs of unemployment of disabled people, various empirical analysis for disability employment will be needed.

[47] As we point out in footnote 21, the BSJ data includes limited information of some non-manufacturing industries. Then, we cannot obtain significant results by using available data in the BSJ. Hence, our paper focuses on the estimations of manufacturing industry.

[48] Because the number of industries within manufacturing is 24, sample size in each industry is very restricted. Then, the statistical power is exclusively low and we cannot obtain significant results in our first stage regression. Hence, we do the additional regression analysis including 23 industry dummies within manufacturing and confirm nearly similar results. The results show that the coefficient of OLS is negative and significant, and that of IV is also negative but insignificant. The only difference between results with and without industry dummies is that the coefficient of IV is more negative than that of OLS. This may suggest firms in some profitable industries hire many disabled workers and cause the positive coefficients in Tables 8 and 9. That is, some industries succeed to offer suitable jobs for disabled workers and tend to be more profitable than other industries. Therefore, the results imply that the effect of disability employment on profits varies among manufacturing industries. In order to review the industry- and prefecture-wide effects and construct the firm's panel data covering all industrial codes, we have submitted applications to the relevant ministries and agencies for permission to use complete survey.

their profits due to the discrimination against disabled workers. Hence, we need to investigate this issue for future analysis. Finally, our study is based on cross-section analysis. In the 2008 system, the levy quota of disability employment for private firms was set to 1.8% of the firm's entire regular workforce. However, the levy quota was increased by 2.0% in April 2013. Our results suggest that the 2008 levy-grant scheme improved disability employment in the Japanese manufacturing industry, but the same results may not necessarily hold under the modified quota. In order to review the economic effects of the quota system, further examination based on panel data will be needed.

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