Master essay in Economics [NEKN01]

Effects of a Reduction in Hours of Work on Labor Productivity and Labor Costs in South Korea

: Evidence from a Regression Discontinuity Design

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Abstract

This investigation aimed at estimating the effects of a reduction in hours worked on labor productivity and labor costs in South Korea. The treatment effect was measured by using the fuzzy RD design with micro data. The data were taken from the Workplace Panel Survey 2007 conducted by the Korea Labor Institute. The main finding of this study was that the fuzzy RD estimates of the effect of a reduction in fixed working hours on labor productivity were larger than the OLS estimates, and the increase in labor costs caused by a reduction in fixed working hours was not as large as previously thought. Thus, the results suggested that industrial competitiveness was not worsened as much as employers' concern.

Keywords: Regression discontinuity; Labor productivity; Hours of work; Korea; Labor costs

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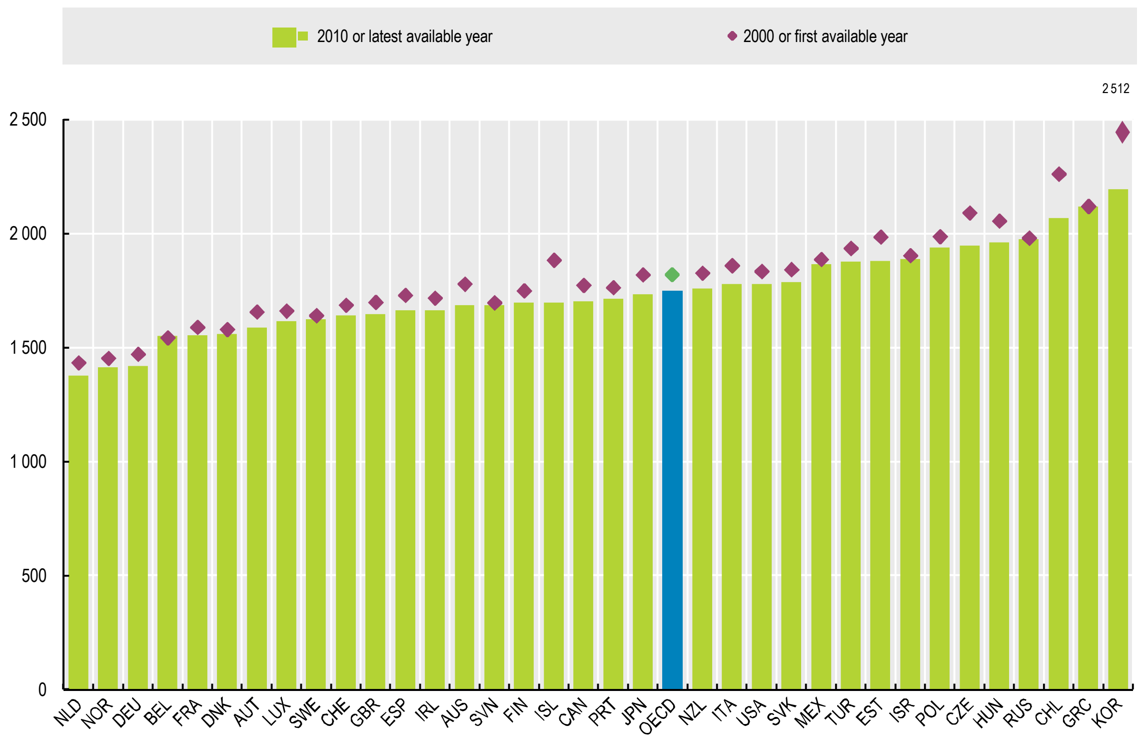
1. Introduction

When it comes to average annual working time, South Korea has been on the top place among member countries of the Organization for Economic Cooperation and Development (OECD) since 1980 in which the data of hours worked in South Korea was first available (OECD, 2011). Although average annual working hours in South Korea have been gradually reduced for 30 years, South Korean people are still working much longer than their counterparts in any other developed countries. As can be seen from figure 1, average annual hours of work in South Korea are 2193 in 2010, which are 444 hours longer than the average annual working time of the OECD countries, and only three countries including South Korea work more than 2000 hours a year among them (OECD, 2011).

Figure 1. Average hours actually worked

Hours per year per person in employment



Data: OECD Factbook 2011: Economic, Environmental and Social Statistics - ISBN 978-92-64-11150-9 - © OECD 2011

Many people have been concerned about the fact that too much work and lack of leisure in South Korea can yield a wide array of different problems. First of all, working long hours deteriorates workers' health (see, for example, Sparks et al., 1997; Harrington, 2001). Studies such as that investigated by White and Beswick (2003) have shown that long hours of work drive people more stressful, thereby adversely affecting their mental health; moreover, they have reported that poor lifestyle behaviors caused by long working hours also have a negative impact on physical health outcomes. In addition, the argument that working long hours can be a fundamental cause of diverse social problems has been ceaselessly discussed. Amagasa et al. (2005) published a paper in which they described that working long hours may cause depression, which can lead suicide, and Tuntiseranee et al. (1998) point out that long working time is a risk factor for sub fecundity especially for women. Taking these research findings into account, it is probable that the highest suicide rate and the lowest fertility rate in South Korea is also partly attributed to its long hours of work since long hours of work make life difficult.

Besides aforementioned problems, another remarkable issue which economists should pay attention to is that South Korea's labor productivity is relatively low in spite of its long working hours. According to Moon (2012), labor productivity per hour worked in South Korea is only about 61.9% of the average labor productivity of the 30 OECD countries, which is on the 28th place among them. Granted, there may be a negative relationship between labor productivity and hours worked because labor productivity is calculated by dividing gross output by the number of hours worked; however, the longest hours of work and low labor productivity in South Korea seem somewhat exceptional. The problem is that South Korean people have worked long hours for the sake of boosting the competitiveness of the business at the expense of their well-being; nevertheless, their productivity has not been as high as it is expected to be. In other words, South Korea does not utilize its labor resource efficiently, struggling with a plenty of problems. Thus, there seems no reason not to demand shorter working hours if long working time deteriorates not only workers' health, but also productivity.

Although it seems evident that reducing working hours have a wide array of positive influence on the society, applying it is not as simple as discussing it. This is attributed to the fact that while workers and the government favor the policy of reducing working time, a plenty of employers are reluctant to decrease hours of work since expected benefits that the employers, especially small businesses, are supposed to receive do not seem substantial enough to appeal them (Kim, 2002, p.8). To be specific, the employers question whether a decrease in hours of work can actually improve labor productivity as much as it can offset loss of gross output led by the reduction in labor input. On top of that, they adamantly believe that business profitability can still be worsened as long as productivity gain is marginal because labor costs also increase as hours worked are reduced (Korean employers federation, 1999). Thus, an elaborate examination of the correlation between hours worked and labor productivity and the correlation between hours worked and labor costs is necessary in order to persuade the employers and to reach agreement, thereby ultimately implementing the reduction in hours worked. Therefore, the main goal of this study is to estimate the causal effects of a reduction in hours of work on labor productivity and labor costs in South Korea. More precisely, this research focuses on comparing the size of the two effects in order to provide reliable grounds for the debate on whether and if so how much a shorter working time undermines industrial competitiveness.

Unlike most studies that rely on simple OLS regressions using time series data, I instead tried to estimate the treatment effect using a regression discontinuity (RD) design, originally introduced by Thistlethwaite and Campbell (1960). One major drawback of the OLS approach is that the simple OLS estimates of the effects of a reduction in hours worked on labor productivity and labor costs can be biased and inconsistent since the treatment, a reduction in hours of work, is not random. To be precise, a company with many employees that is more likely to reduce working hours due to some factors such as the presence of a relative strong labor union may fundamentally have a better labor productivity and high labor costs. In this case, the zero conditional mean assumption does not hold, so that the OLS estimates fail to capture the treatment effect. Hence, in order to overcome this problem and to hold the zero conditional mean assumption, the treatment effect was measured by the RD approach in this paper.

In addition, the effects of a reduction in hours worked on labor productivity and labor costs were examined by using micro data. The data used in the analysis were taken from the Workplace Panel Survey 2007 conducted by the Korea Labor Institute. The Workplace Panel Survey 2007 is a sample survey based on a workplace unit and includes survey data from 1610 private workplaces and 125 public workplaces. Accessibility to micro data allowed estimating the effects of the latest reduction in statutory working hours of South Korea on labor productivity and labor costs with the micro-econometric method.

The main finding of this study is that the OLS estimates underestimate the effect of a reduction in fixed working hours on labor productivity, and the increase in labor costs caused by a reduction in fixed working hours are not as large as previously thought. Thus, the results suggest that industrial competitiveness is not undermined as much as the employers' concern since productivity improvement is larger than previously thought.

The overall structure of the study takes the form of eight chapters, including this introductory chapter. Chapter two begins by providing background on hours of work in South Korea, and chapter three reviews the previous research on this field of study. The fourth chapter is concerned with the methodology, a RD design, and chapter five describes the data and variables used for this study. The sixth chapter presents the empirical results, and the seventh chapter discusses the robustness of the RD design. Finally, the conclusion gives a brief summary and critique of the findings.

2. Background

2.1. The history of a reduction in legal working hours in South Korea

In 1953, the labor standards act of South Korea was first enacted for the purpose of securing and improving the living standard of workers, thereby achieving a well-balanced development of the national economy (The labor standards act of South Korea, 2012). When it was mandated for the first time in 1953, the statutory working hours was 48 hours per week and 8 hours per day excluding recess hours. In 1989, the legal working hours was shortened from 48 hours per week to 44 hours per week, and finally, the labor standards act of South Korea was revised again in 2003, phasing in the mandatory 40-hour work week in July 2004 for firms with over 1000 employees. This gradually expanded to firms with 300 employees or more in July 2005, 100 employees or more in July 2006, 50 employees or more in July 2007, 20 employees or more in July 2008 and a full inclusion to firms with over 5 employees in July 2011. Table 1 below clearly illustrates a process of the gradual introduction of the mandatory 40-hour work week in South Korea.

Table 1. Gradual introduction of the mandatory 40-hour work week in South Korea

Starting date	Applicable party
July 1^{st} in 2004	Enterprises with over 1000 employees
July 1^{st} in 2005	Enterprises with over 300 employees
July 1^{st} in 2006	Enterprises with over 100 employees
July 1^{st} in 2007	Enterprises with over 50 employees
July 1^{st} in 2008	Enterprises with over 20 employees
July 1^{st} in 2011	Enterprises with over 5 employees

2.2. Hours actually worked in South Korea

However, hours actually worked in South Korea have not been dramatically reduced even though the 40-hour work week was mandated, and up to two years of imprisonment or less than 10 million won of fine is imposed to the enterprises that infringe the law. This is largely due to the article 50 of the labor standards act that allows at most 12 hours of overtime work per week if employees and employers reach agreement. Consequently, it has been natural that employers encourage workers to work extended hours, and workers receive extra income. Another reason why the policy has not been very effective is that the article 59 of the labor standards act allows the workers of 12 types of business including transportation, finance, medical, hotel, restaurant, and so on to work an excess of the 12 overtime hours per week. The problem is that the range of those businesses is unclear and too wide. According to report on the establishment status in 2008 investigated by ministry of employment and labor (2008), 54.5% of the total establishments and 37.9% of the entire workers belonged to those business sectors, indicating a plethora of workers in those business sectors were exposure to unlimited long working hours. Lastly, an authoritarian corporate culture also plays a significant role in making the reduction in hours actually worked difficult. For instance, in South Korea, it is considered very bad to leave the office before the boss does, so that it is commonplace for workers to stay the office doing nothing and to wait for their boss leaving. Because of this distinguished culture, it is not easy for them to have much of a life (Olson, 2008). For these reasons, the need of reduction in hours actually worked was continuously being discussed until recently, and the key of the debate concerning a reduction in hours worked today is not a further reduction in legal working hours, but a complete settlement of 40-hour work week.

3. Previous research

A considerable amount of empirical literatures have been published on the impacts of a cut in working time on labor productivity and labor costs. Most of them report that hours of work have negative influence both on labor productivity and labor costs and the impact of a reduction in hours worked on labor costs outweighs that on labor productivity. Lee (1997) investigated the impact of changes in working time on labor productivity by using time series data of average working hours per person and gross output per hour worked in manufacturing sector in South Korea from 1974 to 1995. He demonstrates a negative correlation between the two variables, indicating that when hours of work have increased from 1974 to 1986, a 1 % increase in hours of work has worsened labor productivity by 1.470%, and a 1% reduction in hours worked has increased labor productivity by 0.104% when hours of work have decreased from 1987 to 1995. Similarly, Lee et al. (2000) performed a simple GLS regression with panel data about hours of work and labor productivity from 1972 to 2000, and reveal that a 1% reduction in hours of work has enhanced labor productivity by 0.65%. On the other hand, they point out that expected increase in labor costs will be 10.5% if hours of work are reduced by 9.1% (from 44 hours to 40 hours), which is higher than expected productivity improvement although it depends on the size of increase in overtime work and new employment to cover the output loss. Ahn and Lee (2001) supported their claim by providing the empirical evidence that the rate of increase in hourly wage was higher than the rate of increase in labor productivity during the period from 1989 to 1992 where the legal working hours were reduced from 48 hours to 44 hours. To sum up, previous researches seem to bolster the employer's concern that business profitability can be deteriorated through reduced working time because the impact of a cut in working time on labor costs is larger than the impact of a cut in working time on labor productivity.

However, their findings lead me question whether it is indeed believable that the effect of a reduction in hours worked on labor productivity is not sizeable. One may argue that it is not difficult for workers to enhance productivity by the small amount that previous studies suggest because workers tend to lower operation pace or intensity of labor when working time is long (Sohn, 2002). In addition, since a reduction in legal working hours from 44 hours to 40 hours means the change from six-day work week to five-day work week, there may be an extra motivation to improve productivity. Finally, Omitted variable bias may lead to underestimate the effect of a cut in hours of work on labor productivity. In this case, the effect of a reduction in hours worked on labor costs can also be overestimated because productivity improvement prevents firms from demanding more labor input. Therefore, an elaborate estimation on the size of the increase in labor productivity and labor costs resulting from a shorter working time is required.

4. Methodology

4.1. Regression discontinuity (RD) design

In most recent studies, the effects of a cut in hours worked on labor productivity and labor costs were measured by OLS estimates using time series data. The most serious disadvantage of this method is that the OLS estimates can be biased and inconsistent due to the omitted variables bias which means that some crucial determinants of the change in labor productivity and labor costs of enterprises are omitted in the regression specification. If it is the case where these important covariates are not controlled for, the OLS estimates are not valid any longer. The same problem that makes the OLS regression invalid can be explained in a different way: the OLS estimates can be biased when the treatment, a reduction in working hours, is not randomly assigned. What it means is that enterprises which have different working hours may also differ in terms of underlying productivity, average wage level and other unobserved characteristics, so that a reduction in hours worked is determined not randomly, but by these factors. For instance, big companies that are more likely to have better working conditions including a shorter working time may fundamentally have better labor productivity and high labor costs. Thus, other pivotal covariates that would have an impact on labor productivity and labor costs should be taken into account in the regression specification to measure the unbiased treatment effect.

In order to solve this problem, a RD design, a "quasi-experimental design", was used to estimate the causal effect of a cut in hours worked on labor productivity and labor costs in this paper. The RD design exploits knowledge about random rules determining treatment: in my case, the revised labor standard act introducing the compulsory reduction in legal working hours. To be specific, in 2007, prescribed working hours of companies with over 100 workers should not exceed 40 hours per week since the 40-hour work week had been mandatory for them since July, 2006 according to the labor standard act revised. On the other hand, in 2007, prescribed working time of companies with 99 workers or less could still exceed 40 hours per week. Consequently, determining the treatment, a reduction in working time, was based on the threshold of 100 employees in 2007, so that similar firms in terms of fundamental characteristics might have very different labor productivity and labor costs depending on the cutoff. Thus, the RD compares labor productivity and labor costs of companies just above and below the threshold of 100 employees i.e. we are looking for a discontinuity. Since just above and below the threshold is as good as random, a reduction in working time should be as good as randomized, so that treatment, a reduction in hours of work can be randomly assigned by the RD approach and a comparison of labor productivity and labor costs of both groups therefore provide a good estimate of the treatment effect.

4.2. Fuzzy RD design and local average treatment effect (LATE)

Unlike the sharp RD design where treatment is perfectly determined at the threshold, the RD approach used in this paper is fuzzy. In the fuzzy RD design, reaching the threshold does not necessarily mean being treated, but it just shifts the probability of treatment. In my case where the causal variable of interest, a reduction in hours worked, is not binary, but takes on many different values, it produces a discontinuity in average weekly working hours rather than the probability of treatment. In my fuzzy RD design, not all enterprises followed the threshold-crossing rule. For instance, in 2007, there might be some big firms with over 100 employees that did not reduce hours worked or small businesses with 99 employees or less wanted to shorten working hours regardless the rule; thus, a reduction in hours work did not solely rely on whether the number of workers crossed the threshold of 100 employees. Nevertheless, there were still strong incentives to reduce hours of work discontinuously at the threshold of 100 employees although these incentives were not powerful enough to move all firms from 44-hour work week to 40-hour work week, and the fuzzy RD design exploited this characteristic to estimate a meaningful treatment effect.

As stated above, if we allow for heterogeneous treatment effects that imply treatment effects vary across different units, the fuzzy RD estimate can no longer be interpreted as average treatment effect. However, under some reasonable assumptions illustrated in table 2 below, it can at least capture the effect of treatment on those whose treatment status was changed by the threshold-crossing rule. Hahn et al. (2001) found a similarity between the definition of the treatment effect in the fuzzy RD design and in the Wald estimator in an instrumental variables setting, and they suggested examining the treatment effect by using two-stage least-squares (2SLS) like an IV design. In the case of this paper, the parameter of the fuzzy RD design implies the effect of a reduction in hours of work on the enterprises whose average weekly working hours were affected by the threshold indicator. In other words, The RD approach captures the local average treatment effect (LATE) at the threshold like IV estimates in the heterogeneous treatment effect case do.

Table 2. Four assumptions for the RD estimate to capture a LATE

Assumption 1	The independence assumption: the threshold indicator is independent of potential outcomes and potential treatment assignments
Assumption 2	The exclusion restriction: the threshold indicator only affects potential outcomes through treatment assignments
Assumption 3	The monotonicity assumption: the threshold indicator affects the causal channel of interest only in one direction
Assumption 4	The existence of a first-stage: there is a significant first-stage effect of the threshold indicator on the treatment.

3.3. Measurement framework

The fuzzy RD approach is similar with an IV, so that it estimates the treatment effect by using two-stage least-square (2SLS). The fuzzy RD design can be illustrated by the two equation system:

The main equation: $Y = \alpha + \tau D + f(X - c) + \varepsilon$

The first-stage equation: $D = \gamma + \delta T + g(X - c) + \upsilon$

where Y is the outcome variable, D is the treatment variable, and X is the forcing variable. T is the treatment indicator, c is the cutoff point, and $T = 1[X \geq c]$ indicates whether the forcing variable reaches the cutoff point. If we try to estimate the treatment effect τ directly from the main equation by using OLS approach, the estimate can be biased because the treatment variable D and the error term ε are correlated. However, this endogeneity problem is alleviated using an instrument variable that is associated with D, but that is unassociated with ε. In this RD approach, the treatment indicator T becomes the instrument for the treatment variable D; thus the unbiased treatment effect τ is calculated with 2SLS. The reduced form is obtained by substituting the first-stage equation in the main equation:

The reduced form equation: $Y = \alpha_r + \tau_r T + f_r(X - c) + \varepsilon_r$

where $\tau_r = \tau\delta$. Therefore, the treatment effect τ can be measured by calculating the ratio of the reduced form coefficient τ_r and the first-stage coefficient δ.

Although there are two ways to perform the fuzzy RD design: the local linear regression and polynomial regressions, polynomial regressions are chosen in this essay due to data limitations. For example, if the bandwidth of 5 is set, the number of observation is only 30; thus it is hard to obtain meaningful results from the local linear regression. Since the choice of functional form $f(X - c)$ and $g(X - c)$ plays significant role in the polynomial regressions, a variety of specifications are used to find the most reliable one.

5. Data

The data used for the analysis were taken from the Workplace Panel Survey 2007 conducted by the Korea Labor Institute. The Workplace Panel Survey 2007 is a sample survey based on a workplace unit and includes survey data from 1610 private workplaces and 125 public workplaces. Samples were selected by considering the industry, size and region of the workplaces, and workplaces in agricultural, forestry, fishery and mining industries were excluded.

5.1. Outcome variables ($\ln APL$*,* $\ln ANPL$ *and* $\ln WAGE$*)*

OECD (2001) defines labor productivity as the amount of goods or services that a laborer produces in a given amount of time. Thus, if labor productivity is based on gross output, it can be illustrated as:

$$\frac{\text{Quantity index of gross output}}{\text{Quantitiy index of labor input}}$$

On the other hand, if labor productivity is based on value added, it can be defined as:

$$\frac{\text{Quantity index of value added}}{\text{Quantitiy index of labor input}}$$

Throughout this paper, both gross-output based labor productivity and value-added based labor productivity are used as outcome variables, but replaced by total sales and net profit of the sample enterprises respectively. Therefore, gross-output based labor productivity of firm i (APL_i) is calculated by the formula:

$$APL_i = \frac{SALES_i}{HOUR_i * 52 * LABOR_i}$$

where $SALES_i$ is the total sales of firm i, $HOUR_i$ is the average weekly working hours per person of firm i, and $LABOR_i$ is the number of workers of firm i. 52 simply represents 52 weeks; thus $HOUR_i * 52$ illustrates average annual working hours per person of firm i. Hence, APL_i could be interpreted as sales per hour worked of firm i. In the same way, value-added based labor productivity of firm i ($ANPL_i$) was measured by the formula:

$$ANPL_i = \frac{PROFIT_i}{HOUR_i * 52 * LABOR_i}$$

where $PROFIT_i$ was the net profit of firm i. Hence, $ANPL_i$ indicated net profit per hour worked of firm i.

Labor costs are defined as “the total expenditure borne by employers in order to employ workers” (OECD, 2008, p.299); however, in this paper, hourly wage represents labor costs for the purpose of a comparison with labor productivity. That is to say, since labor productivity is defined as gross output “per hour worked” and value-added “per hour worked”, labor costs per hour worked are considered as labor costs i.e. hourly wage. Thus, labor costs of firm i ($WAGE_i$) are calculated by the formula:

$$WAGE_i = \frac{WAGESUM_i}{HOUR_i * 52 * LABOR_i}$$

where $\mathrm{WAGESUM_i}$ is the sum of all wages of firm i, $\mathrm{WAGE_i}$ represents hourly wage of firm i. All outcome variables are logged in the analysis for easier interpretation.

*5.2. Treatment variables (*FIXHOUR *and* HOUR*)*

According to a definition provided by OECD, normal working hours, also known as fixed working hours and prescribed working hours are "the hours of work fixed by or in pursuance of laws of regulations, collective agreements or arbitral awards, or the number of hours in excess of which any time worked is remunerated at overtime rates" (2008, p.368). Normal working hours are important because they are set by agreements between employees and employers within the legal working hours, thus being affected by a change in legal working hours. In this essay, the fixed working hours per week (FIXHOUR) and the actual working hours per week (HOUR) are used as the treatment variables, and actual working hours per week (HOUR) consist of the sum of fixed working hours per week and average weekly overtime working hours.

*5.3. Forcing variable (*LABOR*) and threshold indicator* (CUTOFF)

The number of workers(LABOR) is used as a forcing variable, the threshold indicator (CUTOFF) illustrates whether the number of workers of firm i reaches the threshold of 100 workers.

5.4. Descriptive statistics

Descriptive statistics are presented in table 3. The average fixed working hours in the sample are 40.383, and the mean of average weekly working hours are 46.828. The full sample includes 1735 observations, but not all samples are exploited for the treatment estimation since the outcome variables have many missing values.

Table 3. Descriptive statistics

Variables	Descriptions	N	Mean	Minimum	Maximum
APL	Sales per hour worked in 2007	1288	1.073	-0.002	149.841
ANPL	Net profit per hour worked in 2007	1262	0.085	-0.549	21.099
WAGE	Hourly wage in 2007	1058	0.056	0.001	8.845
FIXHOUR	Fixed working hours per week in 2007	1729	40.383	18	68
HOUR	Actual working hours per week in 2007	1722	46.828	24	73.75
LABOR	The number of workers in 2007	1735	415.073	3	14702
LABOR06	The number of workers in 2006	1735	410.765	0	14183
CUTOFF	The threshold indicator, $\mathrm{CUTOFF} = 1$ if $\mathrm{LABOR} \geq 100$	1735	0.611	0	1

APL, ANPL, and WAGE are measured in a million Korean won.

6. Results

6.1. OLS estimates

To begin with, the effects of a reduction in hours worked on labor productivity and labor costs were examined by the OLS regressions like most previous researches. Table 4 reports OLS estimates from regressions of sales per hour worked (lnAPL), net profit per hour worked (lnANPL), and hourly wage (lnWAGE) on actual working hours (HOUR) and the number of workers (LABOR). As expected, all coefficients significantly revealed negative correlations between hours actually worked and labor productivity and labor costs, suggesting that both labor productivity and labor costs increase when actual hours of work are reduced. The size of the negative correlations was not substantial, ranging from -0.019 to -0.064; but, the results indicate that the effect of hours actually worked on labor costs are bigger than the effect of hours actually worked on labor productivity. This is in line with most previous researches where economists maintain that a reduction in hours worked may deteriorate industrial competitiveness because labor costs rise more quickly although labor productivity is enhanced by a cut in working hours. However, as mentioned in chapter 4, the OLS estimates are likely to have bias since other important covariates are not controlled for in the specification, and the variable of interest, hours actually worked, is not random. For these reasons, the fuzzy RD approach was applied.

Table 4. OLS estimates of the effects of HOUR on lnAPL, lnANPL and lnWAGE

	lnAPL			lnANPL			lnWAGE		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
HOUR	-0.020**	-0.019**	-0.019**	-0.038***	-0.037***	-0.038***	-0.063***	-0.064***	-0.064***
	(0.008)	(0.008)	(0.008)	(0.012)	(0.012)	(0.012)	(0.007)	(0.007)	(0.007)
LABOR	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
$LABOR^2$	No	No	Yes	No	No	Yes	No	No	Yes
N		1287			1058			1293	

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

6.2. First-stage and reduced form estimates

The first-stage and reduced form estimates of the impact of the threshold indicator (CUTOFF) on fixed working hours (FIXHOUR) and sales per hour worked (lnAPL), reported in table 5 for a variety of specifications, illustrate that reaching the cutoff point is significantly associated with shorter fixed working hours and higher sales per hour worked. The impact of the threshold indicator (CUTOFF) on fixed working hours (FIXHOUR) ranged from -1.734 to -0.722 depending on specifications and all of the F-values in the first-stage regression were higher than 10. The reduced form relationship between the threshold indicator (CUTOFF) and sales per hour worked (lnAPL) was insensitive to specification and statistically significant.

Table 5. First-stage and reduced-form estimates of the effect of CUTOFF on FIXHOUR and lnAPL

	First stage				Reduced form		
	FIXHOUR				lnAPL		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CUTOFF	-0.722***	-0.718***	-0.718***	-1.734***	0.260***	0.232**	0.243**
	(0.103)	(0.107)	(0.115)	(0.236)	(0.097)	(0.101)	(0.108)
LABOR	No	Yes	Yes	Yes	No	Yes	Yes
$LABOR^2$	No	No	Yes	No	No	No	Yes
LABOR * CUTOFF	No	No	No	Yes	No	No	No
F-value	49.36	24.67	16.44	24.44	7.24	4.10	2.76
N	1287				1287		

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

Table 6 describes the similar pattern to that in table 5, but all coefficients were larger in absolute value. The first-stage association between the threshold indicator (CUTOFF) and fixed working hours (FIXHOUR) was negative and strong i.e. all of the F-values were larger than 10. A positive correlation was also found between the threshold indicator (CUTOFF) and net profit per hour worked (lnANPL). From the results in table 5 and 6, it is apparent that there is the positive discontinuity in labor productivity at the threshold of 100 workers.

Table 6. First-stage and reduced-form estimates of the effect of CUTOFF on FIXHOUR and lnANPL

	First stage				Reduced form		
	FIXHOUR				lnANPL		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CUTOFF	-0.782***	-0.774***	-0.770***	-2.104***	0.270*	0.255*	0.329**
	(0.112)	(0.117)	(0.126)	(0.260)	(0.141)	(0.148)	(0.158)
LABOR	No	Yes	Yes	Yes	No	Yes	Yes
$LABOR^2$	No	No	Yes	No	No	No	Yes
LABOR * CUTOFF	No	No	No	Yes	No	No	No
F-value	48.37	24.19	16.12	27.53	3.65	1.89	1.84
N	1058				1058		

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

It is somewhat surprising that the reduced form estimates, reported in table 7, did not find significant a positive association between the threshold indicator (CUTOFF) and hourly wage (WAGE), whereas the effect of reaching the cutoff (CUTOFF) on the fixed working hours (FIXHOUR) was still strong and negative. Contrary to expectations, all of the coefficients of the reduced form regressions were negative and only the coefficient in column (5) was significant, suggesting that unlike labor productivity, labor costs may be unchanged or even decreased when fixed working hours are shortened.

Taking into account the results presented in table 5-7 where the treatment variable is fixed working time, it can be concluded that the first-stage relationship is strong enough, there is a significant positive discontinuity in labor productivity around the cutoff point, and there is an insignificant negative discontinuity in labor costs at the threshold. The coefficients of the first-stage were very similar except for those in column (4) where the interaction of LABOR and CUTOFF was controlled for with LABOR. Thus, if we do not consider coefficients in column (4), the first-stage can be interpreted that the enterprises that are affected by the treatment rule reduced their fixed working hours, on average, about 0.7 hour.

Table 7. First-stage and reduced-form estimates of the effect of CUTOFF on FIXHOUR and lnWAGE

	First stage				Reduced form		
	FIXHOUR				lnWAGE		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CUTOFF	-0.748***	-0.744***	-0.746***	-1.690***	-0.152*	-0.103	-0.059
	(0.104)	(0.108)	(0.116)	(0.237)	(0.081)	(0.084)	(0.090)
LABOR	No	Yes	Yes	Yes	No	Yes	Yes
$LABOR^2$	No	No	Yes	No	No	No	Yes
LABOR * CUTOFF	No	No	No	Yes	No	No	No
F-value	52.16	26.07	17.73	24.34	3.56	3.73	3.16
N	1293				1293		

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

Table 8 presents the first-stage and reduced form estimates of the effect of reaching the threshold (CUTOFF) on actual working time (HOUR) and sales per hour worked (lnAPL). This is similar with the result in table 5, but the only difference is that actual working hours (HOUR) are used as the treatment variable instead of fixed working hours (FIXHOUR). As a result, the first-stage relationship became very weak, so most of the coefficients were not statistically different from zero. The coefficient of column (4) was significant, but its F-value was only 3.59, still smaller than 10. Similarly, the results reported in table 9 and 10 indicate that there is no strong evidence of a negative association between the threshold indicators (CUTOFF) and actual working time (HOUR). Therefore, this finding is rather disappointing because these weak first-stage relationships make it not possible to interpret the ratio of the reduced form and first stage as the treatment effect.

The strong first-stage relationship between the threshold indicator (CUTOFF) and fixed working time (FIXHOUR) and the weak correlation between the threshold indicator (CUTOFF) and actual working time (HOUR) may be largely attributable to the fact that many employers reacted to the labor standard act by reducing their fixed working hours, but by increasing overtime working hours some extent to which made the effect of the threshold (CUTOFF) on actual working hours (HOUR) ambiguous. If we compare the coefficients of the first-stage in table 8-10 with those in table 5-7, we can confirm this hypothesis that the reduction in fixed working hours is partly offset by increased overtime work.

Table 8. First-stage and reduced-form estimates of the effect of CUTOFF on HOUR and lnAPL

	First stage				Reduced form		
	HOUR				lnAPL		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CUTOFF	-0.446	-0.301	-0.088	-2.006***	0.260***	0.232**	0.243**
	(0.323)	(0.337)	(0.359)	(0.746)	(0.097)	(0.101)	(0.108)
LABOR	No	Yes	Yes	Yes	No	Yes	Yes
$LABOR^2$	No	No	Yes	No	No	No	Yes
LABOR ∗ CUTOFF	No	No	No	Yes	No	No	No
F-value	1.91	2.11	2.38	3.59	7.24	4.10	2.76
N	1287				1287		

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

Table 9. First-stage and reduced-form estimates of the effect of CUTOFF on HOUR and lnANPL

	First stage				Reduced form		
	HOUR				lnANPL		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CUTOFF	-0.609*	-0.528	-0.363	-2.647***	0.270*	0.255*	0.329**
	(0.354)	(0.370)	(0.395)	(0.827)	(0.141)	(0.148)	(0.158)
LABOR	No	Yes	Yes	Yes	No	Yes	Yes
$LABOR^2$	No	No	Yes	No	No	No	Yes
LABOR ∗ CUTOFF	No	No	No	Yes	No	No	No
F-value	2.96	1.77	1.64	3.92	3.65	1.89	1.84
N	1058				1058		

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

Table 10. First-stage and reduced-form estimates of the effect of CUTOFF on HOUR and lnWAGE

	First stage				Reduced form		
	HOUR				lnWAGE		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CUTOFF	-0.342 (0.320)	-0.165 (0.335)	-0.014 (0.357)	-1.777** (0.735)	-0.152* (0.081)	-0.103 (0.084)	-0.059 (0.090)
LABOR	No	Yes	Yes	Yes	No	Yes	Yes
$LABOR^2$	No	No	Yes	No	No	No	Yes
LABOR * CUTOFF	No	No	No	Yes	No	No	No
F-value	1.14	2.18	1.95	3.48	3.56	3.73	3.16
N	1293				1293		

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

6.3. Fuzzy RD estimates

The fuzzy RD estimates were examined by two-stage least-square (2SLS) process, and they were compared with the OLS estimates. First, the effect of a reduction in fixed working hours (FIXHOUR) on sales per hour worked (lnAPL) is reported in table 11. The fuzzy RD estimate in a model without any controls for the number of workers is -0.360, and the coefficients from models including linear and quadratic controls for the number of workers are -0.323 and -0.049, respectively. Except for the RD estimate in column (7) including linear control for the number of workers (LABOR) and the interaction term of LABOR and CUTOFF, all estimates revealed significant negative association between fixed working hours (FIXHOUR) and sales per hour worked (lnAPL). This finding supports the idea of labor productivity improvement resulting from a cut in fixed working hours.

The most striking result to emerge from the estimates comparison is that the RD estimates are larger than the OLS estimates in absolute value. This implies that the simple OLS estimates underestimate the effect of a reduction in fixed working hours (FIXHOUR) on sales per hour worked (lnAPL), which suggests labor productivity improvement caused by a reduction in fixed working time is actually bigger than previously thought.

Table 11. OLS and fuzzy RD estimates of FIXHOUR on lnAPL

	OLS			2SLS			
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FIXHOUR	-0.023 (0.026)	-0.021 (0.026)	-0.020 (0.026)	-0.360** (0.143)	-0.323** (0.148)	-0.049*** (0.001)	-0.130 (0.115)
LABOR	No	Yes	Yes	No	Yes	Yes	Yes
$LABOR^2$	No	No	Yes	No	No	Yes	No
$LABOR*CUTOFF$	No	No	No	No	No	No	Yes
N		1287			1287		

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

As we compare the results illustrated in table 11 and 12, the fuzzy RD estimates for net profits per hour worked are similar to the estimates in the corresponding models for sales per hour worked except that the coefficient in column (6) in table 13 is larger in absolute value than that in table 12. Similarly, the effect of a reduction in fixed working hours (FIXHOUR) on net profit per hour worked (lnANPL) is stronger when it is measured by the RD design rather than OLS approach.

Table 12. OLS and fuzzy RD estimates of FIXHOUR on lnANPL

	OLS			2SLS			
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FIXHOUR	-0.042 (0.038)	-0.040 (0.038)	-0.042 (0.038)	-0.346* (0.186)	-0.330* (0.196)	-0.126*** (0.002)	-0.063 (0.145)
LABOR	No	Yes	Yes	No	Yes	Yes	Yes
$LABOR^2$	No	No	Yes	No	No	Yes	No
$LABOR*CUTOFF$	No	No	No	No	No	No	Yes
N		1058			1058		

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

It is more complicated to interpret the results described in table 13 since different interpretations of the result are possible depending on the specification. In column (4) where no covariate is included, the RD estimate has a positive sign and it is significant at 10% level, which surprisingly implies that a reduction in fixed working hours (FIXHOUR) decreases hourly wage (lnWAGE). The coefficients in column (5) and (7) also show positive signs, but they are insignificant. Conversely, in column (6) including linear and quadratic controls for the forcing variable (LABOR), the RD estimate of the effect of the reduction in fixed working hours (FIXHOUR) on hourly wage (lnWAGE) has a negative sign and very low standard error.

Table 13. OLS and fuzzy RD estimates of FIXHOUR on lnWAGE

	OLS			2SLS			
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FIXHOUR	-0.032 (0.021)	-0.036* (0.021)	-0.038* (0.021)	0.203* (0.112)	0.138 (0.116)	-0.114*** (0.001)	0.158 (0.098)
LABOR	No	Yes	Yes	No	Yes	Yes	Yes
$LABOR^2$	No	No	Yes	No	No	Yes	No
LABOR $*$ CUTOFF	No	No	No	No	No	No	Yes
N	1293			1293			

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

Therefore, how to interpret the results and how to make a conclusion of this study is solely dependent on the choice of functional form. If the specification (6) is considered as the precise functional form, which is desirable due to the lowest standard error, it can be concluded that an hour reduction in fixed working hours increases sales per hour worked by about 0.049% and net profit per hour worked by about 0.126%. Likewise, it is also interpreted that an hour reduction in fixed working hours increases hourly wage by about 0.114%. Thus, the increase in labor costs can be bigger than that in labor productivity depending on which productivity indicator is used; nevertheless, it is obvious that the gap is not as large as previously thought. On the other hand, if the basic RD design model only controlling for the forcing variable (LABOR) is adopted, the RD estimates in table 11-13 are -0.323, -0.330, and 0.138 respectively, which indicate that an hour reduction in fixed working hours increases sales per hour worked by about 0.323% and 0.330%, and the change in hourly wage is not significantly different from zero.

Table 14-16 also report the RD estimates of the effects of a reduction in actual working hours on sales per hour worked, net profit per hour worked, and hourly wage; however, they are not interpreted as the treatment effects due to weak first-stage.

Table 14. OLS and fuzzy RD estimates of HOUR on lnAPL

		OLS			2SLS		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HOUR	-0.020**	-0.019**	-0.019**	-0.583	-0.770	-0.042***	0.048
	(0.008)	(0.008)	(0.008)	(0.461)	(0.902)	(0.001)	(0.113)
LABOR	No	Yes	Yes	No	Yes	Yes	Yes
$LABOR^2$	No	No	Yes	No	No	Yes	No
LABOR * CUTOFF	No	No	No	No	No	No	Yes
N		1287			1287		

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

Table 15. OLS and fuzzy RD estimates of HOUR on lnANPL

		OLS			2SLS		
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
HOUR	-0.038***	-0.037***	-0.038***	-0.444	-0.483	-0.108***	0.054
	(0.012)	(0.012)	(0.012)	(0.331)	(0.418)	(0.001)	(0.128)
LABOR	No	Yes	Yes	No	Yes	Yes	Yes
$LABOR^2$	No	No	Yes	No	No	Yes	No
LABOR * CUTOFF	No	No	No	No	No	No	Yes
N		1058			1058		

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

Table 16. OLS and fuzzy RD estimates of $HOUR$ on $\ln WAGE$

	OLS			2SLS			
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$HOUR$	-0.063***	-0.064***	-0.064***	0.445	0.624	-0.098***	0.141
	(0.007)	(0.007)	(0.007)	(0.527)	(1.478)	(0.001)	(0.127)
$LABOR$	No	Yes	Yes	No	Yes	Yes	Yes
$LABOR^2$	No	No	Yes	No	No	Yes	No
$LABOR * CUTOFF$	No	No	No	No	No	No	Yes
N	1293			1293			

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

In short, the most interesting finding to emerge from this study is that the increase in labor costs caused by a reduction in fixed working hours cannot be as large as previously thought. There are several possible explanations for this result. First, labor productivity gain would play a substantial role in covering the loss of gross output due to a shorter working time. Second, the government lowered overtime rate to 25% for the first four hours of overtime work, and this might contribute to control rising labor costs. Lastly, employers might try to lower labor costs by hiring part-time workers rather than by spending money on overtime pay for their regular workers.

7. Robustness check

7.1. Graphical analysis

Figure 2-4 describe the reduced form relationship between the threshold indicator ($CUTOFF$) and the three outcome variables ($\ln APL$, $\ln ANPL$, and $\ln WAGE$). Since the number of observation is not very many, it is unclear to find a discontinuity at the threshold. Nevertheless, when we look at the regression line together with the points around the cutoff, a small positive discontinuity can be observed in figure 2. In figure 3, the jump at the threshold is bigger than that in figure 2. This is consistent with the results in table 6 and 7 where the effect of the threshold indicator ($CUTOFF$) on net profit per hour worked ($\ln ANPL$) is bigger than the effect of the threshold indicator (CUTOFF) on sales per hour worked (lnAPL). In the same way, figure 4 seems to imply the negative correlation between the threshold indicator (CUTOFF) and hourly wage (lnWAGE).

Figure 2. Reduced form relationship between CUTOFF and lnAPL

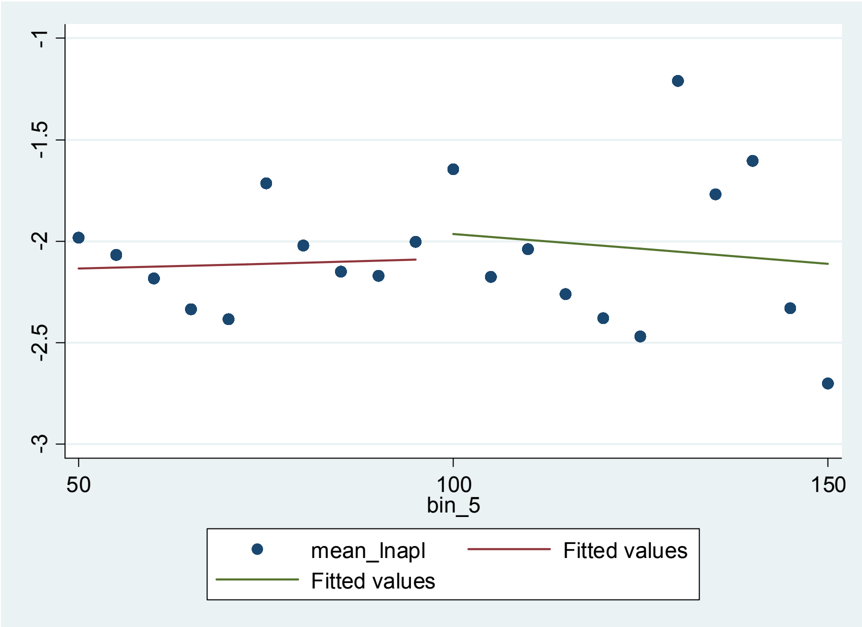


Figure 3. Reduced form relationship between CUTOFF and lnANPL

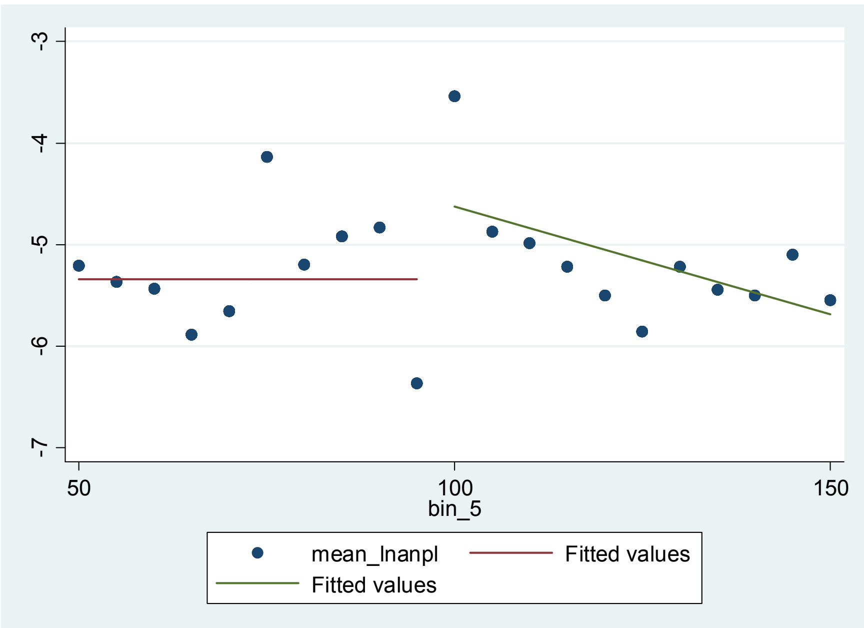


Figure 4. Reduced form relationship between CUTOFF and lnWAGE

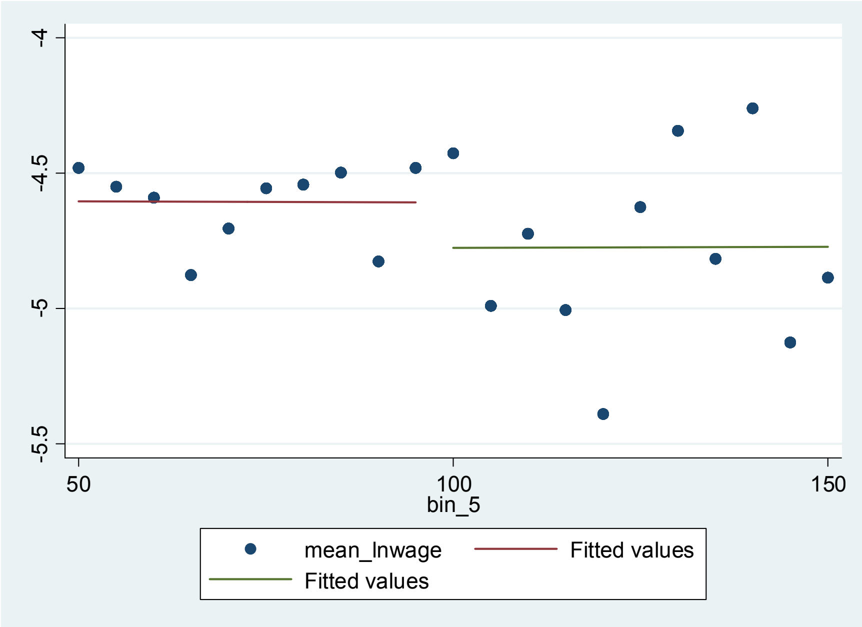


Figure 5 and 6 represent the first-stage association between the threshold indictor (CUTOFF) and the two treatment variables (FIXHOUR and HOUR). It is also difficult to find outstanding jump at the cutoff point because of small number of observations. However, if we compare the two points that are located on each side of the threshold, we can inspect a negative discontinuity at the threshold in figure 5. In the same way, the two points right next to the cutoff imply that there is a negative discontinuity at the threshold in figure 6, but it is less clearer compared to figure 5.

Figure 5. First-stage relationship between CUTOFF and FIXHOUR

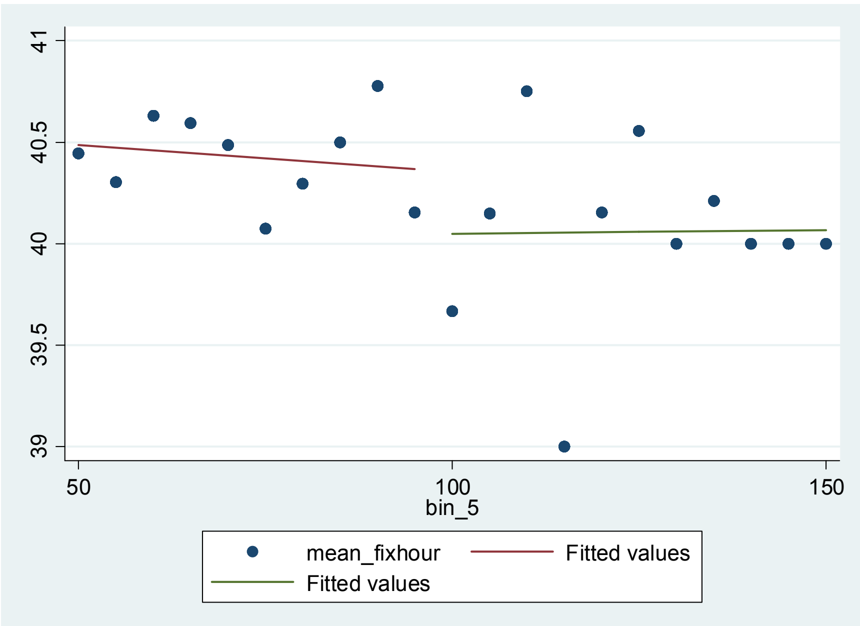
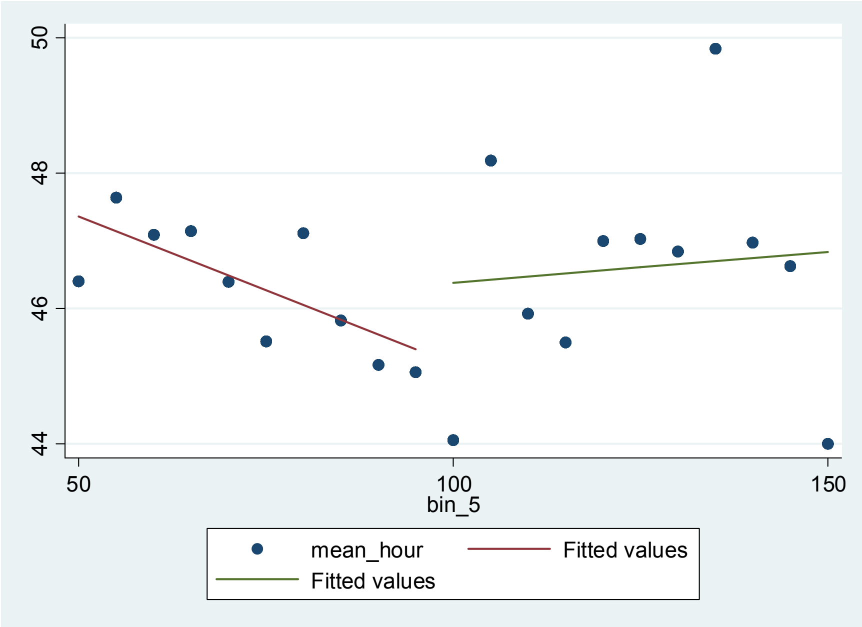


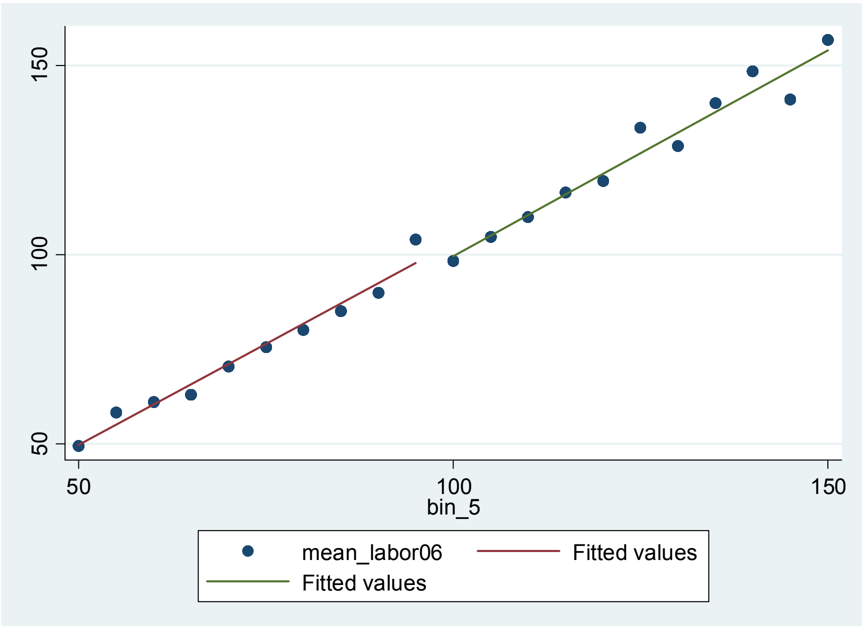
Figure 6. First-stage relationship between CUTOFF and HOUR



7.2. RD analysis on the baseline covariates

An alternative approach to test the validity of the RD design is to examine whether the other covariate is locally balanced on either side of the threshold. The ground behind this is that there should be no jump in other covariates that are determined prior to the assignment.

Figure 7. RD analysis on LABOR06



The number of workers in 2006 (LABOR06) was used as one of other covariates because it was the variable determined before the assignment. Figure 7 reveal that there is not important difference in the number of workers in 2006 (LABOR06) right around the threshold.

In addition to this graphical inspection, the existence of a discontinuity was tested by performing formal RD regression where the number of workers in 2006 (LABOR06) was the outcome variable. Accordingly, any coefficient of different specifications was not significant, rejecting the hypothesis that there is a discontinuity at the threshold.

7.3. Inspection of the density of the forcing variable and Mccrary's test

For the RD design to be valid, thereby capturing the treatment effect, the assumption that each unit has imprecise control over the assignment variable should be hold (Lee and Lemieux, 2010). What it means in the case of this study is that the RD can be invalid if employers can precisely manipulate the number of workers, the forcing variable, in order to avoid introducing the mandatory 40-hour work week. Taking into account labor market inflexibility of South Korea, it does not seem possible; however, there can be a chance of manipulation around the threshold. The intuitive test of this assumption is to inspect the density of the forcing variable and to investigate whether there is a discontinuity in the distribution of the forcing variable around the threshold.

Figure 8 presents the density of the forcing variable when the size of the bandwidth is set to 5, and figure 9 describes the same graph when the size of the bandwidth is 2. In Figure 8, the number of observation of the forcing variable is larger on the left side of the cutoff, and in contrast, in figure 9, the number of observation is larger on the right side of the cutoff. However, we do not know if it means that people can manipulate the forcing variable around the cutoff. In short, it is hard to judge whether there is a discontinuity at the threshold through the histogram.

Figure 8. Density of LABOR (bin 5)

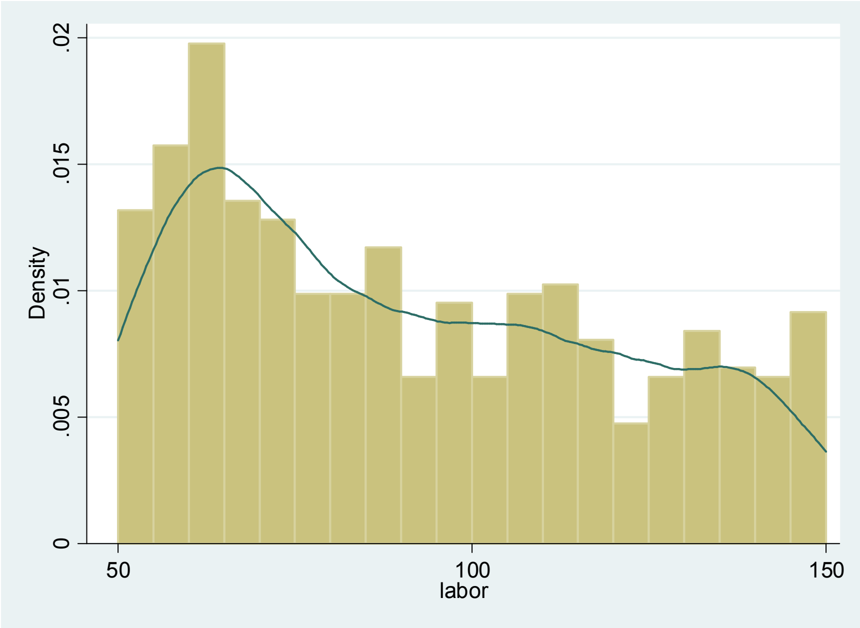
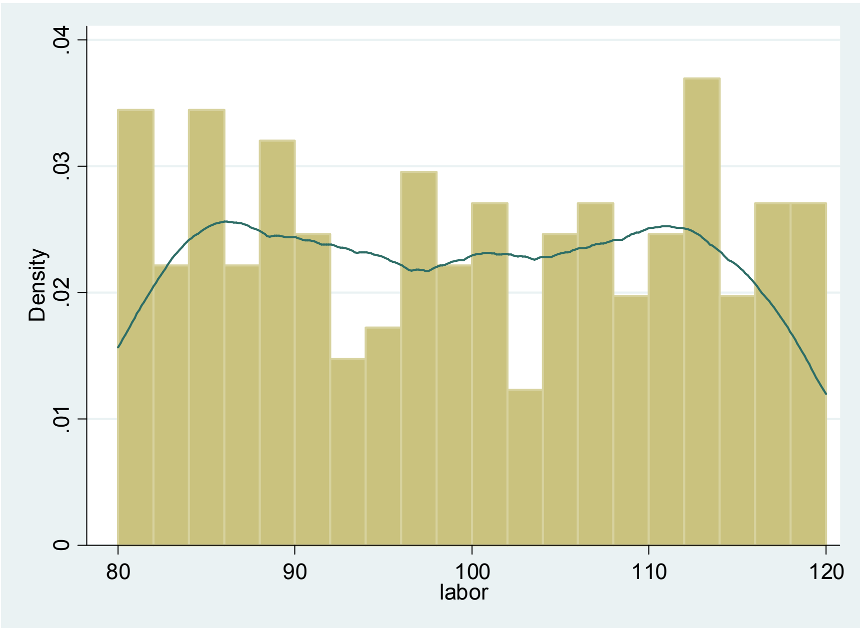


Figure 9. Density of LABOR (bin 2)



I tried to test the discontinuity of the density of the forcing variable at the threshold using a formal test suggested by McCrary (2008). As seen in table 17, any coefficient of CUTOFF is significantly different from zero, which implies that there is no evidence of discontinuity at the cutoff. Therefore, it can be concluded that the RD design used in the paper is valid and the RD estimates can be interpreted as local average treatment effect.

Table 17. McCreary's test

	Bin 5			Bin 2		
	50 ~ 150	80 ~ 120	90 ~ 110	50 ~ 150	80 ~ 120	90 ~ 110
CUTOFF	1.344	-1.500	0.500	1.092	1.363	0.200
	(6.070)	(8.134)	(6.021)	(2.113)	(2.540)	(1.562)
LABOR	Yes	Yes	No	Yes	Yes	No
N	20	8	4	50	20	10

Standard errors in brackets. *Significant at 10%; **Significant at 5%; ***Significant at 1%.

8. Conclusion

The present study was designed to determine the effects of a reduction in hours worked on labor productivity and labor costs. The main finding of this study was that the OLS estimates underestimated the effect of a reduction in fixed working hours on labor productivity, and the increase in labor costs caused by a reduction in fixed working hours were not as large as previously thought. If the specification including linear and quadratic controls for the number of workers was consider as the precise functional form, it was concluded that an hour reduction in fixed working hours increased sales per hour worked by about 0.049%, net profit per hour worked by 0.126%, and hourly wage by about 0.114%. All coefficients were bigger when they were estimated by the fuzzy RD design, indicating that simple OLS estimates could be biased. When the basic RD design specification was chosen, the fuzzy RD design expected larger productivity improvement, and this rendered hourly wage even unchanged. Therefore, the results suggest that industrial competitiveness is not undermined as much as the employers' concern since productivity improvement is larger than previously thought.

However, several caveats need to be noted regarding the present study. The most important limitation lies in the fact that the effect of a reduction in actual working hours on labor productivity and labor costs could not be analyzed with the RD design framework due to weak first-stage. Since the output variables are expressed by productivity "per hour worked" and labor costs "per hour worked", they are directly affected by the change in actual working hours, not by the change in fixed working hours. Thus, the effects of the reduction in fixed working hours on labor productivity and labor costs seem somewhat insufficient to calculate the direct impact of the reduction in hours of work. Another limitation of this study is that effective graphical analysis was not possible due to small number of observation. Lack of observation also made the analysis rely only on parametric RD. If non-parametric version of regression had been possible to apply, more reliable results could have been obtained.

The study has gone some way towards enhancing our understanding of the effects of a reduction in hours worked on labor productivity and labor costs. Although my finding was not able to clearly answer all research question due to lack of elaborate analysis skill, I want to believe the attempt to estimate them by the RD design using micro data was noteworthy. Future study should concentrate on finding the best functional form to make a clearer conclusion. On top of that, more data availability and elaborate econometric approach in the future study would help to establish a greater degree of accuracy on this matter.

References

Ahn, J., & Lee, K. (2001). Effect of a reduction in working hours on labor market: Evidence in Korean manufacturing. Korea labor institute 14,1 (2001.3), 151-170.

Amagasa, T., Nakayama, T., and Takahashi, T. (2005). Karojisatsu in Japan : Characteristics of 22 cases of worked-related suicide. Journal of occupational health 2005, 47, 157-164.

Hahn, J., Todd, P., and van der Klaauw, W. (2001). Identification and estimation of treatment effects with a regression-discontinuity design. Econometrica 69(1), 201-209

Harrington, J. M. (2001). Health effects of shift work and extended hours of work. Occupational and environmental medicine 58 (1), 68-72.

Kim, S. (2002). Issues and problems regarding working hour reduction. Korea employers federation plaza.

Korea employers federation. (1999). Employers position for a reduction in working hours. Korea employers federation plaza.

Lee, D. S. & Lemineux, T. (2010). Regression discontinuity designs in Economics. Journal of economics literature 48, 281-355.

Lee, J., Oh, J., and Song, T. (2000). Effect of a reduction in working hours and its implication to business. LG economic research institute.

Lee, K. (1997). Effect of change in hours of work on labor productivity. Productivity review 45 (1997.4), 37-51.

McCrary, J. (2008). Manipulation of the running variable in the regression discontinuity design: A density test. Journal of econometrics. 142(2), 698-714.

Ministry of Employment and Labor. (2008). Report on the establishment status. Ministry of

employment and labor.
Moon, H. (2012). Let us keep family and health through the adjustment of long working hours. [Website]. Available from: <http://www.idhnews.com/colboard/view.asp?idx=o_column&no=4286> [Accessed: 12 August 2012].
Organization for Economic Cooperation and Development. (2001). Measuring productivity - OECD manual measurement of aggregate and industry-level productivity growth. [Website]. Available from: <http://www.oecd.org/dataoecd/59/29/2352458.pdf> [Accessed: 12 August 2012].
Organization for Economic Cooperation and Development. (2008). OECD glossary of statistical terms. OECD publishing. [Website]. Available from: <http://www.oecd-ilibrary.org.ludwig.lub.lu.se/economics/oecd-glossary-of-statistical-terms_9789264055087-en> [Accessed: 18 August 2012].
Organization for Economic Cooperation and Development. (2011). OECD stat extracts. [Website]. Available from: <http://stats.oecd.org/Index.aspx?DataSetCode=HEALTH_STAT> [Accessed: 12 August 2012].
Olson, P. (2008). The world's hardest working countries. Forbes. [Website]. Available from: < http://www.forbes.com/2008/05/21/labor-market-workforce-lead-citizen-cx_po_0521countries.html> [Accessed: 19 August 2012].
Sohn, H. (2002). A study on the efficient solution for shortening working hours. Unpublished master thesis. Sogang university.
Sparks, K,, Cooper, C., Fried, Y., and Shirom, A. (1997). The effects of hours of work on health: A meta-analytic review. Journal of occupational and organizational psychology 70 (4), 391-408.
The Labor Standards Act. (2012). Chapter 1, Article 1, Law no. 11270.
Thistlethwaite, D., and Campbell, D. (1960). Regression-discontinuity analysis: An alternative to the ex post facto experiment. Journal of educational psychology 51, 309-317
Tuntiseranee, P., Olsen, J., Geater, A., and Kor-anantakul. (1998). Are long working hours and shiftwork risk factors for subfecundity? A study among couples from southern Thailand. Occupational environmental medicine 1998, 58, 99-105.
White, J. & Beswick, J. (2003). Working long hours. Sheffield S 3, 7 HQ