RIETI Discussion Paper Series 15-E-075

The Effects of Minimum Wages on Training

HARA Hiromi
Japan Women's University

The Research Institute of Economy, Trade and Industry
http://www.rieti.go.jp/en/

RIETI Discussion Paper Series 15-E-075
June 2015

The Effects of Minimum Wages on Training*

HARA Hiromi#

Abstract

This study examines how minimum wages affect on-the-job training and worker-initiated training using micro data on Japanese female workers, and is the first to use the difference-in-difference-in-differences method to estimate this effect in a Japanese context. The estimation results show that a 1% increase in minimum wages causes a 2.5% decline in the formal training of female workers with no college education, but no statistically significant decrease in informal training. Assuming that the general components form a large portion of formal training and that firm-specific components are a large part of informal training, we regard the former as general training and the latter as firm-specific training. Therefore, the results indicate that minimum wage increases affect general training more than firm-specific training as predicted by economic theory. Concurrent with the decrease in formal training, the results also show that a 1% increase in minimum wages causes a 3.6% decrease in worker-initiated training activities among this group. This suggests that there is no evidence of workers increasing their self-learning activities to compensate for the decreasing skill development opportunities in the workplace. Thus, increases in minimum wages could lead to skill development inequality between unskilled and skilled workers.

Keywords: Minimum wage, On-the-job training, Worker-initiated training, Japan
JEL Classification Code: J24, J39

* This study is conducted as a part of the Project The Changing Japanese Labor Market: A perspective and desirable policy responses undertaken at Research Institute of Economy, Trade and Industry (RIETI). Utilized micro data is the Basic Survey of Human Resources Development conducted by the Ministry of Health, Labour and Welfare. I would like to express my appreciation to the following persons for their helpful comments: Hiroko Okudaira, Lorien Rice, Keisuke Kawata, Daniel Parent, Hideo Owan, Ayako Kondo, Takahiro Itoh, Masahisa Fujita, Atsushi Nakajima, Masayuki Morikawa, Kotaro Tsuru, Shintaro Yamaguchi, and Daiji Kawaguchi. In addition, I would like to thank the participants of the 17th Labor Economics Conference (Osaka, September 2014), 11th International Conference of Western Economic Association International (Wellington, January 2015), and 2015 Spring Meeting of Japanese Economic (Niigata, May 2015). For this study, I received Grants-in-Aid for Scientist Research (C) (Grant number: 25380371) from the Japan Society for the Promotion of Science.

Associate Professor, Department of Social and Family Economy, Faculty of Human Sciences and Design, Japan Women's University, 2-8-1, Mejirodai, Bunkyo-ku, Tokyo 112-8681, Japan. E-mail: harahiromi@fc.jwu.ac.jp .

1 Introduction

This study examines the effect of minimum wage increases on training, and is the first to use the difference-in-difference-in-differences (DDD) method to estimate this effect[1] in a Japanese context. Economic theory predicts two possibilities from an increase in minimum wages: it will reduce training, and it will increase training. "Standard" human capital theory forecasts the negative effect. That is, an increase in the minimum wage will decrease a worker's opportunity for general training in a perfectly competitive labor market, because workers will struggle to pay the training costs owing to their low wages (Rosen (1972), Becker (1962), Hashimoto (1982)). On the other hand, the "new" human capital theory predicts the positive effect (Acemoglu and Pischke (1999), Acemoglu and Pischke (2003)). Intuitively, if a minimum wage hike forces a firm to pay a higher wage, including to unskilled workers, the binding minimum wage would reduce the surplus (i.e., rent) the firm receives. However, training increases a worker's productivity. Hence, the firm can recover some of the lost surplus by providing training for workers.[2]

The different conclusions among these studies are caused by different model settings in terms of whether they assume a competitive labor market

[1] There is a study that estimates the effect of a minimum wage on employment using this method (Sabia, Burkhauser, and Hansen (2012)).

[2] Lechthaler and Snower (2008) develop the study of Acemoglu and Pischke by including endogenous separation in the model, and show that both positive and negative effects can occur. The negative effect arises because a minimum wage hike reduces the expected profitability of an employee, making it more likely that the firm will fire the employee. However, the firm then cannot appropriate the rent from training and, thus, provides less training.

or an imperfect labor market. In this study, I confirm which of the two effects is dominant in the Japanese labor market.

Previous studies on the economic consequences of minimum wage increases have focused mainly on the *disemployment effects*.[3] Regardless of whether a minimum wage increase induces a reduction in employment, if it decreases the training opportunities for individuals who remain employed, the overall effect on society could be significant. If the skill level in the society changes because of this disturbance in human capital accumulation, it could affect social welfare in the long term.

There are several existing empirical studies on the effect of a minimum wage increase on training.[4] Some researchers have shown that minimum wage increases adversely affect training (Hashimoto (1982), Leighton and Mincer (1981), Neumark and Wascher (2001)). On the other hand, some have reported a positive impact on training (Arulampalam, Booth, and Bryan (2004)), while still others have shown no clear causal relationship

[3]Some studies have reported the disemployment effects of minimum wages (Neumark and Wascher (1992), Neumark and Wascher (1995), Sabia, Burkhauser, and Hansen (2012)), but others have not found evidence to support these effects (Card (1992), Card and Krueger (1994), Dube, Lester, and Reich (2010)). With regard to Japan, disemployment effects have been reported for women and teenagers (Kawaguchi and Yamada (2007), Kawaguchi and Mori (2009)). In contrast, Higuchi (2013) finds that minimum wage increases do not seem to decrease employment in Japan. These studies also suggest the possibility of minimum wages reducing the number of people employed. Moreover, female workers are disproportionately affected in Japan.

[4]Human capital investments consist of formal education and job skill development. Ehrenberg and Marcus (1982) and Neumark and Wascher (1995) show the effect of a minimum wage on school enrollment in the United States. Kawaguchi and Mori (2009) also show the adverse effect that increasing minimum wages can have on high school enrollment.

(Acemoglu and Pischke (2003), Grossberg and Sicilian (1999), Fairris and Pedace (2004)). Thus, there is not yet any consensus on this issue, either theoretically or empirically. Numerous factors make it difficult to compare the results of these directly, including their data sources, countries, periods, and specifications. However, further empirical research on this issue would give us an increasingly clear understanding of the effect of minimum wages on training. Therefore, I examine this issue here in an attempt to start filling in some of the gaps in the literature.

My research design is as follows. In Japan, the minimum wage is established by the Minimum Wage Law, and "regional minimum wages" are widely used.[5] The law was revised and came into effect in mid-FY2008. My analysis period is from FY2007 to FY2010. Before the revision, the minimum wage did not increase very much over time in a prefecture. However, the situation has changed significantly since then, and some (but not all) prefectures have been faced with a high minimum wage growth. Those prefectures that are now experiencing a high wage growth can be regarded as experimental prefectures, with the others being non-experimental prefectures. That is, the revision provides us with a natural experiment to estimate the effect of minimum wage increases by examining the regional variations in minimum wages. In addition, since the revision, Japanese regional minimum wages have been considered exogenous to the regional economies, as I explain in Section 3.

[5]There are 47 prefectures in Japan, and the regional minimum wage is decided on every year by each prefecture. See Section 3 for details.

Furthermore, I use individuals' educational backgrounds as another dimension for this experimental design to increase the reliability of the analysis. My analysis sample consists of female workers under 50 years of age. I divide my sample into two groups: those with lower levels of education (the treatment group), and those with higher levels of education (the control group). Then, I use a DDD estimation to analyze the effects of minimum wages.

This study makes three key contributions to the literature in this field. First, to identify the effects of minimum wage increases, I use variations in minimum wages across regions (location), variations in minimum wage increases over time, and individuals' educational backgrounds. In other words, I use the analysis framework of the DDD estimation. Second, the data I use relate to two types of training: on-the-job training, provided by firms; and worker-initiated training (*jiko-keihatu*), which refers to activities that improve a worker's job skills outside of work hours and at the worker's expense.[6] Additionally, in terms of on-the-job training, I distinguish between formal training and informal training. Formal training occurs away from the job site, such as in a classroom or at a workshop. Informal training occurs on-site, such as receiving instruction or advice from superiors. Third, this is the first study on this issue based on Japanese data.

Let me explain the second point in more detail. Previous studies have examined how a minimum wage affects on-the-job training, but not worker-

[6]Worker-initiated training includes any activities that improve a worker's ability to perform a job. These activities may include reading books, taking online courses, and attending a vocational school.

initiated training. In addition, most of these studies treat formal training as a measure of on-the-job training, or they define the training variable by combining formal training and informal training.[7] Therefore, I address this shortcoming here.

To do so, I first deal with formal training and informal training separately. As mentioned earlier, standard human capital theory (Becker (1962), Hashimoto (1981)) predicts that general training will decrease with a minimum wage increase because the worker will not be able to pay the training cost because he/she cannot accept low wage. On the other hand, with regard to firm-specific training, the worker and the firm might share the training cost (Becker (1962), Hashimoto (1981)). In this case, the wage received by a worker will be higher than in the case of general training (see Figure A1). Therefore, a minimum wage increase is expected to affect general training more than it will firm-specific training. By distinguishing between formal and informal training, I am able to explore this point. Assuming that the general components form a large portion of formal training and that firm-specific components are a large part of informal training, we regard formal training as general training and informal training as firm-specific training.

Second, if opportunities for receiving training at the workplace decrease, individuals might undertake training on their own to compensate or to qualify for better jobs. To investigate the impact of this other channel, I examine worker-initiated training, which can be regarded as general training. By

[7] An exception is the study of Neumark and Wascher (2001).

including these three training variables, I try to provide a comprehensive analysis of how a minimum wage hike affects training.

My results indicate the following three findings. First, a minimum wage increase reduces the incidence of *formal* training disproportionately for Japanese female workers with lower levels of education compared to those with higher levels of education. This suggests that a minimum wage increase might cause female workers with less education to lose training opportunities. Second, a minimum wage increase does not reduce *informal* training. Thus, the effect of a minimum wage increase on firm-specific training is unclear, and general training is more affected than is firm-specific training. Third, I find that a minimum wage increase also decreases worker-initiated training. Although we might expect a decrease in opportunities for skill formation at the current workplace to cause an increase in self-learning activities, there is no evidence of this.

These results suggest that minimum wage increases decline training opportunities for Japanese female workers with lower education. Additionally, this implies that a minimum wage increase could generate inequality in terms of skill formation opportunities between unskilled workers and skilled workers, as emphasized in Lechthaler and Snower (2008). In fact, some previous studies indicate that Japanese female workers who do not undertake on-the-job training receive lower wages than those who do,[8] and this might be

[8]Kawaguchi (2006) and Toda and Higuchi (2005) show the effect of training on wages among Japanese women, and Kurosawa (2001) and Hara (2014b) show the same effect for all Japanese workers.

reflected a difference in human capital accumulation. Thus, there is no doubt that it is important for workers to secure opportunities for skill development, because having fewer training opportunities means future productivities and wages will not increase.

The remainder of this paper is structured as follows. Section 2 surveys previous literature, and Section 3 briefly explains the minimum wage system in Japan. Section 4 explains the data used in this study and the identification strategy of my analysis. Then, Section 5 reports the estimation results. Lastly, Section 6 presents my conclusions.

2 Previous Empirical Literature on the Effects of Minimum Wages on Training

From a theoretical perspective, the effects of minimum wages on training is ambiguous. Relatively few empirical works have examined this issue, with studies tending to focus instead on the disemployment effect of minimum wages. In addition, some works report that minimum wages have negative effects on training, others report positive effects, and still others report no effect at all.

The most well-known early examination of whether a minimum wage increase results in reduced training is that of Hashimoto (1982). This study shows evidence of a negative effect on training for white men. However, Hashimoto uses the experience-earning profile as an indirect variable for

training participation, and infers the minimum wage effects from an empirical analysis based on this indirect variable. Then, Leighton and Mincer (1981) is the other well-known early work. They use a direct variable for on-the-job training and the coverage ratio divided by the index of the standardized state wage as the minimum wage variable. They also conclude that minimum wages tend to discourage on-the-job training, especially for those with less education.

Both of these works reveal ingenious approaches, but there remain potential problems.[9] For example, both works analyze men only, despite the fact that women make up a higher proportion of minimum wage workers. Furthermore, these studies do not use information on variations in minimum wages across different states. Instead, they use that on variations in state wages. However, this may be because there was little variation in minimum wage levels during their analysis periods.[10]

More recent studies attempt to overcome these shortcomings, and base their identification strategies on difference-in-differences (DD) estimations. One such is Neumark and Wascher (2001), who use the state-level increases in minimum wages between 1983 and 1991 as the exogenous source of variation.[11] During the late 1980s, the minimum wage in many states increased.

[9] See Neumark and Wascher (2001) for more details.

[10] Hashimoto (1982) uses the National Longitudinal Survey for Young Men (NLSY) for the period 1966–1969; Leighton and Mincer (1981) uses data from the Panel Study of Income Dynamics (PSID) for the period 1973–1975 and from the NLSY for the period 1967–1969.

[11] In most of their specifications, they use the average percentage difference between the state and federal minimum wages over the previous three years as their minimum wage

The federal minimum wage also increased in 1990. To measure on-the-job training, Neumark and Wascher (2001) use the 1983 and 1991 Current Population Survey (CPS) supplement and distinguish between two types of on-the-job training: training to improve skills on the current job, and training to qualify for the current job. To estimate the mean impact of minimum wage increases on training, they use the DD estimator with two kinds of control samples. The treatment sample comprised younger age groups (ages 16–24, 16–19, or 20–24) in 1991. One of the control samples was an older age group (ages 35–54) in the same year, and the other comprised the same younger age groups in 1983.

Through these two analyses, Neumark and Wascher (2001) find some evidence that a minimum wage increase reduces formal training to improve skills on the current job. Thus, they conclude that the elasticity of incidence of formal training with respect to minimum wages is about -1 to -2.

Additionally, two more recent studies use the DD estimator with a panel data set, namely Acemoglu and Pischke (2003) and Arulampalam, Booth, and Bryan (2004). Acemoglu and Pischke (2003) study US data, as did Neumark and Wascher (2001), and find no clear evidence that minimum wages have a positive or a negative effect on training. They mainly use the National Longitudinal Survey for Young Men (NLSY) for the period 1987–1992. Furthermore, they include both men and women, and restrict their analysis sample to workers most likely to be affected by minimum wages, namely

variable.

those aged 22–34 with 12 years or less of education. They also use variations in minimum wages across states[12] and estimate the effect of minimum wage increases among the states.

On the other hand, Arulampalam, Booth, and Bryan (2004) investigate the effect of a minimum wage on training in Britain. The UK National Minimum Wage was introduced on April 1, 1999. Thus, they estimate the impact of a minimum wage using the British Household Panel Survey for the period 1998–2000. Their findings show that the introduction of a minimum wage increased training opportunities for those workers affected by the new regulations.

Among other studies, Grossberg and Sicilian (1999) examine the effect of a minimum wage for men and women separately using the Employment Opportunities Pilot Project data set. In this case, their findings show no clear evidence that workers in minimum wage jobs receive significantly less training than the comparison groups do, based on an analysis using a direct measure of training. Thus, the findings of previous studies are not consistent, and researchers have yet to reach a consensus on this topic, either theoretically or empirically.

This study is based mainly on that of Neumark and Wascher (2001), but takes a different approach. First, to identify the effect of minimum wage increases on training more precisely, I use data on the variations in minimum

[12]They use dummy variables to denote the minimum wage increase from one year to the next and to denote whether a worker earned below the new minimum wage in the base year.

wages over time and across locations. Then, I examine this data within the framework of a DDD estimation, while controlling for location-specific shocks, as I explain in detail later.

Second, with regard to the exogeneity of the minimum wage variables, though ingenious and careful, the study of Neumark and Wascher (2001) has some limitations. The most serious of these is that it is doubtful whether their minimum wage variable is really exogenous. That is, a state's choice of its own minimum wage rate might not be exogenous to state-level politics and labor market conditions (Neumark and Wascher (2008), Baskaya and Rubinstein (2012)). If there is endogeneity in an explanatory variable, we will not be able to identify its effect precisely. Therefore, they unfortunately do not adequately identify the effect of a minimum wage.

Third, I deal with training comprehensively. Here, I use data on formal and informal training as measures of on-the-job training, as well as data on worker-initiated training. Neumark and Wascher (2001) only examine the effect on on-the-job training, not on worker-initiated training. If opportunities for training participation at the workplace decrease, individuals might undertake training on their own to compensate, and vice versa. To investigate the impact of this alternate channel, I attempt to identify the effect of a minimum wage increase on the entire sphere of training.[13]

Last, my treatment group comprises female workers who graduated from junior high school or high school (i.e., women with lower levels of education).

[13]However, note that the effect on formal education is beyond the scope of my study.

These women are known to be more susceptible than others to changes in minimum wages. With regard to Japan, Kawaguchi and Mori (2009) examine which category of workers has the highest proportion of minimum wage workers. They show that, in 2007, between 22.1% and 40.7% of female workers were minimum wage workers, while between 4.4% and 10.5% of male workers were minimum wage workers. They also show that between 18.5% and 33.5% of junior high school graduates and between 13.5% and 26.2% of high school graduates were minimum wage workers. However, between 11.6% and 23.9% of junior college graduates and between 3.1% and 7.4% of university graduates were minimum wage workers. Based on these results, we can consider that the ratio of minimum wage workers is high among less educated female workers. Therefore, I examine the effects of a minimum wage on the labor market outcome for this group directly.

3 Japan's Minimum Wage System

In Japan, the minimum wage is established by law. The Japanese Minimum Wage Act was enacted in 1955. A revision was approved in 2007, and then came into effect from October 1, 2008. Hereafter, for convenience, I use the *analytical* fiscal year (FY) rather than the *real* fiscal year.[14]

[14]For example, the analytical FY2007 indicates the real FY2006. In most prefectures, the minimum wage in a fiscal year becomes effective in October or November. Thus, the minimum wages of the previous fiscal year are effective during more than half of any given fiscal year. Therefore, I use the minimum wage data of the previous fiscal year as the analytical fiscal year in this study.

Japan does not use a "national" minimum wage. Instead, there are two types of minimum wages, namely a "regional" minimum wage and a "specific" minimum wage. Here, I use the regional minimum wage, because this applies to all workers within the prefecture, regardless of industry.[15] There are 47 prefectures in Japan, and the regional minimum wage is decided on by each prefecture every year according to the Minimum Wage Law.

There are two other advantages to using the regional minimum wage. First, there are large variations over time and across regions in regional minimum wages. Responding to the revision approval in the Diet in FY2008, the regional minimum wage changed substantially. Table 1 reports the minimum wage by prefecture from FY2007 to FY2010, namely, during my analysis period. From Table 1, the average minimum wage growth is 11.7 yen in FY2008, 12.1 yen in FY2009, and 4.3 yen in FY2010. The average growth during this period is 9.1 yen.[16] The differences between the maximum and minimum values are 13 yen in FY2008, 23 yen in FY2009, and 25 yen in FY2010. From these results, the minimum wage variation over time can be considered sufficiently large during this period. For the sake of the simplicity, I consider FY2007 the "before policy change" period, and the period from FY2008 to FY2010 the "after policy change" period.

Table 1 also shows that some prefectures experienced substantial changes in minimum wages, whereas others did not. The minimum values range

[15]The specific minimum wage applies only to core workers in specific industries. Therefore, it is not appropriate here.

[16]$\$1 \simeq 120$ yen.

Table 1: Regional Minimum Wages in Japan

(yen)	Minimum wages				Growth from the previous year			Ave. growth
Prefecture	FY2007	FY2008	FY2009	FY2010	FY2008	FY2009	FY2010	
Hokkaido	644	654	667	678	10	13	11	11
Aomori	610	619	630	633	9	11	3	8
Iwate	610	619	628	631	9	9	3	7
Miyagi	628	639	653	662	11	14	9	11
Akita	610	618	629	632	8	11	3	7
Yamagata	613	620	629	631	7	9	2	6
Fukushima	618	629	641	644	11	12	3	9
Ibaraki	655	665	676	678	10	11	2	8
Tochigi	657	671	683	685	14	12	2	9
Gunma	654	664	675	676	10	11	1	7
Saitama	687	702	722	735	15	20	13	16
Chiba	687	706	723	728	19	17	5	14
Tokyo	719	739	766	791	20	27	25	24
Kanagawa	717	736	766	789	19	30	23	24
Niigata	648	657	669	669	9	12	0	7
Toyama	652	666	677	679	14	11	2	9
Ishikawa	652	662	673	674	10	11	1	7
Fukui	649	659	670	671	10	11	1	7
Yamanashi	655	665	676	677	10	11	1	7
Nagano	655	669	680	681	14	11	1	9
Gifu	675	685	696	696	10	11	0	7
Shizuoka	682	697	711	713	15	14	2	10
Aichi	694	714	731	732	20	17	1	13
Mie	675	689	701	702	14	12	1	9
Shiga	662	677	691	693	15	14	2	10
Kyoto	686	700	717	729	14	17	12	14
Oosaka	712	731	748	762	19	17	14	17
Hyogo	683	697	712	721	14	15	9	13
Nara	656	667	678	679	11	11	1	8
Wakayama	652	662	673	674	10	11	1	7
Tottori	614	621	629	630	7	8	1	5
Shimane	614	621	629	630	7	8	1	5
Okayama	648	658	669	670	10	11	1	7
Hiroshima	654	669	683	692	15	14	9	13
Yamaguchi	646	657	668	669	11	11	1	8
Tokushima	617	625	632	633	8	7	1	5
Kagawa	629	640	651	652	11	11	1	8
Ehime	616	623	631	632	7	8	1	5
Kouchi	615	622	630	631	7	8	1	5
Fukuoka	652	663	675	680	11	12	5	9
Saga	611	619	628	629	8	9	1	6
Nagasaki	611	619	628	629	8	9	1	6
Kumamoto	612	620	628	630	8	8	2	6
Ooita	613	620	630	631	7	10	1	6
Miyazaki	611	619	627	629	8	8	2	6
Kagoshima	611	619	627	630	8	8	3	6
Okinawa	610	618	627	629	8	9	2	6
Average	673	703	713	730	11.7	12.1	4.3	9.1
Max-Min	109	121	139	162	13	23	25	19
Max	719	739	766	791	20	30	25	24
Min	610	618	627	629	7	7	0	5
Standard Deviation	31.9	35.4	39.2	43.1	3.8	4.5	5.6	4.3

Source: Ministry of Health, Labour, and Welfare (MHLW).
Note: 1. FY in the table indicates "analytical" fiscal year (see text for definition); "Ave." indicates average.
2. Average minimum wages from FY2007 to FY2010 are published by the MHLW.

from 0 yen to 7 yen, and the maximum values range from 25 yen to 30 yen. That is, we can consider that there is sufficient variation in minimum wages across regions. I exploit both the exogenous variation across regions and the time variation in Japanese regional minimum wages to identify the effects of minimum wages on training.

Second, the regional minimum wages in Japan are considered to be decided exogenously *at least* during my analysis period. They are decided in two stages every year. In the first stage, the national council on minimum wages decides each prefecture's "criteria" (*meyasu*) for the minimum wage markup. In the second stage, local minimum wage councils deliberate and decide on their own minimum wage levels according to these criteria. Since before the latest revision, the Minimum Wage Law has required the local minimum wage councils to take into account the cost-of-living of workers, the wage level of similar workers, and the wage-paying capacity of businesses when they decide on the regional minimum wage level. However, the 2008 revision also requires that the local councils set the regional minimum wage level so that welfare payments do not exceed the income level of minimum wage workers, because this "reverse" phenomenon had been a social problem in Japan for a long time. In other words, since the 2008 revision, it has been most important that the local councils resolve this issue when deciding on a regional minimum wage level.

The welfare payment includes a winter addition and a housing subsidy. Therefore, it is dependent on where people live, but not on the labor market

situation. In addition, the housing subsidy differs among residential areas, and is of little relevance to the labor market condition.[17] Furthermore, the welfare payment is not dependent on the housing subsidy. During my analysis period, the regional minimum wage level was decided so as to eliminate the situation in which living on a welfare payment was more rewarding than working in a minimum wage job. In other words, the welfare payment was used as a benchmark when deciding on the regional minimum wage level. As a result, the regional minimum wage could be exogenous to the labor market condition.

More recently, this reverse phenomenon is considered to have been resolved.[18] However, because of the requirements of the revision, the chosen regional minimum wages were unrelated to the economic conditions of the prefectures for some time after the revision (i.e., during my analysis period). Thus, the regional minimum wages were not considered to be correlated with other factors that affect on-the-job training.

[17]There are regional-specific factors in regional housing prices in Japan. For example, housing prices differ between Tokyo and Osaka, which form the main economic area of western Japan, but the two areas are similar in terms of labor market conditions.

[18]On July 29, 2014, the Japanese national minimum wage council decided on each prefecture's criteria for the FY2015 minimum wage markup. This resolved the reverse phenomenon in all prefectures in FY2015, for the first time since the 2008 revision of the Minimum Wage Law (*Nikkei Asian Review*, July 30, 2014, http://asia.nikkei.com/Politics-Economy/Economy/Japan-removes-work-disincentive-by-raising-wage-floor).

4 Data and Identification Strategy

4.1 Basic Structure of Estimation

The purpose of this study is to identify how minimum wage increases affect on-the-job training in certain regions (experimental regions) for a particular group of female workers (treatment group). That is, in my model, the outcome of interest is receiving training, and the variable representing a policy change is the minimum wage increase. To accomplish this purpose, we need to control for any systematic shocks to training, which I do using the following natural experimental framework.

First, as I explained in Section 3, a policy change occurred in FY2008. Therefore, the "before policy change" period is FY2007 and the "after policy change" period is from FY2008 to FY2010.

Second, after the policy change, some prefectures experienced high growth in minimum wages, but others did not. Hence, I define the former group of prefectures as the experimental region and the latter group as non-experimental region.

Third, for a more reliable analysis, I include data on individuals' educational background in my model. The treatment group is defined as those with lower levels of education (i.e., graduates from junior high school or high school), and the control group are those with higher levels of education (i.e., graduates from college, university, or graduate school). Unskilled workers are more likely to have their training affected by an increase in minimum wages.

In contrast, skilled workers are considered to be less likely to be affected.

There are advantages and disadvantages to using those with higher levels of education as a control group. A likely disadvantage is that if the incidence of training for those with lower levels of education decreases, then the incidence of training for those with higher levels of education might also be affected. For example, suppose the skills of female workers with lower levels of education can be substituted by the skills of those with higher levels of education. Then, a company will impart more training to those with higher levels of education to maintain the overall quantity of skill in the company when the minimum wage increases. If this is true, then my control group will not be valid.

However, we can still consider that my control group should be valid. That is, the training for those with higher levels of education is not likely to be affected directly by a minimum wage increase. It is natural to expect a difference between the skills that those with higher levels of education and those with lower levels of education are required to have. That is, the company requires those with lower levels of education to have skills for assistant jobs, while those with higher levels of education need to have skills for core corporate tasks. Thus, the skill of those with less education is considered not to be substitute for that of those with higher education. Related to this point, Lechthaler and Snower (2008) propose using a calibration that the most able workers do not receive more training when the minimum wage increases.[19]

[19]Lechthaler and Snower (2008) show theoretically that an increase in minimum wages

In addition, I show later in Section 4.4 that the training of less educated workers in high minimum wage growth regions decreased significantly after the policy change. However, the training of highly educated workers did not. This is the evidence that a minimum wage increase does not directly affect the training of highly educated workers. Therefore, using highly educated workers as the control group is considered to be valid.

Last, I restrict my analysis sample to females younger than 50 years of age. The reason for this restriction is that Japanese employees tend to retire from the labor market in their 50s. As a result, Japanese companies are likely to decrease training for those over 50 (see Figures A2 and A3 in the appendix). That is, there is likely to be a systematic difference in the training workers receive until the age of 49 and from age 50 and older. Using the above framework, I attempt to identify how an increase in a minimum wage affects training.

4.2 Data

For this study, I use micro data from the Basic Survey of Human Resources Development conducted by the Ministry of Health, Labour and Welfare every year since FY2006. This survey is designed to examine how Japanese companies and business establishments train their employees to develop their

leads to less training for workers with less ability and more training for workers with more ability. However, this positive effect converges to zero with ability. They interpret this to mean that "workers in the highest skill class are so productive that minimum wages become progressively less important as skills increase." (p.1230)

job abilities and how they implement skills development for their employees. I construct the direct measures of on-the-job training and worker-initiated training from this data, as I explain later, and match these with the prefectures' minimum wages. The survey comprises three kinds of surveys: a company survey, an establishment survey, and a worker survey. I use the worker survey in my examination of the years between FY2007 and FY2010.

From establishments across Japan with 30 or more full-time employees (*joyo roudousya*) and belonging to 15 industries,[20] around 7,000 establishments are selected as respondents for the establishment survey. For the worker survey, approximately 23,000 workers were extracted randomly from those working in these establishments.[21] The recovery rate of the worker survey for each survey year is around 35%, yielding about 8,000 responses. I pool these samples between FY2007 and FY2010. That is, my data set is composed of repeated cross-sectional data. I restrict my analysis sample to female workers younger than 50 years of age, and exclude those whose educational background is not known. As a result, there are 10,507 observations in my analysis sample. Note that all my analyses are conditional on employment.

[20] 1: Construction, 2: Manufacturing, 3: Electricity, Gas, Heating, and Water, 4: Information and Communications, 5: Transportation and Postal Services, 6: Wholesale and Retail Trade, 7: Finance and Insurance, 8: Real Estate and Rental Services, 9: Eating and Drinking Establishments, 10: Accommodation, 11: Medical, Health Care, and Welfare, 12: Education and Learning Support, 13: Scientific Research, Professional and Technical Services/Living-related Personal Services, and Entertainment, 14: Combined Services, 15: Services (not classified elsewhere).

[21] The company survey is conducted independently of the establishment survey and worker survey.

Table 2: Descriptive Statistics

		Before (FY2007)			After (FY2010)	
	All	Exp. Region (High MW)	Non-exp. Region (Low MW)	All	Exp. Region (High MW)	Non-exp. Region (Low MW)
N	2,331	1,233	1,098	2,463	1,339	1,124
(%)						
(Age)						
–19	1.2	1.4	1.1	0.8	0.6	1.0
20–29	34.5	35.3	33.5	27.1	26.8	27.5
30–39	37.2	38.0	36.4	36.5	37.0	36.0
40–49	27.1	25.4	29.0	35.6	35.6	35.5
(Education)						
Junior/High school	39.0	29.9	49.3	40.5	34.7	47.4
College/Technical college	30.7	31.6	29.8	31.8	32.2	31.3
University (Humanities)	24.9	32.4	16.4	22.8	27.9	16.7
University (Science)	4.0	4.4	3.6	3.8	3.7	3.9
Graduate school (Humanities)	0.5	0.8	0.1	0.7	0.9	0.4
Graduate school (Science)	0.9	0.9	0.9	0.5	0.7	0.2
(Working style)						
Mainly work	91.6	91.6	91.5	87.9	87.2	88.8
Mainly go to school, but work	0.4	0.7	0.2	0.8	1.0	0.6
Mainly household chores, but work	8.0	7.8	8.3	11.3	11.9	10.6
(Tenure (years))						
–1	9.0	9.2	8.7	9.3	8.5	10.1
1–3	21.7	22.6	20.6	19.2	19.6	18.9
3–5	14.4	15.0	13.7	21.6	21.6	21.7
5–10	22.0	21.7	22.3	24.6	24.3	24.9
10–20	24.0	24.0	24.0	18.4	19.0	17.7
20–30	8.7	7.2	10.4	6.5	7.0	6.0
30–	0.3	0.2	0.4	0.4	0.1	0.7
(Occupation)						
Managerial	7.5	8.0	7.0	7.2	7.1	7.3
Professional & technical	3.1	3.7	2.3	2.4	2.8	1.9
Clerical	68.8	71.1	66.2	63.2	64.3	61.9
Sales	5.5	5.6	5.3	5.6	6.2	4.8
Service	8.4	8.0	8.8	13.4	12.7	14.2
Protective services	0.1	0.1	0.2	0.0	0.0	0.0
Transport & communications	0.3	0.2	0.4	0.2	0.1	0.3
Production process & laborer	4.9	2.0	8.2	6.2	4.7	8.0
Others	1.5	1.5	1.6	1.9	2.1	1.6

Source: MHLW "Basic Survey of Human Resources Development."
Note: "Exp." denotes experimental, and "Non-exp." denotes non-experimental. The experimental region indicates prefectures with minimum wage growth rates between FY2007 and FY2010 above the 75th percentile for all prefectures, and the non-experimental region indicates prefectures with growth rates below the 75th percentile. "MW" indicates minimum wage.

Table 2 reports the descriptive statistics of my analysis sample in FY2007 (i.e., before the policy change) and FY2010 (i.e., after policy change), just for simplicity. The proportions of age, working style, tenure, and occupation are similar between both years. The ratio of highly educated workers is around 70%, and that of less educated workers is around 30%. However, a slight difference is observed between both years. I control for the sampling difference by including year dummy variables in the regression model.

4.3 Training Variables

In this study, I deal with two forms of on-the-job training, namely formal training and informal training, as well as worker-initiated training. Formal training occurs away from the job site, and may include training in a classroom at the firm. In this survey, the question asked is, "In the previous fiscal year, did you participate in any off-the-job training?" The formal training variable takes the value 1 if the respondent answers "yes" to this question, and 0 otherwise.

On the other hand, informal training occurs while working on-site, and can include receiving instruction or advice from superiors or colleagues in the course of a year. The question asked in this questionnaire is, "In the previous fiscal year, did you receive any advice or instruction from your supervisor or colleague?" The informal training variable takes the value 1 if the respondent answers "yes," and 0 otherwise.

In addition, I examine the effect of minimum wage increases on worker-

initiated training activities. Worker-initiated training refers to learning activities undertaken outside of work hours and at one's own expense in order to improve one's job skills. The survey asks whether a worker undertook any worker-initiated training activities in the previous fiscal year. The worker-initiated training variable is a dummy variable, as are the formal training variables already explained.

I now confirm the basic information on the training variables. For a rough picture of the relationship between training and minimum wage increases, the means of the training variables are reported in Table 3. Within the regression framework given later, I use all data for the four fiscal years. However, for convenience, I simply compare the means of FY2007 (i.e., before policy change) with those of FY2010 (i.e., after policy change) for each training variable. To divide the prefectures into experimental (those with a high minimum wage growth) and non-experimental regions (those with a low minimum wage growth), I calculate the descriptive statistics of minimum wage growth rates between FY2007 and FY2010. I refer to the prefectures above the 75th percentile as the experimental region, and those below the 75th percentile as the non-experimental region.

Panel A in Table 3 shows that formal training and worker-initiated training decreases significantly among female workers under 50 years of age from 2007 to 2010 in Japan. However, this is not true for informal training. This is likely to be because this period overlaps with the depression after the bankruptcy of Lehman Brothers.

Table 3: Descriptive Statistics of Training Variables (Female, Age under 50)

	Before (FY2007)	After (FY2010)	D
A. All			
Formal training	0.446	0.273	-0.173***
(= 1 if yes)	[0.010]	[0.010]	[0.014]
	(2,331)	(2,463)	(4,794)
Informal training	0.833	0.846	0.014
(= 1 if yes)	[0.007]	[0.007]	[0.011]
	(2,401)	(2,469)	(4,870)
Worker-initiated training	0.489	0.299	-0.190***
(= 1 if yes)	[0.010]	[0.009]	[0.014]
	(2,370)	(2,453)	(4,823)

B. By region	Experimental region (High MW growth)			Non-experimental region (Low MW growth)		
	Before (FY2007)	After (FY2010)	D	Before (FY2007)	After (FY2010)	D
Formal training	0.471	0.286	-0.185***	0.419	0.258	-0.161***
(= 1 if yes)	[0.014]	[0.012]	[0.019]	[0.015]	[0.013]	[0.020]
	(1,233)	(1,339)	(2,572)	(1,098)	(1,124)	(2,222)
Informal training	0.852	0.848	-0.004	0.812	0.845	0.033
(= 1 if yes)	[0.010]	[0.010]	[0.014]	[0.012]	[0.011]	[0.016]
	(1,263)	(1,343)	(2,606)	(1,138)	(1,126)	(2,264)
Worker-initiated training	0.538	0.317	-0.221***	0.435	0.277	-0.157***
(= 1 if yes)	[0.014]	[0.013]	[0.019]	[0.015]	[0.013]	[0.020]
	(1,252)	(1,335)	(2,587)	(1,118)	(1,118)	(2,236)

Source: MHLW "Basic Survey of Human Resources Development."
Notes:
1. The experimental region indicates prefectures with minimum wage growth rates between FY2007 and FY2010 above the 75th percentile for all prefectures, and the non-experimental region indicates prefectures with growth rates below the 75th percentile for this period. "MW" indicates minimum wage.
2. D indicates the difference between FY2007 and FY2010. The results of t-test are reported in columns of the D; *** p $\leq$ 0.01, ** p $\leq$ 0.05, * p $\leq$ 0.1; Standard deviation is shown in [], and the number of observations is shown in ().

Next, Panel B in Table 3 reports the results by region, and shows that formal training and worker-initiated training decrease more significantly in the experimental region than they do in the non-experimental region after the policy change. This suggests that female workers who work in prefectures with high minimum wage increases are likely to lose opportunities for formal and worker-initiated training. However, there is also potential bias associated with a positive correlation between training and unobserved ability or productivity. If more able workers are more likely to receive training, then the variation in the average unobserved productivity or quality of workers across regions may generate a positive bias in the estimates of the effects of minimum wage increases on training.

4.4 DDD Estimation

Before discussing the regression using the full data set, I demonstrate the results of the DDD estimation in a simple way to confirm the effect of minimum wage increases, as in subsection 4.3, which compares the differences between FY2007 and FY2010 (before and after policy change) and between the experimental region and the non-experimental region. The definitions are the same as those given in subsection 4.3. Table 4 reports the DDD estimation for receiving formal training. Here, I confirm only the results of receiving formal training owing to space constraints. Each cell shows the average rate of receiving formal training for the treatment and control groups in the experimental and non-experimental regions in FY2007 and FY2010.

Table 4: The Effect of Minimum Wage on the Rate of Receiving Formal Training (Female, Age under 50)

	Before (FY2007)	After (FY2010)	D
A. Treatment: Less educated			
Experimental region	0.363	0.191	-0.172***
(High MW growth)	[0.025]	[0.018]	[0.030]
	(369)	(465)	
Non-experimental region	0.336	0.236	-0.100***
(Low MW growth)	[0.020]	[0.018]	[0.014]
	(541)	(533)	
DD	-0.072*		
	[0.040]		
	(1908)		
B. Control: More educated			
Experimental region	0.517	0.336	-0.181***
(High MW growth)	[0.017]	[0.016]	[0.023]
	(864)	(874)	
Non-experimental region	0.499	0.277	-0.222***
(Low MW growth)	[0.021]	[0.018]	[0.028]
	(557)	(591)	
DD	0.040		
	[0.037]		
	(2,886)		
C. DDD	-0.112**		
	[0.056]		
	(4,794)		

Source: MHLW "Basic Survey of Human Resources Development."
Notes:

1. The cells contain the average participation rate for the identified group. D is the difference between FY2007 and FY2010 among each group and each region. DD is the difference-in-differences between the experimental and the non-experimental regions in each group. DDD in Panel C is the difference-in-difference-in-differences from the upper panel (Panel A) minus the lower panel (Panel B).
2. The experimental region indicates prefectures with minimum wage growth rates between FY2007 and FY2010 above the 75th percentile for all prefectures, and the non-experimental region indicates prefectures with growth rates below the 75th percentile. "MW" indicates minimum wage.
3. "Less educated" indicates those who graduated from junior high school or high school, and "More educated" indicates those who graduated from college, technical college, university, or graduate school.
4. Standard deviation is shown in [], and the number of observations is shown in ().
5. *** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$.

Panel A compares the changes in the rate of receiving formal training in the experimental regions with the changes in the non-experimental regions for the treatment group. There is a 17.2 percentage point reduction in the rate of receiving formal training for the treatment group in the experimental regions from FY2007 to FY2010. On the other hand, there is a 10.0 percentage point decrease for those in the non-experimental regions. The latter difference is considered to be the result of factors other than minimum wage increases on the treatment group during this period, because the minimum wage increases did not occur there. FY2010 was after the bankruptcy of Lehman Brothers. Therefore, the decline in the rate of receiving formal training is observed even in the non-experimental regions. By removing this entire trend for the treatment group, we can identify the effect of minimum wages more clearly. The difference-in-differences result shows there is a 7.2 percentage point relative decrease in the rate of receiving formal training for the treatment group in the experimental regions, with a 5% statistical significance. This is the DD estimate without controlling for the other factors, and shows secular training differences in the treatment group between the experimental and non-experimental regions. However, if a specific labor market shock affects the training in experimental regions over this period, this estimate does not identify the effect of such a shock on minimum wage increases.

To examine this, I conduct the same exercise for the control group (i.e., more educated female workers) in Panel B of the same table. Here, I find

an 18.1 percentage point decrease in the experimental regions and a 22.2 percentage point decrease in the non-experimental regions. Thus, the rate of receiving formal training also decreased for the control group in both the experimental and the non-experimental regions, but these decreases are unrelated to the minimum wage increases. Therefore, 4.0 percentage points of the DD are considered to be the result of a specific labor market shock in the experimental regions. Furthermore, this is positive, but not statistically significant. This suggests that a specific labor market shock in the experimental regions is small. However, to obtain the effect of minimum wage increases as purely as possible, I control for region-specific shocks when estimating the effects of minimum wages.

Finally, there is a statistically significant -11.2 percentage point difference between the DDs in Panel A and Panel B. This DDD estimate in Panel C provides some evidence that women with less education might have their training influenced adversely by minimum wage increases.

4.5 Regression Framework for DDD Estimation

Next, I move to the regression framework. From the previous subsection, women with less education appear to receive less training when minimum wages increase. However, changes in training participation for those with less education might be systematically different across prefectures as a result of differences in industrial or occupational structure, the proportion of university enrollments across prefectures, and so on, rather than because of

minimum wage increases. Specifically, I estimate the following regression:

$$T_{ijt} = \alpha + \beta_0 X_{ijt} + \beta_1 lessedu_i + \beta_2 pref_j + \beta_3 year_t$$
$$+\beta_4 lowedu_i \times pref_j + \beta_5 lowedu_i \times year_t + \beta_6 pref_j \times year_t$$
$$+\delta MW_{jt} \times lowedu_i + u_{ijt}. \quad (1)$$

In this equation, i indexes individuals, j indexes prefectures, and t indexes fiscal years. Then, T_{ijt} is the training variable for individual i in prefecture j in year t, and the policy variable is MW_{jt}, which indicates the minimum wage in prefecture j in year t.[22] Furthermore, $lessedu_i$ is a dummy variable for the treatment group, taking the value 1 if the individual is in the lower educated group and 0 if she is in the higher educated group.

To identify the minimum wage effect robustly, I first include $lessedu_i$, a dummy variable that captures the difference between the treatment and control groups. Second, $year_t$ are dummy variables for FY2007, FY2008, FY2009, and FY2010, and capture any nationwide trends in training during the analysis period. In the period after the bankruptcy of Lehman Brothers, training participation dropped drastically in Japan. Therefore, it is important to remove this trend to confirm the effect of minimum wages.[23]

Third, I include $pref_j$ as dummy variables for the prefectures to control for secular differences in receiving training between the experimental and non-

[22] I also examined the specification using the natural logarithm of the minimum wages and obtained similar results.

[23] See Hara (2014a), Chapter 1, for details.

experimental regions.For example, industrial and occupational structures differ substantially across prefectures, and different industries and occupations have different training requirements. In addition, the prefecture dummy variables control for the difference among prefectures, including the ratio of affected workers, whether the minimum wage is binding or non-binding, and the variation in the average unobserved productivity or ability of workers.

Fourth, $lessedu_i \times pref_j$ and $lessedu_i \times year_t$ are included to control for specific shocks to the treatment group for each prefecture in each year. Lastly, I include $pref_j \times year_t$ to control for prefecture-specific shocks on training over the period correlated with minimum wage increases.[24] For example, in a prefecture with a high minimum wage, machinery investment might increase, which may cause a decrease in human capital investment.

In summary, singular terms control for fixed effects, the time-invariant characteristics of the treatment group (β_1), the time-invariant characteristics of a prefecture (β_2), and the time-series changes in training participation (β_3). The second-level interaction terms control for the time-invariant characteristics of the treatment group in a prefecture (β_4), changes over time for the treatment group countrywide (β_5), and changes over time in a prefecture (β_6).

Additionally, I control for observable individual characteristics, X_{ijt}, which

[24] $pref_j \times year_t$ picks up the prefecture-level and time-across variation in the minimum wage variable. Therefore, I do not include MW_{jt} directly in the equation.

is a vector including age category, working style,[25] occupation,[26] and tenure at the current workplace,[27] all of which are considered to affect training participation.

Above all, the coefficient of interest is δ, which is the coefficient of $MW_{jt} \times lessedu_i$. This picks up the differences in the incidence of training between those with lower levels of education and those with higher levels of education, along with variations in the prefectures' minimum wage increases from FY2007 to FY2010.[28] I interpret this as the causal effect of increasing minimum wages on training.

5 Results

5.1 Results of Regression

I confirm the DDD estimation results using Equation (1). Table 5 shows the estimation results for on-the-job training. Here, Panel A shows the results for female workers and Panel B shows the results for male workers, as a

[25] Working style comprises 1: mainly working, 2: mainly going to school, but also working, and 3: mainly doing household chores, but also working. I use this variable as a proxy for marital status and children.

[26] 1: managerial, 2: professional and technical, 3: clerical, 4: sales, 5: service, 6: protective service, 7: transport and communications, 8: production process and labor, and 9: others.

[27] Here, the response options are as follows: 1. less than 1 year, 2. more than one year, but less than three years, 3. one week, 4. more than one week, but less than two weeks, 5. more than two weeks, but less than one month, and 6. more than one month. For answers covering a range, the variable uses the median value.

[28] The product $MW_{jt} \times lessedu_i$ contains information on prefecture (j), year (t), and treatment group (i). Therefore, this indicates the third level of interaction between these three variables.

reference.[29] The coefficients and elasticities are also shown in Table 5. Note that the standard errors are clustering standard errors.[30]

Column (1) in Panel A indicates that minimum wage increases reduce the formal training of female workers with lower levels of education, with 5% statistical significance. From Column (2) in Row (a), the elasticity of receiving formal training with respect to an increase in minimum wages is -2.508. This implies that a 1% increase in minimum wages leads to a 2.5% decrease in the participation rate of formal training. However, the effect of higher minimum wages on the rate of receiving informal training is not statistically significant (Column (1) in Row (b)).

These results suggest that training involving direct monetary costs decreases when the minimum wage increases, but that training that does not involve direct costs remains unaffected. Another possible interpretation is that the general component could be greater in formal training and the firm-specific component could be greater in informal training. In other words, both the standard human capital theory, which predicts that a minimum wage increase will decrease general training (Becker (1962), Hashimoto (1981)), and the new human capital theory, which predicts that it will not decrease de facto firm-specific training (Acemoglu and Pischke (1999)), could be true.

[29]The control group is male workers under 50 years of age and with higher levels of education.

[30]The clustering standard errors per prefecture are reported in Table 5, according to Bertrand, Duflo, and Mullainathan (2004).

Table 5: Treatment-dummy Results for On-the-job Training

(MW × less education)	(1) Coefficient	(2) Elasticity	(3) N
A. Female			
(a) Formal training (= 1 if yes)	-0.007**	-2.508	10,496
	[0.003]		
(b) Informal training (= 1 if yes)	-0.0002	-0.019	10,261
	[0.004]		
(c) Worker-initiated training (= 1 if yes)	-0.008***	-3.565	10,493
	[0.003]		
B. Male			
(a) Formal training (= 1 if yes)	0.003	0.650	12,181
	[0.003]		
(b) Informal training (= 1 if yes)	0.001	0.108	11,982
	[0.003]		
(c) Worker-initiated training (= 1 if yes)	0.003	0.869	12,202
	[0.003]		

Source: MHLW "Basic Survey of Human Resources Development."
Notes:

1. The result is the coefficient of $MW_{jt} \times lessedu_i$ from Equation (1) using a probit analysis. The control group is women with higher levels of education. The less education dummy variable, prefecture dummy variables, year dummy variables, less education × prefecture dummy variables, less education × year dummy variables, the prefecture × year dummy variables, age category, working style, occupation, and tenure at the current workplace are included in all equations.
2. The standard errors are clustering standard errors per prefecture.
3. *** p ≤ 0.01, ** p ≤ 0.05, * p ≤ 0.1.

What does this point estimate imply? The average growth of minimum wages from FY2007 to FY2008 was 11.7 yen (see Table 1). Therefore, the rate of receiving formal training decreased by 8.2% points (i.e., 0.7% points $\times$ 11.7). The rate among less educated female workers in FY2007 was 34.7%. Therefore, this estimate implies that the rate decreased to 26.5% (i.e., $34.7 - 8.2$). With regard to the effect on wages, Kawaguchi (2006) shows that receiving formal training increases wages by 4.6% points among Japanese female workers. Considering these results together, the wages of female workers might decrease by 1.2% points. Thus, the effect of minimum wage increases on less educated female workers in Japan is not negligible.

For reference purposes, Panel B of Table 5 reports the estimation results for male workers. In this case, no statistically significant differences are observed between those with less education and those with more education with respect to on-the-job training. The reason for the difference in the results for males and females could be that the proportion of affected workers is larger for females than it is for males. Therefore, this suggests that minimum wage workers are more likely to be influenced in terms of human capital accumulation by minimum wage increases.

Finally, I confirm the estimation results for worker-initiated training, as shown in Table 5. The table shows a statistically significant decrease in worker-initiated training when minimum wages increase. This decrease in the incidence of worker-initiated training is statistically significant at the 1% level. We can hypothetically expect workers to invest in themselves in

order to find a better job or try to compensate for the decrease in on-the-job training when minimum wages increase. However, I find evidence of an opposite effect for female workers with less education.

There are two possible interpretations for this result. Firstly, if an hourly wage increases according to a minimum wage increase, a worker will work longer and, thus, worker-initiated training will decrease. Second, worker-initiated training and on-the-job training are considered to be complementary. That is, those workers who have more opportunities for on-the-job training are likely to engage in self-learning activities. If a worker knows what job skills and knowledge she should acquire through firm-provided training, she will be more likely to take the initiative to learn for herself.[31]

5.2 Robustness Check

To assess the robustness of the estimated relationship between a minimum wage and on-the-job training, I carry out additional analyses. The treatment group is the same as before, namely female workers with lower levels of education. However, the control group now comprises both male and female workers with higher levels of education. I expect that men with higher levels of education will not to be affected by changes to minimum wages. Thus, it is valid to add them to the control group.

The robustness check results are reported in Table 6. The absolute values

[31]Hara (2011) shows that Japanese workers who received on-the-job training previously are more likely to conduct worker-initiated training, and points out the complementarity between firm-provided training and worker-initiated training.

Table 6: Robustness Check for Treatment-dummy Results of Training
Control group: Male and Female Workers with Higher Levels of Education

	(1)	(2)	(3)
(MW × less education)	Coefficient	Elasticity	N
a. Formal training (= 1 if yes)	-0.007**	-1.603	18,327
	[0.003]		
b. Informal training (= 1 if yes)	-0.001	-0.037	17,962
	[0.004]		
c. worker-initiated training (= 1 if yes)	-0.007**	-1.523	18,347
	[0.003]		

Source: MHLW "Basic Survey of Human Resources Development."
Notes:

1. The result is the coefficient of $MW_{jt} \times lessedu_i$ from Equation (1), based on a probit analysis. The control group comprises men and women with higher levels of education. The less education dummy variable, prefecture dummy variables, year dummy variables, less education × prefecture dummy variables, less education × year dummy variables, the prefecture × year dummy variables, age category, working style, occupation, and tenure at the current workplace are included in all equations.
2. The standard errors are clustering standard errors per prefecture.
3. *** p ≤ 0.01, ** p ≤ 0.05, * p ≤ 0.1.

of the elasticity for formal training and worker-initiated training are both slightly higher than those given in Table 5. However, there are no large differences in point estimates or in terms of statistical significance for formal training, informal training, and worker-initiated training.

Additionally, I run a regression in which the control group is female workers who graduated from college, technical college, or university. That is, I exclude graduate school graduates from the basic control group. However, the estimation results are almost the same as those described here (details omitted).

Thus, these checks confirm that my estimation results showing that minimum wages have a significant negative effect on formal training and worker-initiated training are robust.

6 Conclusion

Theoretically, minimum wage increases might affect firm-provided training. However, these effects could be negative or positive. This study attempted to identify how a minimum wage increase affects training using a DDD estimation and micro data of Japanese female workers. In addition, I distinguished between formal and informal training in an attempt to explain the effect of minimum wage increases more clearly.

This study has shown that a minimum wage increase decreases formal training for less educated female workers, but does not affect informal train-

ing. This suggests that a minimum wage increase will disturb the human capital accumulation for a less skilled worker. Moreover, a minimum wage increase affects general training more than it does firm-specific training.

Of course, the possibility remains that a worker will increase worker-initiated training activities to compensate for the reduction in skill development opportunities at the workplace in order to find a better job. However, here I found evidence that a minimum wage increase has a negative effect on worker-initiated training.

One of the reasons for increasing minimum wages is to improve the working conditions of workers with low pay. However, my estimation results show that female workers with lower levels of education (i.e., those most affected by minimum wages) are influenced adversely, and lose opportunities for skill formation when the minimum wage is increased. Moreover, a minimum wage increase could cause inequality in skill development between unskilled and skilled female workers. The number of workers with lower levels of education has decreased in Japan, but still include 44.8% of Japanese female workers below the age of 50 (Statistics Bureau of Japan, "The Employment Status Survey 2012"), which is not negligible.

References

Acemoglu, D., and J.-S. Pischke (1999): "The structure of wages and investment in general training," *Journal of Political Economy*, 107(3), 539–572.

——— (2003): "Minimum wages and on-the-job training," *Research in Labor Economics*, 22, 159–202.

Arulampalam, W., A. L. Booth, and M. L. Bryan (2004): "Training and the new minimum wage*," *The Economic Journal*, 114(494), C87–C94.

Baskaya, Y. S., and Y. Rubinstein (2012): "Using federal minimum wages to identify the impact of minimum wages on employment and earnings across the US states," *Presenting paper at SOLE*.

Becker, G. S. (1962): "Investment in human capital: A theoretical analysis," *Journal of Political Economy*, pp. 9–49.

Bertrand, M., E. Duflo, and S. Mullainathan (2004): "How Much Should We Trust Differences-in-Differences Estimates?," *The Quarterly Journal of Economics*, 119(1), 249–275.

Card, D. (1992): "Do minimum wages reduce employment? A case study of California, 1987–1989," *Industrial and Labor Relations Review*, 46(1), 38–54.

Card, D., and A. B. Krueger (1994): "Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania," *American Economic Review*, 84(4), 772–793.

Dube, A., T. W. Lester, and M. Reich (2010): "Minimum wage effects

across state borders: Estimates using contiguous counties," *The review of economics and statistics*, 92(4), 945–964.

Ehrenberg, R. G., and A. J. Marcus (1982): "Minimum Wages and Teenagers' Enrollment-Employment Outcomes: A Multinomial Logit Model," *Journal of Human Resources*, pp. 39–58.

Fairris, D., and R. Pedace (2004): "The Impact of Minimum Wages on Job Training: An Empirical Exploration with Establishment Data," *Southern Economic Journal*, 70(3), 566–583.

Grossberg, A. J., and P. Sicilian (1999): "Minimum Wages, On-the-job Training, and Wage Growth," *Southern Economic Journal*, 65(3), 539–556.

Hara, H. (2011): "What Motivates Worker-Initiated Training in Japan? The Role of Information and the Effects of Self-development," Presented at the 14th Labor Economics Conference in Japan.

——— (2014a): *Economic Analysis of Job Training*. Keiso-syobo, Tokyo, (in Japanese).

——— (2014b): "The Impact of Firm-provided Training on Productivity, Wages, and Transition to Regular Employment for Workers in Flexible Arrangements.," *Journal of the Japanese and International Economies*, 34, 336–359.

Hashimoto, M. (1981): "Firm-specific human capital as a shared investment," *The American Economic Review*, pp. 475–482.

——— (1982): "Minimum Wage Effects on Training on the Job," *American Economic Review*, 72(5), 1070–1087.

Higuchi, Y. (2013): "The Dynamics of Poverty and the Promotion of Transition from Non-Regular to Regular Employment in Japan: Economic Effects of Minimum Wage Revision and Job Training Support," *Japanese Economic Review*, 64(2), 147–200.

Kawaguchi, D. (2006): "The Incidence and Effect of Job Training among Japanese Women," *Industrial Relations*, 45(3), 469–477.

Kawaguchi, D., and Y. Mori (2009): "Is Minimum Wage An Effective Anti-Poverty Policy In Japan?," *Pacific Economic Review*, 14(4), 532–554.

Kawaguchi, D., and K. Yamada (2007): "The Impact Of The Minimum Wage On Female Employment In Japan," *Contemporary Economic Policy*, 25(1), 107–118.

Kurosawa, M. (2001): "The Extent and Impact of Enterprise Training: The Case of Kitakyushu City," *Japanese Economic Review*, 52(2), 224–242.

Lechthaler, W., and D. J. Snower (2008): "Minimum wages and training," *Labour Economics*, 15(6), 1223–1237.

Leighton, L., and J. Mincer (1981): "The Effects of Minimum Wages on Human Capital Formation," in *The Economics of Legal Minimum Wages*,

ed. by S. Rottenberg, pp. 155–173. American Enterprise Institute for Public Policy Research, Washington.

Neumark, D., and W. Wascher (1992): "Employment effects of minimum and subminimum wages: Panel data on state minimum wage laws," *Industrial and Labor Relations Review*, 46(1), 55–81.

——— (1995): "Minimum wage effects on employment and school enrollment," *Journal of Business & Economic Statistics*, 13(2), 199–206.

——— (2001): "Minimum Wages and Training Revisited," *Journal of Labor Economics*, 19(3), 563–595.

——— (2008): *Minimum Wages*. MIT Press.

Rosen, S. (1972): "Learning and experience in the labor market," *Journal of Human Resources*, pp. 326–342.

Sabia, J. J., R. V. Burkhauser, and B. Hansen (2012): "Are the effects of minimum wage increases always small? New evidence from a case study of New York State," *Industrial and Labor Relations Review*, 65(2), 350–376.

Toda, A., and Y. Higuchi (2005): "Education and Training by Businesses: Changes in their Role," in *Economic Analysis of Labor Market Design: Towards a Stronger Matching Function*, ed. by T. K. Higuchi, Yoshio, and M. Abe, chap. 6, pp. 251–281. Toyo-keizai-sinpou-sya, Tokyo, (In Japanese).

Appendix

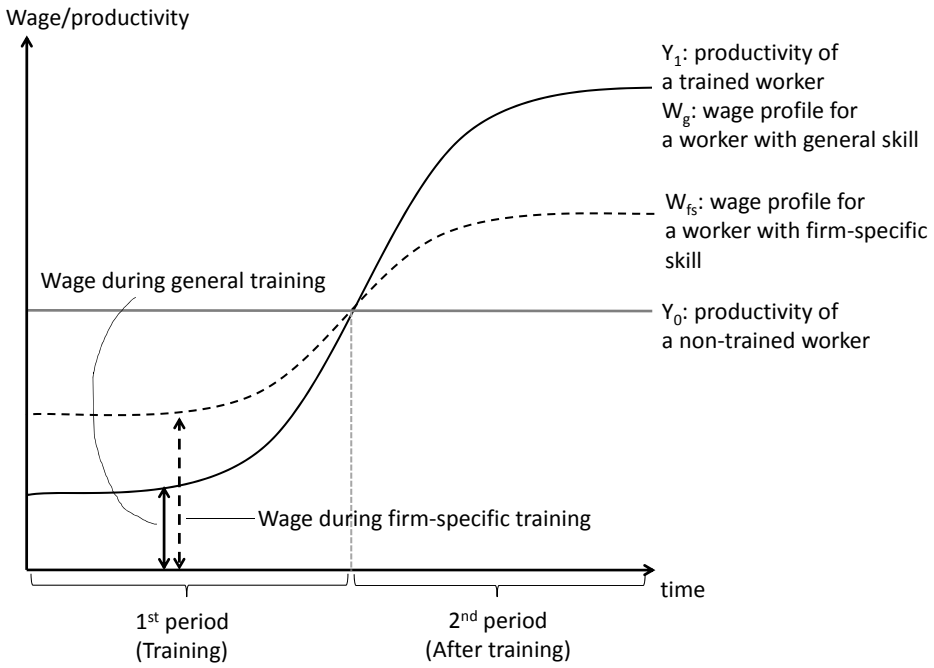

Figure A1: Training and Wage Profile

Note: Created by the author.

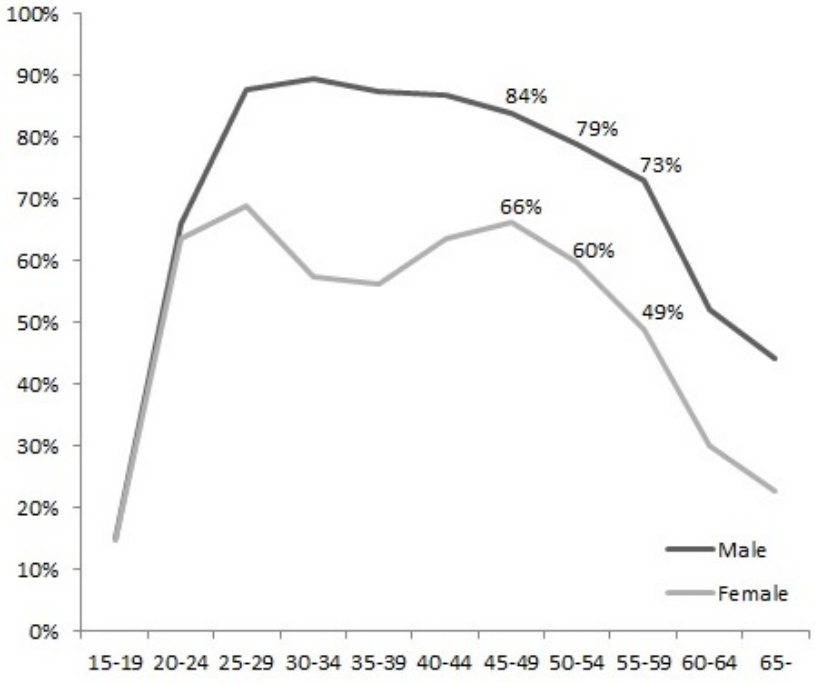

Figure A2: Employment Rate by Age and Gender (2007)

Data: Statistics Bureau of Japan "Labor Force Survey (2007)."
Note: Employment rate is the proportion of employees in the population over 15 years of age.

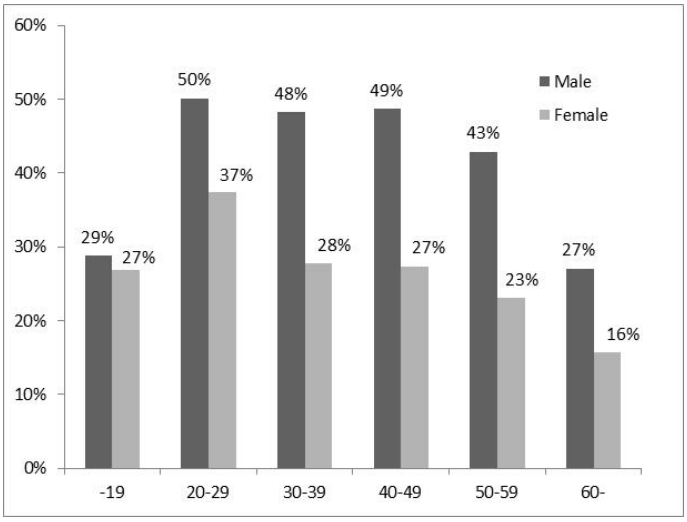

Figure A3: Formal Training Participation Rate by Age and Gender (FY2007–FY2010)

Data: MHLW "Basic Survey of Human Resources Development."
Note: Based on the author's calculations.