Labor Market Outcomes of the Evacuees of the Great East Japan Earthquake

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Abstract

This study analyzes the impact of evacuation status on labor market outcomes such as employment and earnings following the Great East Japan Earthquake by using annual microdata from the 2012 Employment Status Survey in Japan. This is the first research to focus on the effect of evacuation status on labor market performance for the Great East Japan Earthquake. The evacuation status categories are (1) evacuated and still away from home, (2) evacuated and moved to another place, (3) evacuated and already returned home, and (4) did not evacuate. We applied a probit model to estimate unemployment and an interval regression to estimate earnings. To estimate unemployment, we also used propensity score matching to control for selection into evacuation status on observable characteristics. After controlling for selection into evacuation categories on observable characteristics, our findings show that those still away from home have the worst labor market performance in terms of employment. Although we could not control for selection into evacuation categories in the interval regression and the results are not statistically significant, current results also show those who are still away from home seem to have the lowest earnings. Also those who evacuated from Fukushima and still away from home have the lowest earnings. The estimates suggest that we need a specific employment support for those who evacuated especially for those who are still away from home.

Keywords: natural disaster, earthquake, labor market, employment, earnings
JEL classifications: H12, J21, J30[1]

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1. Introduction

The Great East Japan Earthquake on March 11, 2011 caused large damage to Japanese society and its economy. The earthquake and subsequent tsunami also damaged nuclear plants in Fukushima prefecture, resulting in the release of radioactive substances into the environment. The number of people killed by the earthquake and tsunami was 15,894, with another 2,561 people missing (National Police Agency, 2016). The number of evacuees from the disaster-stricken areas and Fukushima prefecture were estimated to be about 470,000 on March 13, 2011 (Reconstruction Agency, 2014) and this number was still 174,000 in February 2016 (Reconstruction Agency, 2016). The damage to the total economy has also been serious, with the annual GDP growth rate declining to -0.5% in 2011 from 4.7% in 2010 (Cabinet Office, Government of Japan, 2016).

While five years has passed since the earthquake, the Japanese government is still struggling to accelerate the reconstruction and recovery of the economy in damaged areas to provide life support to evacuees. Groen and Polivka (2008) analyze the impact of Hurricane Katrina on the labor outcomes of evacuees and find that evacuees who were unable to return to their original residence location suffered a more disadvantageous position in the labor market than evacuees who returned home.

This study analyzes the impact on the labor market outcomes of the evacuees of the Great East Japan Earthquake by using annual microdata from the 2012 Employment Status Survey (ESS) in Japan. The ESS is a nationally representative survey of usual labor force status in Japan. It was conducted on household members aged 15 years old and over in approximately 470,000 households in October 2012. The 2012 survey included additional questions on the impact of the Great East Japan Earthquake on jobs with regular questions on household and labor force status. As far as the authors know, this is the first research focusing on the effect of evacuation status after the Great East Japan Earthquake on labor market performance by using a micro-level dataset that includes rich information on each individual. We explore the effects not only on the employment status of evacuees, but also on their earnings.

Evacuation status was categorized as (1) evacuated and still away from home, (2) evacuated and moved to another place, (3) evacuated and already returned home, and (4) did not evacuate. We applied a probit model to estimate unemployment and interval regressions to estimate earnings. To estimate unemployment, we used propensity score matching (PSM) to control for selection into evacuation status on observable characteristics. After controlling for selection into evacuation categories on observable characteristics, our findings show that those still away from home have the worst labor

errors that remain are the authors' sole responsibility.

market performance in terms of employment. Although we could not control for selection into evacuation categories in the interval regression and the results are not statistically significant, current results also show those who are still away from home have the lowest earnings as well. Also those who evacuated from Fukushima and still away from home have the lowest earnings.

The remainder of this paper is organized as follows. Section 2 reviews previous studies. Section 3 describes the analysis methods. Section 4 is an introduction to the data used. Section 5 provides the descriptive statistics, while section 6 states the estimation results, summary, discussion of the findings and policy implications. The last section presents the main conclusions.

2. Literature Review

Given the increasing trend of natural disasters globally, the amount of research on their economic impact has been rising. Earthquakes, storms, floods, and tsunamis cause average economic losses of USD 250–300 billion each year. Assuming everyone equally shares the risk of exposure to hazardous events, this would be equivalent to an annual loss of approximately USD 70 for each individual in the working age group (UNISDR, 2015). The economic impacts caused by natural disasters are estimated to be not only the direct damage, including the loss of lives and infrastructure, but also the indirect damage such as the effects on businesses, tourism, labor markets, and economic growth. While the mass media and national governments focus overwhelmingly on the direct damage, the latter is a greater concern for economics researchers.

In the United States where natural disasters such as hurricanes have hit several times, economics researchers have examined such exogenous shocks in the given market. Among the various statistical techniques used, the difference-in-difference estimation is commonly adopted (Belasen & Polachek, 2009; McIntosh, 2008; Groen & Polivka, 2008). For example, to measure the effects of hurricanes on employment and earnings in Florida, Belasen and Polachek (2009) compare counties hit by hurricanes with those counties not hit. They also take into account the possibility of labor demand and labor supply changing in the neighboring county. The exogenous shock represented by a hurricane seems to shift the labor supply of stricken counties inward, thus decreasing employment in the stricken county and increasing earnings substantially. At the same time, workers leave the devastation and flee to neighboring counties. Those counties experience a sudden increase in labor supply, moving the equilibrium downward and thereby reducing workers' earnings. If labor demand in the neighboring county is inelastic, the migration of workers does not lead to higher employment in that county. However, the study does not

investigate the characteristics of workers who evacuated or explore whether these determine the possibility of employment and the amount of earnings.

McIntosh (2008) confirms the change in the labor market equilibrium of a neighboring area following an evacuation. The Hurricane Katrina migration to Houston, Texas was associated with a decline in wages and in the probability of being employed among the native population. Workers in sectors or occupations that faced greater labor market competition after the arrival of evacuees suffered the most. On the contrary, the inflow of low-skilled immigrants from Central America to the United States seemed to complement high-skilled native male workers and led to higher hourly wages for this group (Kugler & Yuksel, 2008).

A significant body of research examines the effects of Hurricane Katrina on the labor market because of its severe damage to human capital, not only those killed but also those forced to leave their hometowns. Some studies emphasize measuring hurricane impact by migration status (Groen & Polivka, 2008; Zissimopoulos & Karoly, 2010). After a hurricane hits, people have to evacuate to new areas and new labor markets with which they might be unfamiliar and lacking in social networks. Thus, they face higher costs of seeking jobs, which put them into a disadvantageous position. Specifically, the effects of Hurricane Katrina lowered the labor force participation rate, lowered the employment-population ratio, and raised the unemployment rate of evacuees according to these studies.

Further, among evacuees after such a natural disaster, workers who do not return home have worse labor outcomes. Although individual and family background accounts for some extent of the differences, the primary reason is that non-returnees come from areas that experience greater residence damage (Groen & Polivka, 2008). For example, Zissimopoulos and Karoly (2010) compare non-evacuees, returnee evacuees, and non-returnee evacuees by affected states and find that a natural disaster leads to different experiences for different subgroups of the population and state. Non-returnee evacuees are more severely affected by a hurricane, with many pushed into self-employment.

Regarding research on the impact of the Great East Japan Earthquake, Genda (2014) addresses similar topics to us and uses the same dataset as that presented herein. Genda (2014) analyzes a number of factors:

(1) The determinants of being affected by the earthquake on employment among those employed when the earthquake hit, using a probit model,

(2) The determinants of the changes in employment (taking a leave of absence, leaving one’s job) among those employed when the earthquake hit, using a multinomial logit model,

(3) The determinants of being workless among those who took a leave of absence or left one's job, using a probit model and conducting analyses separately for all regions and affected municipalities,

(4) The determinants of willingness to work among those who took a leave of absence or left one's job, having no job in October 2012, using a probit model,

(5) The determinants of looking for a job among those took a leave of absence or left one's job, having no job in October 2012, using a probit model, and

(6) The effect of evacuation, change of residence, and place of living affected by the earthquake on whether a respondent is employed, willing to work, and looking for a job among those who left a job or took a leave of absence because of the earthquake.

Based on the results, Genda (2014) concludes that the earthquake affected not only those in Iwate, Miyagi, and Fukushima but also those in all prefectures in eastern Japan excluding Hokkaido, especially middle-aged and older generations and less educated groups. In addition, permanent employees tended to be protected and less affected. The manufacturing sector was greatly affected but manufacturing workers were less affected in terms of being workless in fall 2012. He also suggests that those who left a job or took a leave of absence because of the earthquake were much more likely to be without a job in the affected municipalities than those in other municipalities. The negative effect was the strongest in municipalities that included evacuated areas in Fukushima. However, the people in these municipalities did not lose their willingness to work, although they were less likely to look for a job.

Genda (2014) also finds that evacuation and change of residence because of the earthquake were greatly associated with being jobless after leaving a job or taking a leave of absence after the earthquake. Those who left a job or took a leave of absence as well as those who evacuated or moved to other municipalities were less likely to have a job, want to work, and look for a job.

This study replicates the previous analyses by Groen and Polivka (2008) and Zissimopoulos and Karoly (2010), but measures the impacts of the Great East Japan Earthquake in 2011. It segregates evacuees into three groups, namely evacuees who were still away, evacuees who decided to move, and returnees, while previous studies have divided them into only returnees and non-returnees. Unlike Groen and Polivka (2008), Zissimopoulos and Karoly (2010) and Genda (2014) that focus on employment, our study extends the investigation to additionally assess the impacts of the earthquake on earnings.

Although the topic is similar, this study is different from Genda (2014) in several aspects. We focus more on the effect of evacuation status (evacuated and returned home, evacuated and moved, evacuated and still evacuating, did not evacuate). This study also

looks at differences by affected prefecture on the effect of evacuation status. Further, our study looks at the effect on earnings. Lastly, we attempt to control for selection into evacuation status by PSM on observable characteristics when we estimate the effect of evacuation status on employment.

3. Methods

We estimate the impact of the Great East Japan Earthquake on two labor market outcomes, namely employment status and earnings, by evacuation status. This study investigates the differences among three types of evacuees: 1) those who evacuated and are still away from home, 2) those who evacuated and decided to move to another place when the earthquake hit, and 3) those who evacuated and returned home compared with those who did not evacuate. This segregation extends the work of Groen and Polivka (2008) and Zissimopoulos and Karoly (2010), which divides Katrina evacuees into returnees and non-returnees.

3.1 Estimating the Probability of Unemployment by Evacuation Status

First, we perform a probit estimation of the probability of being unemployed and employed by evacuation status, controlling for demographic characteristics. The baseline probit model in our analysis is

$$\Pr(\mathrm{Y}_i = 1|\mathbf{X}_i) = \Phi(\boldsymbol{X_i\beta}) \qquad (1)$$

where Y_i is a binary dependent variable where 1 means being unemployed and 0 means being employed for individual *i*. Φ is the cumulative density function of a standard normal random variable. $\boldsymbol{X}_i$ is a vector of the explanatory variables affecting the unemployment status decision of individual *i*, including dummy variables on evacuation status (still away, moved, and back home), female dummy, age, age squared, marital status, the number of children under 15 years old, unemployment rate by prefecture where individual *i* lives in October 2012, and education level. $\boldsymbol{\beta}$ is the parameter vector of each explanatory variable.

To control for sample selection bias into evacuation status as much as possible based on observable characteristics, we use PSM. Since PSM is used to compare the outcomes of two groups and we cannot construct a statistical model, we control for selection bias in two groups. We estimated the probabilities of unemployment among those (i) who evacuated and are still away from home compared with those who did not evacuate, (ii) who evacuated and moved compared with those who did not evacuate, and (iii) who evacuated and returned home compared with those who did not evacuate.

The propensity score is the conditional probability of assignment to a particular

treatment given the observed covariates (Rosenbaum & Rubin, 1983). PSM constructs a statistical comparison group based on the propensity score estimated by the observed characteristics. People in the treatment group are matched to those not in the treatment group based on the propensity score. Propensity score is the probability of being in the treatment, D give the observed characteristics: $P(X) = \Pr(D = 1|X)$. Then, average treatment effect on the treated (ATT) is estimated by calculating the mean difference in outcomes across the two groups. The PSM estimator for ATT can be written as below assuming that conditional independence holds and that there is common support (overlap between both groups).

$$\tau_{ATT}^{PSM} = E_{P(X)|D=1}\{E[Y(1)|D = 1, P(X)] - E[Y(0)|D = 0, P(X)]\} \qquad (2)$$

where τ_{ATT}^{PSM} is defined as the unemployment probability differential between those who evacuated and are still away (moved or returned) and those who did not evacuate. $Y(1)$ means outcomes for those who are in treatment group (one of three evacuation statuses) and $Y(0)$ outcomes for those who are in control group (non-evacuee). $D=1$ means "evacuated and still away (moved or returned)," $D=0$ means "did not evacuate," Y is unemployment status (1 if unemployed, 0 otherwise), and X is individual characteristics, which are the gender, age, age squared, marital status, number of children under 15, official unemployment rate by prefecture where respondents live, and education dummies. PSM is the only decent method we could currently think of in order to control for selection into evacuation status as much as possible. However, as suggested from the explanation above, we have to note that PSM cannot control for selection bias on unobserved characteristics and therefore the estimates by PSM could still have some bias. In any case, since we match people in two groups on the same observable characteristics using PSM, and drop those who cannot be matched, the estimates of PSM should have less bias than those of probit models.

3.2 Estimating Earnings by Evacuation Status

Second, we estimate the effects of evacuation status on earnings by using an interval regression. We cannot run a conventional ordinary least squares regression because data on earnings are categorical. To estimate the effect of evacuation status and the other characteristics on earnings, we use the interval regression because the earnings variable is an ordered categorical variable. The interval regression used is the "exactly ordered probit with the cut points fixed and with β and σ^2 estimated by maximum likelihood" (Wooldridge, 2002, p. 509). As Wooldridge (2002) explains, in an interval regression, " β_j are interpretable as if we had observed y_i^* for each i and estimated

$E(y^* \mid \mathbf{x}) = \mathbf{x}\boldsymbol{\beta}_j$ by OLS" (p. 509).

The more detailed equations below are based on the study by Bettin and Lucchetti (2012). The dependent variable of interest, annual gross earnings from the main job or main business, y_i^* is unobserved. The observed information is an interval as below:

$$m_i \leq y_i^* < M_i \tag{3}$$

where the interval is right-unbounded. To deal with this constraint, Sterwart (1983) proposes the estimation of interval models by using maximum likelihood. y_i^* is generated in the process below:

$$y_i^* = \boldsymbol{X}_i'\boldsymbol{\beta} + \varepsilon_i \tag{4}$$

where y_i^* itself is unobserved. However, when a distributional hypothesis is made, we can estimate the interval regression by using maximum likelihood techniques. Under normality, the log-likelihood for individual *i* is

$$\ell_i(\beta, \sigma) = \ln P(m_i \leq y_i^* < M_i) = \ln\left[\Phi\left(\frac{M_i - \boldsymbol{X}_i'\boldsymbol{\beta}}{\sigma}\right) - \Phi\left(\frac{m_i - \boldsymbol{X}_i'\boldsymbol{\beta}}{\sigma}\right)\right] \tag{5}$$

To clarify, $\boldsymbol{X}_i$ in (4) and (5) is the explanatory variables affecting earnings, including the dummy variables on evacuation status (still away, moved, and back home), female dummy, experience, experience squared, marital status, number of children under 15 years old, average earnings by prefecture, and education level. $\boldsymbol{\beta}$ is the parameter vector of each explanatory variable and ε_i is the error term. The procedure above can be implemented in several statistical packages including STATA, which we use for the analysis in this study.

We also have endogeneity issues related to evacuation status in this model. However, we are unable to construct a statistical model that overcomes the endogeneity of evacuation status when intervals are used as the outcome. Addressing this issue is thus a task for future studies.

4. Data

The dataset used in this study is the 2012 ESS in Japan, a nationally representative survey of labor force status in Japan, and it was conducted on approximately 470,000 household members aged 15 years old or more in October 2012. The 2012 survey includes

additional questions on the impact of Great East Japan Earthquake on the job with the regular questions on the household and labor force status. In the probit model used to estimate the effect of evacuation status and the other characteristics on unemployment, the dependent variable is binary and equals 1 if individual *i* is unemployed in October 2012 and 0 otherwise. The independent variables are the three types of evacuation status and female dummy (1 if female, 0 otherwise), age, age squared, marital status dummy (1 if married, 0 otherwise), number of children under 15 years old, official unemployment rate of the prefecture where an individual is living, and education level dummies.

In the interval regression used to estimate earnings, the dependent variable is the categories of annual earnings (wages/salaries or profits from business). The earnings categories starts from "no earnings or less than 500,000 yen" followed by "500,000 to 990,000 yen" and "1,000,000 to 1,490,000 yen." After the second category, we have categories for every 500,000 yen until "2,500,000 to 2,990,000 yen." From 3,000,000 yen, we have categories for every 1,000,000 yen ("3,000,000 to 3,990,000 yen") up to "9,000,000 to 9,990,000 yen." The last three categories are "10,000,000 to 12,490,000 yen," "12,500,000 to 14,990,000 yen," and "More than 15,000,000 yen." The independent variables in the model are three types of evacuation status (explained later), female dummy, years of experience, years of experience squared, marital status dummy (1 if married, 0 otherwise), number of children under 15 years old, average earning of the prefecture where an individual is living calculated by authors, education level dummies, and industry dummies.

Lastly, evacuation status (in October 2012) in both models is categorized into three groups: (1) those who evacuated after the earthquake and still live away from home, (2) those who evacuated after the earthquake and have already moved to another place, and (3) those who evacuated after the earthquake and retuned home. The base category is those who did not evacuate.

5. Descriptive Statistics

According to the ESS, 11,771 evacuees of the earthquake are in the labor force (Table 1). The majority of these are from Fukushima, from which many people were evacuated fearing radiation sickness. The second and third largest groups of evacuees come from Miyagi (3,574 evacuees) and Iwate (1,369 evacuees), respectively. More than half of evacuees, however, returned home in 2012. Approximately 28.3% of evacuees report that they are still away from home and 15.1% have moved to another place. The highest proportions of returnees are from Aomori, Ibraraki, and Chiba, since these three prefectures experienced only a minor impact from the earthquake. Whereas most

evacuees from other prefectures returned home, 57.3% of evacuees from Iwate are still away from home. More than 20% of evacuees in Miyagi, Ibraraki, and Chiba decided to move to another place.

Table 1: Evacuee Status by Prefecture of Residence, 15 to 64 Years Old

Prefecture lived during earthquake	Type of evacuation			Total evacuees
	Away	Moved	Returnee	
青森県 Aomori	0 (0.00%)	37 (13.45%)	238 (86.55%)	275 (100%)
岩手県 Iwate	784 (57.27%)	169 (12.34%)	416 (30.39%)	1,369 (100%)
宮城県 Miyagi	1,028 (28.76%)	786 (21.99%)	1,760 (49.24%)	3,574 (100%)
福島県 Fukushima	1,456 (27.14%)	524 (9.77%)	3,384 (63.09%)	5,364 (100%)
茨城県 Ibaraki	27 (4.48%)	177 (22.84%)	571 (73.68%)	775 (100%)
千葉県 Chiba	38 (9.18%)	88 (21.26%)	288 (69.57%)	414 (100%)
Total	3,333 (28.32%)	1,781 (15.13%)	6,657 (56.55%)	11,771

Note: The sample covered here is the working age population (15 to 64 years old) in the labor force (employed or unemployed).

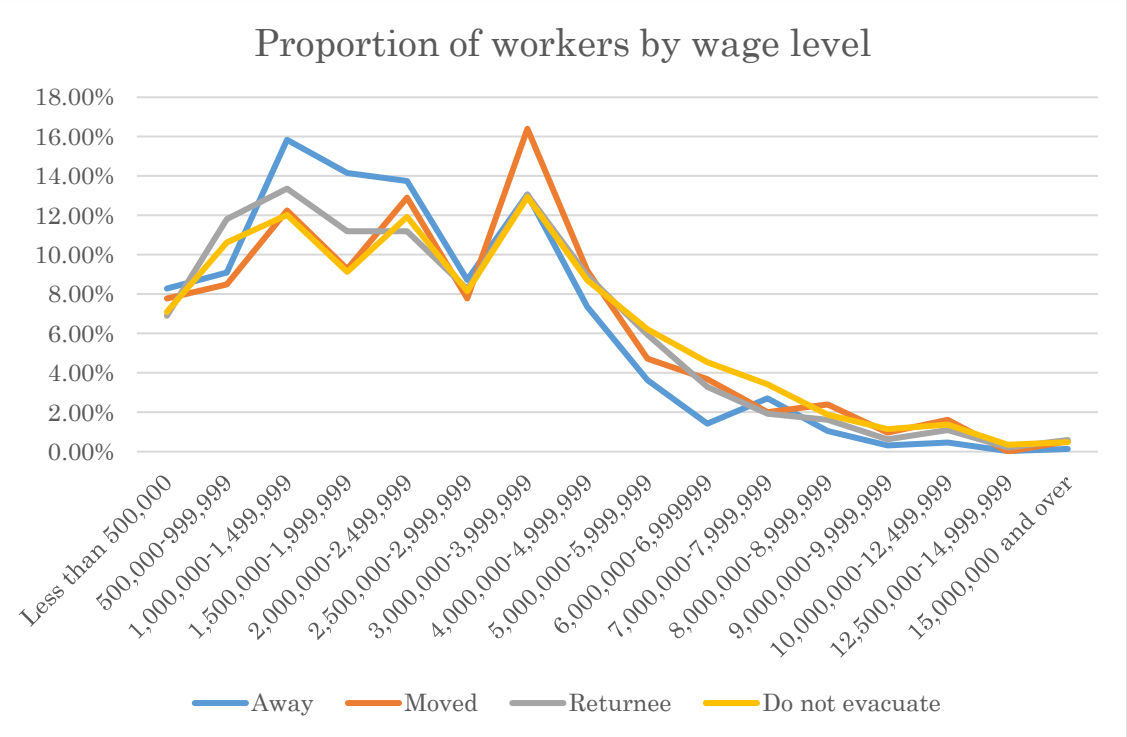
It is also evident from ESS that the unemployment rates of evacuees are higher than those of non-evacuees for both men and women. Here, 6.5% of male evacuees are unemployed, while only 4.5% of the non-evacuee workforce are unemployed. Similarly, 12.1% of female evacuees are unemployed compared with 8.1% for female non-evacuees. Moreover, women are more likely to be jobless for all evacuation statuses. The female unemployment rate is about twice as large as the male unemployment rate.

Figure 1 reports the proportion of workers at each earning level, starting from less than 500,000 yen per annum to greater than 15,000,000 yen per annum. The data is defined by evacuation status. A person who reports being away because of the earthquake is more likely to have lower earnings. Less than 4% of this group have annual earnings between 5,000,000 and 5,990,000 yen compared with more than 6% of non-evacuees. Evacuees who moved to another place tend to receive higher annual earnings than those

away since the group has a smaller proportion of workers in the low earnings category. Returnees seem to earn less (more) than those who moved (are still away). Non-evacuees, on average, enjoy higher earnings than all other types of evacuees. The data indicate a higher proportion of non-evacuees at almost every wage level above 4 million yen per annum. In addition, a lower proportion of non-evacuees tends to be found in the lower earnings category.

Segregated by gender, there is a higher proportion of female workers in the lower earnings category compared with male workers. This pattern seems to switch at an earning level of 1.5 million yen per annum where male workers start to have a higher proportion. The earning distributions of returnees and non-evacuees are similar for both male and female workers.

Figure 1: Proportion of Workers by Earnings Level, 15 to 64 Years Old (in 1,000 yen)



Notes: The sample covered here is the working age population (15 to 64 years old) in the labor force (employed or unemployed) who were living in either Aomori, Iwate, Miyagi, Fukushima, Ibaraki, or Chiba at the time of the earthquake.

Table 2 reports the characteristics of workers by evacuation status. Some of these observed characteristics might have resulted in differences in employment status and

earnings even before the Great East Japan Earthquake. The illustration shows that evacuees who decide to move, on average, are several years younger than workers of other evacuation statuses. They are also more likely to be male compared with non-evacuees and returnees and more likely to be non-married compared to all other evacuation statuses. Moreover, evacuees who report being away are less likely to have a high level of education. More than 80% of "away" evacuees graduated from senior high school or lower. Evacuees who decide to move are more likely to have a higher education level than the "away", "returnee" and "do not evacuate" groups. We also checked the industry variables and they do not show substantial differences among evacuees and non-evacuees.

Table 2: Characteristics by Evacuation Status, 15 to 64 Years Old

Characteristics	**Type of evacuation (those who lived in either of the six affected prefectures when the earthquake hits)**			
	Away	**Moved**	**Returnee**	**Do not evacuate**
Age	44.42	36.58	41.77	44.37
Female (%)	42.12%	43.68%	48.13%	44.65%
Married (%)	61.77%	56.00%	66.58%	64.54%
Number of children under 15 years	0.50	0.62	0.70	0.50
Unemployment rate by current prefecture	4.21	4.32	4.25	4.31
Junior high and lower (%)	15.27%	5.51%	8.98%	9.20%
Senior high (%)	64.83%	46.09%	56.61%	53.80%
Post secondary vocational education and training (%)	5.57%	11.71%	7.80%	7.93%
Junior college (%)	5.84%	9.34%	8.14%	7.67%
College (%)	8.04%	23.35%	16.73%	19.67%
Graduate school (%)	0.24%	4.00%	1.50%	1.56%
Years of experience	26.31	17.11	22.94	24.44

Notes: The sample covered here is the working age population (15 to 64 years old) in the labor force (employed or unemployed) who were living in either Aomori, Iwate, Miyagi, Fukushima, Ibaraki, or Chiba at the time of the earthquake.

6. Results

In this section, we present the results of the estimated impact of the Great East Japan Earthquake on labor market outcomes (employment status and earnings) for evacuees and non-evacuees.

6.1 Effect of Evacuation Status and Other Characteristics on Employment

Table 4 shows the results of the probit estimation of the probability of being unemployed and employed by evacuation status. As shown in Table 4, compared with non-evacuees, those who evacuated and are still away from home have a 3.7% higher unemployment rate. Similarly, those who evacuated and moved have a 3.6% higher unemployment rate than non-evacuees. Further, compared with men, women have a 3.7% higher unemployment rate. If they are married, they have a 3.2% lower unemployment rate. Finally, Table 4 shows that the higher their educational backgrounds are, the lower are their unemployment rates.

Table 4: Probit Regression Estimating Unemployment by Evacuee Status, Marginal Effects

Dependent variable: Unemployed=1, Employed=0			
	Marginal Effects	Standard Errors	P>z
Away	0.037***	0.003	0.000
Moved	0.036***	0.005	0.000
Returned	0.004	0.003	0.212
Female	0.037***	0.001	0.000
Age	-0.002***	0.000	0.000
Age squared	0.000***	0.000	0.000
Married	-0.032***	0.002	0.000
Number of children under 15 years	0.002**	0.001	0.048
Unemployment by prefecture	0.005***	0.001	0.000
Senior high	-0.020***	0.002	0.000
Post secondary vocational education and training	-0.038***	0.003	0.000
Junior college	-0.031***	0.003	0.000
College	-0.036***	0.003	0.000
Graduate school	-0.061***	0.007	0.000
Number of obs	133555		
LR chi2(33)	2158.25		

Prob > chi2	0.0000
Pseudo R2	0.0374

Notes: *** means significant at 1% level, ** significant at 5% level, and * significant at 10% level. The sample covered here is the working age population (15 to 64 years old) in the labor force (employed or unemployed) who were living in either Aomori, Iwate, Miyagi, Fukushima, Ibaraki, or Chiba at the time of the earthquake. The sample here also excludes those who are going to school.

Table 5 shows the results by evacuation status and prefecture. Those who evacuated and returned to pre-earthquake homes are less likely to be unemployed, excluding Miyagi, Fukushima and Ibaraki prefectures. Those who evacuated from Miyagi and Fukushima and are still away from home have a higher unemployment rate. Also those who evacuated from Aomori, Miyagi, Fukushima, and Ibaraki and have moved have a higher unemployment rate.

Table 5: Probit Regression Estimating Unemployment with the Interaction of Evacuee Status and Affected Prefecture, Marginal Effects

Dependent variable: Unemployed=1, Employed=0			
	Marginal Effects	Standard Errors	P>z
Away Aomori		(omitted)	
Away Iwate	0.007	0.008	0.387
Away Miyagi	0.026***	0.006	0.000
Away Fukushima	0.059***	0.005	0.000
Away Ibaraki		(omitted)	
Away Chiba	0.021	0.034	0.530
Moved Aomori	0.113***	0.024	0.000
Moved Iwate	-0.024	0.022	0.259
Moved Miyagi	0.042***	0.007	0.000
Moved Fukushima	0.028***	0.009	0.002
Moved Ibaraki	0.054***	0.014	0.000
Moved Chiba	0.007	0.024	0.783
Returned Aomori	-0.028**	0.017	0.098
Returned Iwate	-0.032**	0.014	0.019
Returned Miyagi	0.002	0.005	0.653
Returned Fukushima	0.013***	0.004	0.001
Returned Ibaraki	0.002	0.010	0.858

Returned Chiba	-0.058***	0.022	0.007
Female	0.037***	0.001	0.000
Age	-0.002***	0.000	0.000
Age squared	0.000***	0.000	0.000
Married	-0.032***	0.002	0.000
Number of children under 15 years	0.002*	0.001	0.053
Unemployment by prefecture	0.005***	0.001	0.000
Senior high	-0.020***	0.002	0.000
Post secondary vocational education and training	-0.038***	0.003	0.000
Junior college	-0.031***	0.003	0.000
College	-0.036***	0.003	0.000
Graduate school	-0.061**	0.007	0.000
Number of obs	133531		
LR chi2(47)	2255.21		
Prob > chi2	0.000		
Pseudo R2	0.0391		

Notes: *** means significant at 1% level, ** significant at 5% level, and * significant at 10% level. The sample covered here is the same as the one in Table 4.The prefecture is where the person was living when the earthquake hits. The interaction of away and Aomori is dropped because of collinearity (actually no one from Aomori is still away from home). The interaction of away and Ibaraki is dropped because it predicts failure perfectly (For more details please see Stata.com-probit http://www.stata.com/manuals13/rprobit.pdf).

Finally, Table 6 shows the impact of evacuation status on employment status estimated by PSM on observable characteristics. The results of those still away and moved do not significantly differ from the results in previous models; however, the estimated effect of being away is much greater than that in the other models. In addition, we now find a statistically significant negative (estimated) impact of "evacuated and returned home" on employment after controlling for selection into this category on observable characteristics, although the estimated effect for this group is still the weakest. As we can see in Table 6, those still away have higher unemployment rate by 6.4% points, those moved have higher unemployment rate by 4.6% points and those retuned home have higher unemployment rate by 1.6% points, than those did not evacuate.

Table 6: PSM of the Linear Probability Model: The Probability of being Unemployed among those who Evacuated Compared with those who did not

Dependent Variable Unemployed=1, 0 otherwise	Away	Moved	Returned
Evacuated and Still Away, Moved or Returned	0.064***	0.046***	0.016**
	(0.011)	(0.013)	(0.007)
Number of treated	3,272	1,657	6,426
Number of untreated	122,200	123,857	122,220

Notes: *** means significant at 1% level, ** significant at 5% level, and * significant at 10% level. The balancing tests for propensity score matching estimation were also conducted and we confirmed the balancing property is satisfied. Results of the balancing test can be shared upon request.

6.2 Effect of Evacuation Status and Other Characteristics on Earnings

Table 7 presents the result of the interval regression of the impact of evacuation status on earnings. It shows that compared with non-evacuees (i.e., those who did not evacuate in six affected prefectures prefecture), annual earnings are not statistically significantly different among those who evacuated and still away from home while the sign of the coefficient is negative and the magnitude is not small. By contrast, those who evacuated and moved have higher annual earnings compared with those did not evacuate by 1,093,700 yen. Those who evacuated and returned home have higher annual earnings compared with those did not evacuate by 356,900 yen. These findings imply that the labor market situation is worse for those who are still away from home. The results for the other individual attributes including educational background were as expected.

Table 7: Interval Regression: The Impact of Evacuation Status and Individual Characteristics on Earnings

Dependent variable: lower bound of earnings, upper bound of earnings (in 10,000 yen)			
	Coefficient	Standard Error	P>z
Away	-29.80	22.13	0.178
Moved	109.37**	44.45	0.014
Returnee	35.69**	16.06	0.026
Female	-204.67***	2.63	0.000
Experience	14.21***	0.41	0.000
Experience squared	-0.24***	0.01	0.000

Married	48.17***	3.18	0.000
Number of children under 15 years	1.99***	1.51	0.188
Average earnings by prefecture	0.74***	0.04	0.000
Senior high	47.22***	4.88	0.000
Post secondary vocational education and training	88.02***	6.57	0.000
Junior college	77.10***	6.14	0.000
College	188.09***	5.54	0.000
Graduate school	352.36***	9.97	0.000
Constant	-180.33***	13.34	0.000
Number of obs	36,108		
LR chi2(33)	15,874.68		
Prob > chi2	0.000		

Notes: *** means significant at 1% level, ** significant at 5% level, and * significant at 10% level. The sample covered here is the working age population (15 to 64 years old) in the labor force (employed or unemployed) with earnings information who were living in either Aomori, Iwate, Miyagi, Fukushima, Ibaraki, or Chiba at the time of the earthquake. The sample here also excludes those who are going to school. Industry dummies are included as independent variables in the estimation but the results are not shown here for brevity.

Table 8 shows the results of the impact of evacuation status on earnings by prefecture. We find that those who evacuated from Fukushima and are still away from home have lower annual earnings than those who live in six prefectures and did not evacuate by 809,500 yen. In contrast, those who evacuated from Fukushima and moved have higher annual earnings than non-evacuees in six prefectures by 2,823,100 yen. Those who evacuated from Iwate and Ibaraki and returned home have higher earnings than those of non-evacuees. As we can see, the numbers of people who are from Aomori, Ibaraki, Chiba and away from home or moved are too small to estimate the impact if these statuses. Therefore, we cannot draw any strong conclusion from the result on the difference of annual earnings by prefecture.

Table 8: Interval Regression: The Impact of Evacuation Status and Individual Characteristics on Earnings by Prefecture

Dependent variable: Dependent variable: lower bound of earnings, upper bound of earnings (in 10,000 yen)

	Coef.	Std. Err.	P>z
Away Aomori		(omitted)	
Away Iwate	27.31	37.46	0.466
Away Miyagi	-36.35	40.00	0.363
Away Fukushima	-80.95**	37.47	0.031
Away Ibaraki		(omitted)	
Away Chiba		(omitted)	
Moved Aomori		(omitted)	
Moved Iwate	-91.81	110.50	0.406
Moved Miyagi	29.49	66.70	0.658
Moved Fukushima	282.31***	70.94	0.000
Moved Ibaraki		(omitted)	
Moved Chiba		(omitted)	
Returnee Aomori		(omitted)	
Returnee Iwate	301.68***	64.35	0.000
Returnee Miyagi	15.42	41.89	0.713
Returnee Fukushima	13.49	21.57	0.532
Returnee Ibaraki	112.62**	47.42	0.018
Returnee Chiba	-44.01	45.23	0.331
Female	-204.60***	2.63	0.000
Experience	14.24***	0.41	0.000
Experience squared	-0.24***	0.01	0.000
Married	48.03***	3.18	0.000
Number of children under 15 years	2.08	1.51	0.169
Average earnings by prefecture	0.74***	0.04	0.000
Senior high	46.94***	4.88	0.000
Post secondary vocational education and training	88.17***	6.57	0.000
Junior college	76.72***	6.14	0.000
College	188.00***	5.54	0.000
Graduate school	351.97***	9.97	0.000
Constant	-181.30***	13.34	0.000
Number of obs	36,108		
LR chi2(47)	15,913.79		
Prob > chi2	0.000		

Note: *** means significant at 1% level, ** significant at 5% level, and * significant at 10% level. The sample covered here is the same as the one in Table 7. Also industry dummies are included as independent variables in the estimation but the results are not shown here for brevity. Some interactions of evacuation status and prefecture are dropped because of collinearity.

6.3 Summary, Discussion and Policy Implications

In summary, our findings show that those still away from home have the worst labor market performance in terms of employment, followed by those who moved, and then those who returned home. This is understandable because it is hard to live in temporary houses or new places and look for a job in an unfamiliar city. Also, those still away from home seem to have least earnings than other groups while the earnings of those who are still away is not statistically significantly different from those of non-evacuees. We find that those who evacuated from Fukushima and are still away from home have lower annual earnings than those who live in six prefectures and did not evacuate while those who evacuated from Fukushima and moved have higher annual earnings than non-evacuees in six prefectures.

The results in our study imply that those who are still away from home have the worst labor market situations in terms of employment and earnings. We could possibly create programs to support evacuees, especially those who are away from home in addition to existing employment support for affected people and prefectures so that they can find jobs or better jobs which match for their qualifications. The important thing is that we need to support those who are living outside of affected prefectures as well. We need further investigations on the details of the situation of those who evacuated to form concrete programs.

7. Conclusion

This study analyzed the impact on the labor market outcomes of evacuees of the Great East Japan Earthquake by using annual microdata from the 2012 ESS in Japan. We estimated the effects not only on the employment status of evacuees, but also on their earnings. Our estimates suggest that those still away from home have the worst labor market performance in terms of employment and earnings. However, further studies are required to investigate the reasons for our findings, such as how education level affects the employment and earnings of those who evacuated after the earthquake. We would also like to note that improved identification strategies are necessary because PSM could not control for selection into evacuation status based on unobserved characteristics. Also, PSM used in this paper could only compare two groups not more than two groups. In

addition, we were unable to construct a model to control for selection into evacuation status in the estimation of the effect of evacuation status on earnings because using an interval regression prevents us from using PSM[2] or other methods. In addition, we need to find a way in which to estimate the effect of evacuation status on employment and earnings taking into account the multinomial categories of evacuation status. The results suggest that we need more employment support for those who are away from home including people those who are living outside of affected prefectures. We need further investigation on evacuees to formulate a more concrete employment support program.

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[2] This statement does not mean PSM completely controls for selection into evacuation status in earnings function. As same as the estimation of employment, PSM could only control for selection on observable characteristics.

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