Doctoral Dissertation

Essays on Consumption, Well-being, and Labor Adjustment

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Chapter I

Introduction

This dissertation empirically examines various topics on the economic activities of individuals, households, and firms by using several micro data sets. Although each chapter focuses on a different topic, all the chapters explore empirical evidence that may affect the macro economy. Chapters II, III, and IV investigate a "bias" in people or household behavior, with the former two chapters focusing on consumption and the latter on well-being. Chapter V studies a firm's optimization behavior from the exchange rate fluctuation. The details of each chapter are provided below.

Chapter II explores the upward bias of the Japanese Consumer Price Index (CPI). The CPI is used in many policy decisions such as inflation target and pension payment. However, the index is considered as overestimating the cost of living. If so, the policy might not be efficient. This chapter estimates the Engel curve based on the National Survey of Family Income and Expenditure data to measure the bias. The estimated bias for the period from 1989 to 2004 was 0.53 percentage points per annum. Correcting this bias lowered the inflation rate to 0.14 percent per year against the official inflation rate of 0.65 percent during the same period. Demographic analysis indicated that a household with an unemployed spouse encountered a larger bias, suggesting that the opportunity cost of shopping determines the size of the bias.

Chapter III studies the gender gap in Japanese household educational spending. Previous works have shown that families paid more for their sons' education in the 1980s, and this gap decreased throughout the 1990s. This chapter extends the literature in two aspects: estimating the gender gap in household educational spending with a longer time period, between 1989 and 2004, and estimating the gap with more detailed spending categories, namely total educational spending, after-school academic educational spending, and after-school non-academic spending. This chapter finds that there is no gender gap in total educational spending at all in 2004. It also finds that boys received more after-school academic educational spending to go to a cram school in 1989 and 1994. There was no gap in after-school academic spending in 1999. However, in 2004, boys received more academic spending than girls did. In addition, throughout the sample period, girls receive more after-school non-academic spending than boys do.

Chapter IV analyses people's life satisfaction measurement. In the literature on happiness, numerous studies have discussed the Easterlin Paradox, where Easterlin (1974) states that the increase in the reported happiness does not seem to be related with the economic growth. There are several possibilities that result in observing the paradox. The first possibility is the recent personal news shock effect that people's happiness is higher if they receive good news before the interview. Another possibility is of a social norm where people may report happiness by considering the expectation of others they interact with. The third possibility, which this chapter focuses on, is the change in one's criteria of the happiness level. If the measurement of happiness changes over time, the level of happiness is not comparable across different time periods. This chapter uses the British Household Panel Survey to estimate the criteria of people's happiness levels. It finds that the measurement is not consistent across time.

Chapter V investigates the effect of the exchange-rate fluctuation on the employment adjustment of regular and non-regular workers by using heterogeneous dependence on international trade across firms for identification. The analysis of Japanese firm-level panel data reveals that appreciation of the yen decreases the employment of exporting firms. The adjustment elasticity of non-regular employment is seven to eight times larger than that of regular employment. Regular employment reacts more to the permanent exchange rate shocks extracted by the Beverage and Nelson decomposition whereas non-regular employment reacts less. The estimation results suggest a significant difference of adjustment costs between regular and non-regular employment in the Japanese segmented labor market.

Chapter VI concludes this dissertation.

Chapter II

Estimating Upward Bias of Japanese Consumer Price Index Using Engel's Law

1 Introduction

The general consumer price index (CPI) represents the cost of living and the inflation rate. The nature of the CPI as a cost of living index entails many policies, such as public pension benefits, that are linked to the CPI. Despite the importance of the CPI as a cost of living index, it has been criticized for its upward bias based on several grounds, including the consumers' substitution behavior and improper sampling of surveyed items (Shiratsuka, 1999). An overstated cost of living index directly leads to the overcompensation of associated beneficiaries and excessive government spending. Moreover, the Bank of Japan recently adopted a two-percent annual inflation rate target as measured by the CPI. This policy change makes an analysis of the CPI bias increasingly important.

Several studies have estimated the bias in Japan's CPI. Shiratsuka (1999) estimated the size of the overall bias as 0.9 percentage points per year. Ariga and

Matsui (2003) concluded that the CPI is upwardly biased by at least 0.5 percentage points per year. Measuring the bias in Japan's CPI based on the calculation methodology and bias estimates of the U.S. CPI, Broda and Weinstein (2007) concluded that Japan's CPI overstates the cost of living by approximately 1.8 percentage points per year. These studies analyzed the causes of the CPI bias such as the limitations of the price survey, calculation methods, and exclusion of the effects of new product rotations and quality improvements. Then, they added up all the causes and estimated the size of the CPI bias. Watanabe and Watanabe (2014) constructed a daily price index using scanner data and found that the CPI inflation rate was 0.5 percentage points higher than the corresponding inflation rate.

Following a different approach from previous studies, this chapter applies the Engel curve method suggested by Hamilton (2001) and Costa (2001)-used for examining the bias of the U.S. CPI-to estimate the overall bias of Japan's CPI. The Engel curve method exploits the fact that the change in the share of food expenditure represents the change in real income after accounting for the change in relative food prices. If the CPI correctly represents the cost of living and household preferences are stable, then the CPI-deflated Engel curve should be stable across different periods after the relative price change in food and household characteristics are controlled for. Using this approach, a shift of the Engel curve from one year to the next indicates the CPI bias. Several previous studies have relied on this method (Beatty and Larsen, 2005 for Canada; Barrett and Brzozowski, 2010 for Australia; Chung, Gibson, and Kim, 2010 for Korea). In contrast to previous Japanese studies wherein the CPI bias was analyzed in terms of its causes, this approach estimates the overall CPI bias.

In addition, this chapter analyzes the causes of this bias from the viewpoint of the opportunity cost of shopping. Aguiar and Hurst (2007) and Abe and Shiotani (2014) analyzed the relationship between the prices faced by households and their frequency of shopping. Both studies suggested that households that have enough time to find lower commodity prices (e.g., households comprising elderly members) may face a lower inflation rate. Therefore, based on the same idea, this chapter estimates the bias for households featuring either an employed or an unemployed spouse. A household having more time for shopping can seek out lower-priced or discounted goods as a substitute for more expensive goods. Consequently, the household faces lower relative prices that suggest a greater upward bias of the official CPI.

The results of this chapter indicate that the overall bias between 1989 and 2004 was 0.53 percentage points per year for households with household heads aged 20-59 years. This bias is substantial considering that the official inflation rate during this period was 0.65 percent per year. In addition, based on an analysis of household characteristics, households featuring an unemployed spouse faced an upward bias of 0.55 percentage points per year that is substantially larger than the bias of 0.45 percentage points per year for households featuring an employed spouse. Thus, households featuring an unemployed spouse experienced lower inflation. Presumably, households featuring an unemployed spouse can allocate more time for shopping and searching for bargains.

2 Model

This chapter follows the approach of Hamilton (2001) and Costa (2001) to estimate Japan's CPI bias. This approach depends on five assumptions. First, this chapter assumes that the income elasticity of food is less than unity, which implies that food share declines as real income increases and facilitates an inference of real income from food share. Second, food has no durability, so food expenditure is identical to food consumption. This implies that food expenditure in one period cannot lead to food consumption in another period. Third, the food component can be separated from the non-food component by a utility function, which implies that the CPI bias of non-food items does not affect food share through an unexpected mechanism. Fourth, household preferences are stable over time. This condition ensures that the shift of the Engel curve is caused only by the CPI bias. To control for changes in household preference, several household demographic variables are included in a regression equation. Fifth, the relative CPI bias between food and non-food items is constant over time. This implies that the bias between food and non-food prices is of the same size. As this might be a strong assumption, the effect of violating this assumption on the bias estimates is discussed in this chapter.

To estimate the CPI bias, this chapter proceeds as follows. Firstly, an Engel curve is derived from the almost ideal demand system (AIDS) by Deaton and Muellbauer (1980). It can be expressed as a linear function of food share and the log of real income:

$$\omega_{it} = \phi + \gamma(\ln P_t^f - \ln P_t^{nf}) + \beta(\ln Y_{it} - \ln P_t) + X'\theta + u_{it}, \tag{1}$$

where ω_{it} is the food–income ratio of household i at time t and Y is the nominal household income. The terms P^f, P^{nf}, and P are true but unobservable price indices of food, non-food items, and all goods, respectively. The vector X represents the household characteristics, and u is the error term.

Secondly, the true price index of all goods is defined as the weighted average of the true price indices of food and non-food items:

$$\ln P_t = \alpha \ln P_t^f + (1-\alpha) \ln P_t^{nf}. \tag{2}$$

Each true price index is obtained by removing the error term from the observed price index:

$$\ln P_t^G = \ln P_t'^G + \ln(1 + E_t^G), \tag{3}$$

where P' is the observed price index and G represents food, non-food items, and all goods. The term E_t is the percent cumulative measurement error in the cost of living index from time 0 to time t. In this chapter, the term E_t represents the cumulative CPI bias.

Thirdly, by defining $y \equiv \ln Y$, $\pi \equiv \ln P'$, and $\varepsilon \equiv \ln(1+E)$ and substituting two price assumptions, the estimated Engel curve is

$$\begin{aligned}\omega_{it} &= \phi + \gamma(\pi_t^f - \pi_t^{nf}) + \beta(y_{it} - \pi_t) + X'\theta + \gamma(\varepsilon_t^f - \varepsilon_t^{nf}) - \beta\varepsilon_t + u_{it} \\ &= \phi + \gamma(\pi_t^f - \pi_t^{nf}) + \beta(y_{it} - \pi_t) + X'\theta + \textstyle\sum_{t=1}^{T} \delta_t D_t + u_{it}, \end{aligned} \tag{4}$$

where D_t represents the year dummy and $\delta_t = \gamma(\varepsilon_t^f - \varepsilon_t^{nf}) - \beta\varepsilon_t$. Then,

$$\varepsilon_t = \frac{-\delta_t}{\beta} + \frac{\gamma}{\beta}(\varepsilon_t^f - \varepsilon_t^{nf}). \tag{5}$$

Based on the fifth assumption, which assumes the constant relative bias between food and non-food price indices $\varepsilon_t^f = \varepsilon_t^{nf}$,

$$\varepsilon_t = \ln(1+E_t) = \frac{-\delta_t}{\beta}. \tag{6}$$

Finally, one can calculate the cumulative percentage points of the CPI bias at time t, where

$$BIAS_t^{linear} = 1 - \exp\left(\frac{-\delta_t}{\beta}\right). \tag{7}$$

Costa (2001) applies the quadratic functional form of the Engel curve, which can be expressed as follows:

$$\omega_{it} = \mu + \gamma(\pi_t^f - \pi_t^{nf}) + \beta_1(y_{it} - \pi_t) + \beta_2(y_{it} - \pi_t)^2 + X'\theta + \textstyle\sum_{t=1}^{T} \delta_t D_t + v_{it}. \tag{8}$$

When the relative bias is constant, the cumulative bias is calculated as follows:

$$BIAS_t^{quadratic} = 1 - \exp\left(\frac{\beta_1 + \sqrt{\beta_1^2 + 4\beta_2\delta_t}}{2\beta_2}\right). \tag{9}$$

The annual bias is calculated as follows:

$$annual\ bias = ((1 + BIAS)^{\frac{1}{period}} - 1) \times 100, \tag{10}$$

where *BIAS* is as defined in equation 7 or 9, and *period* is the sample period from the base year.

3 Data

This section introduces the data set used in this chapter and explains the construction of the analysis sample. The cross-sectional data set is sourced from the National Survey of Family Income and Expenditure conducted by the Ministry of Internal Affairs and Communication. This survey collects comprehensive data on family incomes, expenditures, savings, debts, durable consumer goods, and assets. Starting in 1959, this survey has been conducted every five years thereafter. It covers households with two or more people as well as single person households. Households with two or more people were surveyed during the three-month period from September to November, whereas single person households were surveyed in October and November. Each household was requested to fill in a household consumption diary, household questionnaire, consumer durables questionnaire, and income and savings questionnaire.

This chapter used 80 percent resampled and anonymized data sets for 1989, 1994, 1999, and 2004, and focused on the sample of households with two or more people. Each data set contained approximately 45,000 households. Considering the Retirement-Savings Puzzle, the sample was restricted to households with heads aged 20-59 years. As shown in Banks, Blundell, and Tanner (1998), household which a household head experienced a retirement would change the consumption behavior.

Further, as discussed in Aguiar and Hurst (2007) and Abe and Shiotani (2014), the elderly have sufficient time to seek lower-priced food. Therefore, this chapter focuses on estimating the CPI bias for households with household heads aged 20-59 years. Households headed by persons who are farmers or fishermen were excluded taking into consideration the matter of personal consumption. Expenditure on housing was also excluded considering the matter of imputed rent. Further, expenditure on alcoholic beverages and food consumed outside the house were excluded, as the Engel curves for these items would be increasing or have an inverted U-shape and thus differ from those for the other food items (Banks, Blundell, and Lewbel, 1997).

Food share, obtained by dividing food expenditures by living expenditures, was used as a dependent variable that takes a value between zero and one. Based on the definition of expenditure categories, this chapter uses living expenditure to represent households' permanent income; in contrast, Hamilton (2001) used family income and Costa (2001) used total expenditure. The exclusion of alcoholic beverages and food consumed outside the house produced negative food and living expenditure values.[1] Thus, the sample of food share was restricted to values between zero and one. To exclude observations involving unusual food demand, the sample was trimmed at the 3rd and 97th percentiles of the cross-sectional distributions of food share and real living expenditure for each survey year. Without the trimming, the Engel curves predicted that food shares would be negative at some expenditure levels.

The independent variable includes the real living expenditure, relative price

[1]Some households reported zero values for expenditure, food expenditure, or income even if they reported non-zero values for annual income, food consumption, rent, or savings. For unknown reasons, these respondents did not spend during the sample period.

of food and non-food items, family characteristics, year dummy variables, and the regional dummy variable. Real living expenditure was deflated by the official Japanese CPI. The demographic controls are as follows: the number of adult family members aged 18-59 years, the number of elderly people (i.e., family members aged 60 years or more), the number of preschool children, the number of children in elementary school, and the number of children attending junior high or high school.

The control variable also included a dummy variable for being employed, which takes the value one if the household head was employed; the job type of the household head; and the age of the household head. Industry dummy variables associated with the household head's job were also included under various industrial categories: mining; construction; manufacturing; electricity, gas, heat supply, and water; transportation and communication; wholesale and retail trade; finance and insurance; real estate; service; government; and others. The year dummy variables were for 1989, 1994, 1999, and 2004. The regional dummy variable takes the value one if the household lived in an urban area.

Price indices were constructed as follows. The official 2010-based price indices, as reported by the government, were used for the Japanese CPI, food price index, and non-food price index. The definition of urban area in the National Survey of Family Income and Expenditure data included small cities near the main cities and differed from the definition used in the CPI data; therefore, nationwide price indices were used for households living in rural areas, whereas the price indices of cities with a population exceeding 50,000 were used for households living in urban areas. Three price indices were constructed: excluding alcoholic beverages, excluding food consumed outside the house, and excluding housing.[2]

[2]The calculation method is explained in Appendix.

4 Empirical Analysis

4.1 Analysis of summary statistics

Table 2.1 shows the summary statistics of food share and real living expenditure per month for each sample year. Food share decreased by 3.9 percentage points (15 percent) during the sample period-from 25.96 percent in 1989 to 22.06 percent in 2004. The substantial decrease in food share implies an improvement in the standard of living and necessitates an increase in real living expenditure. However, real living expenditure decreased by approximately six percent during the sample period-from 242,950 yen in 1989 to 229,450 yen in 2004.[3] This skewed relationship suggests an underestimation of the deflated CPI real living expenditure because of an upward bias in the CPI.

Table 2.2 shows the summary statistics of the demographic variables for household characteristics such as the job type and age of the household head, the rate of homeownership, and the proportion of households living in urban areas. The table shows that more than 40 percent of the household heads were engaged in either the manufacturing or the service industry. The share of manufacturing jobs decreased by 4 percentage points from 1989 to 2004, in contrast to a 3.5 percentage point increase in service-related jobs. In this data set, household heads aged 20-24 years constituted less than one percent of the total. Most household heads were more than 30 years old.

Table 2.3 shows the changes in the number of children.[4] This table shows that the proportion of households with no children increased over time. Approximately 30 percent of households in 1989 and 40 percent of households in 2004 had no

[3]The trends noted in the National Health and Nutrition Survey indicated that calorie intake dropped by 124 kilo calories (6 percent) between 1990 and 2004, which suggests a decrease in food consumption. However, if this trend resulted in higher expenditure on other goods, it might imply that the standard of living was improved.

[4]The definition of children included preschool children and those who attended elementary school, junior high, and high school.

children. Although the proportion of single-child households was almost stable during the sample period, households with two children declined by approximately 10 percentage points.

Figure 2.1 shows the Engel curves, specified as quadratic functions of the real living expenditure, for each survey year. If Japan's CPI accurately corresponded to changes in the true cost of living, then the Engel curves would be stable across different periods. However, this figure shows that the curves shifted further downward in succeeding periods. This implies that the CPI was potentially upwardly biased.

4.2 Analysis of overall bias

To estimate the Engel curve, food share was regressed on the log of real living expenditure, individual year dummy variables, the log of relative prices, and dummy variables of family characteristics: being a homeowner, living in urban areas, being employed, the job types of the household head, the age of the household head as well as the number of adults, elderly people, preschool children, children in elementary school, and children in junior high or high school. To estimate the quadratic Engel curve, the quadratic term of the log of real living expenditure was included as an independent variable. Table 2.4 shows the regression results for the linear and quadratic Engel curves. Using the linear model, the coefficient of the log of real living expenditure was statistically significant at the one percent significance level. The result shows that food share declined as real living expenditure increased. A 1-percent increase in real living expenditure resulted in a 0.17-percent decrease in food share. In terms of the quadratic specification, the coefficient of the quadratic term was statistically significant at the one percent significance level. This result shows that the quadratic Engel curve nests in the linear specification and is more appropriate.[5] It implies that the linear Engel curve might overestimate the bias. The income elasticities of the two specifications are approximately 0.440, evaluated at the sample means of food share and the log of real living expenditure.

The crucial variable in this chapter is the year dummy variable. As previously noted, if Japan's CPI was unbiased and corresponded to the true cost of living, the Engel curve would be stable across the sample period. If so, the parameters of the year dummy variables would not differ from zero. However, the regression results from both the linear and quadratic models showed that the dummy variables-dummy-94, dummy-99, and dummy-04-were statistically significant and negative. This finding corroborates with an upward bias in the official Japanese CPI.

Estimates of the annual bias are reported in Table 2.5. Based on the linear Engel curve, the overall upward bias between 1989 and 2004 was 1.73 percentage points per year. The annual bias increased with every successive five-year period: 1.69 percentage points during 1989-1994, 2.04 percentage points during 1994-1999, and 2.55 percentage points during 1999-2004. Based on the quadratic Engel curve, the overall bias was 0.5 percentage points per year from 1989 to 2004-a lower bias compared with that of the linear model. Furthermore, though the bias was much lower compared with that of the linear model, it increased in later periods: 0.45 percentage points during 1989-1994, 0.55 percentage points during 1994-1999, and 0.69 percentage points during 1999-2004.

The 1.7-percentage-point annual CPI bias estimate based on the linear Engel curve was larger than the 0.9-percentage-point bias estimated by Shiratsuka (1999) but close to the 1.8-percentage-point bias reported by Broda and Weinstein (2007). In contrast, the 0.5-percentage-point CPI bias estimate based on the quadratic Engel curve was much lower compared with these two studies; this bias

[5]Unayama (2008) estimated the quadratic coefficient in an AIDS for food and other goods using the Japanese Family Income and Expenditure Survey data from 1982 to 2000. The author did not find evidence of a significant quadratic form for food. It focused on households with married couple with no children, living in their own house. The difference in results might be due to sample construction differences.

estimate is similar to the lower bound reported by Ariga and Matsui (2003) and the estimate by Watanabe and Watanabe (2014). As the regression result shows that the quadratic term is statistically significant, the estimated annual bias from the linear model could be overestimated. The estimate of Broda and Weinstein (2007) based on the U.S. CPI bias was much higher than the estimates of Shiratsuka (1999), Ariga and Matsui (2003), and this chapter. As expressed by Shiratsuka (1999), several differences such as the individual price surveys in Japan and the U.S. may have caused the large differences in the results. Shiratsuka (1999) obtained a 0.9-percentage-point CPI bias per year; the key cause of this CPI bias was the quality adjustment of items, which resulted in a 0.7-percentage-point CPI bias per year. To obtain this result, the author applied the hedonic approach for pricing personal computers, camcorders, automobiles, and apparel. The quality improvement of these items may be much higher than that of the other items, so the bias estimates may be overestimated.

The estimation method employed herein contains any potential bias driven by, for example, the calculation method and price survey. If the CPI is upwardly biased for any reason, the real living expenditure (or real income) would be underestimated. Consequently, this method estimates the CPI bias as the downward shift of the Engel curve. Thus, this approach acknowledges the critiques made in previous studies and more comprehensively estimates the CPI bias.

Estimates of the annual bias indicate that the official Japanese CPI and inflation rate are likely to be upwardly biased. Figure 2.2 shows the official and revised Japanese CPI. The revised CPI was obtained from equation 3 and the estimated annual bias. This figure shows that the official CPI is placed above the revised CPI. In 2004, the cumulative bias amounted to almost 7 percentage points. The revised CPI implies lower inflation and, thus, more serious deflation. It shows moderate inflation from 1992 to 1998 and subsequently severe deflation, which is more acute than that suggested by the official CPI. The inflation rate based on the official

CPI was 0.65 percent from 1989 to 2004. This contrasts with the 0.14 percent inflation rate based on the revised CPI for the same period. Moreover, the bias correction suggests severe deflation after 1998 when the annual deflation rate was 0.95 percent based on the corrected CPI compared with 0.36 percent according to the official CPI.

4.3 Analysis by demographics

The above discussion shows that the CPI was upwardly biased and presents the degree of bias across the sample period. This subsection analyzes the causes of the bias by examining the differences in the bias across demographic groups, which presumably represent the differences in the opportunity cost of shopping.

In principle, the Ministry of Internal Affairs and Communications collects normal retail prices and service charges and excludes outlet or discount sale prices in its Retail Price Survey.[6] In addition, the survey specifies the names of brands for specific goods. This implies that lower-level substitution is implicitly assumed away (Broda and Weinstein, 2007). Aguiar and Hurst (2007) and Abe and Shiotani (2014) analyzed the relationship between the prices that households encounter and their frequency of shopping. Both studies suggested that households with sufficient time to find lower prices for commodities (e.g., households comprising elderly members) face lower inflation. Thus, this section estimates the CPI bias between households featuring an employed and unemployed spouse. Compared with households featuring an employed spouse, households featuring an unemployed spouse may have more time to locate lower-priced, discounted goods and may substitute more

[6] The Retail Price Survey is designed to collect nationwide information on the prices of goods, services, and house rents to calculate the CPI and other statistics. It originally started in 1950 and principally collects monthly price information. In April 2013, about 710 brands among approximately 510 items were surveyed for the price of goods. The set of surveyed brands and items are revised every five years. The enumerators visit stores and obtain prices through interview surveys. In principle, the survey collects normal retail prices and service charges for specific brand items at each store. The price information related to bargain sales, clearance sales, and discount sales that last less than seven days are excluded. The prices of auctioned and second-hand goods are also excluded.

expensive goods with these lower-priced goods. According to the Survey on Time Use and Leisure Activities, by the Ministry of Internal Affairs and Communications, the weekly average time allocated for shopping by a household where both the head of the household and the spouse are employed is 44 minutes in 2006. In contrast, the weekly average time spent on shopping by a household with an employed head and an unemployed spouse is 66 minutes. This means that a household featuring an employed spouse cannot spend as much time on shopping as a household featuring an unemployed spouse. Therefore, this situation results in a larger upward bias for households featuring an unemployed spouse.

Table 2.6 shows the bias estimates for households featuring an employed or unemployed spouse. Households featuring an unemployed spouse faced an overall bias of 0.55 percentage points per year from 1989 to 2004 compared with 0.45 percentage points for those featuring an employed spouse. This means that households featuring an employed spouse presumably had less shopping time, resulting in a lower upward bias. A household featuring an unemployed spouse can spend more time looking for cheaper goods and therefore faces lower inflation, resulting in a larger CPI bias for the household. This result implies a similar conclusion as previous studies. If a household can allocate more time for shopping or go shopping more frequently, it faces lower prices and lower inflation. Therefore, excluding outlet and discounted sale prices from government surveys and not allowing for lower-level substitution are some of the reasons for the upward bias in the official CPI.

4.4 Robustness check when a constant relative bias assumption is violated

The above analysis assumes that the relative bias between food and non-food items is of the same size, the fifth assumption in the model section. This section estimates the bias when this assumption is violated. This means that the CPI bias is expressed as follows:

$$\begin{aligned}\ln \varepsilon_t &= \alpha \ln \varepsilon_t^f - (1-\alpha) \ln \varepsilon_t^{nf} \\ &= \alpha \ln \varepsilon_t^f - (1-\alpha) \ln \varepsilon_t^f / k \\ &= \ln \varepsilon_t^f - (1-\alpha) \ln k,\end{aligned}$$

where k is the size of the relative bias between food and non-food items $(\varepsilon_t^f / \varepsilon_t^{nf})$ and α is the weight between food and non-food prices. Equation 9 becomes:

$$BIAS_t^{quadratic} = 1 - \exp\left(\frac{\beta_1 + \frac{\gamma(1-k)}{1-\alpha(1-k)} + \sqrt{\left(\beta_1 + \frac{\gamma(1-k)}{1-\alpha(1-k)}\right)^2 + 4\beta_2\delta_t}}{2\beta_2} \right). \quad (11)$$

If the bias of non-food price is larger than the bias of food price, which means that k is less than 100 percent, then the true bias estimates would be larger than the estimates of the CPI bias under the constant relative bias assumption. Conversely, if the bias of food price is larger than the bias of non-food price, which means that k is greater than 100 percent, then the true bias estimates would be smaller than the estimates when the relative bias is constant.

Table 2.7 calibrates the annual bias under several values of k because there is no exact number for the degree of relative bias between food and non-food prices. If the relative bias did not exist, i.e., k is 100 percent, then the estimate of the CPI bias is 0.52 percentage points. If the relative bias is 99 percent, the estimate of the CPI bias is also 0.52 percentage points. These estimates are very close to the size of the bias under the equal relative bias assumption, the fifth assumption. This table shows that the smaller the relative bias is, the larger the bias estimates are. If the relative bias is 80 percent, the estimated size of the bias is 0.61 percentage points. The greater the size of the relative bias is, the smaller the bias estimates are. The estimate is 0.46 percentage points when the relative bias is 120 percent. These estimates mean that if the constant relative bias assumption is violated, then the CPI bias is larger or smaller than the bias estimate under this assumption. However, if the relative bias is within the reasonable range of 80-100 percent, then the CPI bias falls in the range of 0.46-0.61 percentage points. Therefore, a consideration of the differential bias does not significantly alter the previous condition that the annual CPI bias is approximately 0.53 percentage points.

4.5 Robustness check when the price index weight differs among households

In the definition of the price index of all goods, the weight between true price indices of food and non-food, α, takes a constant value. However, the share of food expenditure differs among households. This implies that the weight might be different for each household. This section estimates the CPI bias when the weight α is replaced with the food expenditure share. Equation 2 is now expressed as follows:

$$\ln P_t = \omega_i \ln P_t^f + (1 - \omega_i) \ln P_t^{nf}. \tag{12}$$

With this expression, equation 11 is expressed as follows:

$$BIAS_{it}^{quadratic} = 1 - \exp\left(\frac{\beta_1 + \frac{\gamma(1-k)}{1-\omega_i(1-k)} + \sqrt{\left(\beta_1 + \frac{\gamma(1-k)}{1-\omega_i(1-k)}\right)^2 + 4\beta_2\delta_t}}{2\beta_2} \right). \tag{13}$$

Taking summation for i, the CPI bias is estimated as follows:

$$\overline{BIAS}_t^{quadratic} = \frac{1}{N}\sum_{i=1}^{N}\left\{1 - \exp\left(\frac{\beta_1 + \frac{\gamma(1-k)}{1-\omega_i(1-k)} + \sqrt{\left(\beta_1 + \frac{\gamma(1-k)}{1-\omega_i(1-k)}\right)^2 + 4\beta_2\delta_t}}{2\beta_2}\right)\right\}$$

$$= 1 - \exp\left(\frac{\beta_1 + \frac{\gamma(1-k)}{1-\bar{\omega}(1-k)} + \sqrt{\left(\beta_1 + \frac{\gamma(1-k)}{1-\bar{\omega}(1-k)}\right)^2 + 4\beta_2\delta_t}}{2\beta_2}\right). \qquad (14)$$

Table 2.8 is the estimated result of the CPI bias when the price index weight is replaced with the food expenditure share. When the price index weight was a constant, the size of the bias was 0.53 percentage points per annum between 1989 and 2004. If the price index weight was varied among households, the estimated size of the CPI bias was 0.54 percentage points per annum between 1989 and 2004. The size of the bias varies from 0.48 percentage points to 0.63 percentage points when the constant relative bias assumption is violated. This result means that the bias was within the reasonable range even if the weight between food price and non-food price differed among households.

5 Summary and Conclusion

Using the National Survey of Family Income and Expenditure data, this chapter estimated the upward bias in Japan's CPI based on Engel's law. The estimated overall bias was 0.53 percentage points per year between 1989 and 2004. This estimate was close to the lower bound reported by Ariga and Matsui (2003) and the estimate by Watanabe and Watanabe (2014) but lower than the result reported by Shiratsuka (1999) and Broda and Weinstein (2007). Previous studies have analyzed the CPI bias in terms of its causes. However, this chapter applied a different approach to estimating the Engel curve by calculating the overall CPI bias and thereby including all causes of the CPI bias. The method relied on several assumptions, especially the relative bias between food and non-food prices. If the relative bias of non-food price is greater than that of food price, then the estimates in this chapter are underestimations. If the relative bias of food price is greater than that of non-food price, then the estimates in this chapter are overestimations. The differences in the bias estimates, however, are minimal when the relative bias between food and non-food prices is within a plausible range. Also, even if the price index weight between food price and non-food price was varied among households, this effect was limited.

The 0.53 percentage point upward bias implies that the official CPI overstates the true cost of living. Consequently, the bias-corrected annual inflation rate from 1989 to 2004 is estimated to be 0.14 percent, whereas the official inflation rate is 0.65 percent during the same period. The deflation during this period was severe, especially after 1998 when the deflation rate was 0.95 percent compared with 0.36 percent based on the official statistics. These results suggest that government payments linked to Japan's CPI, such as pension benefits, may overcompensate the recipients.

A demographic analysis showed that households featuring an unemployed spouse face lower inflation and create a greater bias compared with households featuring an employed spouse, as they presumably have more time to shop and seek out lower-priced goods. The results suggest that excluding sales based on discounts and brand substitution is an important source of Japan's CPI bias.

Appendix

This analysis eliminates the effects of alcoholic beverages, food consumed outside the house, and the cost of housing. Accordingly, Japan's CPI, food prices, and non-food prices are calculated as follows. For CPI,

$$\text{CPI} = \frac{p_T \times w_T - p_A \times w_A - p_O \times w_O - p_H \times w_H}{w_T - w_A - w_O - w_H}.$$

For food price,

$$\text{food-price} = \frac{p_F \times w_F - p_A \times w_A - p_O \times w_O}{w_F - w_A - w_O}.$$

For non-food price,

$$\text{non-food-price} = \frac{p_T \times w_T - p_F \times w_F - p_H \times w_H}{w_T - w_F - w_H}.$$

The variables p_T, p_F, p_A, p_O, and p_H are the price indices of all goods, food, alcoholic beverages, food consumed outside the house, and cost of housing. The variables w_T, w_F, w_A, w_O, and w_H, respectively, represent the weights of these variables.

Table 2.1: Summary statistics of standard of living

Year	1989	1994	1999	2004
Observations	29,594	28,745	26,723	23,820
Food share (%)	25.96	23.34	22.75	22.06
	(10.85)	(10.45)	(10.82)	(10.86)
Real living expenditure	242.95	245.74	235.68	229.45
per month (1000 yen)	(109.03)	(118.16)	(117.03)	(119.71)

Source: National Survey of Family Income and Expenditure.

Notes: Food share is obtained by dividing the food expenditure by real living expenditure. Real living expenditure per month is deflated by the official 2010-based CPI. Standard deviations are provided in parentheses.

Table 2.2: Summary statistics of the demographic variables

	1989	1994	1999	2004
Variable	Percent	Percent	Percent	Percent
Household head employed	98.00	98.18	97.47	97.28
Household head jobs				
Mining	0.32	0.22	0.16	0.18
Construction	12.53	12.43	13.05	12.31
Manufacturing	25.54	24.45	23.40	21.57
Electricity, gas, heat supply and water	1.29	1.41	1.29	1.48
Transportation and IT	9.08	9.12	8.58	9.39
Wholesale and retail trade	15.58	15.34	14.72	14.41
Finance and insurance	3.56	3.66	3.39	3.23
Real estate	0.78	0.81	0.93	0.99
Service	18.46	20.14	21.43	22.04
Government	10.78	10.55	10.59	11.82
Others	2.06	1.85	2.45	2.58
Household head's age				
20-24	0.75	0.79	0.84	0.63
25-29	5.06	4.69	5.19	4.32
30-34	11.46	11.15	10.80	10.38
35-39	18.47	15.19	14.03	14.13
40-44	20.64	19.43	16.68	16.05
45-49	17.73	19.31	18.28	17.20
50-54	13.74	16.57	18.08	18.30
55-59	12.16	12.88	15.98	18.85
Home owner	70.44	65.67	67.82	70.31
Living in urban area	40.60	42.37	42.70	40.92

Source: National Survey of Family Income and Expenditure.

Table 2.3: Summary statistics of the numbers of children

	1989	1994	1999	2004
	Percent	Percent	Percent	Percent
Total children				
0	27.88	33.71	37.31	38.82
1	21.93	22.12	21.78	22.88
2	36.05	31.37	29.29	27.90
3	13.09	11.95	10.59	9.50
4	0.98	0.80	0.98	0.76
5	0.07	0.07	0.06	0.14

Source: National Survey of Family Income and Expenditure.

Table 2.4: Results of selected regression coefficients

	Linear model coefficient	Quadratic model coefficient
Constant	2.49***	5.79***
	(0.01)	(0.17)
Log (real living expenditure)	-0.17***	-0.71***
	(0.00)	(0.03)
(Log (real living expenditure))^2		0.02***
		(0.00)
Dummy-94	-0.04***	-0.04***
	(0.00)	(0.00)
Dummy-99	-0.05***	-0.05***
	(0.00)	(0.00)
Dummy-04	-0.07***	-0.07***
	(0.00)	(0.00)
Observations	108,882	108,882
Adjusted R-squared	0.40	0.40

Source: National Survey of Family Income and Expenditure.

Note: Results are obtained by regressing food share on the log of real living expenditure, the log of relative price, and the dummy variables of homeowner, living in urban areas, employment status, job type, age, adult, elderly people, preschool children, children in elementary school, children in junior high or high school, and year. Robust standard errors are in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 2.5: Annual bias (percentage points)

	1989-2004	1989-1994	1994-1999	1999-2004
Linear model	1.73	1.69	2.04	2.55
	(0.02)	(0.09)	(0.08)	(0.09)
Quadratic model	0.53	0.45	0.53	0.69
	(0.02)	(0.03)	(0.03)	(0.03)

Source: National Survey of Family Income and Expenditure.

Note: Standard errors from 500 bootstrap replications are provided in parentheses.

Table 2.6: Annual bias by demographics (percentage points)

	1989-2004	1989-1994	1994-1999	1999-2004
Household head is employed	0.55	0.53	0.50	0.71
and spouse is unemployed	(0.03)	(0.04)	(0.04)	(0.05)
Household head is employed	0.45	0.33	0.48	0.59
and spouse is employed	(0.02)	(0.03)	(0.04)	(0.04)

Source: National Survey of Family Income and Expenditure.
Note: Results are obtained by regressing food share on the log of real living expenditure, the quadratic term of the log of real living expenditure, the log of relative price, and dummy variables of the homeowner, living in the urban areas, employment status, job type, age, adult, elderly people, and year. Standard errors from 500 bootstrap replications are provided in parentheses.

Table 2.7: Robustness check when a constant relative bias assumption is violated (percentage points)

Relative bias ($\varepsilon_t^f/\varepsilon_t^{nf}$)	1.20	1.15	1.10	1.05	1.01	
CPI bias estimates	0.46	0.47	0.49	0.50	0.52	
with a quadratic model	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	
Relative bias ($\varepsilon_t^f/\varepsilon_t^{nf}$)	1.00	0.99	0.95	0.90	0.85	0.80
CPI bias estimates	0.52	0.52	0.54	0.56	0.58	0.61
with a quadratic model	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)

Source: National Survey of Family Income and Expenditure.

Note: Standard errors from 500 bootstrap replications are provided in parentheses. The term α, which is the weight between food prices and non-food prices in equation 2, is 0.25; this is taken from the weight of the 2010-based official CPI.

Table 2.8: Robustness check when the price index weight differs among households (percentage points)

Relative bias ($\varepsilon_t^f/\varepsilon_t^{nf}$)	1.20	1.15	1.10	1.05	1.01	
CPI bias estimates	0.48	0.50	0.51	0.53	0.54	
with a quadratic model	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	
Relative bias ($\varepsilon_t^f/\varepsilon_t^{nf}$)	1.00	0.99	0.95	0.90	0.85	0.80
CPI bias estimates	0.54	0.55	0.56	0.58	0.61	0.63
with a quadratic model	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)	(0.04)

Source: National Survey of Family Income and Expenditure.

Note: Standard errors from 500 bootstrap replications are provided in parentheses.

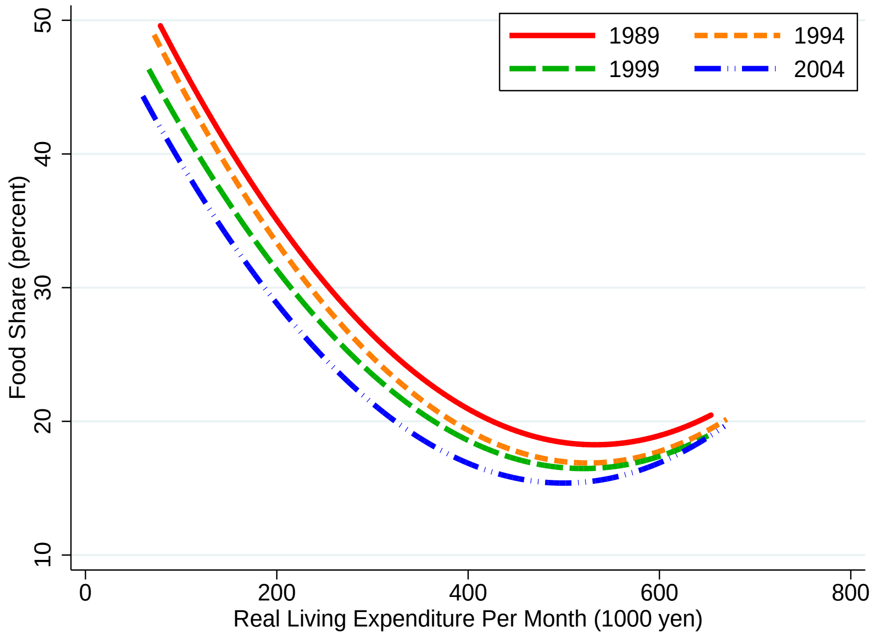

Figure 2.1: Engel curves

Source: National Survey of Family Income and Expenditure.

Note: The lines represent simple Engel curves for each year.

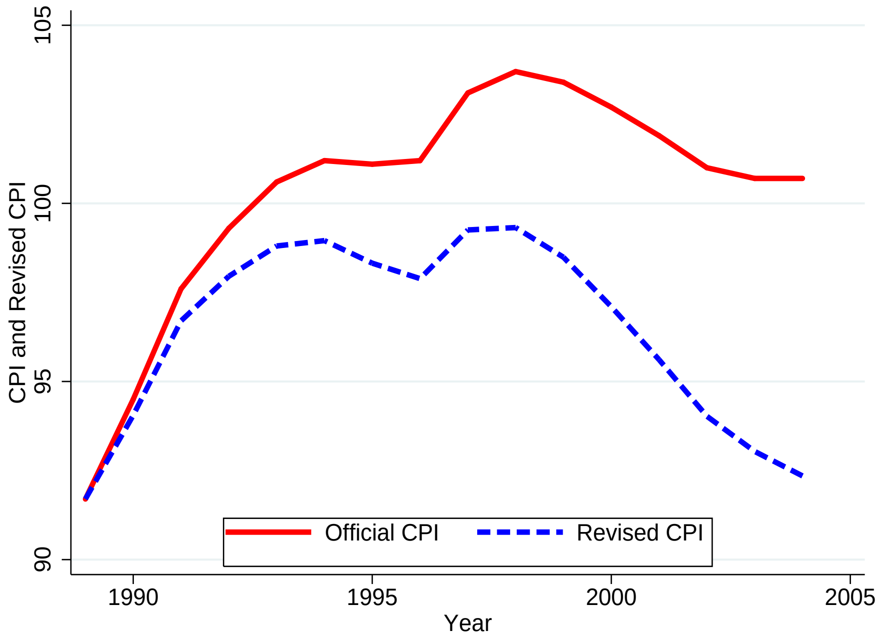

Figure 2.2: CPI and revised CPI

Source: Official CPI statistics. Revised CPI is based on author's calculations.

Chapter III

The Gender Gap in Japanese Household Educational Spending

1 Introduction

In Japan, the persistent difference between the wage of men and women is a cause for concern. The gender wage gap, defined as women's wage as a percent of men's wage, was 60.2 percent in 1989. Although the gap has decreased since then, it remained at 67.5 percent in 2004 (Figure 3.1).

One of the causes of the gender wage gap could be the longstanding gender difference in the university entrance rate (Figure 3.2). While the university entrance rate of males was 34.1 percent in 1989, it has been increased to 49.3 percent in 2004. For females, the university entrance rate was much lower than that of males; it was 14.7 percent in 1989, though increasing substantially to 35.2 percent in 2004. Therefore, the gap in the university entrance rate between males and females still exists but it has been decreasing. On the other hand, the entrance rate for two-year college is larger for females (Figure 3.3). The rate for males was almost stable around 1.7 percent between 1989 and 2004. The college entrance rate for females was 22.1 percent in 1989, decreasing to 13.5 percent in 2004. As mentioned in

Hirao, Nagai, and Sakamoto (2007), attendance of university rather than two-year colleges is becoming increasingly popular for females.

This trend implies that girls have started to receive more educational spending than before to enter a university. Several studies have analyzed the gender difference in intra-household educational spendings in many countries. Among developing countries, Subramanian and Deaton (1991) have studied the gap in India and have found that sons aged between 10 and 14 years are weakly favored in educational spending. Several studies have applied the methodology suggested by Subramanian and Deaton (1991) and have found that boys received more educational spending (Deaton, 1997; Kingdon, 2002; Kingdon, 2005; Aslam and Kingdon, 2008; Aslam, 2009). On the other hand, Himaz (2010) has found that Sri Lankan parents spend more on their daughters' education, and daughters aged between 17 and 19 years are more likely to be enrolled in school than sons.

For the case of gender differences on educational expenditure in Japan, Nagase and Nagamachi (2002) have found that parents spend more on education for their sons than for their daughters in both university and junior high school, while daughters receive more educational spending in high school. In addition, Hirao et al. (2007) have analyzed the gap in total education spending, which includes any educational fees such as tuition, school fees, and after-school academic educational expenditure, which is a payment for cram schooling, and found that the tendency for parents to spend more on their sons changed in the late 1990s. They found that in particular, the gap on after-school academic educational expenditure focused on academic subjects has decreased. These results imply that even though boys are expected to go to a better school and to obtain a better job, girls have started to receive more educational spending than before and this might result in the increase of the university entrance rate of females.

This chapter analyzed the gender gap in educational spending in Japan, extending previous studies in two ways. Firstly, we analyzed the gender gap in total education spending and its two components: after-school academic educational expenditure to go to a cram school and after-school non-academic educational expenditure to learn non-academic subjects such as music. Since total educational expenditure includes any spending related to education, through this division, we can identify specific areas of educational investment. On the one hand, parents spend on after-school academic educational expenditure to let their children learn academic subjects, hoping to enable their children to enter a better school and to fetch a well-paid university graduate job. On the other hand, parents spend on after-school non-academic educational expenditure for their children to learn non-academic subjects. While taking lessons may not be directly related to obtaining a well-paid job, in Japan, it plays an important educational role so that children can enjoy playing musical instruments or sports. Thus, these categories represent parents' preferences that we can analyze by gender for educational spending on their children. Further, we estimated the gender gap from 1989 and 2004, extending the analysis for a longer period. The previous studies have considered the 1980s and the 1990s. This chapter includes the 2004 sample to analyze the trend of educational spending.

2 Data

This section explains the data set used in this study and the construction of the sample. This chapter uses cross-sectional data from the National Survey of Family Income and Expenditure of Japan. The survey has been conducted every five years since 1959 to collect comprehensive data on family income, expenditure, saving, debt, durable consumer goods, and assets. It covers single-person households and households of two or more people. A household is asked to fill in the household accounts, household questionnaire, annual income, and educational expenditure questionnaire. This chapter uses 80% re-sampled and anonymized data sets for

1989, 1994, 1999, and 2004, focusing on the sample of households of two or more people. For each year, the data set contains almost 40,000 households. The sample was restricted to households headed by persons aged 20 to 59 years with at least one child.

The educational expenditure categories are defined as follows. Total education spending is the sum of three educational expenditure components: expenditure on education including school fees, after-school academic educational expenditure, and after-school non-academic educational expenditure. School fees include spending on private or public schooling such as entrance fees and tuition, while after-school academic educational expenditure includes spending for cram school to train for academic entrance test at better schools and spending for reference books. The after-school non-academic educational expenditure include spending for non-academic subjects such as music and sports.

The description of the independent variables is as follows. The independent variables include living expenditure, family characteristics, and a dummy variable that captures the region in which the household lived. Family characteristics contain the following variables: the ratio of pre-school children, the ratio of children going to elementary school, the ratio of children going to junior high school, and the ratio of children going to high school. Family characteristics also include the number of family members aged over 60 years, the number of children going to university, the job type dummy variables of the household head, a single-parent dummy variable, and a female head dummy variable. Job dummy variables that indicate the industries of household head's jobs are also included. The single-parent dummy variable takes one if a household has a single parent, and the female head dummy variables takes one if a household has a female head. The regional dummy variable takes one if a household lives in an urban area. All the price variables are realized using the consumer price index which the base year is 2010.

3 Estimation Model

The survey asks the respondents how much they spend on total educational spending, after-school academic educational spending, and after-school non-academic educational spending. It does not have the information on how much they spend on these expenditures for a specific person, a son or a daughter, in a household. We cannot identify whether a spending on after-school academic education is for the son, for the daughter, or both. To assess the analysis with the data, this chapter followed Subramanian and Deaton (1991) as with previous studies of the educational gender gap. The estimation model is that

$$\omega_{it} = \alpha + \beta \ln Y_{it} + \gamma \ln n_{it} + \sum_{k=1}^{4} \delta_k^B (\frac{n_k^B}{n})_{it} + \sum_{k=1}^{4} \delta_k^G (\frac{n_k^G}{n})_{it} + X'\tau + u_{it}, \quad (1)$$

where ω_{it} is educational spending share to real living expenditure for family i in year t, Y is real living expenditure, and n is the number of family members. The variable $\frac{n_k^B}{n}$ is the ratio of boys in the kth education level to the number of household members, for example, the ratio of preschool boys. Similarly, the variable $\frac{n_k^G}{n}$ is the ratio of girls in the kth education level to the number of household members, for example, the ratio of preschool girls. The term k represents the four education levels, which are preschool, elementary school, junior high school, and high school; X contains demographic variables; and u is the error term.

To analyze the gender gap in the household educational spending, the regression equation is tested to see if the coefficient of the share of boys in the kth education level is equal to the coefficient of the share of girls in the kth education level. The coefficient of δ_k^B means that all other things are equal, if the ratio of boys in the kth educational level were increased by one percent, the expenditure share would increase by δ_k^B percent. The interpretation is the same for the coefficients δ_k^G, which is for the girls in the kth education level. If the coefficients are different, this means that there is gender gap in educational spending for children at that education level. The test is applied for all education levels.

4 Empirical Analysis

4.1 Analysis of Summary Statistics

Firstly, Table 3.1 shows the summary statistics for expenditures. Real living expenditure was about 350,000 yen and virtually stable throughout the period from 1989 and 2004. Total education spending increased steadily during the period from 24,809 yen in 1989 to 32,247 yen in 2004. After-school academic spending increased during the period, and it was 5,705 yen in 1989 and 7,643 yen in 2004. The standard deviation of the spending gets larger in the latter periods. After-school non-academic spending also increased during the period, and it was 5,769 yen in 1989 and 6,187 yen in 2004. The standard deviation of this spending also increased during the sample period. About ten percent of households reported zero educational spending. About 50 percent of the households in each period reported zero after-school academic spending and after-school non-academic spending.

Secondly, Table 3.2 shows the transition of household composition. The number of family members was 4.54 in 1989 decreasing throughout the sample period to 4.25 in 2004. The number of children was about 1.82 in 1989 and gradually decreased during the period. The ratio of families with only boys or only girls was almost stable across the period, and almost 75 percent of households had a male household head.

Table 3.2 shows the transition of the share of each gender and the respective education levels in a family. The ratios of both preschool boys and preschool girls to the number of household members were about 0.04 at the mean and stable across the period. The ratio of number of elementary school boys and the ratio of number of elementary school girls to the number of household members were about 0.08 at the mean and stable during the period. The ratio of number of boys in junior high school and high school and the ratio of number of girls in junior high school and high school to the number of household members were 0.04 at the mean. The table shows that the ratio of gender and education level did not change dramatically during the sample period.

Thirdly, Table 3.3 presents the comparison of the number of children between boys and girls depending on the education level of the first-born child. If a household had its oldest boy in university, the number of total children was about 1.60 people at the mean. If the oldest boy was in high school, the number of total children was 1.85 people at the mean. If a household had its oldest girl in university, the number of total children in a household was 1.69 people at the mean. If the oldest girl was in high school, the number of total children was 1.85 at the mean. The table shows that there is not obvious gender preference according to the gender of the first-born child.

4.2 Analysis of the Gender Difference

This subsection explains the regression results of the gender difference in the three educational spendings. Firstly, this section analyzed the gender gap for total educational spending. To examine the gender bias in total education expenditure, we regressed the share of total education expenditure on linear and quadratic forms of the log of real living expenditure, the log of family member, ratios of boys and girls in each educational level, and household demographic variables in each year. Table 3.4 reports the key results. The coefficients of high school children were larger than those of other education levels, indicating that spending for high school children cost more. Most of the coefficients for boys were slightly larger than those of girls.

Operationally, we calculated the differences in the coefficient of boys minus that of girls in the same education level, and these coefficient differences are also reported in Table 3.4. If the difference is positive, it means that the coefficient of boys is larger. For the total educational spending, there was statistically significant difference in elementary school children in 1989 and 1994. However, most of the differences in the coefficients were both positive and negative but were not statistically significant. Thus, in total education expenditure, we could not observe a consistent pattern in which parents favor boys or girls in educational spending.

Secondly, we regressed the share of after-school academic educational spending on the same independent variables as with the total educational spending regression. Table 3.5 shows the key regression results for after-school academic education expenditure. The coefficients are larger for children in junior high school. The coefficients generally increased throughout the sample period, and almost all of coefficients of boys were larger than those of girls.

The differences in coefficients for children in elementary school were positive and statistically significant in 1989 and 1994. The differences for children in junior high school in 1989 and for high school children in 1994 were statistically significant. However, the differences disappeared in 1999. This trend was consistent with previous works. The sizes of differences decreased for children in elementary school and in junior high school in latter period, and the significance was lost. By contrast in 2004, the difference for high school children was observed and statistically significant, indicating that the gap appeared again in 2004. The size of the difference was largest in 2004.

To obtain the difference of the quantitative size, this section considers a household with three members including two children. The hypothetical household has one adult, one preschool boy and one preschool girl. If the preschool boy entered an elementary school, the household would have paid about 12,000 yen per month on the after-school academic education for the boy in 2004. On the other hand, if the preschool girl entered an elementary school, the household would have paid about 11,000 yen per month on the after-school academic education for her. Thus, the gender difference on the after-school academic spending at the elementary school level is about 1,000 yen per month. This implies that even though the estimation result shows that there was a gender difference in after-school academic spending for some education levels, the difference in payment was not very large.

Thirdly, we regressed the after-school non-academic education expenditure share on the same independent variables as with the total educational spending regression. Table 3.6 shows the key regression result. Notice that the coefficients are larger for children in elementary school, and further that compared to the previous two educational spendings, all coefficients of girls were larger than those of boys. We tested if the differences of coefficients were statistically significant for each educational level. All were negative and statistically significant for the entire sample period. Most of the sizes of the differences gradually decreased during the sample period. Specifically, the differences were larger for children in elementary school, implying that there is a clear pattern that parents spend more on non-academic spending for their daughters than that for their sons.

To calculate the gender difference in the spending on the after-school non-academic education, this chapter considers a household with three members including two children. The hypothetical household has one adult, one preschool boy and one preschool girl. If the preschool boy entered an elementary school, the household would have paid about 13,700 yen per month on the after-school non-academic education for the boy in 2004. On the other hand, if the preschool girl entered an elementary school, the girl would have received about 16,200 yen per month for the after-school non-academic educational spending. This result implies that there is gender gap in after-school non-academic educational spending, where girls receive more than boys. The size was 2,500 yen for elementary school children, which is twice more than the size of the after-school academic educational spending.

4.3 Robustness Check

In this section, we ran the following educational spending regression to analyze if we can find the gender difference related to the number of children for both genders:

$$\omega_{it} = \alpha' + \beta' \ln Y_{it} + \gamma' \ln n_{it} + \sum_{j=0}^{4} \delta_B'^j DumB_{it}^j + \sum_{j=0}^{4} \delta_G'^j DumB_{it}^j + X'\tau' + u_{it}', \quad (2)$$

where $DumB_{it}^j$ is a dummy variable of the number of boys in household i at year t, and $DumG_{it}^j$ is a dummy variable of the number of girls in household i at year t. Then, we test if the coefficients of these dummy variables are the same for each corresponding number of children.

Firstly, the key regression of the total educational spending is reported in Table 3.7. The more children there were in a household, the larger the coefficients got. If there were three boys in a household, the household payed more educational spending than other households did. The differences in coefficients were positive and significant when we compared households with two boys and households with two girls in 1994. Also they were positive and significant when we compared households with three boys and households with three girls in 1994. This means that for these households, the educational spending for boys was larger. However, the coefficient difference was negative and statistically significant when we compared households with four boys and households with four girls.

Table 3.8 gives the key regression result for after-school academic spending. If there were three boys in a household, the household spent more on after-school academic spending than other households did. The differences in coefficients were positive for most cases, indicating that households with boys spent more on academic spending than households with girls did. The differences were significant when we compared households with two boys and households with two girls in 1994 and when we compared households with three boys and households with three girls in 1994.

Table 3.9 shows the key regression result for after-school non-academic spending. All the coefficients were larger for households with girls. The coefficient differences were negative and statistically significant for almost all the cases. This means that households with girls pay more non-academic spending than households with boys. Although the sizes were decreasing for the latter period, but the sign of the coefficients is consistent.

5 Conclusion

This chapter analyzed the gender difference in an intra-household educational expenditure by using the National Survey of Family Income and Expenditure from 1989 and 2004. We found that for total education spending, we cannot obtain consistent patterns that parents spent more for their sons or daughters. However, when looking at more detailed educational spending, we found that boys received more after-school academic spending, which was paid for cram schooling, than girls did. Further, this chapter obtained a clear pattern that the girl received more after-school non-academic spending for all education levels and for each sample period.

Previous works have found that there has been gender gap in the after-school academic spending but that this was converging. This chapter also obtained similar results, but it seems that as small gender gap still exists in academic spending. The calculated difference in spending on the after-school academic education was about 1,000 yen per month for elementary school children in 2004. The size of this difference did not seem large. This would result in the convergence of the university entrance rate and in the decrease in college entrance rate of girls. Thus, this phenomenon would lead to the decrease in the gender wage difference.

On the other hand, for after-school non-academic spending, we obtained that girls receive more than boys do. The calculated difference on the after-school non-academic educational spending was about 2,500 yen per month for elementary school children in 2004. The size of this difference is larger than that of the difference in the after-school academic educational spending in 2004. The School Basic Survey by the Ministry of Education, Culture, Sports, Science and Technology shows that there are more female students in majors such as Literature, Nursing, Home Economics, the study of education such as Kindergarten curriculum, and Arts and Music. Specifically, the number of females majoring Home Economics is about nine times as many as the number of males majoring Home Economics.

Table 3.1: Summary statistics of expenditure variables (in yen per month)

Year	Total	1989	1994	1999	2004
Observations	80,146	23,615	21,525	18,480	16,526
Real living spending	353,329.50	356,182.70	364,929.00	352,268.10	349,006.30
	(1,145.50)	(1,535.72)	(1,491.65)	(1,555.75)	(1,886.11)
Real total education	31,801.35	24,808.71	31,456.45	31,746.22	32,247.03
spending	(206.25)	(204.47)	(281.67)	(286.08)	(337.14)
Real after-school	7,778.22	5,705.40	8,369.91	7,742.41	7,643.15
academic spending	(96.21)	(104.95)	(147.99)	(135.11)	(154.84)
Real after-school	6,400.75	5,768.90	6,858.90	6,568.09	6,186.55
non-academic spending	(58.15)	(75.81)	(83.10)	(92.75)	(93.20)

Source: National Survey of Family Income and Expenditure.

Notes: Standard deviations are in parentheses.

Table 3.2: Summary statistics of the demographic variables

Year	1989	1994	1999	2004
Number of family members	4.54	4.44	4.37	4.25
Number of children	1.82	1.80	1.79	1.75
Only boy family (%)	0.33	0.34	0.34	0.35
Only girl family (%)	0.31	0.31	0.32	0.32
Male head of household (%)	0.70	0.75	0.76	0.74
City (%)	0.39	0.41	0.42	0.42
Single parent (%)	0.04	0.06	0.06	0.08
Ratio of boys (%)	0.21	0.21	0.21	0.21
Ratio of girls (%)	0.20	0.20	0.20	0.20
Ratio of preschool boys (%)	0.03	0.04	0.04	0.04
Ratio of preschool girls (%)	0.03	0.03	0.04	0.04
Ratio of boys in elementary school (%)	0.08	0.08	0.08	0.08
Ratio of girls in elementary school (%)	0.07	0.08	0.07	0.07
Ratio of boys in junior high school (%)	0.04	0.04	0.04	0.04
Ratio of girls in junior high school (%)	0.04	0.04	0.04	0.04
Ratio of boys in high school (%)	0.04	0.04	0.04	0.04
Ratio of girls in high school (%)	0.04	0.04	0.04	0.04

Source: National Survey of Family Income and Expenditure.

Notes: The ratios of boys and girls in each education level are obtained by dividing number of children in kth education level by number of children in a family.

Table 3.3: Number of children by the education level of the oldest child

	Oldest boy child in				Oldest girl child in			
	University	High school	Junior high school	Elementary school	University	High school	Junior high school	Elementary school
Total number of children	1.60	1.85	2.08	2.01	1.69	1.85	2.06	2.00
	(0.70)	(0.77)	(0.75)	(0.65)	(0.72)	(0.78)	(0.76)	(0.65)
Boys	1.29	1.40	1.52	1.43	0.38	0.46	0.57	0.60
	(0.51)	(0.60)	(0.64)	(0.58)	(0.56)	(0.62)	(0.65)	(0.62)
Girls	0.31	0.45	0.56	0.58	1.32	1.38	1.49	1.40
	(0.53)	(0.61)	(0.65)	(0.62)	(0.54)	(0.58)	(0.63)	(0.56)
High school boys	0.16				0.19			
	(0.37)				(0.40)			
High school girls	0.15				0.18			
	(0.37)				(0.40)			
Junior high school boys	0.05	0.22			0.07	0.23		
	(0.22)	(0.43)			(0.26)	(0.43)		
Junior high school girls	0.05	0.21			0.06	0.21		
	(0.22)	(0.42)			(0.25)	(0.42)		
Elementary school boys	0.03	0.12	0.40		0.03	0.11	0.40	
	(0.17)	(0.33)	(0.57)		(0.17)	(0.33)	(0.56)	
Elementary school girls	0.02	0.11	0.39		0.03	0.11	0.38	
	(0.15)	(0.33)	(0.57)		(0.16)	(0.33)	(0.56)	
Preschool boys	0.00	0.01	0.04	0.20	0.00	0.01	0.03	0.19
	(0.06)	(0.08)	(0.21)	(0.42)	(0.06)	(0.09)	(0.19)	(0.41)
Preschool girls	0.00	0.01	0.03	0.18	0.00	0.01	0.03	0.19
	(0.06)	(0.09)	(0.18)	(0.40)	(0.05)	(0.09)	(0.18)	(0.41)

Source: National Survey of Family Income and Expenditure.

Table 3.4: Estimation results (total education expenditure share)

Variable	1989	1994	1999	2004
Ratio of preschool boys	0.194***	0.206***	0.191***	0.213***
	(0.006)	(0.006)	(0.007)	(0.007)
Ratio of preschool girls	0.197***	0.200***	0.200***	0.213***
	(0.006)	(0.007)	(0.007)	(0.008)
Ratio of elementary school boys	0.048***	0.054***	0.042***	0.062***
	(0.004)	(0.005)	(0.005)	(0.006)
Ratio of elementary school girls	0.039***	0.046***	0.042***	0.053***
	(0.004)	(0.005)	(0.005)	(0.006)
Ratio of junior high school boys	0.166***	0.206***	0.195***	0.203***
	(0.006)	(0.009)	(0.008)	(0.008)
Ratio of junior high school girls	0.163***	0.194***	0.186***	0.210***
	(0.006)	(0.006)	(0.007)	(0.008)
Ratio of high school boys	0.209***	0.241***	0.245***	0.279***
	(0.007)	(0.007)	(0.008)	(0.009)
Ratio of high school girls	0.214***	0.237***	0.246***	0.265***
	(0.006)	(0.007)	(0.008)	(0.009)
Difference between gender coefficients				
Preschool children	-0.003	0.006	-0.009	0.000
Children in elementary school	0.009***	0.008*	0.000	0.009
Children in junior high school	0.003	0.013	0.008	-0.007
Children in high school	-0.005	0.004	-0.001	0.014
Observations	23,615	21,525	18,480	16,526
Adjusted R-squared	0.261	0.258	0.253	0.268

Source: National Survey of Family Income and Expenditure.

Notes: The linear and quadratic terms of the log real living expenditure, the job dummy variable of a household head, the single parent dummy variable, the female head dummy variable, the urban dummy variable, the log of family member, the number of university children, the number of people aged over sixty, and intercept are included in the independent variable. Robust standard errors are in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 3.5: Estimation results (after-school academic educational spending share)

Variable	1989	1994	1999	2004
Ratio of preschool boys	0.001	0.008***	0.004	0.008**
	(0.002)	(0.003)	(0.003)	(0.003)
Ratio of preschool girls	0.001	0.008***	0.005*	0.004
	(0.002)	(0.003)	(0.003)	(0.003)
Ratio of elementary school boys	0.040***	0.050***	0.043***	0.049***
	(0.002)	(0.003)	(0.003)	(0.004)
Ratio of elementary school girls	0.032***	0.042***	0.041***	0.042***
	(0.002)	(0.003)	(0.003)	(0.003)
Ratio of junior high school boys	0.113***	0.142***	0.129***	0.127***
	(0.004)	(0.005)	(0.005)	(0.005)
Ratio of junior high school girls	0.101***	0.137***	0.126***	0.126***
	(0.004)	(0.004)	(0.005)	(0.006)
Ratio of high school boys	0.020***	0.036***	0.032***	0.045***
	(0.004)	(0.004)	(0.004)	(0.005)
Ratio of high school girls	0.018***	0.028***	0.030***	0.033***
	(0.003)	(0.004)	(0.004)	(0.005)
Difference between gender coefficients				
Preschool children	0.000	0.000	-0.001	0.004
Children in elementary school	0.008***	0.008**	0.003	0.006
Children in junior high school	0.012**	0.005	0.003	0.001
Children in high school	0.003	0.008*	0.002	0.012**
Observations	23,615	21,525	18,480	16,526
Adjusted R-squared	0.220	0.222	0.207	0.203

Source: National Survey of Family Income and Expenditure.

Notes: The linear and quadratic terms of the log real living expenditure, the job dummy variable of a household head, the single parent dummy variable, the female head dummy variable, the urban dummy variable, the log of family member, the number of university children, the number of people aged over sixty, and intercept are included in the independent variable. Robust standard errors are in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 3.6: Estimation results (after-school non-academic educational spending share)

Variable	1989	1994	1999	2004
Ratio of preschool boys	0.022***	0.024***	0.018***	0.022***
	(0.003)	(0.003)	(0.003)	(0.003)
Ratio of preschool girls	0.030***	0.035***	0.030***	0.031***
	(0.003)	(0.003)	(0.003)	(0.003)
Ratio of elementary school boys	0.044***	0.049***	0.050***	0.059***
	(0.002)	(0.002)	(0.002)	(0.003)
Ratio of elementary school girls	0.083***	0.087***	0.084***	0.082***
	(0.002)	(0.002)	(0.003)	(0.003)
Ratio of junior high school boys	-0.012***	-0.006***	-0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.003)
Ratio of junior high school girls	0.013***	0.017***	0.019***	0.018***
	(0.003)	(0.002)	(0.003)	(0.003)
Ratio of high school boys	-0.012***	-0.007***	-0.010***	-0.008***
	(0.002)	(0.002)	(0.002)	(0.002)
Ratio of high school girls	0.001	0.002	0.001	0.001
	(0.002)	(0.002)	(0.003)	(0.003)
Difference between gender coefficients				
Preschool children	-0.009***	-0.010***	-0.012***	-0.009***
Children in elementary school	-0.039***	-0.038***	-0.034***	-0.023***
Children in junior high school	-0.025***	-0.023***	-0.021***	-0.017***
Children in high school	-0.013***	-0.009***	-0.011***	-0.009***
Observations	23,615	21,525	18,480	16,526
Adjusted R-squared	0.237	0.240	0.204	0.214

Source: National Survey of Family Income and Expenditure.

Notes: The linear and quadratic terms of the log real living expenditure, the job dummy variable of a household head, the single parent dummy variable, the female head dummy variable, the urban dummy variable, the log of family member, the number of university children, the number of people aged over sixty, and intercept are included in the independent variable.

Robust standard errors are in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 3.7: Robustness check: total education expenditure share

Variable	1989	1994	1999	2004
Dum. 1 boy	0.018***	0.023***	0.024***	0.027***
	(0.001)	(0.001)	(0.002)	(0.002)
Dum. 2 boys	0.039***	0.048***	0.045***	0.053***
	(0.002)	(0.002)	(0.002)	(0.003)
Dum. 3 boys	0.061***	0.069***	0.066***	0.073***
	(0.003)	(0.004)	(0.005)	(0.005)
Dum. 4 boys	0.050***	0.074***	0.052***	0.047***
	(0.013)	(0.022)	(0.013)	(0.017)
Dum. 1 girl	0.019***	0.022***	0.022***	0.026***
	(0.001)	(0.001)	(0.002)	(0.002)
Dum. 2 girls	0.037***	0.044***	0.046***	0.052***
	(0.002)	(0.002)	(0.002)	(0.003)
Dum. 3 girls	0.055***	0.059***	0.065***	0.065***
	(0.004)	(0.004)	(0.004)	(0.005)
Dum. 4 girls	0.069***	0.128***	0.084***	0.059***
	(0.016)	(0.037)	(0.013)	(0.013)
Difference between gender coefficients				
1 child	-0.001	0.001	0.002	0.001
2 children	0.002	0.004*	-0.001	0.001
3 children	0.006	0.010*	0.001	0.008
4 children	-0.019	-0.054	-0.032*	-0.012
Observations	23,615	21,525	18,480	16,526
Adjusted R-squared	0.088	0.096	0.083	0.071

Source: National Survey of Family Income and Expenditure.

Notes: The linear and quadratic terms of the log real living expenditure, the job dummy variable of a household head, the single parent dummy variable, the female head dummy variable, the urban dummy variable, the log of family member, the number of university children, the number of people aged over sixty, and intercept are included in the independent variable.

Robust standard errors are in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 3.8: Robustness check: after-school academic educational spending share

Variable	1989	1994	1999	2004
Dum. 1 boy	0.010***	0.014***	0.013***	0.013***
	(0.001)	(0.001)	(0.001)	(0.001)
Dum. 2 boys	0.021***	0.028***	0.025***	0.027***
	(0.001)	(0.001)	(0.001)	(0.001)
Dum. 3 boys	0.028***	0.041***	0.033***	0.036***
	(0.002)	(0.003)	(0.002)	(0.003)
Dum. 4 boys	0.014***	0.042***	0.036***	0.024***
	(0.004)	(0.010)	(0.010)	(0.005)
Dum. 1 girl	0.009***	0.014***	0.012***	0.013***
	(0.001)	(0.001)	(0.001)	(0.001)
Dum. 2 girls	0.018***	0.025***	0.025***	0.025***
	(0.001)	(0.001)	(0.001)	(0.002)
Dum. 3 girls	0.024***	0.031***	0.031***	0.029***
	(0.002)	(0.002)	(0.002)	(0.003)
Dum. 4 girls	0.020***	0.049***	0.020***	0.026**
	(0.007)	(0.018)	(0.006)	(0.012)
Difference between gender coefficients				
1 child	0.001	0.000	0.002**	0.000
2 children	0.004***	0.002**	0.000	0.002
3 children	0.004	0.010***	0.001	0.008**
4 children	-0.006	-0.008	0.016	-0.002
Observations	23,615	21,525	18,480	16,526
Adjusted R-squared	0.108	0.109	0.099	0.106

Source: National Survey of Family Income and Expenditure.

Notes: The linear and quadratic terms of the log real living expenditure, the job dummy variable of a household head, the single parent dummy variable, the female head dummy variable, the urban dummy variable, the log of family member, the number of university children, the number of people aged over sixty, and intercept are included in the independent variable.

Robust standard errors are in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 3.9: Robustness check: after-school non-academic educational spending share

Variable	1989	1994	1999	2004
Dum. 1 boy	0.005***	0.007***	0.006***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Dum. 2 boys	0.008***	0.011***	0.010***	0.013***
	(0.001)	(0.001)	(0.001)	(0.001)
Dum. 3 boys	0.011***	0.015***	0.012***	0.017***
	(0.001)	(0.001)	(0.002)	(0.002)
Dum. 4 boys	0.010	0.014**	0.009*	0.025***
	(0.008)	(0.006)	(0.005)	(0.009)
Dum. 1 girl	0.010***	0.011***	0.010***	0.010***
	(0.001)	(0.001)	(0.001)	(0.001)
Dum. 2 girls	0.020***	0.022***	0.020***	0.020***
	(0.001)	(0.001)	(0.001)	(0.001)
Dum. 3 girls	0.026***	0.032***	0.029***	0.025***
	(0.002)	(0.002)	(0.002)	(0.002)
Dum. 4 girls	0.027***	0.031***	0.023***	0.030**
	(0.007)	(0.008)	(0.008)	(0.012)
Difference of gender coefficients				
1 child	-0.005***	-0.004***	-0.004***	-0.004***
2 children	-0.012***	-0.011***	-0.009***	-0.008***
3 children	-0.014***	-0.017***	-0.017***	-0.009***
4 children	-0.017	-0.017*	-0.014	-0.005***
Observations	23,615	21,525	18,480	16,526
Adjusted R-squared	0.138	0.143	0.110	0.112

Source: National Survey of Family Income and Expenditure.

Notes: The linear and quadratic terms of the log real living expenditure, the job dummy variable of a household head, the single parent dummy variable, the female head dummy variable, the urban dummy variable, the log of family member, the number of university children, the number of people aged over sixty, and intercept are included in the independent variable.

Robust standard errors are in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

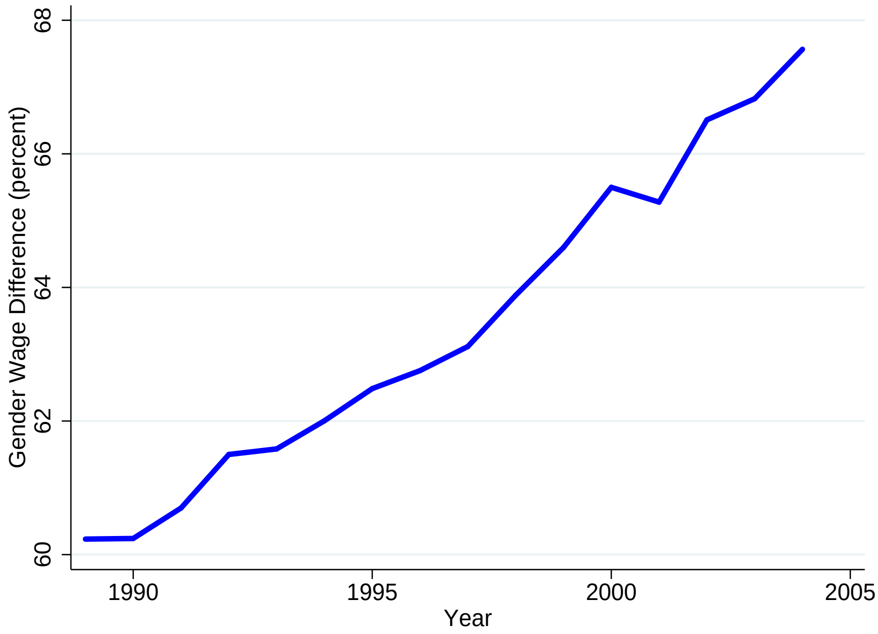

Figure 3.1: Gender wage difference for general worker

Source: The Japanese Ministry of Health, Labour and Welfare.

Note: The curve shows the ratio of wages between female and male workers.

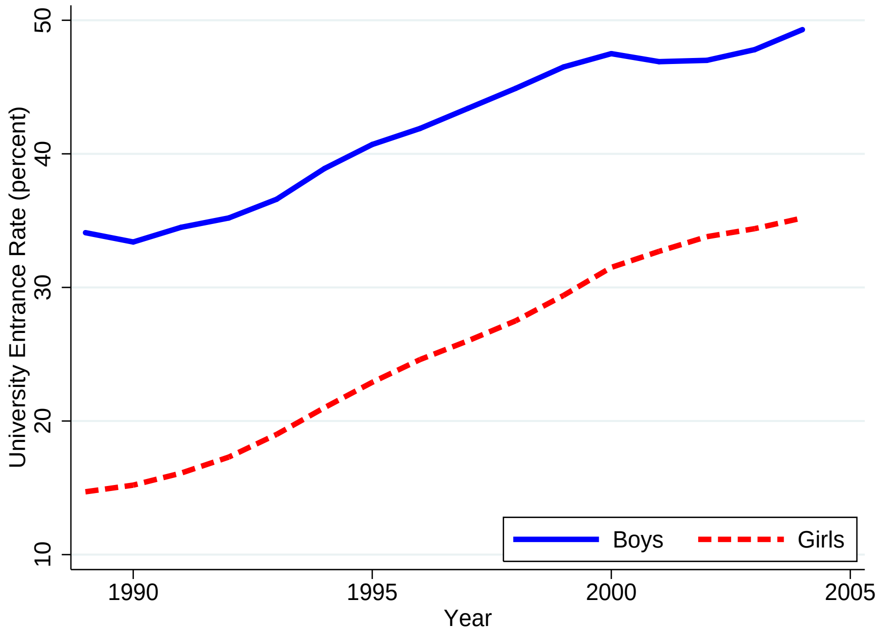

Figure 3.2: University entrance rate

Source: The Japanese Ministry of Education, Culture, Sports, Science and technology.

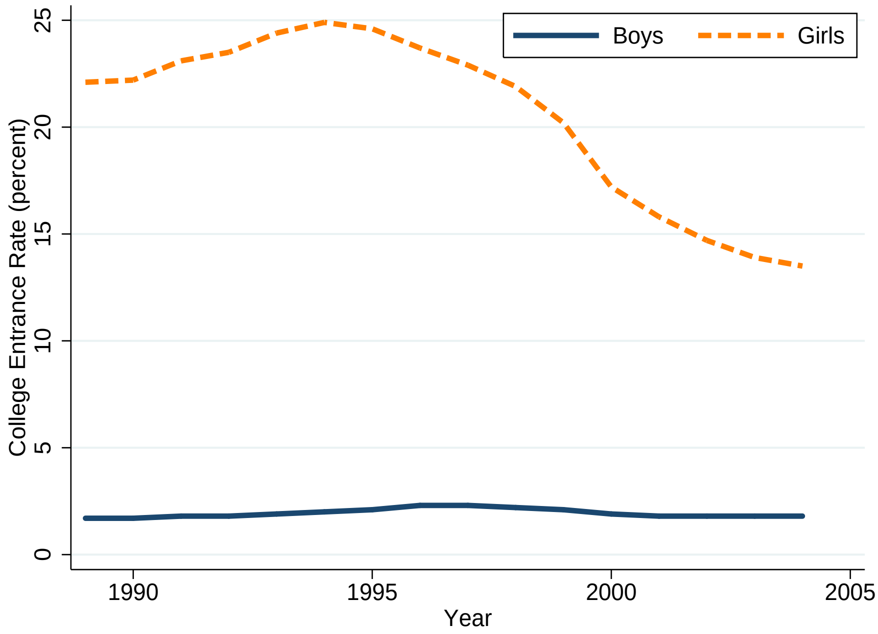

Figure 3.3: College entrance rate

Source: The Japanese Ministry of Education, Culture, Sports, Science and technology.

Chapter IV

Do People Correctly Measure Their Satisfaction?

1 Introduction

In the literature on happiness, a paradox that the increase in the level of reported happiness does not correlate with the economic growth in Easterlin (1974) motivated further studies to analyze happiness. The happiness and subjective well-being are related to the policy and social changes, and thus, analyzing the well-being would be valuable for policymakers.

In the analysis of happiness and income relationship, two opposite results have been observed. On the one hand, Easterlin (1974) and Easterlin (1995) stated that happiness level is higher in developed countries in cross-country analysis, but the positive correlation between income and happiness was not observed within country analysis. Blanchflower and Oswald (2004) support Easterlin's views but found the positive correlation for some demographic groups. On the other hand, Stevenson and Wolfers (2008) assessed the paradox by using more recent data of a broad array of countries and found positive relationship between income and happiness within and across countries. Stevenson and Wolfers (2008) also used several micro-data sets and confirmed the positive correlation between the level of average subjective well-being and GDP per capita across countries. Deaton (2008) stated there is a strong positive relationship between the log of GDP and life satisfaction. Di Tella, MacCulloch, and Oswald (2003) used several macroeconomic variables in a happiness equation and found that GDP per capita has positive effects on life satisfaction. In addition, there are empirical studies that have found a positive correlation between these variables (for example Clark and Oswald, 1994; Frey and Stutzer, 2000; van Praag, Frijters, and Ferrer-i-Corbonell, 2003; Ferrer-i-Corbonell and Frijters, 2004; Ferrer-i-Corbonell, 2005).

Several approaches have been taken to analyze the relationship between the well-being and income. First, we consider the literature that uses the linear and nonlinear relationship between them (for example Deaton, 2008). This type of approach assumes that people obtain their life satisfaction mainly from their income. Second, we consider the literature that considers the effect of others' preferences on an individual's preference[1] (Easterlin, 1995). This means that the individual's well-being depends on not only her income in absolute terms but also her status in a social group. The study including reference income considers that one's happiness depends on one's status and other's.

This chapter, with the aim of finding the relationship between income and happiness, focuses on one's personal measurement of well-being. In a survey, individuals are asked to report their happiness or well-being on a zero-to-ten scale, based on their own criteria. In next year, they are asked to report their respective happiness levels again. In the one-year gap between both surveys, individuals might have had various life events such as income increase, marriage, and moving to a big city. Then, if one's income increased, her life satisfaction would increase. However, the positive relationship might not be observed due to some reasons. One possible reason is the recent personal news shock effect. If she had a temporal bad

[1]Ferrer-i-Corbonell (2005) briefly summarized the interdependence of preference.

news, say, the previous night, she would report lower satisfaction even if she had an income increase.[2] Another possible reason is of a social norm (Easterlin, 1974). One may report the satisfaction level considering another individual's expectation. This would result in a bias in the correlation between well-being and income. The third possibility is the change in one's criteria of the satisfaction level. If the measurement of life satisfaction was changing over time, the level of life satisfaction is not comparable across time. If one was promoted and got higher income, one might have a different criteria of satisfaction. This causes a bias in the correlation between income and well-being.

This chapter analyzes the third possibility by using two life satisfaction variables. The two life satisfaction variables are life satisfaction overall (overall satisfaction) and current life satisfaction compared with that of the previous year (compared satisfaction). The purpose of using two life satisfaction variables is that the overall satisfaction might not be comparable over time because the life satisfaction measurement can change with time. When a respondent was asked to answer her overall satisfaction, she would evaluate it considering her past life. Because numerous events might have happened to her from the last time she was asked the same question, the measurement of the overall satisfaction might have changed over time. Thus, the criterion of the current overall satisfaction would be different from the criterion last time. However, the questionnaire on the compared satisfaction asked the individual to compare her current life satisfaction with that of the previous year directly, and thus, this approach allows us to evaluate the satisfactions of two periods with the same measurement. Therefore, the compared satisfaction implies direct increase from that of the previous year.

The next section explains the data used in this chapter. Section three discusses an estimation model and an estimating approach of the criteria analysis. Section

[2]Sano and Ohtake (2007) analyzed temporal news shock on life satisfaction. They stated that if one had a good news, her life satisfaction tended to be higher. However, if she had a bad news, her life satisfaction tended to be lower.

four discusses the regression results and threshold analysis. Then this chapter concludes in Section five.

2 Data

This section explains the data set used in this chapter and the construction of the analysis sample. This chapter used the British Household Panel Survey (BHPS) which is a panel survey that began in 1991, conducted by the Institute for Social and Economic Research at the University of Essex. The survey interviewed the same representative individuals over a period of years and collected the information of social and economic changes at the individual level and at the household level in the UK. It was also motivated to understand the changes, causes, and consequences related to a range of socio-economic variables. It was an annual survey targeting each household member aged over 16 years. More than 5,000 households were interviewed, and approximately 10,000 individuals were interviewed and reported information on economic activities such as income and job status. In addition, the survey questionnaire asked about a variety of topics of policy interest, such as household composition, education and training, health, and labor market behavior.

This chapter used the data sets from Wave 6, year 1996-1997, to Wave 18, year 2008-2009. Wave 1 to Wave 5 and Wave 11 did not have a life satisfaction questionnaire, and thus, we dropped six waves from the analysis sample.

The key life satisfaction variables used in this chapter were the overall satisfaction and the compared satisfaction. For the overall satisfaction, people are asked to answer the question, "How dissatisfied or satisfied are you with your life overall?," where they have to report one for "not satisfied at all" to seven for "completely satisfied." Then, for the compared satisfaction, they answer the following question, "Would you say that you are more satisfied with life, less satisfied or feel about the same as you did a year ago?," where they answer one of the three options accordingly.

The description of the independent variable was as follows. The independent variable included the real annual income, reference income, age variables, and dummy variables of gender, household size, number of kids, education, region, housing type, and wave. The real annual income was used as an income variable and was deflated by the consumer price index, which is the 2010-based price index. We included two age variables: one's age and its square. For one's education level, there are seven categories: higher degree; 1st degree; Higher National Diploma (HND), Higher National Certificate (HNC), and teaching; General Certificate of Education Advanced Level (A-level); General Certificate of Education Ordinary Level (O-level); Certificate of Secondary Education (CSE); and others. According to Brown and Roberts (2012), this chapter categorized the education level as following: university level for higher degree and 1st degree; some higher education level for HND, HNC, teaching and A-level; high school level for O-level and CSE; and others. The regional variable included nineteen values such as Inner London, Outer London, Wales, Scotland, and Northern Ireland. There are eight types of housing, for example, Owned Outright and Owned with Mortgage.

3 Model

3.1 Model of Estimation

This chapter follows the methodology of Ferrer-i-Corbonell (2005). It considers a satisfaction function as follows:

$$W = W(y, y^r, X), \tag{1}$$

where W is the concept of life satisfaction, y is the household income, y^r represents the reference income, and X is the socio-economic and demographic chracteristics.

Ferrer-i-Corbonell (2005) considered several specifications of the reference income. This chapter applies the specification of Ferrer-i-Corbonell (2005) to include the cell-average of the reference group by age cohort, gender, education, region, and wave.

In an empirical application, this chapter used the following specification:

$$W_{it} = \beta_0 + \beta_1 \ln(y_{it}) + \beta_2 \ln(y_t^r) + X'\gamma + u_{it}, \quad (2)$$

where i indicates individuals and t indicates waves.

3.2 Model to Estimate Threshold Points

This section explains how we estimate and test the inconsistency of the life satisfaction measurement over time. Primary, we estimate the measurement by applying an ordered probit estimation of equation 2. Let W be the overall life satisfaction response taking the values between one and seven. The value of W is derived from a latent variable model in which the latent variable W^* is determined as follows:

$$W^* = \boldsymbol{x}\boldsymbol{\beta} + e, \quad e|\boldsymbol{x} \sim N(0, 1), \quad (3)$$

where $\boldsymbol{x}$ indicates explanatory variables and $\boldsymbol{\beta}$ is the parameter vector. We define the threshold point α_{kt}, where k is the threshold level and t is the wave, as follows:

$$
\begin{aligned}
W &= 1 \quad if \quad W^* \leq \alpha_{1t} \\
W &= 2 \quad if \quad \alpha_{1t} < W^* \leq \alpha_{2t} \\
W &= 3 \quad if \quad \alpha_{2t} < W^* \leq \alpha_{3t} \\
W &= 4 \quad if \quad \alpha_{3t} < W^* \leq \alpha_{4t} \\
W &= 5 \quad if \quad \alpha_{4t} < W^* \leq \alpha_{5t} \\
W &= 6 \quad if \quad \alpha_{5t} < W^* \leq \alpha_{6t} \\
W &= 7 \quad if \quad \alpha_{6t} < W^*.
\end{aligned}
\tag{4}
$$

Estimating the ordered probit for each wave cannot give a time-consistent threshold. The survey information on people's satisfaction in comparison with the previous year allows us to compensate for the information on the comparable threshold over time. Therefore, we applied the ordered probit estimation to the life satisfaction equation with the compared satisfaction variable:

$$q = \boldsymbol{x}\boldsymbol{\gamma} + v, \tag{5}$$

where q represents the compared satisfaction variable.

Estimating these two models together, we estimate the corrected life satisfaction measurement criteria α_{kt}. However, the regression with only these equations, equations 3 to 5, does not allow us to identify the estimates of $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$. Thus, we estimate the following equation together:

$$\Delta y = \Delta \boldsymbol{x} \beta + \Delta e. \tag{6}$$

This equation is the first difference of equation 3. Equation 6 gives the estimate of

$\boldsymbol{\beta}$. Therefore, we can estimate and identify all parameters.

We use the GMM estimation to estimate three equations at the same time. If the measurement of life satisfaction is the same over time, the threshold points, α_{kt}, would not vary over time. Thus, if these thresholds changed over time, people might measure their life satisfaction with different criteria in each wave. This would result in the underestimation of the effect of income on well-being. This implies that the Easterlin Paradox could be observed in the well-being analysis.

4 Empirical Analysis

Table 4.1 shows the summary statistics of the main variables. The overall satisfaction was about 5.2 on the one-to-seven scale. People in the UK were relatively happier. The compared satisfaction was 0.1. Since people who reported "less satisfied," "about the same," or "more satisfied" took -1, 0, or 1, respectively, the mean of the compared satisfaction showed that there were more people who reported "more satisfied" than people who reported "less satisfied." The number of people in a household was about 2.8, and the number of kids in a household was about 0.6. The average age was about 46 yeas. There were almost equal number of males and females in the sample. The real annual income was about $\pounds 17,326$.

Table 4.2 is the key table in this chapter, which shows the comparison between the first difference of the overall satisfaction and the compared satisfaction. Both measures indicate the life satisfaction changes between the current time and the previous year. Thus, if there was an increase or a decrease in the first difference of the overall satisfaction, people would report "more satisfied" or "less satisfied," respectively. However, the table shows inconsistency between these life satisfaction variables. There were people whose change in the overall satisfaction was positive, meaning their overall satisfaction improved, but they reported that they were "less satisfied" than they were a year ago. There were people who took negative values on the change in the overall satisfaction, meaning that they felt less satisfied that they did a year ago, but they reported "more satisfied" than a year ago. Further, even though there were people who reported their change in life satisfaction was positive or negative, they stated they had about the same satisfaction compared to the previous year. The table presumably indicates that people might not correctly measure their satisfaction with their lives.

From the distribution of these life satisfaction variables, we constructed two life satisfaction variables using the overall satisfaction and the compared satisfaction. One is the add-up satisfaction, which is the corrected life satisfaction upon adding -1, 0, or 1 to the initial overall satisfaction, depending on the answer to the compared life satisfaction, "less satisfied," "about the same," or "more satisfied." Thus, this is the consistent life satisfaction variable between the overall satisfaction change and the compared satisfaction. Another is the trimmed satisfaction. The scale of the add-up satisfaction is not one-to-seven scale. Thus the trimmed satisfaction is constructed by replacing zero and eight of the add-up satisfaction for one and seven in each wave to keep the trimmed satisfaction to have one-to-seven scale as with the overall satisfaction. The distribution tables of both the add-up satisfaction and the trimmed satisfaction are in Appendix.

Figure 4.1 shows the trend of three satisfaction variables, which are the overall satisfaction, the add-up satisfaction, and the trimmed satisfaction, and the log of real income. The dashed line, which is the log of real income over the sample period, shows continuous increase over time, from 6.6 to 7.0. The solid line is the actual overall satisfaction. This line has a small blip and dip but seemes decreasing over time. These lines seem to imply the Easterlin paradox that the increase in life satisfaction does not seem to be correlated with the income increase. The dash-dot line is the add-up satisfaction. This line shows continuous increase in life satisfaction, implying that the add-up satisfaction increases depending on the increase of the log of real income. The dotted line is the trimmed satisfaction.

Since this satisfaction is bounded between one to seven, it is placed between the overall satisfaction and the add-up satisfaction. This line seems to have moderate increase and to have positive increase compared to the overall satisfaction. This figure shows that we could not observe a clear positive correlation between the overall satisfaction and income, but constructing consistent life satisfaction variables between the overall satisfaction and the compared satisfaction, we might find a clearer correlation between constructed satisfaction variables and income.

Table 4.3 shows the regression result specified by equation 2. The OLS estimation results are reported in the first to third columns. The first column shows the OLS estimation of the overall satisfaction. The coefficient of income is negative and not statistically significant. This implies that the increase in one's income does not seem to increase one's life satisfaction. The second column displays the regression result for the add-up satisfaction. The income effect on life satisfaction was 0.22 and was positive and statistically significant. The result of this estimate is noteworthy. The third column shows the estimation result for the trimmed satisfaction. The coefficient was positive; however, it was not statistically significant. The fourth to sixth columns report the fixed-effect estimation results. In the fixed effect estimation, the coefficient of income is positive but not significant in the overall satisfaction regression. However, with add-up satisfaction, the coefficient was 0.022. The magnitude of the income coefficient in the fifth column was larger than that in the fourth column. This indicates that if life satisfaction was corrected by arranging the original overall satisfaction for consistent change with the compared satisfaction, the income effect was larger. We might obtain this result because the scale is different from that of the overall satisfaction. The original life satisfaction had the one-to-seven scale; however, the add-up satisfaction had a different scale. This implies that as the overall satisfaction was bounded between one and seven, the coefficient in the fourth column was smaller. If the life satisfaction were not bounded, the effect of income would be larger. The sixth column discusses if the scale was fixed in the one-to-seven scale; consequently, the income coefficient was 0.016, which was smaller than the coefficient in the fifth column but larger than the coefficient in the fourth column. These results mean that consistently using the life satisfaction variable between the overall satisfaction and the compared satisfaction, the income effect on life satisfaction was larger than when using the original life satisfaction. Similar to prior studies, the reference income had a negative impact on life satisfaction; however, the fixed-effect estimation was not significant for the add-up and trimmed satisfaction variables.

Table 4.4 contains the regression result of the change in life satisfaction. In the first column, an increase in income has a positive effect on the increase in the overall satisfaction. The second column shows that if a person experiences increase in income, they report being happier than a year before. Also, in fixed-effect estimation, the coefficient of income was positive and significant. These results imply that increase in income tends to improve one's life satisfaction.

4.1 Threshold Point Analysis

Individuals' measurement of satisfaction could change over time because of various life events. These events would affect people's criteria of life satisfaction. This section analyzes if the threshold points of life satisfaction were stable across the sample period.

Table 4.5 shows application of the ordered probit estimation to the specification in equation 2. The income coefficient was not significant in the first column; however, it was positive and significant for the add-up and trimmed satisfaction variables. The coefficients of the reference income were negative, and they are significant for the overall and trimmed satisfaction variables.

Figure 4.2 shows the shifts of the threshold points of the overall satisfaction through the sample period. Applying GMM estimation for equations 3, 5, and 6 together gives the threshold estimates. The figure shows that the cut points were almost constant during the first five waves. For example, threshold 1 was varying around -3.2 in early sample period. However, after Wave 12, the thresholds varied with a large amount. Threshold 1 varied between -3 and -2 during the latter period. Then, we applied a test to check whether all the means were equal over time for each threshold point. The test result yielded that the hypotheses were rejected for all threshold points. This means, as the table shows, that the thresholds were not stable across time. Thus, the measurement of the reported life satisfaction was changing over time. This might result in weak correlation between life satisfaction and income. This would be one reason why previous studies observed the Easterlin Paradox.

4.2 Robustness check

In previous sections, the estimation models include the linear terms of income and reference income. In this section, the estimation models include the linear and quadratic terms of income and reference income. Table 4.6 shows the regression result specified by equation 2 including the quadratic terms. The first column shows the OLS estimation result of the overall satisfaction. The coefficient of the squared income was positive. This means that if income increased, people reported a higher level of life satisfaction. The second column shows the OLS estimation result of the add-up satisfaction. The coefficient of the squared income was larger than the respective coefficient in the first column. The third column shows the OLS estimation of the trimmed satisfaction. The coefficient of the squared income was larger than the coefficient in the first column but smaller than the coefficient in the second column. In the fourth to sixth columns, the fixed-effect estimation results are reported. If we consider a fixed effect, the sizes of the coefficients of the squared income were smaller than the coefficients in the OLS estimation.

Table 4.7 gives the regression result of the change in life satisfaction. It shows that the linear and quadratic terms of income were not statistically significant with the change in the overall satisfaction. However, these terms were statistically significant when we used the life satisfaction compared with that of the previous year.

In Table 4.8, the ordered probit estimation was applied to the specification in Table 4.5 including the quadratic terms of income and reference income. The quadratic terms of income were positive and the linear terms of income were negative for the three life satisfaction variables. The reference income was not statistically significant for the overall satisfaction, but it was significant for the add-up and the trimmed satisfaction variables.

5 Conclusion

In the literature on happiness, the linear and nonlinear happiness–income analyses and the analysis including reference income were adapted to study the correlation between happiness and income. This chapter focused on estimating one's own measurement of life satisfaction to reveal that the life satisfaction criteria is changing over time.

Even though both the change in the overall life satisfaction and life satisfaction compared with that of the previous year might show the change in life satisfaction from the previous year, there was inconsistency between these variables. Constructing new life satisfaction variables that are consistent between those variables, we obtained larger relationship between income and happiness compared with previous studies. The regression results show that the estimate of the income effect on the overall life satisfaction was positive, but it was lower than the estimates of the constructed life satisfaction variables, which were the add-up and the trimmed life satisfaction variables. In addition, the threshold point analysis shows that one's measurement of life satisfaction was changing over time. This implies that since the criteria is changing with time, we might not compare the overall life satisfaction over time. Therefore, the previous literature obtained low happiness–income correlation and the Easterlin paradox.

In this chapter, we constructed two life satisfaction variables to have consistency between the change in the overall satisfaction and life satisfaction compared with that of the previous year. However, there are more ways to construct life satisfaction variables. Thus, further studies are required to examine the income effect on well-being.

Table 4.1: Summary statistics of demographic variables

Variable	Mean	Std. Dev.
Overall life satisfaction	5.24	1.28
Life satisfaction compared with that of the previous year	0.13	0.65
Number of people in household	2.83	1.37
Number of children in household	0.59	0.97
Age	46.11	18.25
Gender	1.55	0.50
Real annual income (in £)	17,326.332	17,466.132

Source: British Household Panel Survey.

Note: The real annual income is obtained by dividing annual income by the consumer price index based on 2010.

Table 4.2: Life satisfaction comparison matrix

ΔLife satisfaction (overall)	Life satisfaction compared with that of the previous year					
	Less satisfied		About the same		More satisfied	
	Obs.	%	Obs.	%	Obs.	%
-6	49	0.05	42	0.04	10	0.01
-5	81	0.08	53	0.05	24	0.02
-4	287	0.27	149	0.14	47	0.04
-3	879	0.82	642	0.60	142	0.13
-2	2,351	2.18	2,639	2.45	628	0.58
-1	4,798	4.45	12,583	11.67	4,113	3.81
0	5,377	4.99	31,287	29.02	13,805	12.80
1	2,027	1.88	11,620	10.78	6,707	6.22
2	540	0.50	2,739	2.54	1,944	1.80
3	152	0.14	783	0.73	612	0.57
4	53	0.05	235	0.22	196	0.18
5	9	0.01	69	0.06	58	0.05
6	10	0.01	65	0.06	21	0.02
Total	16,613	15.41	62,906	58.34	28,307	26.25

Source: British Household Panel Survey.

Table 4.3: Life satisfaction regression (level)

	LS overall OLS	Add-up LS OLS	Trimmed LS OLS	LS overall FE	Add-up LS FE	Trimmed LS FE
Ln inc	-0.001	0.022**	0.011	0.005	0.022***	0.016***
	(0.005)	(0.009)	(0.007)	(0.004)	(0.006)	(0.005)
Ln ref. inc	-0.095***	-0.017	-0.045**	-0.041***	0.020	-0.003
	(0.015)	(0.023)	(0.020)	(0.011)	(0.017)	(0.014)
Age	-0.043***	-0.078***	-0.067***	-0.012	0.125***	0.068***
	(0.003)	(0.004)	(0.003)	(0.012)	(0.017)	(0.014)
Age^2	0.001***	0.001***	0.001***	-0.000	-0.001***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	147,283	147,283	147,283	147,283	147,283	147,283
R-squared	0.057	0.051	0.048	0.008	0.041	0.021

Source: British Household Panel Survey.
Note: The add-up satisfaction is the life satisfaction constructed by adding compared satisfaction to initial overall life satisfaction. The trimmed satisfaction is the life satisfaction variable that is constructed by replacing zero and eight in the add-up satisfaction for one and seven, respectively. The reference income is the cell-average of the annual real income by age cohort, gender, education, region, and wave. The additional dependent variables are log of number of kids + 1, log of number of adult, education dummy variables, gender dummy variable, regional dummy variables, time dummy variables, house type dummy variables, and marital status dummy variables. Standard errors robust against individual-level clustering are reported in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 4.4: Life satisfaction regression (FD)

	ΔLS (overall)	LS compared with the previous year	ΔLS (overall)	LS compared with the previous year
	OLS	OLS	FE	FE
Ln inc	0.008**	0.007***	0.012**	0.012***
	(0.003)	(0.002)	(0.006)	(0.003)
Ln ref. inc	-0.006	-0.017***	0.001	-0.008
	(0.009)	(0.006)	(0.015)	(0.007)
Age	0.004***	-0.025***	-0.007	-0.018***
	(0.001)	(0.001)	(0.017)	(0.006)
Age^2	-0.000***	0.000***	-0.000**	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Other controls	Yes	Yes	Yes	Yes
Observations	107,826	147,283	107,826	147,283
R-squared	0.003	0.066	0.004	0.013

Source: British Household Panel Survey.
Note: The reference income is the cell-average of the annual real income by age cohort, gender, education, region, and wave. The additional dependent variables are log of number of kids + 1, log of number of adult, education dummy variables, gender dummy variable, regional dummy variables, time dummy variables, house type dummy variables, and marital status dummy variables. Standard errors robust against individual-level clustering are reported in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 4.5: Life satisfaction regression (Ordered probit estimation)

	LS (overall)	Add-up LS	Trimmed LS
Ln inc	-0.004	0.015***	0.009*
	(0.005)	(0.005)	(0.005)
Ln ref. inc	-0.081***	-0.011	-0.026*
	(0.013)	(0.013)	(0.014)
Age	-0.036***	-0.043***	-0.046***
	(0.002)	(0.002)	(0.002)
Age^2	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Other controls	Yes	Yes	Yes
Observations	147,283	147,283	147,283
Pseudo R-squared	0.018	0.013	0.013

Source: British Household Panel Survey.
Note: The add-up satisfaction is the life satisfaction constructed by adding compared satisfaction to initial overall life satisfaction. The trimmed satisfaction is the life satisfaction variable that is constructed by replacing zero and eight in the add-up satisfaction for one and seven, respectively. The reference income is the cell-average of the annual real income by age cohort, gender, education, region, and wave. The additional dependent variables are log of number of kids + 1, log of number of adult, education dummy variables, gender dummy variable, regional dummy variables, time dummy variables, house type dummy variables, and marital status dummy variables. Standard errors robust against individual-level clustering are reported in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 4.6: Robustness check: life satisfaction regression (level)

	LS overall OLS	Add-up LS OLS	Trimmed LS OLS	LS overall FE	Add-up LS FE	Trimmed LS FE
Ln inc	-0.093***	-0.100***	-0.092***	-0.026**	-0.020	-0.018
	(0.013)	(0.021)	(0.018)	(0.015)	(0.011)	(0.012)
$(Ln\ \text{inc})^2$	0.009***	0.012***	0.010***	0.003***	0.005***	0.004***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
Ln ref. inc	-0.002	0.186**	0.103	-0.058	0.035	0.011
	(0.058)	(0.085)	(0.071)	(0.043)	(0.066)	(0.050)
$(Ln\ \text{ref. inc})^2$	-0.008*	-0.017**	-0.013**	0.001	-0.002	-0.002
	(0.005)	(0.007)	(0.006)	(0.003)	(0.005)	(0.004)
Other controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	147,283	147,283	147,283	147,283	147,283	147,283
R-squared	0.057	0.051	0.049	0.008	0.041	0.022

Source: British Household Panel Survey.
Note: The add-up satisfaction is the life satisfaction constructed by adding compared satisfaction to initial overall life satisfaction. The trimmed satisfaction is the life satisfaction variable that is constructed by replacing zero and eight in the add-up satisfaction for one and seven, respectively. The reference income is the cell-average of the annual real income by age cohort, gender, education, region, and wave. The additional dependent variables are log of number of kids + 1, log of number of adult, education dummy variables, gender dummy variable, regional dummy variables, time dummy variables, house type dummy variables, and marital status dummy variables. Standard errors robust against individual-level clustering are reported in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 4.7: Robustness check: life satisfaction regression (FD)

	ΔLS (overall) OLS	LS compared with the previous year OLS	ΔLS (overall) FE	LS compared with the previous year FE
Ln inc	0.002	-0.020***	-0.000	-0.006
	(0.010)	(0.006)	(0.015)	(0.007)
$(Ln \text{ inc })^2$	0.001	0.003***	0.001	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Ln ref. inc	-0.082*	0.045*	-0.067	-0.010
	(0.046)	(0.027)	(0.058)	(0.026)
$(Ln \text{ ref. inc})^2$	0.006*	-0.005**	0.005	-0.000
	(0.003)	(0.002)	(0.004)	(0.002)
Other controls	Yes	Yes	Yes	Yes
Observations	107,826	147,283	107,826	147,283
R-squared	0.003	0.066	0.004	0.013

Source: British Household Panel Survey.
Note: The reference income is the cell-average of the annual real income by age cohort, gender, education, region, and wave. The additional dependent variables are log of number of kids + 1, log of number of adult, education dummy variables, gender dummy variable, regional dummy variables, time dummy variables, house type dummy variables, and marital status dummy variables. Standard errors robust against individual-level clustering are reported in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 4.8: Robustness check: life satisfaction regression (Ordered probit estimation)

	LS (overall)	Add-up LS	Trimmed LS
Ln inc	-0.063***	-0.047***	-0.046***
	(0.011)	(0.012)	(0.012)
$(Ln \text{ inc })^2$	0.006***	0.006***	0.005***
	(0.001)	(0.001)	(0.001)
Ln ref. inc	-0.013	0.106**	0.073
	(0.050)	(0.049)	(0.048)
$(Ln \text{ ref. inc})^2$	-0.006	-0.010**	-0.008**
	(0.004)	(0.004)	(0.004)
Other controls	Yes	Yes	Yes
Observations	147,283	147,283	147,283
Pseudo R-squared	0.018	0.013	0.013

Source: British Household Panel Survey.
Note: The add-up satisfaction is the life satisfaction constructed by adding compared satisfaction to initial overall life satisfaction. The trimmed satisfaction is the life satisfaction variable that is constructed by replacing zero and eight in the add-up satisfaction for one and seven, respectively. The reference income is the cell-average of the annual real income by age cohort, gender, education, region, and wave. The additional dependent variables are log of number of kids + 1, log of number of adult, education dummy variables, gender dummy variable, regional dummy variables, time dummy variables, house type dummy variables, and marital status dummy variables. Standard errors robust against individual-level clustering are reported in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

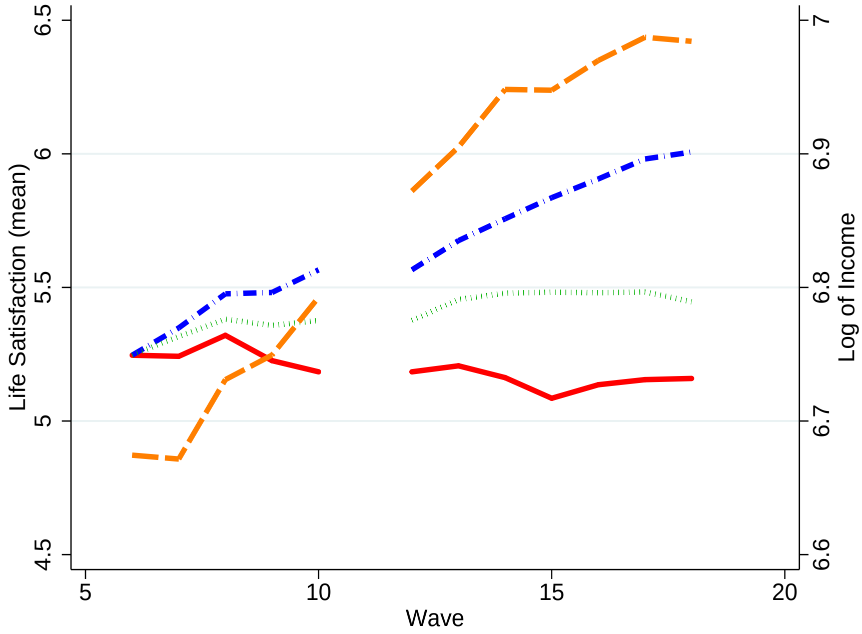

Figure 4.1: Life satisfaction comparisons

Source: British Household Panel Survey.
Note: The red solid line is the overall life satisfaction. The orange dashed line is the log of real total income in the previous month. The blue dash-dot line is the add-up satisfaction. The green dotted line is the trimmed satisfaction.

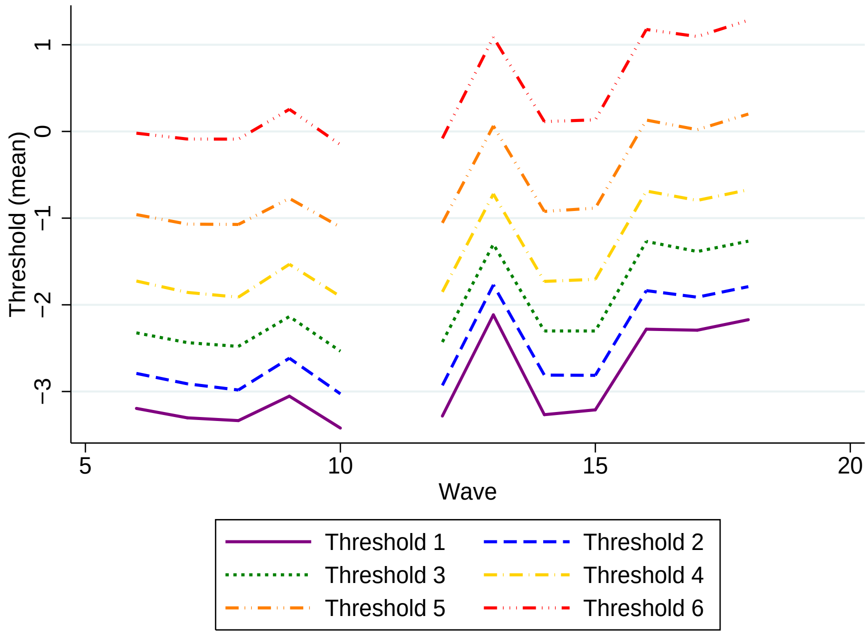

Figure 4.2: Threshold points transitions

Source: British Household Panel Survey.

Appendix

Table 4.9: Constructed life satisfaction distribution (in %, add-up life satisfaction)

Add-up satisfaction	wave							
	6	7	8	9	10			
-3	0.0	0.0	0.0	0.0	0.1			
-2	0.0	0.0	0.0	0.1	0.1			
-1	0.0	0.0	0.2	0.2	0.4			
0	0.0	0.4	0.7	0.6	1.1			
1	1.5	1.7	1.8	2.3	2.2			
2	2.4	3.1	3.5	3.2	3.2			
3	5.8	6.4	6.6	6.4	6.6			
4	14.4	13.4	12.1	12.2	11.8			
5	28.3	23.0	20.2	20.5	18.6			
6	31.5	28.5	25.2	25.1	23.7			
7	16.1	19.9	21.2	20.0	19.4			
8	0.0	3.6	6.9	6.2	7.7			
9	0.0	0.0	1.7	2.5	3.5			
10	0.0	0.0	0.0	0.6	1.4			
11	0.0	0.0	0.0	0.0	0.4			
	12	13	14	15	16	17	18	Total
-5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-4	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0
-3	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.1
-2	0.0	0.0	0.0	0.2	0.3	0.3	0.6	0.1
-1	0.0	0.0	0.3	0.3	0.5	0.8	0.9	0.3
0	0.0	0.5	0.5	0.8	1.2	1.4	1.5	0.8
1	1.5	1.3	1.8	2.1	2.4	2.3	2.4	1.9
2	1.9	2.9	3.3	3.6	3.4	3.8	3.8	3.2
3	5.9	6.2	6.4	6.2	6.5	6.2	6.1	6.3
4	13.5	13.2	12.4	11.6	10.8	10.6	10.5	12.2
5	29.2	23.4	21.0	20.0	18.2	16.7	16.8	21.2
6	32.6	29.5	26.2	24.2	23.2	21.9	20.7	25.9
7	15.5	19.5	19.8	18.4	17.4	17.3	16.4	18.4
8	0.0	3.6	6.9	8.2	8.9	8.7	8.8	5.9
9	0.0	0.0	1.5	3.6	4.6	5.5	5.2	2.4
10	0.0	0.0	0.0	0.8	2.0	2.8	3.5	1.0
11	0.0	0.0	0.0	0.0	0.5	1.2	1.6	0.3
12	0.0	0.0	0.0	0.0	0.0	0.3	0.7	0.1
13	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0

Source: British Household Panel Survey.

Table 4.10: Constructed life satisfaction distribution (in %, trimmed life satisfaction)

Trimmed satisfaction	wave						
	6	7	8	9	10		
0	–	0.38	0.76	0.7	1.3		
1	1.48	1.67	1.91	2.43	2.43		
2	2.36	3.12	3.46	3.24	3.2		
3	5.82	6.41	6.62	6.44	6.65		
4	14.42	13.43	12.08	12.24	11.85		
5	28.34	23.02	20.2	20.61	18.76		
6	31.53	28.49	25.45	25.56	24.31		
7	16.07	19.92	22.32	22.03	22.71		
8	–	3.56	7.2	6.75	8.79		
	12	13	14	15	16	17	18
0	–	0.51	0.67	1.03	1.6	2	2.42
1	1.45	1.26	1.88	2.27	2.7	2.77	3.02
2	1.93	2.87	3.34	3.7	3.53	3.93	4.05
3	5.85	6.15	6.37	6.22	6.52	6.3	6.14
4	13.52	13.19	12.39	11.57	10.85	10.69	10.65
5	29.2	23.38	21.03	20	18.35	16.94	17.07
6	32.56	29.52	26.31	24.75	24.09	23.16	22.73
7	15.49	19.54	21.22	21.03	22.21	23.46	23.67
8	–	3.59	6.8	9.43	10.15	10.75	10.26

Source: British Household Panel Survey.

Chapter V

The Effect of Exchange-Rate Fluctuations on Employment in a Segmented Labor Market[1]

1 Introduction

In the aftermath of the US financial crisis, which peaked in summer 2008 with the collapse of Lehman Brothers, the Japanese Yen appreciated by more than 25%, and it coincided with a surge of the unemployment rate from 4% to 5.5%, as shown in Figure 5.1. During this turbulent time, the job loss of non-regular workers, whose employment is less protected than that of regular workers, attracted much attention from media and policy makers. As exemplified by this episode, policy makers frequently discuss whether swings in the exchange rate cause swings in employment, particularly that of non-regular workers.[2] The causal effect of

[1]This chapter is organized based on the paper: Izumi Yokoyama, Kazuhito Higa, and Daiji Kawaguchi (2015) "The Effect of Exchange-Rate Fluctuations on Employment in a Segmented Labor Market."

[2]Koichi Hamada, a Special Adviser to the Cabinet of the Prime Minister Shinzo Abe, later blamed the Bank of Japan for not expanding its balance sheet sufficiently to counter the balance-sheet expansion of the Federal Reserve Bank of the US and European Central Bank that allegedly caused a sudden Yen appreciation and subsequent job loss in exporting industries. He went as

the exchange rate on employment requires that monetary and fiscal authorities formulate exchange-rate policies that take their impacts on employment into consideration. Moreover, the exchange-rate policy has a distributional consequence if the cost of the exchange-rate fluctuation falls especially on non-regular workers in segmented labor markets, which are pervasive in some continental European countries and South Korea, as well as Japan.

The causal effect of the exchange-rate fluctuation on employment outcomes has long attracted researchers and policy makers' attention because of its significant implications for monetary and fiscal policies. Reflecting this attention, numerous empirical studies examine the effect of the exchange-rate fluctuation on employment adjustment. Studies based on industry-level data include Brunello (1990), Dekle (1998), and Tomiura (2003) for Japan, Gourinchas (1999a) and Campa and Goldberg (2001) for the US, and Gourinchas (1999b) for France. Recent studies based on firm-level gross job flow data include Klein, Schuh, and Triest (2003) for the US and Moser, Urban, and di Mauro (2010) for Germany. These studies exploit heterogeneous dependence on international trade across industries for identification. Klein et al. (2003) report that the exchange-rate fluctuation significantly affects net job flow through job destruction in the US, while Moser et al. (2010) find a similar effect on net job flow but through job creation in Germany; for firms in exporting industries, appreciation of own currency destructs jobs in the US, whereas it suppresses job creation in Germany. The difference in results probably reflects the strictness of employment protection legislation across the two countries. The negative labor demand shock created by the exchange-rate fluctuation is absorbed by firing existing workers in the US, whereas it is absorbed by suppressing recruitment in Germany. The contrasting results from the US and Germany highlight the significant role of labor-market institutions in the process

far as to claim that the Bank of Japan caused the bankruptcy of Elpida Memory, Inc., which heavily depended on exports and went bankrupt in February 2012 (Press conference at Foreign Correspondents' Club on January 18, 2013).

of labor reallocation during the exchange-rate adjustment.

Heterogeneity of employment adjustment costs arises within a country where the labor market is segmented because regular and non-regular workers have different degrees of employment protection. The differential employment protection between regular and non-regular employment contracts tends to make employers rely on non-regular workers to absorb exogenous shocks and thus results in segmented labor markets within a country (OECD, 2014). A strand of literature examines the differential adjustments of regular and non-regular workers in response to exogenous shocks (Hunt, 2000; Houseman, 2001; Holmlund and Storrie, 2002; Varejão and Portugal, 2007; Hijzen, Kambayashi, Teruyama, and Genda, 2015). Much less is known, however, about the differential elasticities of employment adjustment between regular and non-regular workers based on a credibly exogenous source of labor demand shock that is heterogeneous across firms. Our aims in this study are twofold. First, we attempt to fill the gap of policy makers' interest and the literature by estimating the causal effect of exchange-rate fluctuations on the employment adjustment of regular and non-regular workers. Second, we examine the differential adjustment costs between regular and non-regular workers using exchange-rate fluctuations combined with heterogeneous dependence on international trade across firms as the source of exogenous variation for labor demand.

Nucci and Pozzolo (2010) is the closest study to ours that examines the impact of the exchange-rate fluctuation on employment adjustment exploiting firms' heterogeneity in the exposure to international trade. Recent literature reveals that only a fraction of firms within an industry have access to international trade (Melitz and Redding, 2014), but studies that exploit the industry-level variation in trade exposure do not use firm-level heterogeneity in international trade exposure to estimate the causal relationship. Nucci and Pozzolo (2010) use unique Italian firm-level panel data that record costs of foreign purchases and revenues from foreign sales, along with the usual accounting information. They shed light on the impacts of the exchange-rate fluctuation on employment and working hours across Italian firms, exploiting heterogeneous dependence on export across firms for identification, and find that the appreciation in Italian Lira increases both employment and hours of importing firms, while it decreases those of exporting firms. They do not pay attention, however, to the differential impacts on regular and non-regular workers. Hosono, Takizawa, and Tsuru (2013) examine the effect of Yen appreciation on firms' performance comparing exporting and non-exporting firms using the same data set as in our study; they find that exporting firms suffer from the sudden appreciation of the Yen and cut the employment of term-contracted workers after the 2008 financial crisis. They, however, do not systematically examine the impact of the exchange rate on regular and non-regular employment. Hanagaki and Hori (2015) examine the effect of exchange rate fluctuation on firms' performance, such as sales and return on assets (ROA), exploiting the heterogeneous dependence on international trade, drawing on the same data set as in our study, and find that Yen depreciation boosts net exporters' (those firms whose export amount exceeds import amount) performance, on average. They do not pay attention, however, to its effect on employment.

The current study draws from firm-level panel data collected in the Basic Survey of Japanese Business Structure and Activities conducted by the Ministry of International Trade and Industry that covers all enterprises with 50 or more employees and whose paid-up capital or investment fund is over 30 million Yen, operating in wide range of industries. This survey records information on each company's level of dependence on foreign trade and the numbers of employees of different contract forms. We exploit the heterogeneity in the dependence on international trade to identify the impact of exchange fluctuation on employment adjustment; for example, the impact of Yen appreciation on employment is examined by comparing the changes of employment in exporting firms – the treatment group – and non-exporting firms – the control group – in a virtually difference-in-differences framework. We furthermore consider two types of exchange-rate shocks: permanent and temporary. As Nucci and Pozzolo (2001) pointed out in the context of physical investment, firms are unlikely to modify their employment levels after temporary fluctuations of exchange rates in the presence of adjustment costs. For this reason, we extract the trend component of exchange-rate variations from the observed exchange-rate fluctuation using the Beveridge-Nelson decomposition. We then examine how employment responds to permanent shocks, using the trend component of the exchange-rate fluctuation as the instrumental variable (IV); the standard IV estimator recovers the employment response to the permanent exchange-rate shock based on the local average treatment effects (LATE) interpretation of the IV estimator.

The empirical analysis reveals that the appreciation of Yen increases the sales and the employment of exporting firms; to take a firm that exports 10% of its total sales as an example, a 10% appreciation of Japanese Yen measured in the real effective exchange rate decreases sales by around 9%, regular employment by about 1.7%, and non-regular employment by about 8%. The elasticity of non-regular workers is about 5 times larger than that of regular workers, and this implies a significant difference in the adjustment costs between regular and non-regular employments. Regular employment reacts more to the permanent change of the exchange rate than to the transitory change, whereas non-regular employment reacts more to the transitory component than to the permanent component. These findings imply that firms use non-regular workers as an adjustment margin for a transitory exchange-rate fluctuation. Contrary to the findings for exporting firms, the appreciation of Japanese Yen does not increase the regular or non-regular employment of importing firms, perhaps because the effect of price changes of foreign intermediate inputs, such as energy, propagates to the firms that do not directly import intermediate inputs.

2 Theoretical Model

This section introduces a dynamic model of a firm that maximizes the discounted sum of future profits, using regular and non-regular workers as inputs. The firm incurs an adjustment cost for changing the number of regular workers, while it does not incur such a cost for non-regular workers. Nucci and Pozzolo (2001, 2014) introduce q theory of physical capital investment to consider the effect of the exchange rate on it. The key idea here is that physical capital investment, I_t, requires an convex adjustment cost $C(I_t)$ with properties $C', C'' > 0$. We apply this theory to the employment adjustment of regular workers, because it also incurs an adjustment cost $C(I_t)$, given the cost of recruiting new workers and firing existing workers. We define the short-run as the period during which regular workers cannot be adjusted according to the standard convention. We modify the model by Nucci and Pozzolo (2001, 2014) by replacing the stock of capital K with the stock of regular workers R. The first difference of R, ΔR, represents a net flow into the pool of regular workers, which requires adjustment cost $C(\Delta R_t)$ that $C', C'' > 0$.

The following Bellman equation for the state variable, R_t, characterizes the firm's dynamic profit maximization:

$$V_t(R_{t-1}) = \max_{\Delta R_t}\Big(\pi(R_t, e_t) - C(\Delta R_t) + \beta E_t\big[V_{t+1}(R_t)\big]\Big). \tag{1}$$

Note that there is no adjustment cost for non-regular workers, and thus it does not appear in the Bellman equation that includes only the state variables. The parameter β is a constant discount factor. The regular-worker stock is governed by the accumulation equation for R_t; $R_t = (1-\delta)R_{t-1} + \Delta R_t$, where δ is the natural rate of job separation.

Applying the envelope theorem renders the Euler equation that characterizes the optimal path of regular worker adjustment:

$$\frac{\partial V_t}{\partial R_{t-1}} = \frac{\partial \pi(R_t, e_t)}{\partial R_t}\frac{\partial R_t}{\partial R_{t-1}} + \beta E_t\left[\frac{\partial V_{t+1}}{\partial R_t}\frac{\partial R_t}{\partial R_{t-1}}\right] = \frac{\partial \pi(R_t, e_t)}{\partial R_t}(1-\delta) + \beta E_t\left[\frac{\partial V_{t+1}}{\partial R_t}(1-\delta)\right]. \tag{2}$$

We denote $\partial V_t/\partial R_{t-1}$ as q_t, representing the shadow value of regular workers. Equation 2 can be summarized as follows:

$$q_t = \frac{\partial \pi(R_t, e_t)}{\partial R_t}(1-\delta) + \beta(1-\delta)E_t\left[q_{t+1}\right]. \tag{3}$$

Repeating the substitution of q_{t+j}, equation 3 can be summarized as follows:

$$\begin{aligned} q_t &= \frac{\partial \pi(R_t, e_t)}{\partial R_t}(1-\delta) + \beta E_t\left[\left(\frac{\partial \pi(R_{t+1}, e_{t+1})}{\partial R_{t+1}}(1-\delta) + \beta E_{t+1}\left[q_{t+2}(1-\delta)\right]\right)(1-\delta)\right] \\ &= E_t\sum_{j=0}^{\infty}\beta(1-\delta)^{j+1}\left(\frac{\partial \pi(R_{t+j}, e_{t+j})}{\partial R_{t+j}}\right). \end{aligned} \tag{4}$$

Equation 4 means that q_t is equivalent to the discounted present value of the marginal profit of regular-workers.

The first-order condition with respect of ΔR_t can be calculated from equation 1 as follows:

$$\frac{\partial C(\Delta R_t)}{\partial \Delta R_t} = \frac{1}{1-\delta}\,q_t. \tag{5}$$

Given the increasing and convex shape of $C(\Delta R_t)$, ΔR_t is an increasing function of q_t. Substituting equation 4, ΔR_t can be expressed as an increasing function g ($g' > 0$) of the expected present value of marginal profits, as follows:

$$\Delta R_t = g(q_t) = g\left[E_t\sum_{j=0}^{\infty}\beta(1-\delta)^{j+1}\left(\frac{\partial \pi(R_{t+j}, e_{t+j})}{\partial R_{t+j}}\right)\right]. \tag{6}$$

Note that the increasing property of $g(\cdot)$ comes from the adjustment costs of regular workers. To explore the impact of exchange rates on regular workers, we need to know the sequence of the marginal profitability of regular workers. To derive this, we will solve the static profit-maximization problem.

We assume that the firm has market power in both domestic and foreign markets and faces downward sloping inverse demand functions. The firm maximizes profits in each period subject to a certain production technology that consists of a quasi-fixed factor, regular workers, and non-regular workers (N_t), as in Campa and Goldberg (2001) and Nucci and Pozzolo (2001). The firm does not have market power in the labor market, and the wages of regular and non-regular workers are given at w^R and w^N, respectively.

$$\pi(R_t, e_t) = \max_{Q_t, Q_t^*, N_t} Q_t p(Q_t, e_t) + e_t Q_t^* p^*(Q_t^*, e_t) - w_t^R R_t - w_t^N N_t, \tag{7}$$

$$s.t.\ \ Q_t + Q_t^* = F(R_t, N_t),$$

where e_t is the exchange rate of Yen for a foreign currency unit and an increase in e_t means a Yen's depreciation.

The Lagrangian function for this optimization problem can be written as follows:

$$\mathcal{L} = Q_t p(Q_t, e_t) + e_t Q^* p^*(Q^*, e_t) - w_t^R R_t - w_t^N N_t + \lambda_t \Big(F(R_t, N_t) - Q_t - Q_t^* \Big). \tag{8}$$

Then, the first-order conditions can be solved in the following way:

$$\frac{\partial \mathcal{L}}{\partial Q_t} = p'(Q_t) Q_t + p_t - \lambda_t = 0, \tag{9}$$

$$\frac{\partial \mathcal{L}}{\partial Q_t^*} = p'^*(Q_t^*) Q_t^* + e_t p_t^* - \lambda_t = 0, \tag{10}$$

$$\frac{\partial \mathcal{L}}{\partial N_t} = -w_t^N + \lambda_t F_{Nt} = 0. \tag{11}$$

From Equations 9 and 10, we obtain the marginal value of output, which is:

$$\lambda_t = p_t \Big(1 + \frac{1}{\eta_t} \Big) = e_t p_t^* \Big(1 + \frac{1}{\eta_t^*} \Big), \tag{12}$$

where $\eta_t = (p_t/Q_t)(\partial Q_t/\partial p_t)$ and $\eta_t^* = (p_t^*/Q_t^*)(\partial Q_t^*/\partial p_t^*)$. The stronger domestic and foreign market powers are, the smaller these demand elasticities become. From equation 11, we obtain the optimality condition for non-regular workers:

$$p_t\left(1+\frac{1}{\eta_t}\right)F_{Nt} = e_t p_t^*\left(1+\frac{1}{\eta_t^*}\right)F_{Nt} = w_t^N. \tag{13}$$

This equation implies that N_t increases in response to an increase in the domestic price p_t, the foreign price p_t^*, and the depreciation of Japanese Yen (increase in e_t).

Using the envelope theorem and equations 7 and 12, if we consider the long-run optimal path of regular workers, we have:

$$\frac{\partial \pi_t}{\partial R_t} = -w_t^R + \lambda_t F_{R_t} = -w_t^R + p_t\left(1+\frac{1}{\eta_t}\right)F_{R_t}. \tag{14}$$

We assume constant returns to scale for the production function. By Euler's theorem:

$$F(R_t, N_t) = F_{R_t}R_t + F_{N_t}N_t. \tag{15}$$

Let $1/\mu_t$ and $1/\mu_t^*$ be the mark-up ratios in the domestic and foreign product markets, respectively. Then, we have:

$$\lambda_t = \frac{p_t}{\mu_t} = \frac{e_t p_t^*}{\mu_t^*}. \tag{16}$$

Assuming that the exchange rate is the only source of uncertainty and varies permanently, the expected value of the marginal profit of capital stock in the future is equal to the marginal profit at time t, equation 6 is reconfigured as below:

$$\Delta R_t = g\left(\frac{1-\delta}{1-\beta(1-\delta)}\frac{\partial \pi(R_t, e_t)}{\partial R_t}\right). \tag{17}$$

Partially differentiating ΔR_t by the exchange rate e_t in consideration of equation 18, the effect of a permanent shift in the exchange rate on the inflow of regular workers is expressed as follows:[3]

$$\frac{\partial \Delta R}{\partial e} = g_q(\cdot)\frac{1-\delta}{1-\beta(1-\delta)}\frac{\partial^2 \pi}{\partial R \partial e} \tag{18}$$

[3] From now on, for simplicity, we shall omit the explicit time notation.

The expansion of the last term yields the next expression:[4]

$$\frac{\partial^2 \pi}{\partial R \partial e} = g_q(\cdot)\frac{1-\delta}{1-\beta(1-\delta)}\frac{pQ+p^*Q^*}{Re}\Bigg[\frac{1}{\mu}(1-\chi)\big(\eta_{pe}(1+\eta)-\epsilon_{\eta e}\big)$$
$$+\frac{1}{\mu^*}\chi\big(\eta_{p^*e}(1+\eta^*)+1-\epsilon_{\eta^*e}\big)-\left(\overline{\eta_{W^Re}}\frac{w^RR}{pQ+p^*Q^*}+\overline{\eta_{W^Ne}}\frac{w^NN}{pQ+p^*Q^*}\right)\Bigg], \tag{19}$$

where χ denotes the export ratio to the total revenue, which is defined as $p^*Q^*/(pQ+p^*Q^*)$; η_{pe} denotes the exchange rate elasticity of domestic price, i.e., $\frac{\partial p}{\partial e}\frac{e}{p}$; and η_{p*e} denotes the exchange rate elasticity of foreign price. The elasticities η and η^* are respectively the price elasticities in domestic and foreign demand, which have been already defined. The $\epsilon_{\eta e}$ and ϵ_{η^*e} are respectively the exchange-rate elasticity of markups in domestic and foreign markets, i.e.,$\frac{\partial \mu}{\partial e}\frac{e}{\mu}$ and $\frac{\partial \mu^*}{\partial e}\frac{e}{\mu^*}$. $\overline{\eta_{w^Re}}$ denotes the exchange-rate elasticity of regular workers' wage without distinguishing between domestic and international markets, while $\overline{\eta_{w^Ne}}$ denotes the exchange-rate elasticity of non-regular workers' wage.

The depreciation of Yen, an increase in e, affects the employment of regular-workers through three channels, as implied by equation 19. The first term on the right-hand side represents a channel for domestic sales. Since $\eta_{pe} > 0$, $\eta < 0$, and $\epsilon_{\mu e} > 0$, if $\eta < -1$, as Yen depreciates, domestic sales revenue decreases with decreasing marginal profit, and then the flow of regular workers decreases.

The second term is an exporting channel. $\eta_{p^*e} = -1$ means a complete pass-through to foreign prices of an exchange-rate variation, while $\eta_{p^*e} = 0$ means no path-through, and thus η_{p^*e} ranges from minus one to zero. For more details, see Nucci and Pozzolo (2001). Since "1" is added to the same expression of the domestic channel, more possibilities can be realized depending on the elasticity of foreign demand. It is still true, however, that the larger the negative value that

[4] The details are written in the Appendix.

the price elasticities of foreign demand take, the larger the effect of a large external orientation becomes.

Holding other things constant, firms with lower product market power react more significantly to the exchange-rate shift. The smaller market power in domestic and foreign markets is represented by a lower markup rate; μ and μ^* are close to zero. The larger the markup, the smaller is the reaction, as evident from equation 19.

3 Empirical Model

3.1 Model

This section introduces the empirical model to estimate how the fluctuation in the exchange rate influences the change in employment of a firm via the change in imports and exports. Slightly modifying Nucci and Pozzolo (2010), the empirical model for the labor adjustment according to the fluctuation in the exchange rate is as follows:

$$\begin{aligned}\%\Delta Y_{ijt} = \beta_0 + \beta_1 Imp_{it-1}\%\Delta E_t + \beta_2 Exp_{it-1}\%\Delta E_t + \beta_3 Imp_{it-1} + \beta_4 Exp_{it-1} \\ + \beta_5 Markup_i \, (+\beta_6 \ln Y_{ijt-1}) + d_{jt} \, (+c_i) + u_{ijt},\end{aligned} \quad (20)$$

where $\%\Delta Y_{ijt}$ is the percentage change in the outcome variables that are the total sales, the number of regular or non-regular employees of firm i in industry j in year t. The percentage change of an outcome variable is defined as $(Y_{ijt} - Y_{ijt-1})/[(Y_{ijt} + Y_{ijt-1})/2]$ to allow for zero values. Imp_{it-1} is the share of imported inputs among all intermediate inputs, and Exp_{it-1} is the share of export sales among all sales. The term $\%\Delta E_t$ is the percentage change in the real effective exchange rate, the amount of foreign currency units to 100 Yen, and thus its increase corresponds to Yen appreciation. The variable $Markup_i$ is defined as the sample-period average of (Total sales - Sales cost)/Total sales. The model includes the industry (17 categories) $\times$ year fixed effects, d_{jt}, to control for time-variant industry-specific factors, such as product and input prices. By including these fixed effects, the effects of the exchange-rate fluctuation on sales or employment are identified off the firm heterogeneity of trade exposure within an industry $\times$ year cell. The linear term of $\ln E_t$ is not included, because the effect is captured by the industry $\times$ year fixed effects.

The estimation equation expresses the difference-in-differences estimation. The change in the exchange rate affects the employment of importing and exporting firms, but it does not affect the employment of firms with neither imports nor exports; firms exposed to international trade serve as a treatment group, and firms not exposed to international trade serve as a control group. Thus the error term u_{it} is not correlated with the treatment status, Imp_{it-1} or Exp_{it-1}, if firms with and without international trade exposures share the same unobserved factors determining the employment adjustment. To make this exogeneity assumption plausible, we allow for industry $\times$ year specific shocks. Thus the comparison of high-exposure firms and low-exposure firms is made within an industry $\times$ year cell. Given the exogeneity assumption,

$$E(u_{ijt}|Imp_{it-1}, Exp_{it-1}, \Delta \ln E_t, Markup_{it}, d_{jt}) = 0,$$

the OLS estimator is an unbiased and consistent estimator.

We first confirm the validity of the specification by using total sales as the dependent variable. The appreciation of Yen – an increase in $\ln E_t$ – is supposed to increase the total sales of importing firms through cost reduction; thus, we expect β_1 to be positive. In contrast, the appreciation of Yen is supposed to decrease the total sales of exporting firms through the increase of product price; thus we expect the coefficient β_2 to be negative. After confirming the validity of the specification, we proceed to examine the effect of the exchange-rate fluctuation on the adjustment of regular and non-regular workers.

In the estimation of employment equations, we include lagged regular employment, $\ln Y_{ijt-1}$, as an additional explanatory variable to capture the effect of the state variable on employment adjustment, as expressed by equation A.1.

The choice of invoice currency has a subtle impact on the estimation, but it does not affect the expected sign of the coefficient. The appreciation of Yen, for example, decreases the total sales of exporting firms through the reduction of export quantity if the invoice currency is Yen, because the product price in local currency increases given a positive pass-through; whereas it decreases the total sales of exporting firms through price reduction if the invoice currency is foreign currency, because the Yen amount received for a foreign currency decreases, again, given a positive pass-through. Ito, Koibuchi, Sato, and Shimizu (2012) document that Japanese firms tend to use US dollars and Euros for trade with the US or European countries, respectively, and they use US dollars as the invoice currency even for trade with Asian countries. According to them, as of the second half of 2008, the share of Yen invoicing is 39.4% in Japanese exports to the world and 20.7% in Japanese imports from the world.

We decompose the change in the exchange rate into trend and transitory components and estimate the employment response to a permanent change of the exchange rate by estimating the equation by the instrumental variable method, using the trend component of the exchange rate as the instrumental variable. Using the Beverage and Nelson decomposition (Beveridge and Nelson, 1981), we first elicit the trend component in the exchange rate. Then, the elicited trend component interacted with import/export shares serve as the instrumental variables for the endogenous variables: the interactions of the percentage change in the exchange rate and the import/export shares in equation 20. The IV estimate is the employment response to the permanent change in the exchange rate, as the literature on the local average treatment effect suggests (Angrist and Imbens, 1994; Angrist, Imbens, and Rubin, 1996).

We further allow for firm-level fixed effects, c_i, in the estimation of the sales equation to allow for the possible correlation of an unobserved firm-specific growth factor with the firm's import or export dependence. Recent literature emphasizes both theoretically and empirically that firms with high productivity tend to engage in international trade, because only these firms can recoup the fixed cost of engaging in such trade. Although the productivity heterogeneity in levels is differenced out in the specification, heterogeneity in the growth rate may create a spurious correlation between high sales growth and heavy dependence on international trade. We address this concern by examining whether allowing for unobserved growth determinants changes the estimation results significantly.

4 Data

This study uses the Basic Survey of Japanese Business Structure and Activities, published by the Ministry of Economy, Trade, and Industry of the Japanese government. The Basic Survey of Japanese Business Structure and Activities is a panel survey of firms conducted at each year covering firms that hire 50 employees or more, hold stated capital (or contribution) of at least 30 million Yen and operate in following industries: mining, manufacturing, public utility, communication, wholesale and retail, finance and insurance, real estate and leasing, academic research and professional service, lodging and restaurant, daily-living service and leisure, education and miscellaneous services. The survey was first launched in 1992, but it started asking the number of workers from temporary help agencies from 2001. Thus, this study uses data from 2001 to 2012, covering the period during which the global financial crisis took place.

We constructed the variables used for this study as follows. The number of employees is the number of executives with compensation and permanent employees. A permanent employee is defined as an employee with a contract period that extends one month or longer, or an employee who worked 18 days or more in each of past two months. The permanent employee includes several classifications of workers, such as *Seishain, Seishokuin, Part, Arubaito, Shokutaku, Keiyakushain.* The number of permanent employees is divided into the number of regular workers (*Seishain* and *Seishokuin*) and part-time workers who work fewer hours per day than a regular worker, or a worker who works fewer days per a week than a regular worker. The survey further asks for the number of temporary workers with a contract period that extends less than one month and the number of workers dispatched from temporary help agencies. Regular workers (*Seishain* and *Seishokuin*) typically work full-time with an indefinite contract. We define non-regular workers as the sum of part-time workers, temporary workers with contract periods extending less than one month, and workers dispatched from temporary help agencies. Although Japanese labor law does not explicitly provide differential degrees of employment protection between regular and non-regular employment, court precedents conventionally endow stronger protection for regular employees than for non-regular employees (Asano, Ito, and Kawaguchi, 2013).[5]

We construct each firm's exposure to international trade by the amount of imports among total purchases and the amount of exports among total sales. The amounts of imports and exports record the respective amounts that the firm directly clears through customs. We calculate market power using the Lerner index: (Total sales−Operating cost)/Total sales.[6] The Lerner index corresponds to the degree of price markup.

[5]The famous court precedent that clearly endows non-regular workers with weaker employment protection over regular workers is the Hitachi Medico Case. In this case, the Supreme Court demonstrated that it is not unreasonable to terminate a worker with a fixed term contract in advance of regular employees when there is economic redundancy (Takeuchi-Okuno, 2010).

[6]The operating cost includes cost of sales and services and selling and administrative expenses.

Table 5.1 reports the descriptive statistics of the firm-level panel data. The average import share – the fraction of imports among all purchases – is 0.043, with standard deviation of 0.148. The average export share – the fraction of exports among total sales – is 0.027, with standard deviation of 0.099. Among all firm-year observations, 22% record a positive export share and 22% record a positive import share. The distributions of import and export shares are drawn in Figure 5.2 given positive shares. Both distributions have a long right tail; many firms do not engage in international trade, but a few firms actively engage in it. This heterogeneity of exposure to international trade assures the validity of the difference-in-differences estimation strategy employed in this chapter. The correlation coefficient of import and export shares is 0.243; the firms engaging in import trade are more likely to engage in export trade. The average market power approximated by the Lerner index is 0.033, whereas its standard deviation is 0.044.

Decomposing firms into four types by their involvement in import and export sheds light on the heterogeneity of firms among types. Firms involved in international trade are larger in terms of sales, operating cost, and regular employment size; and this tendency applies more to exporting firms than to importing firms. The market power, approximated by (Total sales - Operating cost)/Total sales, is higher among exporting firms than other firms; the evidence is consistent with empirical regularities found in existing studies that firms with high productivity tend to export. Those firms involved in international trade, particularly exporting, tend to rely less on non-regular employment.

We use a broad index of the real effective exchange rate (REER) constructed by the Bank of International Settlement (BIS) as the measure of the exchange rate. The BIS REER is the geometric average of exchange rates of Yen for a unit of multiple currencies using the lagged trade volume as the weight. For example, the weight basket for Japan between 2008 and 2010 includes China (29.5%), the US (16.6%), Euro area (14.0%), Korea (5.9%), Chinese Taipei (3.8%), Thailand

(3.6%), and Singapore (2.8%), followed by the UK, Canada, and Australia. We draw on the broad index regardless of the fact that the US dollar or the Euro are dominant invoice currencies, because the exchange rates between local currencies and the invoice currencies eventually determine the trade flows as well. Figure 5.1 draws the time series of the REER and suggests that the foreign exchange fluctuations are sufficiently large throughout the sample period.

We decompose the change in the exchange rate into permanent and transitory components using the Beveridge-Nelson decomposition (Beveridge and Nelson, 1981). The Beveridge-Nelson decomposition method first applies the autoregressive (AR) model to the first-differenced exchange-rate series. Then the temporary shock predicted to affect the variable in the far (infinite) future is classified as the trend component (the sum of deterministic and stochastic trends), and the rest is classified as the cyclical component. We estimated the AR(2) model based on Bayesian Information Criterion. Figure 5.3 draws the results of the decomposition, showing that the much of the variation in the exchange rate is attributable to the trend component.

The Basic Survey of Japanese Business Structure and Activities had asked about the firm's situation on June 1 until 2006 and on March 31 from 2007. We match an annual average of REER prior to the survey: The average of REER between June of year $t-1$ and May of year t is matched until 2006, and it is matched between April of year $t-1$ and March of year t from 2007.

5 Empirical Results

5.1 The effects on total sales

Table 5.2 shows the regression results looking at the impact of the exchange-rate fluctuation on the total sales change. The coefficients of interest pertain to the interaction terms between the percentage change in the exchange rate and the import and export shares in the previous year. The OLS result reported in the first column shows that the coefficient of the interaction between the exchange-rate fluctuation and the import share is not statistically significant. This means that Yen appreciation does not increase the total sales of importing firms. The reason why Yen appreciation does not increase the total sales of importing firms is not clear, but we speculate that importing firms do not expand production in response to cost reduction, because either they face inelastic domestic product demand or non-importing firms similarly benefit from the decrease of purchase cost. One might think that the effect of the exchange-rate fluctuation cancels out in the case of firms involved in both import and export activities. To address this concern, we implement a subsample analysis that excludes exporting firms, but we find that Yen appreciation does not affect sales even in the subsample that excludes exporting firms.

Yen appreciation reduces the total sales of exporters as the negative coefficient for the interaction term of the exporting share and the increase of the exchange rate. A 10% appreciation of Yen reduces total sales by 0.826% for firms that export 10% of total sales, according to the OLS estimate reported in the first column; the estimated coefficient is statistically significant at the 5% level. The contrasting results on the effects of the exchange-rate fluctuation on sales between importers and exporters are not surprising, because the effect of the exchange rate on sales among importers is through the production cost reduction, and thus it is not as direct as the effect among exporters, where the exchange rate directly affects sales through price or quantity channels.

The fixed-effects estimates reported in the second column show that the estimates on the exchange-rate fluctuation do not change significantly even after allowing for unobserved growth heterogeneity across firms. The change of coefficients on the linear terms of import and export shares implies that the unobserved growth factor is negatively correlated with the import share and positively correlated with the export share; the results imply that exporting firms grow faster than importing firms during the analysis period of 2001-2012. This finding is not surprising, given that the sample period covers the long-term Yen depreciation period that started in the early 2000s and ended in 2007, the right before the outbreak of the global financial crisis. In the end, however, similar estimated coefficients on the interaction terms imply that allowing for the unobserved growth rate is not necessary for our purpose.

The estimates based on the instrumental variable method, using the trend component of the exchange-rate fluctuation as the IV, appears in the third column in Table 5.2. The absolute size of the coefficients on the interaction term of the export share and the exchange rate fluctuation becomes about 9% larger, from -0.826 to -0.904, compared with the OLS results. This increase of the estimated coefficient implies that firms' sales amounts react more to the permanent change of the exchange rate than to the temporary change of the exchange rate.

The results of the fixed-effects instrumental variable estimation appear in the fourth column. The estimated coefficients for the interaction terms of import/export shares and the change of the exchange rate becomes slightly larger than the results without firm-fixed effects. The changes of the size of coefficients, however, are quantitatively limited. For example, the coefficient on the interaction term of the export share and the exchange-rate fluctuation increases by about 3%, from -0.904 to -0.935. From this minor change in the estimation results, we argue that the estimated effects of exchange-rate fluctuations on importers and exporters are not biased because of an unobserved firm-specific growth factor. Accordingly, we do not explicitly consider the effects of unobserved heterogeneity in the subsequent employment analysis.

Overall, we confirm that Yen appreciation reduces the total sales of exporters across various specifications. This robust finding assures that our empirical framework captures the demand shock to a firm caused by the exchange-rate fluctuations through the exporting channel. We now examine how the product demand shock caused by the exchange-rate fluctuation is transmitted to the employment adjustment.

5.2 The effects on regular workers

We next examine the effect of the exchange-rate fluctuation on the adjustment of regular workers. The first two columns of Table 5.3 tabulate the regression results of the percentage change in regular employment on the exchange-rate fluctuation interacted with each firm's dependence on international trade and other covariates. The first and second columns report the instrumental variable estimation results that use the two-year-lagged employment as the instrumental variable for the one-year-lagged employment. The first column reports the estimation result without instrumenting the exchange-rate fluctuation. The signs of the estimated coefficients are consistent with the signs of the total sales regression; Yen appreciation does not affect the employment of regular workers of importers but reduces that of exporters. A 10% appreciation of Yen decreases the number of regular workers by 0.161% among firms that export 10% of total sales. To compare this estimate with existing estimates of wage elasticity of labor demand, consider a firm that exports 100% of its total sales. Fixing the product price in a foreign currency, an appreciation of Yen induces the fall of the product price measured in Yen and thus implies an increase in the real wage, while the product price fall increases both the real wage and the real rental costs, whereas a nominal wage rise increases only the real wage without changing the real rental cost. The estimated elasticity 0.161 is smaller than the consensus estimate of the labor demand elasticity, which is 0.30 in the literature, but this is plausible given the absence of the substitution to capital.

The estimated coefficients on explanatory variables other than the exchange-rate fluctuation are consistent with the estimation results for the sales-change equation reported in Table 5.2. Importing firms are on a declining trend, whereas exporting firms are on an ascending trend in terms of regular employment during the sample period between 2001 and 2012. The long-term Yen depreciation trend from 2000 to 2007 –right before the outbreak of the global financial crisis– as shown in Figure 5.1 does not contradict the decline of importing firms and the growth of exporting firms. These findings suggest that the actual exchange-rate fluctuation, including the trend component extracted from it, does not fully capture firms' expectation for future exchange-rate fluctuation. The positive coefficient for the average market power, each firm's average of the price-cost margin during the sample period, implies that those firms with higher market power increased permanent employment more than those firms without market power. A one-percentage-point increase in the price-cost margin, whereas the average of the price-cost margin is 3.3%, as shown in Table 5.1, increases the regular employment growth rate by 0.283%. Theory predicts that firms with market power react less to the exchange-rate fluctuation. To test this prediction, we implemented a subsample analysis dividing the sample by the criterion of whether the firm's average market power is above or below the median of the average market power distribution. We, however, did not find a significant difference in the estimated elasticities by the subsamples.

The coefficient on the lagged natural log of the number of regular workers is -0.004, implying the mean reversion of the regular employment adjustment. Since both the dependent and independent variables contain lagged employment, the OLS estimator would be biased downward if the lagged employment is subjected to measurement error. To deal with this problem, the lagged variable is instrumented by the 2-year lagged variable, and thus the estimates are free from the bias, given that the AR(1) structure fully captures the time series property of the employment adjustment process and no serial correlation is left in the error term.

Instrumenting the exchange-rate fluctuation with the trend component increases the estimated response of exporters by about 7% from -0.161 to -0.173 compared with the estimate without instrumenting the exchange-rate fluctuation, as reported in the second column in Table 5.3; the trend components of the exchange-rate fluctuation affects regular employment more significantly than the mixture of trend and transitory components. This finding is consistent with the theoretical prediction that firms adjust regular employment more to a permanent change in the exchange rate, taking the adjustment cost into consideration. The estimated coefficients on explanatory variables other than the exchange-rate fluctuation do not change from the results without instrumenting the exchange-rate fluctuation, as reported in Column 1 of Table 5.3.

5.3 The effects on non-regular workers

We next examine the effect of the exchange-rate fluctuation on the adjustment of non-regular workers. The third and fourth columns of Table 5.3 tabulate the regression results of the percentage change in non-regular employment on the exchange-rate fluctuation interacted with each firm's dependence on international trade and other covariates. Note that the number of observations is smaller than that used to estimate the regular employment equation, because the dependent variable is not well defined, and thus those observations with zero non-regular workers in two consecutive years are dropped from the estimation. The signs of the coefficients estimated without instrumenting the exchange-rate fluctuation reported in the third column are similar to the regular employment regression, but their magnitudes are quite different; Yen appreciation does not affect the number of non-regular workers of importers, but it reduces that of exporters. To take a firm that exports 10% of total sales as an example, a 10% appreciation of Yen decreases the number of regular workers by 0.854%; the size of coefficient is about 5 times larger than the regression coefficient for the number of regular workers reported in the first column of Table 5.3. This larger adjustment response implies that the adjustment cost of non-regular workers is significantly lower compared with that of regular workers. To repeat the same discussion introduced in the regular employment estimation, the estimated elasticity is closely related to the usual labor demand elasticity, because 100% depreciation of Yen and 100% increase of real wage have arguably similar impacts on employment neglecting the capital substitution and scale effect. The estimated elasticity of 0.854 is larger than the consensus estimate of the labor demand elasticity in the literature, around 0.3. Again, this large elasticity is consistent with a low adjustment cost of non-regular workers.

Estimated coefficients for other covariates are also worth mentioning. As pointed out before, 2001-2012 sample period covers the long-term Yen depreciation that ends at the global financial crisis in 2008. This long-term trend of Yen depreciation may well have created expectation on long-term depreciation that cannot be captured by actual exchange-rate movement. The negative coefficient on import and export shares imply that both importing and exporting firms had shrunk non-regular employment in this long-term trend. That importing firms were cutting non-regular employment in the process of long-term Yen depreciation seems natural, but that exporting firms were doing so may seem surprising at the first glance. These seemingly counterintuitive findings do not contradict the theoretical prediction, though. In the period of long-term Yen depreciation, exporting firms increased regular workers and decreased non-regular workers; these findings are consistent with the theoretical prediction that firms adjust regular workers in response to a permanent change in the exchange rate under the assumption that regular and non-regular workers are substitutable. Firms with higher average market power tend to increase non-regular employment as well as the regular employment. The coefficient on the lagged regular employment implies that the firms with higher level of lagged regular employment are more likely to increase the non-regular employment.

The estimation results where the exchange-rate fluctuation is instrumented with the trend component appear in the fourth column in Table 5.3. The estimated coefficient for the export share × the exchange-rate fluctuation shrinks by about 12% compared with the estimate obtained without instrumenting the exchange-rate fluctuation; the trend component of the exchange-rate fluctuation affects the number of non-regular workers in a less significant way than the temporary component of the exchange-rate fluctuation. This IV estimate implies that exporters rely on non-regular workers for the employment adjustment to the temporary exchange-rate shock and that they adjust permanent employment in response to the permanent exchange-rate shock. How this adjustment behavior contrasts with the permanent change in exchange-rate is consistent with a substantial difference in the adjustment cost of regular and non-regular workers. The estimated coefficients other than the exchange-rate fluctuation are almost identical to the estimation results without instrumenting the exchange-rate fluctuation.

Non-regular workers are further classified into several categories based on the difference in the criteria used to define non-regular workers, such as work hours, length of contract period, whether a worker is employed by the workplace or a temporary help agency, and the career-track classification (*Seishain/Seishokuin* or other categories, as pointed out by Kambayashi and Kato (2013) and Asano et al. (2013). Our definition of non-regular workers includes three categories: permanent employee with part-time status, temporary employees, and workers hired by temporary help agencies. To shed light on the heterogeneity of the employment adjustment process among non-regular workers, we estimate the same model using each detailed definition of non-regular workers as the dependent variable. The estimation results do not render a systematic pattern because of the smaller sample size for each category, and perhaps more importantly, firms use these three categories of non-regular employment interchangeably to absorb temporary exchange-rate shocks.

5.4 Robustness check

In this section, we try the Hodrick Prescott filter to take the trend component of the exchange rate (Hodrick and Prescott, 1997). The smoothing parameter used in calculating the HP filter is $\lambda = 1600$. Table 5.4 shows the regression results of the impact of the exchange-rate fluctuation on the total sales change. The estimates based on the instrumental variable method, using the trend component of the exchange-rate fluctuation using the HP filter as the IV, appears in the third column. The absolute size of the coefficients on the interaction term of the export share and the exchange rate fluctuation becomes about 14% larger, from -0.826 to -0.958, compared with the OLS results. In the fourth column, the result of the fixed-effects instrumental variable estimation is reported. The absolute size of the coefficients on the interaction term of the export share and the exchange rate fluctuation becomes slightly larger than the results without firm-fixed effects.

Table 5.5 reports the effect of the exchange-rate fluctuation on employment. Instrumenting the exchange-rate fluctuation with the trend component now decreases the estimated response of exporters from -0.161 to -0.149 compared with the estimate without instrumenting the exchange-rate fluctuation. On the other hand, the effect on the non-regular workers are larger when the trend component is used as the IV, and the absolute size of the coefficient becomes by about 22% larger compared to the coefficient reported in Table 5.3.

6 Conclusion

We identify the impact of the exchange-rate fluctuation on the employment adjustment, conceptually implementing a difference-in-differences estimation, employing unique firm-level panel data that record accurate employment information and measures of each firm's exposure to international trade. We confirm that the appreciation of Yen decreases the employment of exporting firms. The sensitivity of adjustment of the number of non-regular workers to the exchange-rate fluctuation is about 5 times larger than that of the number of regular workers. The difference in the adjustment sensitivity implies a significantly lower adjustment cost of non-regular workers compared with regular workers to exogenous demand shocks created by the exchange-rate fluctuation. Firms adjust the regular workers to the permanent exchange-rate shock more significantly than to the temporary exchange-rate shock, whereas firms adjust non-regular workers more significantly to the temporary shock than to the permanent shock.

We contribute to the literature in several ways. First, we first show that stabilizing the exchange rate contributes to stabilizing employment, particularly that of non-regular workers. Credible evidence on the effect of the exchange-rate fluctuation on employment relying on firms' heterogeneous dependence on international trade is limited, except for the results based on Italian firm-level panel data by Nucci and Pozzolo (2010), who do not distinguish between regular and non-regular workers. Second, we identify the difference of adjustment costs between regular workers and non-regular workers, using the exchange fluctuation as a credible exogenous source of a labor-demand shifter. This finding gives support for the claim that firms use non-regular workers as a buffer of employment adjustment because of their lower adjustment cost.

The estimation results suggest a moderate effect of exchange-rate stabilization on employment stabilization: To take a firm that exports 10 % of total sales as an example, a 10 % appreciation of Japanese Yen decreases the regular employment of the firm by 0.161%. Although the average impacts seem moderate, given the large heterogeneity in the exposure to international trade, the impacts are quite different across firms. Moreover, the effect of the exchange-rate fluctuation affects non-regular workers more than regular workers; the impact on the non-regular workers is about 5 times as large as the impact on the regular workers. Therefore, policy makers should pay careful attention to the heterogeneous impact of the exchange-rate fluctuation on employment across firms and workers.

Improving the measurement of permanent and temporary components of the exchange-rate fluctuation is left for future research. To decompose the permanent and temporary exchange-rate fluctuation, we rely on the Beveridge and Nelson decomposition method, which is a univariate decomposition method that extracts the time-series properties of the exchange rate without imposing restrictions implied by economic theory. Extraction of permanent and temporary shocks to the exchange rate by the Blanchard and Quah (1989) – a decomposition method to a bivariate system of the exchange rate and the current account – and using them to analyze the impacts of permanent or transitory exchange-rate fluctuations on labor market outcomes are left for future research.

Estimating the nonlinear effect of the exchange-rate fluctuation will also be future research. In our estimation, the linear effect of the fluctuation is considered. There was large amount of change in the exchange-rate in 2009. Taking acount of these effect is left for the future work.

Appendix

To derive the expression of equation 19, we first utilize the expression of $\partial\pi/\partial R$ and then differentiate it with respect to e. Those are the overall steps to be taken, but just for preparation, before moving on to the differentiation of $\partial\pi/\partial R$, we derive the expression of F_R utilizing the equation of π/R. To simplify the notation we have dropped all time indices.

$$\frac{\pi}{R} = \frac{Qp + eQ^*p^*}{R} - w^R - w^N\frac{N}{R} \tag{A.1}$$

$$= \frac{Qp + eQ^*p^*}{R} - w^R - p\Big(1+\frac{1}{\eta}\Big)F_N\frac{N}{R} \tag{A.2}$$

$$= \frac{Qp + eQ^*p^*}{R} - w^R - p\Big(1+\frac{1}{\eta}\Big)\frac{F - F_R R}{N}\frac{N}{R} \tag{A.3}$$

$$= \frac{Qp + eQ^*p^*}{R} - w^R - p\Big(1+\frac{1}{\eta}\Big)\Big(\frac{Q+Q^*}{R} - F_R\Big) \tag{A.4}$$

$$p\Big(1+\frac{1}{\eta}\Big)F_R = \frac{\pi}{R} - \frac{Qp + eQ^*p^*}{R} + w^R + p\Big(1+\frac{1}{\eta}\Big)\frac{Q+Q^*}{R} \tag{A.5}$$

From equation 15:

$$\frac{\partial\pi}{\partial R} = -w^R + p\Big(1+\frac{1}{\eta}\Big)F_R. \tag{A.6}$$

Next, we substitute $p\Big(1+\frac{1}{\eta}\Big)F_R$ in equation (A.5) into equation 15 (or equivalently, equation (A.6)), which yields the following expression:

$$\frac{\partial\pi}{\partial R} = \frac{\pi}{R} - \frac{Qp + eQ^*p^*}{R} + p\Big(1+\frac{1}{\eta}\Big)\frac{Q+Q^*}{R} \tag{A.7}$$

$$= \frac{Qp + eQ^*p^* - w^R R - w^N N}{R} - \frac{Qp + eQ^*p^*}{R} + p\Big(1+\frac{1}{\eta}\Big)\frac{Q+Q^*}{R} \tag{A.8}$$

$$= \Big(1+\frac{1}{\eta}\Big)\frac{pQ + pQ^*}{R} + \frac{-w^R R - w^N N}{R} \tag{A.9}$$

$$= \frac{1}{R}\Bigg(pQ\big(1+\frac{1}{\eta}\big) + ep^*Q^*\big(1+\frac{1}{\eta^*}\big) - w^R R - w^N N\Bigg) \tag{A.10}$$

$$= \frac{1}{R}\Bigg(pQ\frac{1}{\mu} + ep^*Q^*\frac{1}{\mu^*} - w^R R - w^N N\Bigg) \tag{A.11}$$

To derive equation 19 in the text, we differentiate (A.11) with respect to the exchange rate e.

$$
\begin{aligned}
\frac{\partial^2 \pi}{\partial R \partial e} &= \frac{1}{R}\left[\frac{\partial p}{\partial e} Q \frac{1}{\mu} + p \frac{\partial Q}{\partial p}\frac{\partial p}{\partial e}\frac{1}{\mu} - pQ\frac{1}{\mu^2}\frac{\partial \mu}{\partial e}\right] && \text{(A.12)}\\
&+ \frac{1}{R}\left[p^* Q^* \frac{1}{\mu^*} + e\frac{\partial p^*}{\partial e} Q^* \frac{1}{\mu^*} + ep^* \frac{\partial Q}{\partial p^*}\frac{\partial p^*}{\partial e}\frac{1}{\mu^*} - ep^* Q^* \frac{1}{\mu^2}\frac{\partial \mu^*}{\partial e}\right]\\
&+ \frac{1}{R}\left[-\frac{\partial w^R}{\partial e} R - \frac{\partial w^N}{\partial e} N\right]\\
&= \frac{1}{R}\left[\frac{\partial p}{\partial e}\frac{e}{p}\frac{p}{e} Q \frac{1}{\mu} + p\frac{\partial Q}{\partial p}\frac{p}{Q}\frac{Q}{p}\frac{\partial p}{\partial e}\frac{e}{p}\frac{p}{e}\frac{1}{\mu} - pQ\frac{1}{\mu^2}\frac{\partial \mu}{\partial e}\frac{e}{\mu}\frac{\mu}{e}\right] && \text{(A.13)}\\
&+ \frac{1}{R}\left[p^* Q^* \frac{1}{\mu^*} + e\frac{\partial p^*}{\partial e}\frac{e}{p^*}\frac{p^*}{e} Q^* \frac{1}{\mu^*} + ep^*\frac{\partial Q^*}{\partial p^*}\frac{p^*}{Q^*}\frac{Q^*}{p^*}\frac{\partial p^*}{\partial e}\frac{e}{p^*}\frac{p^*}{e}\frac{1}{\mu^*} - ep^* Q^* \frac{1}{\mu^{*2}}\frac{\partial \mu^*}{\partial e}\frac{e}{\mu^*}\frac{\mu^*}{e}\right]\\
&+ \frac{1}{R}\left[-\frac{\partial w^R}{\partial e}\frac{e}{w^R}\frac{w^R}{e} R - \frac{\partial w^N}{\partial e}\frac{e}{w^N}\frac{w^N}{e} N\right]\\
&= \frac{1}{Re}\left[\frac{\partial p}{\partial e}\frac{e}{p} pQ \frac{1}{\mu} + pQ\frac{\partial Q}{\partial p}\frac{p}{Q}\frac{\partial p}{\partial e}\frac{e}{p}\frac{1}{\mu} - pQ\frac{\partial \mu}{\partial e}\frac{e}{\mu}\frac{1}{\mu}\right] && \text{(A.14)}\\
&+ \frac{1}{Re}\left[ep^* Q^* \frac{1}{\mu^*} + e\frac{\partial p^*}{\partial e}\frac{e}{p^*} p^* Q^* \frac{1}{\mu^*} + ep^* Q^* \frac{\partial Q^*}{\partial p^*}\frac{p^*}{Q^*}\frac{\partial p^*}{\partial e}\frac{e}{p^*}\frac{1}{\mu^*} - ep^* Q^* \frac{\partial \mu^*}{\partial e}\frac{e}{\mu^*}\frac{1}{\mu^*}\right]\\
&+ \frac{1}{Re}\left[-\frac{\partial w^R}{\partial e}\frac{e}{w^R} w^R R - \frac{\partial w^N}{\partial e}\frac{e}{w^N} w^N N\right]\\
&= \frac{pQ + p^* Q^*}{Re}\frac{pQ}{pQ + p^* Q^*}\frac{1}{\mu}\left[\frac{\partial p}{\partial e}\frac{e}{p} + \frac{\partial Q}{\partial p}\frac{p}{Q}\frac{\partial p}{\partial e}\frac{e}{p} - \frac{\partial \mu}{\partial e}\frac{e}{\mu}\right] && \text{(A.15)}\\
&+ \frac{epQ + ep^* Q^*}{Re}\frac{ep^* Q^*}{epQ + ep^* Q^*}\frac{1}{\mu^*}\left[1 + \frac{\partial p^*}{\partial e}\frac{e}{p^*} + \frac{\partial Q^*}{\partial p^*}\frac{p^*}{Q^*}\frac{\partial p^*}{\partial e}\frac{e}{p^*} - \frac{\partial \mu^*}{\partial e}\frac{e}{\mu^*}\right]\\
&- \frac{pQ + p^* Q^*}{Re}\left[\frac{\partial w^R}{\partial e}\frac{e}{w^R}\frac{w^R R}{epQ + ep^* Q^*} + \frac{\partial w^N}{\partial e}\frac{e}{w^N}\frac{w^N N}{epQ + ep^* Q^*}\right]\\
&= \frac{pQ + p^* Q^*}{Re}\frac{pQ}{pQ + p^* Q^*} Re \frac{1}{\mu}\left[\eta_{pe} + \eta\eta_{pe} - \epsilon_{\eta e}\right] && \text{(A.16)}\\
&+ \frac{pQ + p^* Q^*}{Re}\frac{pQ}{pQ + p^* Q^*} Re \frac{1}{\mu^*}\left[\eta_{p^* e} + \eta^* \eta_{p^* e} + 1 - \epsilon_{\eta^* e}\right]\\
&- \frac{pQ + p^* Q^*}{Re}\left[\overline{\eta_{W^R e}}\frac{w^R R}{pQ + p^* Q^*} + \overline{\eta_{W^N e}}\frac{w^N N}{pQ + p^* Q^*}\right]
\end{aligned}
$$

$$\frac{\partial^2 \pi}{\partial R \partial e} = \frac{pQ + p^* Q^*}{Re} \frac{1}{\mu}(1-\chi)\big(\eta_{pe}(1+\eta) - \epsilon_{\eta e}\big) \tag{A.17}$$

$$+ \frac{pQ + p^* Q^*}{Re} \frac{1}{\mu^*}\chi\big(\eta_{p^* e}(1+\eta^*) + 1 - \epsilon_{\eta^* e}\big)$$

$$- \frac{pQ + p^* Q^*}{Re} \left(\overline{\eta_{W^R e}} \frac{w^R R}{pQ + p^* Q^*} + \overline{\eta_{W^N e}} \frac{w^N N}{pQ + p^* Q^*} \right)$$

$$= \frac{pQ + p^* Q^*}{Re} \Bigg[\frac{1}{\mu}(1-\chi)\big(\eta_{pe}(1+\eta) - \epsilon_{\eta e}\big) + \frac{1}{\mu^*}\chi\big(\eta_{p^* e}(1+\eta^*) + 1 - \epsilon_{\eta^* e}\big) \tag{A.18}$$

$$- \left(\overline{\eta_{W^R e}} \frac{w^R R}{pQ + p^* Q^*} + \overline{\eta_{W^N e}} \frac{w^N N}{pQ + p^* Q^*} \right) \Bigg]$$

Table 5.1: Descriptive statistics of sample firms, 2001-2012

Variable	All	Non-import and non-export	Import but non-export	Export but non-import	Import and Export
Import share	0.043	0.000	0.220	0.000	0.178
	(0.148)	(0.000)	(0.297)	(0.000)	(0.243)
Export share	0.027	0.000	0.000	0.108	0.131
	(0.099)	(0.000)	(0.000)	(0.172)	(0.183)
Total sales	23,395	14,242	28,105	41,756	55,733
in million Yen	(168,838)	(91,583)	(162,218)	(287,834)	(312,537)
Operating cost	22,657	13,814	26,906	40,409	54,050
in million Yen	(165,462)	(89,884)	(152,157)	(284,160)	(306,975)
Market power	0.033	0.030	0.035	0.046	0.042
	(0.044)	(0.042)	(0.043)	(0.054)	(0.048)
Employment:	319.265	233.148	342.779	512.333	624.376
regular worker	(1,253.141)	(666.251)	(1,370.741)	(2,134.614)	(2,280.699)
Employment:	134.449	142.775	196.332	63.601	97.579
non-regular worker	(1,121.094)	(1,208.090)	(1,512.972)	(272.966)	(579.122)
Observations	322,849	228,204	23,825	22,456	48,364

Standard deviations are in parentheses. The import share is calculated by dividing the purchase turnover (total value of overseas purchase) by the purchase turnover (total transaction value). The export share is calculated by dividing the sales amount (total value of direct exports) by another variable: the sales amount (total transaction value). Operating cost is calculated from cost of sales and services + selling and administrative expenses. Market power is calculated using the Lerner index: (Total sales - Operating cost)/Total sales. Because the number of employed regular worker is not directly recorded before 2006, it is calculated by the number of total permanent employees minus the number of part-time workers. The number of non-regular workers is the sum of the numbers of part-time workers, temporary workers whose contract period is less than one month, and workers dispatched from temporary help agencies.

Table 5.2: Impact of exchange-rate fluctuation on total sales, 2001-2012

	%Δ of total sales$_{it}$			
	OLS	FE	IV	FEIV
Import share$_{it-1}$× %Δe_t	-0.017	-0.033	-0.067	-0.089
	(0.073)	(0.075)	(0.075)	(0.076)
Export share$_{it-1}$× %Δe_t	-0.826***	-0.835***	-0.904***	-0.935***
	(0.192)	(0.205)	(0.211)	(0.230)
Import share$_{it-1}$	-1.106***	-0.438	-1.150***	-0.455
	(0.361)	(0.667)	(0.365)	(0.669)
Export share$_{it-1}$	-0.476	-6.587***	-0.532	-6.499***
	(0.832)	(1.927)	(0.835)	(1.926)
Average market power$_i$	31.909***	–	31.895***	–
	(2.463)		(2.445)	
Industry-year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	Yes	Yes
Observations	215,457	215,457	215,457	215,457
R-squared	0.091	0.101	0.091	–

The term $\ln e$ is the log of the Real Effective Exchange Rate (REER). In an IV regression, the log of the trend in the exchange rate, the cross term of the first difference of the log of the trend in the exchange rate and the one-period lag of the import share, and the cross term of first difference of the log of the trend in the exchange rate and the one-period lag of the export share are used as IV for the cross terms of the exchange rate and Import and Export share. Standard errors robust against firm-level clustering are reported in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 5.3: Impact of the exchange-rate fluctuation on regular and non-regular workers, 2001-2012

	%Δ of the number of regular workers$_{it}$		%Δ of the number of non-regular workers$_{it}$	
IV for exchange rate movement	NO	Trend component	NO	Trend component
Import share$_{it-1}$× %Δe_t	-0.039	-0.059	0.086	0.030
	(0.040)	(0.047)	(0.131)	(0.148)
Export share$_{it-1}$× %Δe_t	-0.161**	-0.173***	-0.854***	-0.754**
	(0.066)	(0.057)	(0.274)	(0.298)
Import share$_{it-1}$	-0.588**	-0.605**	-2.312***	-2.359***
	(0.298)	(0.304)	(0.822)	(0.820)
Export share$_{it-1}$	0.899*	0.891*	-5.107***	-5.034***
	(0.464)	(0.458)	(1.328)	(1.344)
Average market power$_i$	28.287***	28.284***	23.637***	23.633***
	(2.369)	(2.370)	(4.203)	(4.206)
Log(regular worker)$_{it-1}$	-0.406***	-0.406***	0.517***	0.517***
	(0.076)	(0.076)	(0.150)	(0.150)
Industry-year fixed effects	Yes	Yes	Yes	Yes
Observations	215,457	215,457	189,646	189,646
R-squared	0.012	0.012	0.017	0.017

The term $\ln e$ is the log of the Real Effective Exchange Rate (REER). For the first column, the two-year lag of log of regular worker is used as IV for the one-year lag of log of regular worker. For the second column, the log of the trend in the exchange rate, the cross term of the first difference of the log of the trend in the exchange rate and the one-period lag of import share, the cross term of the first difference of the log of the trend in the exchange rate and the one-period lag of export share, and two-year lag of log of regular worker are used as IV for the cross terms of the exchange rate and Import and Export share and one-year lag of log of regular worker. Standard errors robust against firm-level clustering are reported in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 5.4: Robustness check: impact of exchange-rate fluctuation on total sales, 2001-2012

	%Δ of total sales$_{it}$			
	OLS	FE	IV	FEIV
Import share$_{it-1}$× %Δe_t	-0.017	-0.033	-0.030	-0.051
	(0.073)	(0.075)	(0.065)	(0.067)
Export share$_{it-1}$× %Δe_t	-0.826***	-0.835***	-0.958***	-0.969***
	(0.192)	(0.205)	(0.199)	(0.216)
Import share$_{it-1}$	-1.106***	-0.438	-1.119***	-0.436
	(0.361)	(0.667)	(0.357)	(0.662)
Export share$_{it-1}$	-0.476	-6.587***	-0.572	-6.488***
	(0.832)	(1.927)	(0.851)	(1.917)
Average market power$_i$	31.909***	–	31.896***	–
	(2.463)		(2.444)	
Industry-year fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	Yes	Yes
Observations	215,457	215,457	215,457	215,457
R-squared	0.091	0.101	0.091	–

The term $\ln e$ is the log of the Real Effective Exchange Rate (REER). In an IV regression, the log of the trend in the exchange rate, the cross term of the first difference of the log of the trend in the exchange rate and the one-period lag of the import share, and the cross term of first difference of the log of the trend in the exchange rate and the one-period lag of the export share are used as IV for the cross terms of the exchange rate and Import and Export share. Standard errors robust against firm-level clustering are reported in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

Table 5.5: Robustness check: impact of the exchange-rate fluctuation on regular and non-regular workers, 2001-2012

	%Δ of the number of regular workers$_{it}$		%Δ of the number of non-regular workers$_{it}$	
IV for exchange rate movement	NO	Trend component	NO	Trend component
Import share$_{it-1}\times$ %Δe_t	-0.039	-0.043	0.086	0.154
	(0.040)	(0.043)	(0.131)	(0.146)
Export share$_{it-1}\times$ %Δe_t	-0.161**	-0.149**	-0.854***	-0.975***
	(0.066)	(0.067)	(0.274)	(0.351)
Import share$_{it-1}$	-0.588**	-0.591**	-2.312***	-2.256***
	(0.298)	(0.296)	(0.822)	(0.816)
Export share$_{it-1}$	0.899*	0.907**	-5.107***	-5.196***
	(0.464)	(0.455)	(1.328)	(1.318)
Average market power$_i$	28.287***	28.287***	23.637***	23.642***
	(2.369)	(2.369)	(4.203)	(4.204)
Log(regular worker)$_{it-1}$	-0.406***	-0.406***	0.517***	0.517***
	(0.076)	(0.076)	(0.150)	(0.150)
Industry-year fixed effects	Yes	Yes	Yes	Yes
Observations	215,457	215,457	189,646	189,646
R-squared	0.012	0.012	0.017	0.017

The term $\ln e$ is the log of the Real Effective Exchange Rate (REER). For the first column, the two-year lag of log of regular worker is used as IV for the one-year lag of log of regular worker. For the second column, the log of the trend in the exchange rate, the cross term of the first difference of the log of the trend in the exchange rate and the one-period lag of import share, the cross term of the first difference of the log of the trend in the exchange rate and the one-period lag of export share, and two-year lag of log of regular worker are used as IV for the cross terms of the exchange rate and Import and Export share and one-year lag of log of regular worker. Standard errors robust against firm-level clustering are reported in parentheses. * indicates significance at the 10% level. ** indicates significance at the 5% level. *** indicates significance at the 1% level.

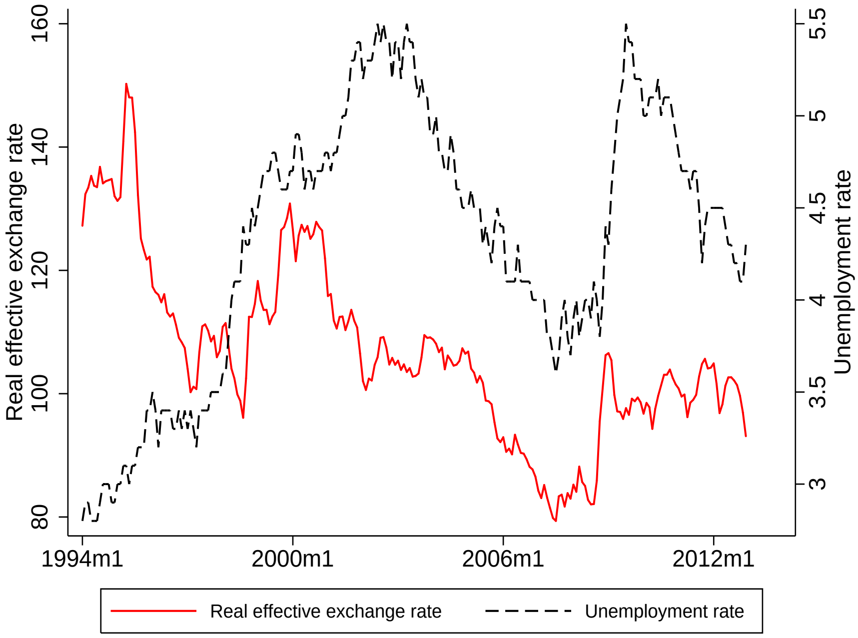

Figure 5.1: The real effective exchange rate and the unemployment rate

Source: The real effective exchange rate is from the Bank for International Settlements. The Unemployment rate is from the Labour Force Survey by the Ministry of Internal Affairs and Communication.

Note: Because of the Great East Japan Earthquake, the unemployment rate is calculated using Supplementary-estimated figures by the Ministry of Internal Affairs and Communication for some months.

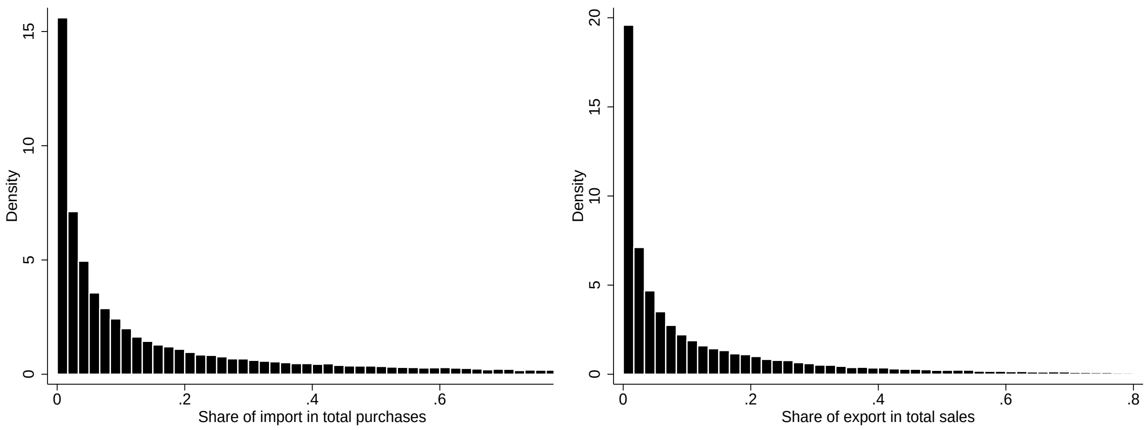

Figure 5.2: Distributions of import share and export share

The import share is calculated by dividing the purchase turnover (total value of overseas purchase) by the purchase turnover (total transaction value). The export share is calculated by dividing the sales amount (total value of direct exports) by another variable: the sales amount (total transaction value). The import share has a mean value of 0.043 and a standard error of 0.148. The export share has a mean value of 0.027 and a standard error of 0.099. The 22% of firm-year observations records positive export and 22% records positive import. The correlation between the import share and the export share is 0.234. The number of observations is 322,849. The graphs draw the distributions of import and export shares given positive numbers.

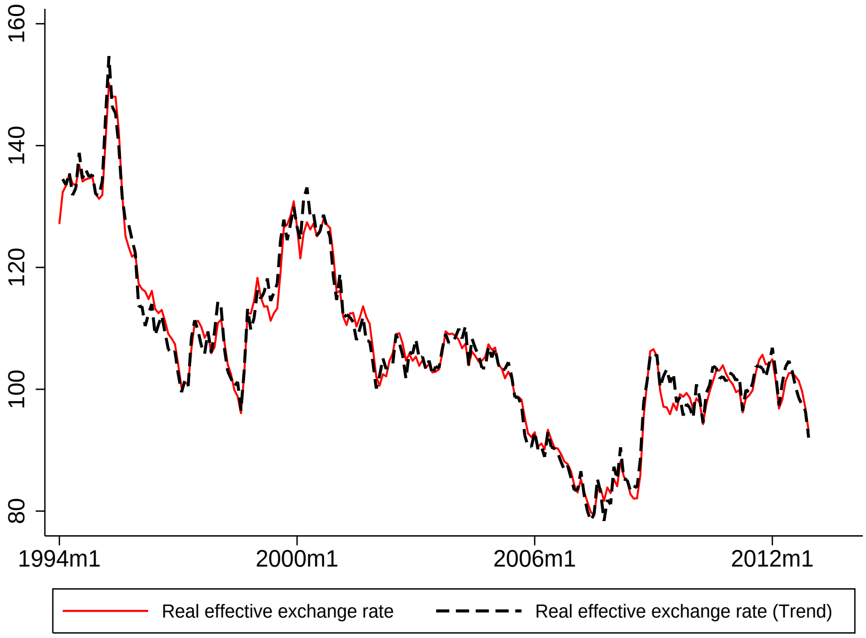

Figure 5.3: Real effective exchange

Source: Real effective exchange rate from the Bank for International Settlements. The trend series is obtained by applying the BN decomposition.

Chapter VI

Conclusion

This dissertation explores new findings related to several topics of the economic activities of individuals, households, and firms.

Chapter II examines the upward bias of the Japanese consumer price index. It uses Engel's curve approach to estimate the size of the bias. The analysis found that there were 0.53 percentage points per year of overall bias between 1989 and 2004. If the strict assumption on estimating the Engel curve was not applied, the bias estimates varied between 0.46-0.61 percentage points per year related to the relative bias between food price and non-food price. This shows that the bias estimates of this chapter are within a plausible range. These resulted in lower inflation rate, where the bias corrected annual inflation rate from 1989 to 2004 was 0.14 percent, whereas the official inflation rate was 0.65 percent during the same period. Further, the demographic analysis shows that if a household has more time for shopping, it faces a larger upward bias and lower inflation. This implies that the exclusion of discounts and brand substitution is an important source of the CPI bias.

Chapter III analyzes the intra-household educational expenditure. Persistent trend in gender wage difference has been observed in Japan, but the wage difference has been decreasing. The possible reason for this is that the gender gap in the university entrance rate has been decreasing. The two-year college entrance rate of females had been decreased in the 1990s and the 2000s. Thus, the educational spending allocation in a household has been changing over time. The estimate result of total educational spending shows that we cannot obtain a clear gender gap. If the spending was decomposed into two sub education spendings, this chapter finds a clearer pattern. For the after-school academic educational spending, which is payment for cram schooling in this chapter, boys received more than girls did. The gap on the spending was not observed in 1999 but was observed in 2004. On the other hand, this chapter obtains that girls received more after-school non-academic educational spending than boys did, and this trend was persistent in the 1990s and the 2000s.

Chapter IV motivates to find why the Easterlin paradox is observed in the happiness literature. The Easterlin paradox is the paradox that the reported happiness increase and the economic growth are poorly correlated. The literature applied the linear and nonlinear happiness–income model and the relative income approach. This chapter focuses on one's own measurement of life satisfaction. If one's life event, such as promotion, has changed her economic status, her own measurement of life satisfaction would change over time. If so, life satisfaction is not comparable over time. This chapter estimated that the happiness–income relationship in the literature was underestimated. Thus, this chapter constructed new life satisfaction variables that enabled to compare it over time by using two life satisfaction variables: overall life satisfaction and current life satisfaction compared to that a year ago. Further, the GMM estimation of the ordered probit estimation of happiness–income relationship yields that one's criteria of life satisfaction is changing over time. This implies that the income increase results in the change in one's economic status and in one's life satisfaction measurement. Thus, the literature would observe poor correlation between happiness and income, namely the Easterlin paradox.

Chapter V investigates the effect of the exchange rate fluctuation on the labor adjustment of regular and non-regular workers in Japan. The analysis used unique firm-level panel data that record accurate employment information and measure of each firm's exposure to international trade. This chapter finds that the appreciation of the yen decreases the employment of exporting firms. The adjustment of the number of non-regular workers to the exchange-rate fluctuation is sensitive and seven to eight times larger than that of the number of regular workers.

These chapters provide new information about the behaviors of the individuals, households, and firms that is valuable for evaluating policies related to inflation, gender wage gap, individual happiness, and labor market adjustment. The approaches in this dissertation are applicable and extendable to study several aspects related to these policies. In future studies, these approaches would be valuable for evaluating policies and for providing further policy implications.

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