The Effect of Exchange-Rate Fluctuations on Employment in a Segmented Labor Market*

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Abstract

How does the exchange-rate fluctuation affect the employment of regular and non-regular workers? We investigate the effect of the exchange-rate fluctuation on the employment adjustment of regular and non-regular workers 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 7 to 8 times larger than that of regular employment. Non-regular employment reacts more to the permanent exchange rate shocks extracted by the Beverage and Nelson decomposition. The estimation results suggest a significant difference of adjustment costs between regular and non-regular employment in the Japanese segmented labor market.

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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 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 markers. Represented by this episode, policy makers frequently discuss whether swings in the exchange rate causes swings in employment, particularly that of non-regular workers.\(^1\) A causal link from the exchange rate to employment demands that monetary and fiscal authorities formulate exchange-rate policies taking its 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 continental European countries and South Korea, as well as Japan.

Understanding the causal relationship between the exchange-rate fluctuation and employment outcomes also helps us understand how quickly workers are reallocated across sectors in response to changes in relative prices: the faster the adjustment, the larger the gains from trade. Reflecting attention to the issue from researchers and policy makers, 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 et al. (2003) for the US and Moser et al. (2010) for Germany; both studies exploit the heterogeneous dependence on international trade across industries for identification. Klein et al. (2003) report that the exchange-rate fluctuation

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\(^1\) 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 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).
significantly affects net job flow through job detraction in the US, while Moser et al. (2010) find a similar effect on net job flow but through 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 significance of labor-market institutions in the process of labor reallocation during the exchange-rate adjustment.

Heterogeneity of employment adjustment costs arises within a country when the strictness of employment protection depends on contractual types. The differential employment protection between regular and non-regular employment contracts tends to make employers rely on non-regular workers to absorb demand shocks and thus results in dual or 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, Varejo and Portugal 2007). Much less is known, however, about the differential elasticities of employment adjustment between regular and non-regular workers based on credibly exogenous source of labor demand shock that is heterogeneous across firms. Our aim in this study is to 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. Our attempt also contributes to filling 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.

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 purchase and revenues from foreign sales, along with the usual accounting information, and 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. They find that importing firms increase both employment and hours, while exporting firms reduce them when the Italian Lira appreciates. It is worth noting that they do not find statistically significant relationships with industry-level aggregate data. They do not pay attention to the differential impacts on regular and non-regular workers. Hosono et al. (2013), whose study is also closely related to ours, examine the effect of yen appreciation on firms’ performance comparing exporting and non-exporting firms; they find that exporting firms suffer from the sudden appreciation of the yen and cut the employment of contract workers after the 2008 financial crisis. They, however, do not systematically examine the impact of exchange rate on regular and non-regular 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 covering 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 is pointed out by Nucci and Pozzolo (2001) in the context of physical investment, firms are unlikely to modify their employment level after temporary fluctuations of exchange rates in the presence of adjustment costs. For this reason, we extract the permanent component of exchange-rate variations from observed the exchange-rate fluctuation using the Beveridge-Nelson decomposition. We then examine how employment responds to permanent shocks using the permanent component of 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 employment of exporting firms; a 10% appreciation of Japanese yen measured in the real effective exchange rate decreases the regular employment of a firm that exports 10% of its total sale by 0.15-0.18%, whereas it decreases the non-regular employment by 1.06-1.32%. The elasticity of non-regular workers is 7 to 8 times larger than that of regular workers, and the difference arguably implies a significant difference in the adjustment costs between regular and non-regular employment. The adjustment of non-regular employment is more significant to the permanent change of the exchange rate, but the adjustment of regular employment with respect to the permanent component does not differ significantly. This finding implies that firms use non-regular workers as an adjustment margin even for a permanent change of the exchange-rate fluctuation. Contrary to the findings for exporting firms, the appreciation of Japanese yen apparently increases neither the regular nor non-regular employments of importing firms. All the estimation results are virtually unchanged in specifications that allow for firm-level unobserved heterogeneity in the employment-growth equation.

The rest of this paper is organized as follows. Section 2 describes the framework of the basic model. Section 3 presents an empirical strategy to test the implications of the theoretical model. Section 4 provides a brief description of the data, and Section 5 discusses the empirical results. Finally, Section 6 presents the conclusion.

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 business investment to consider the effect of the exchange rate on investment. The key idea here is that physical capital investment,
It, requires an adjustment cost $C(I_t)$ that $C', C'' > 0$. 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 $R, \Delta R$, 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 characterizes the firm’s dynamic profit maximization as follows:

$$V_t(R_{t-1}) = \max_{\Delta R_t} \left( \pi(R_t, e_t) - C(\Delta R_t) + \beta_{t+1} E_t [V_{t+1}(R_t)] \right).$$

(1)

Note that there is no adjustment cost for non-regular workers. $\beta_{t+1}$ is a discount factor between period $t$ and period $t + 1$. The regular-worker stock (pool) is governed by the standard accumulation equation for $R_t; R_t = (1 - \delta) R_{t-1} + \Delta R_t$, where the typical depreciation is replaced by $\delta$, the natural rate of job separation here.

Applying the Envelope theorem renders the Euler equation that characterizes the optimal path of investment:

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

$$= \frac{\partial \pi(R_t, e_t)}{\partial R_t} (1 - \delta) + \beta_{t+1} E_t \left[ \frac{\partial V_{t+1}}{\partial R_t} (1 - \delta) \right]$$

(2)

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

$$q_t = \frac{\partial \pi(R_t, e_t)}{\partial R_t} (1 - \delta) + \beta_{t+1} (1 - \delta) E_t [q_{t+1}]$$

(3)
Repeating the substitution of $q_{t+j}$, Equation 3 can be summarized as follows:

$$q_t = \frac{\partial \pi(R_t, e_t)}{\partial R_t} (1 - \delta) + \beta_{t+1} E_t \left[ \left( \frac{\partial \pi(R_{t+1}, e_{t+1})}{\partial R_{t+1}} (1 - \delta) + \beta_{t+2} E_{t+1} [q_{t+2}(1 - \delta)] \right) (1 - \delta) \right]$$

$$= E_t \sum_{j=0}^{\infty} \beta_{t+j} (1 - \delta)^j \left( \frac{\partial \pi(R_{t+j}, e_{t+j})}{\partial R_{t+j}} \right)$$

(4)

Equation 4 means that $q_t$ is equivalent to the discounted present value of the marginal profit of regular-workers’ stock. The discount factor is expressed as $\beta_{t+j} = \Pi_{i=1}^{j} (1 + r_{t+i-1})^{-1}$ where $r_{t+i}$ represents the nominal required rate of return between period $t$ and period $t+i$.

The first-order condition with respect of $\Delta R_t$ can be calculated from Equation 1 as follows:

$$\frac{\partial C(\Delta R_t)}{\partial \Delta R_t} = q_t$$

(5)

Given the increasing and convex shape of $C(\Delta R_t)$, $\Delta R_t$ is an increasing function of $q_{t+1}$. Substituting Equation 4, $\Delta R_t$ can be expressed as an increasing function $g (g' > 0)$ of the expected present value of marginal profits, as follows:

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

(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.

$$\pi(R_t, e_t) = \max_{Q, Q^*, N, N^*} Qp(Q_t, e_t) + e_t Q^* p^*(Q^*_t, e_t) - w^R_t R_t - w^N_t N_t,$$ 

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

(7)

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:

$$L = Q_t p(Q_t, e_t) + e_t Q^* p^*(Q^*_t, e_t) - w^R_t R_t - w^N_t N_t + \lambda(F(R_t, N_t) - Q_t - Q^*_t)$$ 

(8)

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

$$\frac{\partial L}{\partial Q} = p'(Q_t) Q_t + p_t - \lambda = 0$$ 

(9)

$$\frac{\partial L}{\partial Q^*} = p'^*(Q^*_t) Q^*_t + e_t p^*_t - \lambda = 0$$ 

(10)

$$\frac{\partial L}{\partial N} = -w^N_t + \lambda F_N = 0$$ 

(11)

From Equations 9 and 10, we obtain:

$$\lambda = p_t \left(1 + \frac{1}{\eta_t}\right) = e_t p^*_t \left(1 + \frac{1}{\eta^*_t}\right).$$ 

(12)

From Equation 11, the next equation follows:

$$p_t \left(1 + \frac{1}{\eta_t}\right) F_N = w^N_t$$ 

(13)

From this equation, we know that in response to an increase in $p_t$, $N_t$ will also increase, and note that the product price $p_t(e_t)$ is a function of exchange rates. Thus, in response to the fluctuation in exchange rates, the number of non-regular workers is adjusted every period, according to Equation
Using the envelope theorem and Equations 7 and 12, if we consider the long-run optimal path of regular workers, we have:

\[
\frac{d\pi}{d\Delta R} = \frac{d\pi}{dR} \frac{dR}{d\Delta R} = \frac{d\pi}{dR} \times 1 = -w_t^R + \lambda F_R = -w_t^R + p_t \left(1 + \frac{1}{\eta_t}\right) F_R
\]

(14)

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

\[
F(R_t, N_t) = F_R R + F_N N
\]

(15)

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

\[
\lambda = \frac{p_t}{\mu} = \frac{e^*_t p^*_t}{\mu^*}
\]

(16)

Substituting Equation 15 for Equation 14, we have:

\[
\frac{d\pi}{d\Delta R} = -w_t^R + p_t \left(1 + \frac{1}{\eta_t}\right) \frac{F - F_N N}{R}
\]

\[
= -w_t^R + p_t \left(1 + \frac{1}{\eta_t}\right) \frac{F - w_t(N)N/p_t \left(1 + \frac{1}{\eta_t}\right)}{R}
\]

\[
= -w_t^R + \frac{1}{R} \left(F p_t \left(1 + \frac{1}{\eta_t}\right) - w_t(N)N\right)
\]

\[
= -w_t^R + \frac{1}{R} \left((Q + Q^\ast) p_t \left(1 + \frac{1}{\eta_t}\right) - w_t(N)N\right)
\]

\[
= -w_t^R + \frac{1}{R} \left((Q + Q^\ast) \lambda - w_t(N)N\right)
\]

\[
= -w_t^R + \frac{1}{R} \left(\frac{p_t Q_t}{\mu_t} + \frac{e^*_t p^*_t Q^*_t}{\mu^*_t} - w_t(N)N\right)
\]

(17)

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 in time t. Also, assuming the discounted factor is fixed through time, $\beta_t = \beta_{t+1}$, Equation 5 is reconfigured as below:

$$\Delta R_t = g \left( \frac{1 - \delta}{1 - \beta(1 - \delta)} \frac{\partial \pi(R_t, e_t)}{\partial R_t} \right)$$  \hspace{1cm} (18)$$

Partially differentiating $\Delta R_t$ by the exchange rate $e_t$ in consideration of Equation 17, the effect of a permanent shift in the exchange rate on the inflow of regular workers is expressed as follows:

$$\frac{\partial \Delta R_t}{\partial e_t} = g\frac{1 - \delta}{1 - \beta(1 - \delta)} TR \frac{1}{1 + \mu^{e_\text{e}}} \chi \left( \eta_{p^e} (1 + \eta_{Q^e p^e}) - \epsilon_{\mu^e} \right)$$

$$+ \frac{1}{1 + \mu^{e_\text{e}}} \left( \eta_{pe} (1 + \eta_{Qp}) + 1 - \epsilon_{\mu e} \right) - \frac{1}{\mu} (1 + \eta_{w^e} \alpha)$$  \hspace{1cm} (19)$$

where $TR$ denotes total revenue, $\chi$ denotes the export ratio to the total revenue, $\eta_{p^e}$ denotes the exchange rate elasticity of domestic price, and $(\eta_{p^e} e)$ denotes the exchange rate elasticity of foreign price. The elasticities $\eta_{Qp}$ and $\eta_{Q^e p^e}$ are respectively the price elasticities in domestic and foreign demand. The $\epsilon_{\mu e}$ and $\epsilon_{\mu^e}$ are respectively the exchange-rate elasticity of markups in domestic and foreign markets. The $\alpha$ is the fraction of imports in the total purchase, $\eta_{w^e}$ denotes the exchange-rate elasticity of the imported input price, $\mu$ denotes the markup obtained without distinguishing between domestic and international markets.

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 an exporting channel. Given that $-1 \leq \eta_{p^e} e \leq 0$, $\eta_{Q^e p^e} < 0$, and $\epsilon_{\mu^e} > 0$, if foreign demand is elastic ($\eta_{Q^e p^e} < -1$), the depreciation of the exchange rate (i.e., an increase in $e$) increases the inflow of regular workers. The second term is a channel for domestic sales. Since $\eta_{pe} > 0$, $\eta_{Qp} < 0$, and $\epsilon_{\mu e} > 0$, if $\eta_{Qp} < -1$, as yen depreciates, relative domestic sales revenue decreases with decreasing marginal profit, and then the flow of regular workers decreases. Last, the third term is an importing

\footnote{$\eta_{p^e} e = -1$ means a complete pass-through to foreign prices of an exchange-rate variation, while $\eta_{p^e} = 0$ means no path-through, and thus $\eta_{p^e}$ ranges from minus one to zero. For more details, see Nucci and Pozzolo (2001).}
channel. Given that $0 \leq \eta_{we} \leq 1$, the depreciation of yen makes the foreign-produced input more expensive, which decreases marginal profit and decreases regular workers.

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; $\mu$ and $\mu^*$ 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:

$$
\Delta \ln Y_{ijt} = \beta_0 + \beta_1 \text{Imp}_{it-1} \Delta \ln E_t + \beta_2 \text{Exp}_{it-1} \Delta \ln E_t + \beta_3 \text{Imp}_{it-1} + \beta_4 \text{Exp}_{it-1} + \beta_5 \text{Markup}_i + d_{jt} (c_i) + u_{ijt},
$$

where $\ln Y$ is the outcome variables that are the log of total sales, the number of regular employees or non-regular employees, $\text{Imp}$ is the share of imported inputs among all intermediate inputs, and $\text{Exp}$ is the share of export sales among all sales. The term $\ln E$ is the log of the real effective exchange rate—the amount of foreign currency units to 100 yen, and $\text{Markup}_i$ is defined as the sample-period average of (Total sales - Sales cost)/Total sales. The model include the industry (17 categories) - year fixed effects, $d_{jt}$, to control for time-variant industry-specific factors, such as product and input prices. The linear term of $\ln E_t$ is not included, because the effect is captured by the industry - year dummy variables.

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, \( \text{Imp}_{it-1} \) or \( \text{Exp}_{it-1} \), 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-year specific shocks. Thus the comparison of high-exposure firms and low-exposure firms is made within an industry-year cell. Given the exogeneity assumption, \( E(u_{ijt}|\text{Imp}_{it-1}, \text{Exp}_{it-1}, \Delta \ln E_t, \text{Markup}_{it}, d_{jt}) = 0 \), the OLS estimator is an unbiased and a 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 \( \ln E \) – is supposed to increase the total sales of importing firms through cost reduction; thus, we expect \( \beta_1 \) 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 \( \beta_2 \) to be negative. After confirming the validity of the specification, we proceed to examine the effect of exchange-rate fluctuation on the adjustment of regular and non-regular workers.

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; whereas it decreases the total sales of exporting firms through price reduction if the invoice currency is foreign currency, because the yen amount for a foreign currency decreases. Ito et al. (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 permanent 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 permanent component of the exchange rate as the instrumental variable. Using the Beveridge and Nelson decomposition (Beveridge and Nelson 1981), we first elicit the trend component (i.e., permanent component) in the exchange rate. The endogenous variables are the interactions of the differenced log of the exchange rate and the import/export shares in Equation 20, and the instrument variables are the differenced log of the permanent component in the exchange rate and its interaction terms with import/export shares. 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 et al. 1996).

We further allow for firm-level fixed effects, $c_i$, in some specifications 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 international trade. The unobserved high productivity may create a spurious correlation between high growth and heavy dependence on international trade, and this concern necessitates a fixed-effects estimation.

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 the end of 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, information and 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 subprime 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 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, 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 et al. 2013).³

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 amount of imports records the amount of imports that the firm directly clears through customs. The amount of exports records the amount of exports that the firm directly clears through customs. We calculate market power using the Lerner index: (Total sales−Operating cost⁴)/Total sales (Lerner 1934). The Lerner index

³The 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).

⁴The operating cost includes cost of sales and services and selling and administrative expenses.
corresponds to the degree of price markup.

Table 1 reports the descriptive statistics of the firm-level panel data. The average import share – the fraction of imports among all purchases – is 0.044, with standard deviation of 0.147. The average export share – the fraction of exports among total sales – is 0.030, with standard deviation of 0.102. The distributions of import and export shares are drawn in Figure 2. The modes of the distributions are zero import and export shares, and both distributions have long right tail; many firms do not engage in international trade, but a few firms actively engage in it. 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 heterogeneity of exposure to the international trade assures the validity of the difference-in-differences estimation strategy employed in this paper. The average market power approximated by the Lerner index is 0.034, whereas its standard deviation is 0.043.

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 a 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. Figure 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(11) model based on Akaike Information Criterion. Figure 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. The REER is an annual average within a calendar year. The gap in measurement periods creates a subtle issue in matching the two data sources. We match the survey in year \( t \) with the exchange rate in year \( t - 1 \), considering that the survey takes place in an earlier period of a year after 2007. Therefore, for example, we explain the change in sales between 2002 and 2003 by the change in the exchange rate between 2001 and 2002. This data construction allows for 3 to 6 months of a time lag before sales or employment react to the exchange rate by design.

5 Empirical Results

5.1 The effects on total sales

Table 2 shows the results of the OLS and IV regression that look at the impact of the exchange-rate fluctuation on the change in total sales. The coefficients of interest pertain to the interaction terms between the change in the exchange rate and the import and export shares in the previous year. The coefficient of the interaction between the exchange-rate fluctuation and the import share is not statistically significant for either estimation. This means that a 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 they face inelastic domestic product demand or non-importing firms similarly benefit from the decrease of purchase cost. Whatever the case, 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.

Yen appreciation reduces the total sales of exporters as the negative coefficient for the interaction term of exporting share and the increase of exchange rate. A 10% appreciation of yen reduces the total sales by 1.206% for the firms that export 10% of the total sales, according to the
OLS estimate reported in the first column; the estimated coefficient is statistically significant at the 5% level. The instrumental variable method using the trend component of the exchange-rate fluctuation as the IV inflates the estimated coefficient by about 8%. This increase of the estimated coefficient implies that firms’ sales amounts react to the permanent change of exchange rate more significantly than to the temporary change of the exchange rate.

The other estimated coefficients are also worth mentioning. The negative coefficients for import share in both the OLS and IV estimations imply that importing firms reduced the total sales amount regardless of the exchange-rate movement during the sample period, 2001-2012. The positive coefficients for average market power during the sample period imply that those firms with market power measured by price markup increased total sales.

Previous research has revealed that firms dealing with international trade tend to be more productive than other firms (Melitz and Redding 2014). This fact casts doubt on the validity of our research design, depending on the conditional mean assumption that the unobserved determinant of sales growth is not correlated with import or export share conditional on the average market power and industry (17 categories) - year fixed effects. To address this concern, we estimate a firm-fixed effects model to allow for unobserved firm heterogeneity potentially correlated with import and export shares. The results of the fixed-effects estimation appear in the third column, and the results of the fixed effects IV estimation appear in the fourth column. The estimated coefficients for the interaction terms of import/export shares and the change of the exchange rate do not change significantly from the results without firm-fixed effects; the estimated effects of exchange-rate fluctuations on importers and exporters are not biased because of unobserved firm heterogeneity. The changes of coefficients for import shares and export shares imply that the firm-specific unobserved sales growth factor is negatively correlated with import share, whereas it is positively correlated with export shares. This finding is arguably due to the long-term yen depreciation trend in the 2000s until the financial crisis in 2008.

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 demand shock caused by exchange-rate fluctuation is transmitted to the employment adjustment.

5.2 The effects on regular workers

We first examine the effect of the exchange-rate fluctuation on the adjustment of regular workers. Table 3 tabulates the regression results of the change in log regular employment on the change in the exchange rate interacted with each firm’s dependence on international trade and other covariates. The signs of the coefficients estimated by OLS reported in the first column are consistent with the signs of the total sales regression. The OLS estimate indicates that yen appreciation does not affect the number of regular workers of importers but reduces that of exporters. A 10% appreciation of yen decreases the number of regular workers by 0.15% of firms that export 10% of total sales. The IV estimates reported in the second column are almost identical to the OLS estimates; both the trend and transitory components of the exchange-rate fluctuation affect the number of regular workers in a similar way.

The estimated effect of the exchange-rate fluctuation on the number of regular employees of exporters is amplified in the firm-fixed effects estimation, as reported in the third and fourth columns. The change of results from cross-sectional estimates implies that the unobserved growth factor is positively correlated with export share interacted with yen appreciation. According to the firm-fixed effects estimation, a 10% appreciation of yen decreases the number of regular workers by 0.19% of firms that export 10% of total sales.

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. Table 4 tabulates the regression results of the change in log non-regular employment on the change in the exchange rate interacted with each firm’s dependence on international trade and other covariates. The signs of the coefficients estimated by OLS reported in the first column are
similar to the signs of the total sales and regular employment regressions. Similar to the regular employment adjustment, yen appreciation does not affect the number of non-regular workers of importers, but it reduces the exporter’s number of non-regular workers. A 10% appreciation of yen decreases the number of regular workers by 1.06% of firms that export 10% of total sales; the size of coefficient is about 7 to 8 times larger than the regression coefficient for the number of regular workers. This significantly larger adjustment response implies the significantly lower adjustment cost of non-regular workers compared with that of regular workers. The IV estimate for export share - exchange-rate change interaction reported in the second column - is about 20% larger than the OLS estimate; the trend component of the exchange-rate fluctuation affects the number of non-regular workers in more 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 permanent exchange-rate shock.

The estimated effects of the exchange-rate fluctuation on the number of regular employees of exporters in the firm-fixed effects estimation are almost identical to the cross-sectional estimates, as reported in the third and fourth columns of Table 4.

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 the yen decreases the employment of exporting firms. The sensitivity of adjustment of the number of non-regular workers to the exchange-rate fluctuation is 7 to 8 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 numbers of non-regular workers to the permanent exchange-rate shock more significantly than
to the temporary exchange-rate 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.

The estimation results suggest a moderate effect of exchange-rate stabilization on employment stabilization: A 10% appreciation of Japanese yen decreases the regular employment of a firm with a 10% export share by 0.150%. Although the average impacts seem moderate, given the large heterogeneity in the exposure to the international trade, the impacts are quite different across firms. Moreover, the effect of yen appreciation on the adjustment of non-regular workers is 7 to 8 times as large as that of regular workers. Policy makers should pay careful attention to the heterogeneous impact of the exchange-rate fluctuation on employment across firms and workers with different contract forms.

The exercise in this paper has an important limitation in terms of measuring permanent and temporary components of the exchange-rate fluctuation. 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. Applying the Blanchard and Quah (1989) decomposition method to a bivariate system of the exchange rate and the current account to extract permanent and temporary shocks to the exchange rate is left for future research.
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URL http://www.jstor.org/stable/10.1086/509825
Table 1: Descriptive statistics of sample firms, 2001-2012

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Import share</td>
<td>0.044</td>
<td>0.147</td>
</tr>
<tr>
<td>Export share</td>
<td>0.030</td>
<td>0.102</td>
</tr>
<tr>
<td>Total sales (million yen)</td>
<td>26,388</td>
<td>185,786</td>
</tr>
<tr>
<td>Operating cost (million yen)</td>
<td>25,556</td>
<td>182,191</td>
</tr>
<tr>
<td>Market power</td>
<td>0.034</td>
<td>0.043</td>
</tr>
<tr>
<td>Employment (regular worker)</td>
<td>344.699</td>
<td>1,356.3</td>
</tr>
<tr>
<td>Employment (non-regular worker)</td>
<td>144.052</td>
<td>1,192.095</td>
</tr>
<tr>
<td>Observations</td>
<td>215,457</td>
<td></td>
</tr>
</tbody>
</table>

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 2: Impact of Exchange-rate Fluctuation on Total Sales, 2001-2012

<table>
<thead>
<tr>
<th></th>
<th>OLS</th>
<th>IV</th>
<th>OLS</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Import share_{it-1} × Δln e_{it}</td>
<td>-0.095</td>
<td>-0.078</td>
<td>-0.113</td>
<td>-0.100</td>
</tr>
<tr>
<td></td>
<td>(0.091)</td>
<td>(0.092)</td>
<td>(0.086)</td>
<td>(0.088)</td>
</tr>
<tr>
<td>Export share_{it-1} × Δln e_{it}</td>
<td>-1.206***</td>
<td>-1.310***</td>
<td>-1.253***</td>
<td>-1.350***</td>
</tr>
<tr>
<td></td>
<td>(0.306)</td>
<td>(0.305)</td>
<td>(0.305)</td>
<td>(0.313)</td>
</tr>
<tr>
<td>Import share_{it-1}</td>
<td>-0.012***</td>
<td>-0.012***</td>
<td>-0.006</td>
<td>-0.006</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.004)</td>
<td>(0.007)</td>
<td>(0.006)</td>
</tr>
<tr>
<td>Export share_{it-1}</td>
<td>-0.008</td>
<td>-0.008</td>
<td>-0.071***</td>
<td>-0.071***</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.009)</td>
<td>(0.019)</td>
<td>(0.019)</td>
</tr>
<tr>
<td>Average market power_{i}</td>
<td>0.319***</td>
<td>0.319***</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.023)</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Industry-year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Firm fixed effects</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.092</td>
<td>0.092</td>
<td>0.102</td>
<td>0.102</td>
</tr>
<tr>
<td>Observations</td>
<td>215,457</td>
<td>215,457</td>
<td>215,457</td>
<td>215,457</td>
</tr>
</tbody>
</table>

Standard errors are in parentheses. *p < 0.10, **p < 0.05, ***p < 0.01

Standard errors robust against firm-level clustering are reported in parentheses. 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.
Table 3: Impact of the Exchange-rate Fluctuation on Regular Workers, 2001-2012

<table>
<thead>
<tr>
<th></th>
<th>OLS</th>
<th>IV</th>
<th>OLS</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Import share(_{t-1}) × Δln(e_t)</td>
<td>-0.073</td>
<td>-0.069</td>
<td>-0.068</td>
<td>-0.071</td>
</tr>
<tr>
<td></td>
<td>(0.048)</td>
<td>(0.047)</td>
<td>(0.045)</td>
<td>(0.047)</td>
</tr>
<tr>
<td>Export share(_{t-1}) × Δln(e_t)</td>
<td>-0.150**</td>
<td>-0.151**</td>
<td>-0.187**</td>
<td>-0.182**</td>
</tr>
<tr>
<td></td>
<td>(0.066)</td>
<td>(0.071)</td>
<td>(0.071)</td>
<td>(0.077)</td>
</tr>
<tr>
<td>Import share(_{t-1})</td>
<td>-0.006**</td>
<td>-0.006**</td>
<td>-0.001</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(0.003)</td>
<td>(0.003)</td>
<td>(0.005)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Export share(_{t-1})</td>
<td>0.002</td>
<td>0.002</td>
<td>-0.007</td>
<td>-0.007</td>
</tr>
<tr>
<td></td>
<td>(0.005)</td>
<td>(0.005)</td>
<td>(0.009)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>Average market power(_i)</td>
<td>0.273***</td>
<td>0.273***</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
<td>(0.022)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry-year fixed effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Firm fixed effects</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.010</td>
<td>0.010</td>
<td>0.007</td>
<td>0.007</td>
</tr>
<tr>
<td>Observations</td>
<td>215,457</td>
<td>215,457</td>
<td>215,457</td>
<td>215,457</td>
</tr>
</tbody>
</table>

Standard errors robust against firm-level clustering are reported in parentheses. 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 import share, and 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 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. 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 import share, and 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 are used as IV for the cross terms of the exchange rate and Import and Export share.

* p < 0.10, ** p < 0.05, *** p < 0.01
Table 4: Impact of the Exchange-rate Fluctuation on Non-Regular Workers, 2001-2012

<table>
<thead>
<tr>
<th></th>
<th>ΔLog of the number of temporary workers ( n_{it} )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OLS</td>
</tr>
<tr>
<td>Import share ( s_{it-1} ) × Δln ( e_t )</td>
<td>-0.035</td>
</tr>
<tr>
<td>(0.204)</td>
<td>(0.194)</td>
</tr>
<tr>
<td>Export share ( s_{it-1} ) × Δln ( e_t )</td>
<td>-1.059***</td>
</tr>
<tr>
<td>(0.381)</td>
<td>(0.405)</td>
</tr>
<tr>
<td>Import share ( s_{it-1} )</td>
<td>-0.024**</td>
</tr>
<tr>
<td>(0.010)</td>
<td>(0.010)</td>
</tr>
<tr>
<td>Export share ( s_{it-1} )</td>
<td>-0.044**</td>
</tr>
<tr>
<td>(0.017)</td>
<td>(0.017)</td>
</tr>
<tr>
<td>Average market power ( i )</td>
<td>0.249***</td>
</tr>
<tr>
<td>(0.044)</td>
<td>(0.044)</td>
</tr>
<tr>
<td>Industry-year fixed effects</td>
<td>Yes</td>
</tr>
<tr>
<td>Firm fixed effects</td>
<td>No</td>
</tr>
<tr>
<td>( R^2 )</td>
<td>0.016</td>
</tr>
<tr>
<td>Observations</td>
<td>189,646</td>
</tr>
</tbody>
</table>

Standard errors robust against firm-level clustering are reported in parentheses. 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 import share, and 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 are used as IV for the cross terms of the exchange rate and Import and Export share.
Figure 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 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 0.044 and a standard error of 0.147. The export share has a mean value of 0.030 and a standard error of 0.102. The correlation between the import share and the export share is 0.234. The number of observations is 215,457.
Figure 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.