# Exporting Firms and Employment of Temporary Workers: Human Capital and Firing Costs

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**Abstract**

Globalization is often blamed for the rise of temporary workers employed in Japanese firms. Popular belief is that the increased competition from abroad and the rise of fluctuation of the outputs are the two main causes why firms hire non-regular temporary workers. Using the panel data of individual Japanese plants, we find that in general exporting firms tend to hire less temporary workers although the size of the plant matters for raising the ratio of non-regular temporary workers in the total labor hired by the plant.

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# 1 Introduction

Between 1999 and 2008 the share of temporary (or fixed-term contract) workers in Japanese labor market has increased from 25% to 35%. These temporary workers were the primary target for job cut when the recession started after the Lehman shock in 2008. Indeed, the rise of unemployment rate fell mostly on those who used to work under fixed-duration contract (as opposed to those under tenured contract). This increase of unemployment among temporary workers created a huge social distress because we observe both the rising inequality of income and the increased number of homeless around the same time.

Figure 1 provides the decline of Japanese GDP after the Lehman shock. The growth rate of GDP fell sharply in 2008 and turned negative from the year. Growth rate of export (from Japan) also fell sharply and many people claim the recesion is mainly the export driven.

Figure 2 unveils how Japanese firms adjusted from output decline following the shock. It is clear from the graph that the employment of temporary non-regular workers increased more than the employment of regular workers before the shock. However, once the Lehman shock hits the economy, the reduction of labor force comes primarily from the reduction of non-regular (temporary) workers.

Top management of the major firms blamed the globalization for their inability to keep employment level at the before-shock level. They say that the increased uncertainty from foreign sales makes Japanese firms hire larger portion of temporary workers because it makes easier to adjust output levels with temporary workers than to do it with permanent employees.

Major reason why it is costly to adjust output levels (in response to uncertainty) by changing the number of permanent workers is because it is costly to fire regular workers in Japan. The labor law in Japan makes it difficult for the firms to fire so-called permanent workers. On the other hand, it is relatively cheaper to adjust number of employees by stop hiring temporary workers. Because the labor contract with the temporary workers is the one of fixed term, in general, terminating the contract (not extending into the next fiscal year) is not considered "firing" or "lay-off" of the workers. Therefore, it is cheaper to "fire" temporary workers in response to output decline such as the shock after the Lehman incident.

Although it is easier to adjust output by changing the number of temporary workers, the firms have good reasons to hire a certain amount of permanent workers. Higher skill level acquired by permanent workers by human capital investments is the major reason. It is a well-known fact that the firms provide on-the-job training when the workers are young. (For example, see Kanemoto and MacLeod 1989.) Sometimes it is said that the cost to train younger workers exceeds the productivity of those workers under training. The firms try to capture this temporal loss by paying lower than productivity wage rate when the workers become older. For this reason, the firms want to hire permanent employees because there are some jobs within the firm that require skilled labor after the human capital investment.

This paper proposes a model where firms hire both permanent and temporary workers. Especially, some industry requires higher percentage of permanent workers because those industries require higher proportion of skilled labor inputs. At the same time, we also want to introduce output fluctuations where firms have incentives to hire temporary workers in order to avoid high cost of firing regular workers in case the firms must reduce output levels. While there are some literature in labor economics about why firms hire temporary workers, there are almost none in trade literature that discuss the relationship between export behavior of firms and hiring of temporal workers. This paper is at least one of the first to analyze such a problem.

By looking at the firm (plant)-level panel data for Japan, this paper tries to determine the decision factors by firms to hire what percentage of temporary workers to hire. The trade off of hiring regular workers is between the high cost of firing regular workers and the accumulation of human capital investment (hence higher productivity) by regular workers. If the firms hire larger temporary workers, it can reduce the cost of firing in response to output fluctuations, however, it also loses the opportunity to hire higher productive workers.

The paper is organized as follows. Section 2 develops the basic theoretical model of heterogeneous firms that hire both permanent regular and temporary non-regular workers. Section 3 looks at the empirical analysis of plant level data. The final section summarizes the results and suggests some possible extensions.

# 2 The Model

We will look at two period model which can be extended to multi-period model. In this paper, we focus on two period case.

## 2.1 Consumers and Workers

Consumers and workers are endowed with one unit of labor. They are either hired by firms as temporary workers or to decide to join the firm as regular workers who undertake on-the-job training by making an effort level at $e > 0$ in the first period.

Workers preference (per period) is written in the two-tier utility function in the following form:

$$U(W, e) = u(\mathbf{P}, W) - v(e); v' > 0, v'' > 0, v(0) = 0$$

where the second term comes from disutility of making human capital investment effort and the first term is an indirect utility from Cobb-Douglas preference:

$$u(\mathbf{P}, W) = \max\{\prod C_i^{\alpha_i}; s.t.; \sum P_i C_i \leq W\}, \sum \alpha_i = 1$$

where $\mathbf{P} \equiv (P_1, P_2, ..., P_N)$ is a vector of price index for industry (sector) $i \in \{1, 2, ..., N\}$ and $W$ is an income paid to the ownership of labor. In the utility maximization problem, $C_i$ is the composite goods of varieties in sector $i$. Because this Cobb-Douglas utility function is the one of homogeneous of degree one, the indirect utility can be written as $u(\mathbf{P}, W) = \widehat{u}(\mathbf{P}) \cdot W$ where $\widehat{u}(\mathbf{P})$ can be considered to be a kind of consumer price index.

The composite goods is a combination of varieties (within a sector) described as CES (constant elasticity of substitution) sub-utility function a la Dixit-Stiglitz (1977).

$$C_i = \left[ \int_{\varpi \in \Omega_i} q_{\varpi}^{\rho} d\varpi \right]^{\frac{1}{\rho}}$$

from here we can derive the price index of the varieties in a sector $i$:

$$P_i = \left[ \int_{\varpi \in \Omega_i} p_{i,\varpi}^{1-\sigma} d\varpi \right]^{\frac{1}{1-\sigma}}, \sigma = \frac{1}{1-\rho} > 1$$

This subutility structure is borrowed from Kamata (2010).

Let us assume workers are identical and indifferent between taking temporary and regular jobs. Then the participation constraint for both temporary and permanent workers is written as

$$U(W_1^R, \widetilde{e}) + \delta E\left[U(W_2^R, 0)\right] = U(W_1^T, 0) + \delta E\left[U(W_2^T, 0)\right]$$

where $W_t^R$ and $W_t^T$ are the incomes from regular and temporal jobs at period $t$ and $\widetilde{e} > 0$ is the effort level that the firms contracted with the regular workers. $\delta < 1$ is the discount factor. The incentive compatibility constraint for the permanent workers to undertake human capital investment effort is written as

$$U(W_1^R, \widetilde{e}) + \delta E\left[U(W_2^R, 0)\right] \geq U(W_1^R, 0) + \delta E\left[U(W_2^T, 0)\right].$$

**Lemma 1** *The undiscounted lifetime income of the regular workers is higher than that of the permanent workers.*

$$W_1^R + W_2^R > W_1^T + W_2^T$$

**Proof.** Suppose not. Suppose the above inequality is written as $\leq$ instead. Then everyone prefers becoming temporary workers because permanent worker when young must incur effort cost. To avoid this, firms must compensate permanent workers and give higher lifetime income to them. ■

This lemma says that there will be income disparity between permanent and temporary workers even if there is no difference in ability or preference among workers ex ante. In reality, there may be some differences in ability or preference that make the choice by workers as they are now. In this theoretical model, we forego such ex ante differences.

**Lemma 2** *1st period income for the regular worker is smaller than that of the temporal workers.*

$$W_1^T \geq W_1^R$$

This result comes from combining the participation constraint and the incentive compatibility constraint. The proof is omitted since it is a straightforward calculation.

**Lemma 3** *2nd period income of the regular worker is strictly larger than that of the temporal workers.*

$$W_2^R > W_2^T$$

This is also clear from both Lemma 1 and 2. These results are similar to the ones in Kanemoto and MacLeod (1989) although our derivations are much simpler.

# 3 Industry and Firms

In considering the production sector, we will look at many industry version of heterogeneous firms monopolistic competition model similar to Kamata (2010). In this model, we have two factors of production: skilled labor and unskilled labor. The industry differs in the intensity of skilled labor relative to unskilled labor.

## 3.1 Industrial Technology

Let us first define the industry level production technology by the Cobb-Douglas production function:

$$q_i = \left(\frac{H_i}{\beta_i}\right)^{\beta_i} \left(\frac{L_i}{1-\beta_i}\right)^{1-\beta_i}$$

where $q_i$ is output in the sector $i$, and $H_i$ is the amount of skilled labor hired in the sector and $L_i$ is the amount of unskilled labor hired in the sector. Also we rank the industry by the order of skilled labor intensity:

$$\beta_1 < \beta_2 < ... < \beta_N.$$

The higher the (index) number of industry, the higher the skill intensity is.

## 3.2 Firms

A firm $\varpi \in \Omega_i$ within the industry faces two sources of uncertainty. First it draws its productivity $\phi_{i,\varpi} \sim G(\phi)$. Second, in period two, it faces another demand shock $\theta \sim F(\theta)$ which is a uniform distribution over the interval $[1 - \overline{\theta}_i, 1 + \overline{\theta}_i]$ from domestic market and a uniform distribution over the interval $[1 - \overline{\theta}_{iX}, 1 + \overline{\theta}_{iX}]$ from the exporting market. Assume that $\overline{\theta}_{iX} > \overline{\theta}_i > 0$. The random variable $\theta$ is like an independent output shock for the firm. Notice that $\theta$ has the same mean 1 for both market but has higher variance from the export market than the domestic market.

The demand shock appears on the demand functions.

$$D_{i,\omega} = \theta \left[ \frac{p_{i,\varpi}^{-\sigma}}{P_i} \right] \alpha_i Y$$

where $D_{i,\omega}$ is the demand for the variety and $Y$ is the national income of the country. For the exporting products, the demand function is

$$D_{iX,\omega} = \theta \left[ \frac{\tau p_{i,\varpi}^{-\sigma}}{P_i} \right] \alpha_i Y^*$$

where $Y^*$ is the national income of the trading partner.

The cost function for the firm $\varpi \in \Omega_i$ in industry $i$ is written

$$\Gamma_{i,\varpi} = \left[ f_i + \frac{q_i}{\phi_{i,\varpi}} \right] \cdot (s)^{\beta_i} (w)^{1-\beta_i}$$

where $s$ is wage rate for skilled labor and $w$ is wage rate for unskilled labor. $f_i$ is an entry fixed cost.

**Notation 1** *There is a difference between $W_t^R$ - $W_t^T$ and $s$ - $w$ combinations. The former is the income level received by each worker in each period. The latter is an effective wage rate per unit of labor the firms must pay in the equilibrium. One source of this difference comes from the size of effective unit due to human capital investment made by the permanent workers. Another source of this difference comes from the fact that individual wage rate differs from the average wage rate because some workers will be fired after the resolution of uncertainty.*

The logic behind this is basically the same as all the Melitz (2003) type models. Simple profit zero condition (in expectation) will determine the productivity cut off level for entry/exit into domestic production. Whether the firms engage in exporting or not depends on another fixed costs for exporting:

$$\text{Export fixed Costs } = f_{Xi} \cdot (s)^{\beta_i} (w)^{1-\beta_i}$$

and the variable costs in an iceberg form such that only a portion $1/\tau_i$ of the shipped quantity arrives at the destination. ($\tau_i > 1$)

For now, we assume all the fixed costs contain the same skill intensity for the industry as the production process of the goods themselves. Therefore the unit cost is represented by $(s)^{\beta_i} (w)^{1-\beta_i}$.

The optimal pricing by firms is standard. The price equals the constant markup over marginal cost.

$$p_{i,\varpi}(\phi_{i,\varpi}) = \frac{(s)^{\beta_i} (w)^{1-\beta_i}}{\rho \cdot \phi_{i,\varpi}}$$

for the domestic market.

$$p_{Xi,\varpi}(\phi_{i,\varpi}) = \frac{\tau_i \cdot (s)^{\beta_i} (w)^{1-\beta_i}}{\rho \cdot \phi_{i,\varpi}}$$

for the export market in foreign countries.

Notice that the shock parameter $\theta$ does not enter the pricing equations. This is because we assume that pricing and labor contracts comes before the realization of $\theta$.

**Assumption 1** The timing of the model is as follows: (1) the firms must pay entry fixed cost $f_e \cdot (s)^{\beta_i}(w)^{1-\beta_i}$ in order to know their productivity parameter $\phi_{i,\varpi}$. This entry cost will become sunk. (2) After observing its productivity draw, the firm must pay another production fixed cost $f_i \cdot (s)^{\beta_i}(w)^{1-\beta_i}$ if it deccides to produce for domestic market. If a firm's productivity is below the domestic cutoff, then such a firm will exit. (3) If their productivity is above the domestic cut-off and the export cut-off level, then the firms pay another fixed cost $f_{Xi} \cdot (s)^{\beta_i}(w)^{1-\beta_i}$ to enter the export market. (4) The firms write a contract with the retailers or the final users of the firm's products about the price and the amount. (5) The firms also hire the combination of permanent regular and temporary non-regular workers and they write contracts about wage rates. (6) The shock occurs in both domestic and exporting markets. The actual size of $\theta$ has now become known by firms. (7) The firms must decide how many permanent workers to fire.

How does a firm hire both permanent and temporary workers? Let $m_{i,\varpi,t}$ and $n_{i,\varpi,t}$ be the number of permanent and temporary workers hired by the firm with productivity draw $\phi_{i,\varpi}$ at period $t$. From now on, we want to focus on the differences of firms within a particular industry and let us drop subscript $i$ for industry if it is clear from the context.

For a firm $\varpi$ in a certain industry that observes its productivity draw to be $\phi_{\varpi,t}$ in period $t$, decides to hire $m_{\varpi,t}$ of new entry permanent workers and $n_{\varpi,t}$ of non-regular temporary workers whose contract can be terminated at the end of this period $t$. In the beginning of the period $t$, the firm has already the amount $m_{\varpi,t-1}$ of permanent workers from previous period who will retire at the end of this period. Because these permanent workers who were hired in period $t-1$ conducted efforts in order to enhance their human capital skills, their productivity is larger than one unit by $\lambda > 1$. Not only their productivity has increased, they are now considered to be skilled workers. At the same time, the firm may fire some of the permanent workers in response to the individual shock $\theta$. Let $\mu_{\varpi,t} \in (0,1)$ be the fraction of permanent workers who the firm keeps employment, then the fraction $1-\mu_{\varpi,t}$ are the workers who must be let go. Then the endowment of skilled workers for this firm can be written as

$$H_{\varpi,t} = \lambda \cdot \mu_{\varpi,t} m_{\varpi,t-1}.$$

The endowment of unskilled workers in period $t$ comes from the combination of young (before training) permanent and temporary workers:

$$L_{\varpi,t} = m_{\varpi,t} + n_{\varpi,t}.$$

The firm $\varpi$ wants to minimize its total cost after observing firm-specific shock $\theta$. With the same discount factor as consumer-worker, total cost from period 1 and 2 can be written as

$$\begin{aligned} TC &= W_1^R \cdot m_{\varpi,1} + W_1^T \cdot n_{\varpi,1} + W_2^R \cdot H_{\varpi,1} + \\ &\quad \delta E \left[ W_1^R \cdot m_{\varpi,2} + W_1^T \cdot n_{\varpi,2} + W_2^R \cdot H_{\varpi,2} + g \cdot (1 - \mu_{\varpi,2}) m_{\varpi,1} \right] \end{aligned}$$

where $g \cdot (1 - \mu)$ is the firing cost of the permanent workers.

From here up to Proposition 3, let us assume that the firing cost is zero, i.e., $g = 0$. This is because we want to focus on finding out the industry-level tendencies rather than within industry variances.

**Proposition 1** *The optimal ratio of permanent and temporary workers differs across industry. The higher the index number is, the higher the ratio is. Skill intensive industry tends to hire higher proportion of permanent workers.*

**Proof.** Because production function is in a Cobb-Douglas form, we know that for the same skilled and unskilled wage ratio in the equilibrium the higher index industry tend to have higher skilled labor ratio. (Heckscher-Ohlin) We now have to show the relationship between $H_i/L_i$ and the industry average of $m_t/n_t$. We consider a stationary equilibrium. Then, we should have $m_{\varpi,t} = m_{\varpi,t-1} = m_{\varpi}$ and $n_{\varpi,t} = n_{\varpi,t-1} = n_{\varpi}$ for all $t$. In such an equilibrium, we should also have $H_{\varpi,t} = H_{\varpi,t-1} = H_{\varpi}$ and $L_{\varpi,t} = L_{\varpi,t-1} = L_{\varpi}$. We can now write

$$\frac{H_{\varpi}}{L_{\varpi}} = \frac{\lambda \cdot \mu_{\varpi} m_{\varpi}}{m_{\varpi} + n_{\varpi}} = \lambda \cdot \mu_{\varpi} \left( 1 + \frac{n_{\varpi}}{m_{\varpi}} \right)^{-1}$$

from here, we can easily show that

$$d\left(\frac{H_{\varpi}}{L_{\varpi}}\right) / d\left(\frac{m_{\varpi}}{n_{\varpi}}\right) = \frac{\lambda \cdot \mu_{\varpi}}{(1 + \frac{m_{\varpi}}{n_{\varpi}})^2} > 0.$$

Therefore, if the skill ratio is higher, then the ratio of permanent workers to temporary workers is also higher. This proves the proposition. ■

From this result, we can say that the optimal regular-non-regular worker ratio (permanent-temporary ratio) differ across industry.

**Assumption 2** This country is skilled labor abundant.

If we assume this country is, like Japan, a skill abundant country. Then by the logic of multi-goods Heckscher-Ohlin model, we can conclude the following.

**Remark 1** *This country has comparative advantage in the higher index number industries.*

By the results derived in Kamata (2010), we can say the following.

**Proposition 2 (Kamata 2010)** *This country has larger shares of exporting firms for industries in which the country has a comparative advantage.*

From this results with Proposition 1, we can conclude the following result.

**Proposition 3** *There must be a negative correlation between the ratio of temporal worker employment (versus permanent worker employment) and the ratio of export within the total production of the industry. The higher the index number is, the proportion of regular permanent workers is larger (the proportion of temporary workers is smaller), and the higher the percentage of exports within the total production.*

This is an empirically testable proposition.

In Figure 3, we can see the negative correlation between the export ratio versus the temporary worker ratio at indutry level.

What happens then if the firing cost is strictly positive, i.e., $g > 0$? Firing can occur only because of firm specific demand shock $\theta$. The shock has mean 1 but actual firing (ex post) occurs only for the negative shock to the firm. If the shock were positive, the firms need not pay firing costs.

We can consider three cases about the nature of firing costs. (1) The firing cost is common to all firms and all indutries within the country. (2) The firing cost is industry-specific. It is common to all the firms within the same industry, but can be different across indutry sectors. (3) The firing cost is firm-specific. It is totally individualistic and different from each other. In reality, cases (2) and (3) are likely to be true, however, in this paper we focus on the case (1).

We can now discuss what will happen to the firms with negative shocks.

The larger the volatility (of the firm) is, the larger the number of fired permanent workers in the equilibrium. In order to minimize total cost, the firms with larger volatility tends to reduce the number of permanent workers compared to the case of $g = 0$. Therefore, high var$(\theta)$ implies low value of $\mu$.

**Proposition 4** *When $g > 0$, the more productive firms (hence the firms with higher exporting ratio) tend to reduce the amount of permanent workers compared to the case with $g = 0$.*

The existence of firing cost makes all the firms to hire smaller number of permanent employees than the case without firing costs. Moreover, the firms with higher export ratio face larger risk (variance) and tend to reduce the number of permanent workers. Therefore, if the firing costs are positive, then export ratio has positive correlations with the *change* in the number of temporary workers.

**Proposition 5** *When exports increase in the industry (due to increase in $Y^*$, or reduction of trade cost $\tau$, or positive demand shock for export goods, and so on), the exporting firms tend to reduce the amount of permanent workers compared to the case with $g = 0$. Hence, we should observe higher ratio of temporary workers.*

This result is shown in the data also. In Figure 4 we can see the positive relationship between the change in exports and the level of temporary worker share. We will look more closely the data in the next empirical section.

# 4 Empirical Findings

In this section we will present some empirical findings relating to the theoretical model derived in the previous section.

## 4.1 Data Overview

In order to have a big picture of the available data, we first look at the industry level aggregation of data on the export ratio and the ratio of temporary workers among the total workers.

Table 1 presents the ratio of export to total shipment by industry. The data comes from the Census of Manufacturer of Ministry of Economy, Trade and Industry of Japan. Two things are noteworthy. First, there is a substantial large cross-sectional difference in export ratio among industries. While the export ratio for Chemical and Machinery and Equipment manufacturing sector ranges from 1.2% to 2.5% in 2006, the ratio for Food products and textiles is 0.1%, which is almost zero. Second, when we look at the change of the ratios between 2001 and 2006, only two sectors, namely, chemical and Machinery and Equipment manufacturing, observe an increase in the export share larger than 1% point. However, the changes of the ratio for most other industries are less than 0.6% point.

The ratio of temporary worker to total employment by industries is presented in table 2. There are various sources of statistics on temporary worker at aggregate-level; however, we used the Census of Manufacturer to maintain consistency of the data for export ratio. In this data set, we adopt the broadest definition of the temporary workers: the sum of part-timers, workers dispatched from other (mainly from Temporary Help Service) companies, and temporary employees (day laborers).

There are two findings. First, when we focus on the cross-sectional differences, Food products (49.5%) industry hires the largest proportion of temporary workers in 2006 and Textile industry (28.2%) being the second highest ratio. Second, when we look at the time trends, the changes in temporary worker ratio between 2001 and 2002 are big for Electric machinery (8.0% point) and Transport equipment (8.4% point) industries. On the contrary, the percentage increase for Food products and Textile industries are moderate level, namely at 3.7% and 4.3% respectively.

Next, we want to investigate the deteiled relationship between the export ratio and the temporary worker ratio at plant-level micro data. Here, we want to focus on machinery and equipment (M&E) manufacturing industry, including general machinery, electrical machinery, transportation equipment and precision instrument, because these industries experienced an increase in both the export ratio and temporary worker ratio at the same time.

In relation to Melitz (2003) type model, we want to know the relationship between those variables with the heterogeneous differences in productivity of the firms (plants). We want to compare those ratios (export and temporary worker) between the high productivity firms with low productivity firms. To use as the measure of productivity, we decided to use the level of labor productivity (LP) at plant level. We define high LP firms as those plants whose LP is above the industry average. We call low LP firms if the firm's labor productivity is below the average. We use the data for levels of temporary worker ratio and export ratio as of 2006. When we look at the change of the variables, the data are based on the difference between 2001 and 2006. Table 3 presents the differences in both the export ratio and the temporary worker ratio between high productivity plants and low productivity plants.

When we look at the difference of the temporary worker ratio between high and low productivity firms, low productivity plants tend to hire larger proportion of temporary workers and observe the growth in its ratio between 2001 and 2006. High productivity plants tend to hire smaller number of temporary workers. This confirms the observation from the theoretical section of the paper. (Proposition 1)

On the other hand, when we focus on the differences in the export ratio, both level and growth rate in export ratio are higher for plants with high labor productivity. The relationship between the level of export ratio and productivity has been extensively investigated by Bernard and Jensen (1994, 1999) and recent theoretical studies by Melitz (2003) and Helpman, Melitz and Yeaple (2004) revealed its mechanics. Our findings are consistent with these previous studies.

Next, we now compare the temporary worker ratio by exporting status of each firm in table 4. The level of temporary worker ratio is lower for exporting plants. While the temporary worker ratio for exporter is 20.2%, that for non-exporter is 28.0%. This confirms the theoretical result in Proposition 3. When we look at the growth rate or the changes in temporary worker ratio, it looks like the growth rate is higher for exporters. However, the difference is just 0.6% point and it's not statistically significant.

(Table 3 and Table 4 are around here.)

Next, to link the evidence from micro-data with macro or industry-level findings, we can decompose the temporary worker ratio by industry as following methodology; First, we define industry-level temporary worker ratio ($P$) as weighted average of micro-level temporary worker ratio ($P_{it}$).

$$P = \sum_i s_{it} P_{it}$$

where $s_{it}$ is the labor share for plant $i$ in year $t$. Then, the change in the industry-level temporary worker ratio is decomposed into the following three factors.

$$\begin{aligned} P_t - P_{t-1} &= \sum_i s_{it-1}(P_{it} - P_{it-1}) + \sum_i (s_{it} - s_{it-1}) P_{it-1} \\ &+ \sum_i (s_{it} - s_{it-1})(P_{it} - P_{it-1}) \end{aligned}$$

First term in the right hand side is a weighted average of each plant's change in its temporary worker ratio. Second term is the effect of the share change weighted by initial temporary worker share. Third term is the cross-product of change in both shares. This term will increase if there are many plants which observed an increase in both the temporary worker share and its market share. These three terms are usually called as within effect, between effect and cross effect, respectively. Furthermore, each term can be further decomposed into subgroups; exporters and non-exporters as follows;

$$\begin{aligned} P_t - P_{t-1} &= \sum_{i \in non-exporter} s_{it-1}\Delta P_{it} + \sum_{i \in exporter} s_{it-1}\Delta P_{it} \\ &+ \sum_{i \in non-exporter} \Delta s_{it} P_{it-1} + \sum_{i \in exporter} \Delta s_{it} P_{it-1} \\ &+ \sum_{i \in non-exporter} \Delta s_{it}\Delta P_{it} + \sum_{i \in exporter} \Delta s_{it}\Delta P_{it} \end{aligned}$$

where $\Delta s_{it} = (s_{it} - s_{it-1})$ and $\Delta P_{it} = (P_{it} - P_{it-1})$.

Table 5 presents the results of decomposition of change in industry-level temporary worker ratio. Column (1) indicates the decomposition of changes in temporary worker ratio for the overall Machinery and Equipment (M&E) manufacturing sector. And column (2) is the one for those subsectors which mainly produces finished products[1]. The reason why we compare the overall M&E sector with the Finished Products M&E is to avoid the possiblity for us to be misguided by the reasults. We may find no link between output fluctuations and temporary worker employment for intermediate goods producers. Intermediate goods producers may be affected by the demand fluctuations from abroad. For example, even if a plant dose not engage in exporting by itself, it might be affected by the foreign demand fluctuations thorough input-output linkage. Restricting our sample to the finished products producers enables us to focus on the contrast between pure exporters and pure non-exporters. In table 5, the industry-level temporary worker ratio has increased both for the overall M&E sector and the Finished-product M&E manufacturing sector from 7.8% to 12.1% and from 6.2% to .9.0%, respectively.

Now we can use the decomposition method we investigated above. The changes in the ratio can be decomposed into three parts; within effect, between effect and cross effect. More than half of change in industry-level temporary worker ratio can be explained by within effect. In case of the overall M&E sector, while the change in the ratio is 4.3% point, the contribution of within effect is amount to 2.6% point. However, for the overall M&E sector, the contribution of non-exporter exceeds the one of exporters. The contribution of exporter is 0.7% point, which can be accounted for just about 25% of within effect. Turning to the Finished-product M&E sector, we find that there is a considerable contribution

[1]Finished products sectors are defined as those industries whose products are mainly consumed as final demand or intermediate input for non-manufacturing sectors. More precisely, we calculate the ratio of intermediate demand to total demand from 2005 Input-Output table for each sector and those sectors with less than 10% intermediate demand ratio are regarded as finished-product manufacturing sector.

of within effect. It accounts for nearly 60% in the changes in the temporary worker ratio. As for the contribution of exporters, nearly half of the within effect can be explained by the contribution of exporters.

How can we interpret these results? While table 3 and table 4 calculate the simple average of plant characteristics, table 5 presents weighted average. If there is a large heterogeneity among plants in terms of plant size, simple average in table 3 and table 4 might be biased toward small plants' characteristics. Large part of industry-level changes in the temporary worker ratio is explained by the within effect. Therefore, taking into account the fact that exporters tend to be larger and having higher productivity, the increases in the temporary worker ratio by the larger size exporting plants might have played an important role in explaining the changes in the industry-level export ratio.

## 4.2 Simple regression analysis

To confirm the above speculation, we estimated the following simple regression analysis.

$$\begin{aligned}\Delta P &= \alpha + \beta_1 * Scale + \beta_2 * LP + \beta_3 * EXshare + \beta_4 * Changeshare \\ &\quad + \beta_5 * Scale * EXshare + \beta_6 * Scale * Changeshare\end{aligned}$$

The dependent variable $\Delta P$ is the change in temporary worker ratio at plant level between 2001 and 2006. "$Scale$" indicates the plant size measured by the logged number of employees as of year 2001. "$LP$" is labor productivity for each plant as of year 2001. And "$EXshare$" and "$Changeshare$" represent the export share and the changes in export share, respectively. All the level variables are measured at year 2001. We further add the interaction term of the plant size and the exporting activity. If only the largeer plants have increased the temporary worker ratio, we can expect the positive significant coefficients to be emerged. The column (1) and column (2) are simple OLS estimates without interaction term for the overall M&E sector and the finished-product M&E sector. While the export share in 2001 negatively affects the changes in the temporary worker share for the overall M&E sector, it dose not for the finished-product M&E sector. The result in column (3) is estimated by weighted least squares. We used the number of employees as weight. We found, while the export share in 2001 has a negative coefficient, the change in the export share has a positive and significant effect on the changes in the temporary worker ratio. Column (4) is an estimation result with the interaction terms of plant scale and export activity. In case of the finished-product M&E sector, we obtained a positive and significant coefficient, which is consistent with our speculation.

Theoretical part of this paper cannot answer this part of empirical results. We need to conduct further research on this respect.

# 5 Conclusion

The paper presented a model of heterogeneous firms with many industry. It tries to capture the stylized facts about temporary worker employment. Without the firing cost, the model predicts that the share of exporting firms in the total number of domestic producers is higher in the country's comparative advantage industries and that the share of exporting firms has negative correlations with the ratio of temporary workers.

The empirical findings supported most of the propositions in the theory section. If we look at the industry-level data, the firm's productivity and the ratio of temporary workers have a negative correlation. Moreover, the export share of the firms also have a negative correlation with the temporary worker share.

Scale effects found in the last empirical section is still unsoved in the theory part. Future research can include the application of Helpman (1984) that the fixed cost of export may have different skill intensity.[2] Here in this paper we assumed that the skill intensity of all the fixed costs to be the same as in the production process. In the real world, however, the pattern of usage of permanent and temporary workers differ across production and export preparation. For a simple production process, unskilled temporary workers can be substituted for permanent workers relatively easily. But in order to export the firm's product, the firm must hire college graduates who have knowledge in both foreign language and IT (Information Technology). To hire the college graduates, the firms must offer permanent positions. Therefore, it is likely that export fixed costs should contain larger proportion of skilled workers in comparison to the regular production process. In the future research, we may look into the possibility of export costs having the different cost structure than the production processes.

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[2] In Helpman (1984), it is called the headquater service that must be combined together with production process of manufacturing products. In this papaer's framework, export fixed cost corresponds to the headquater service in Helpman (1984).

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