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# Exposure to Low-wage Country Imports and the Growth of Japanese Manufacturing Plants


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Abstract

Japan's trade structure has changed remarkably in the past two decades with an increase of imports of manufactured goods from low-wage countries, in particular China. This has contributed to the impression of a hollowing out effect in manufacturing. Against this background, we analyze the role of international trade in the reallocation of Japanese manufacturing within and across industries from 1989 to 2006. We estimate the impact of industry exposure to low-wage country imports on Japanese plants' survival and employment growth. The analysis is conducted with a panel dataset of over 4.5 million observations on Japanese manufacturing plants. Our results are broadly consistent with the factor proportions model of trade, as we find that plant survival and growth are negatively associated with industry exposure to low-wage country imports. [1]

*Keywords*: Low-wage country import competition; Manufacturing plant; Comparative advantage; Japan
*JEL classification*: F11, F14, L25, L60



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## I. INTRODUCTION

1. Asia has changed considerably in the last two decades and now accounts for a quarter of world GDP. This is largely due to the opening up of China to international markets which has driven Emerging Asia's 8-fold increase in GDP (IMF 2011). Large changes in income have been accompanied by substantial transformations in Asia's trade structure. One of the main features of these transformations has been the development of complex supply chains. China is a key player in these supply chains, importing raw materials, intermediate goods and finished capital goods that are either assembled or go into the production of final consumption goods destined for exports to third economies. As a consequence, China's exports now account for approximately 10 percent of world goods exports, and are expected to grow to about 15 percent of world trade by 2015 (IMF 2011).

2. The rise of large supply networks that benefit from China's low-wage costs, raises important economic trade-offs for Japan. For most high-wage countries, the increase of imports from low-wage countries is likely to result in a decline in manufacturing activity overall, but also a reallocation of activity across industries within manufacturing towards skill-intensive and capital-intensive sectors. In fact, this is the exact pattern of changes experienced in Japan. Aggregate statistics show that imports from China have increased more than ten-fold and employment in manufacturing has declined by 7 percent between 1990 and 2010. However, due to the reallocation of resources towards skill-intensive and capital-intensive activities[2], the share of manufacturing in GDP has not decreased substantially in Japan over the same period of time (see Figures 1-3).

3. Against this background, this paper seeks to analyze the role of international trade in the reallocation of Japanese manufacturing, within and across industries from 1989 to 2006. In particular, we estimate the impact of industry exposure to low-wage country imports on Japanese plants' survival and employment growth. To conduct the analysis, we use a panel dataset of Japanese manufacturing plants with over 4.5 million observations between 1989 and 2006 (the Census of Manufactures conducted by the Ministry of Economics, Industry, and Trade). The dataset importantly includes small firms, where much of the reallocation in activity takes place. The paper builds on previous studies that estimate the impact of low-wage country imports on manufacturing in the U.S. (Bernard, Jensen and Schott 2006) and in Chile (Alvarez and Claro 2009).

4. This paper is one of the first to use the panel dataset of Japanese manufacturing plants. The project's focus on both small and large firms[3] also sets it apart as it is possible to more accurately measure the overall impact of low-wage imports. Another important contribution of this paper is to address the likely endogeneity of import penetration, driven for example by unobserved demand and supply shocks that affect both import penetration and, respectively,

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[2] This can be seen by drawing a histogram of plant capital intensities for large plants in 1980 and 2007 (Census of Manufactures, results not shown).

[3] Both papers in the literature using the plant level dataset for Japan (Itoh 2005, Inui et.al. 2011) and Bernard, Jensen, and Schott (2006) exclude small plants.

plants' survival and employment growth. We instrument import penetration in Japan with import penetration in the U.S. The assumption is that, while both these measures are likely to be affected by supply shocks in China and other low wage countries, the U.S. measure should not be affected by Japan-specific (demand and supply) shocks.

5. We indeed find evidence that low-wage country imports have decreased the probability of survival of Japanese plants and have reduced surviving plants' employment growth. We also find evidence of significant variation in the impact of low-wage country imports across plants of different sizes (i.e., plants with less than 10 employees, plants with 10-29 employees and, finally, plants with more than 30 employees), across different regions and across sectors with different factor intensities (low, medium and high capital-intensity sectors, respectively).

6. The remainder of this paper is organized as follows. In the next section we summarize existing studies, highlighting our contribution to the literature. In section III, we describe our unique dataset and some of the broader data issues we faced in constructing this dataset. We also present summary statistics. We present our empirical framework in section IV and discuss our empirical results in, respectively, section V (basic results) and section VI (results by plant size, region and capital intensity). Finally, section VII concludes.

## II. Literature Review

7. The paper most closely related to ours is Bernard, Jensen and Schott (2006) (BJS2006) which analyzes the impact of imports from low-wage countries on U.S. manufacturing plants during the 1977-1997 period. In particular, BJS2006 uses manufacturing plant-level data from the U.S. Census Bureau's Census of Manufactures to investigate the impact of low-wage countries imports on reallocation of U.S. manufacturing within and across industries. The authors find that low-wage competition–through imports to the U.S.–has a negative impact on manufacturing plants' employment and that this negative effect is less pronounced for high-productivity and capital-intensive plants. In addition, the analysis reveals that imports from low-wage countries lead to an increase in plant-level productivity as well as in capital/skill usage. The estimation is carried out taking into account the potential endogeneity of low-wage country import competition, which is instrumented using data on U.S. industry-year ad valorem tariff rates as well as freight rates.

8. BJS2006 is the first paper in the literature to analyze the impact of low-wage country import competition using plant-level data. Previous works on the topic exploit industry-level datasets (see, for example, Freeman and Katz 1991 and Sachs and Shatz 1994). Among the more recent contributions to this literature using industry-level data, Khandelwal (2010) is worth mentioning for its focus on quality ladders. This paper develops a novel approach to estimating the quality of products exported to the United States. Based on these estimates, Khandelwal (2010) measures the extent of vertical product differentiation ("quality ladder") of products and shows that the negative impact of imports from low-wage countries on U.S. manufacturing employment and output is more pronounced for products characterized by short quality ladders. The intuition of this result is straightforward: in markets featuring short quality ladders, firms cannot insulate themselves from low-wage competition by specializing in top-quality products. Federico (2010) tests the same idea using sector-level Italian

manufacturing data. This paper finds evidence of a negative employment impact of sector-level imports from low-wage countries: importantly, and consistent with Khandelwal (2010), this impact is weaker for sectors characterized by a longer quality ladder (as well as for more capital and skill-intensive sectors). Finally three papers in the literature – which use industry-level data – are relevant for our work given their focus on Japanese manufacturing. Tomiura (2003) shows a significant impact of import price changes on Japanese employment. The author interprets this result as evidence of an important role played by intensified import competition in the average employment decline taking place in Japan, especially in the yen appreciating recession years. Tomiura (2004) investigates the impact of import competition on Japanese employment during and after the burst of the real estate and stock bubble. Using 4-digit industry-level data, this paper finds evidence of a significant but small effect. Finally, Sakurai (2004) shows that the estimated loss of employment in aggregate manufacturing attributable to increased imports, between 1980 and 1990, is 4.7 percent of the 1980 level of employment.

9. An increasing number of papers has followed the lead of BJS2006 and has used firm-level or plant-level data to analyze the impact of low-wage country (or simply Chinese) import competition on the manufacturing sector of the importing country. Alvarez and Claro (2009) is the first application of the BJS2006 analysis to the case of a developing country. This is an especially interesting case since Chinese production is likely to have a greater overlap with the production bundle of a low-income country. The authors use Chilean plant-level data for the years from 1990 to 2000 and show that Chinese imports give rise to a decrease in plant-level employment growth as well as in the plant's probability of survival – although these effects are not significantly different across plants. In addition, Chinese imports do not lead to increases in plant-level productivity nor capital/skill usage, on the contrary the opposite effect takes place: Chinese import competition makes domestic plants' techniques more labor intensive.

10. Other papers that use firm-level or plant-level data to analyze the impact on domestic manufacturing of low-wage country (or Chinese) competition are Bloom, Draca and Van Reneen (2011), which uses European data and focuses more specifically on the impact on innovation activity; Iacovone, Rauch and Winters (2010), which investigates effects on the Mexican manufacturing sector; Greenaway, Gullstrand and Kneller (2008), which looks at the impact of both low-wage country and high-wage country import competition on Swedish firms; Baldwin and Lileeva (2008), which investigates how Canadian manufacturing plants change their commodity mix in reaction to an increase in low-wage import competition; and, finally, Inui et.al. (2011) and Itoh (2005), which are the most closely related to our own work given their focus on the Japanese manufacturing sector.

11. Since we began our work with the Japanese Census of Manufactures, we have become aware of another related but independent paper (Inui et al. 2011) which uses the same plant-level dataset as ours. Inui et al. (2011) confirms our results and shows that employment growth and survival of plants are both negatively affected by increased import

penetration from low-wage countries.[4] This effect is estimated to be less pronounced for high productivity and large plants. In addition, Inui. et.al. (2011) finds that plants in regions with high input linkage agglomeration and/or high intra-industry agglomeration suffer less from such a negative impact. Our analysis improves upon this study in a number of ways, for example, by using an improved concordance, by employing higher-quality IVs, etc. – discussed in greater detail below.

12. Iacovone, Rauch and Winters (2010) is another example of work following the BJS2006 empirical approach. This paper is one of the most significant contributions to the literature given that it improves upon BJS2006's analysis along two main dimensions. First, the authors explore the impact of imports from low-wage countries (in particular, China) on the reallocation of the Mexican manufacturing sector not only across sectors and across plants within a sector, but also across products within a plant. Second, the paper analyzes effects on both the Mexican domestic manufacturing sector and on Mexican exporters in third markets (the U.S. market).

13. Finally, a few papers in this literature employ the same empirical approach as BJS2006 to analyze the impact of low-wage country (or Chinese) import competition on additional outcome variables. Besides Bloom, Draca and Van Reneen (2011) – mentioned above – which looks at European innovation activity, several recent papers are worth noting. Iacovone, Keller and Rauch (2010) provide evidence on how import competition shapes the innovation activity of firms, using data for Mexico. Bugamelli, Fabiani and Sette (2010) provides evidence on the effect of Chinese import competition on the pricing behavior of Italian firms. Finally, Auer and Fischer (2010) also analyze the impact of low-wage import competition on inflationary pressure in the United States; however, this paper uses industry-level data.

14. To conclude, one of the most recent contributions to this literature is Autor, Dorn and Hanson. The focus of this paper is on the impact of Chinese import competition on U.S. local labor markets. Thus, this analysis differs from all the previous ones mentioned above, as well as ours, since it exploits regional, as opposed to industry or plant-level, variation in the data.

## III. DATA

15. Following BJS2006, to examine the link between Japanese manufacturing and international trade, we use import penetration measures that focus on the origin country of imports. In particular, we differentiate between imports coming from low-wage countries and imports coming from all other countries (middle and high-wage countries). This focus by origin country is important because the within- and across-industry reallocation implied by the factor proportions framework is brought about by trade between countries with different factor endowments. For example, the factor proportions framework makes predictions on the impact of Japanese imports from China, but not from the U.S. (in that framework, we should not even observe Japanese imports from the U.S.). In general, the existence of high imports

[4] See also Itoh (2005), which shows a similar pattern of growth in employment and sales using the Basic Survey of Japanese Business Structure and Activities for 1997 and 2002.

from low-wage countries in a sector allows us to identify that sector as a comparative disadvantage sector – the more so the higher those imports – which should shrink under free trade. The same is not true for sectors characterized by high imports from high-wage countries since in those sectors two-way trade is likely to be taking place.

16. Let $LWPEN_{i,t}$ denote the import penetration of low-wage countries in industry *i* in year *t*,

$$LWPEN_{i,t} = \frac{M_{i,t}^{L}}{M_{i,t} + Q_{i,t} - X_{i,t}}$$

where $M_{i,t}^{L}$ and $M_{i,t}$ represent the value of imports from low-wage countries and all countries, respectively, $Q_{i,t}$ is domestic production, and $X_{i,t}$ represents Japanese exports. Low-wage country import penetration is the product of the share of imports from low-wage countries, $M_{i,t}^{L} / M_{i,t}$ , and aggregate import penetration, .$M_{i,t} / (M_{i,t} + Q_{i,t} - X_{i,t})$. Throughout the empirical analysis we also control for the import penetration of Japan's other trading partners, which we refer to as $OTHPEN_{i,t}$ (for "other penetration").

$$OTHPEN_{i,t} = \frac{M_{i,t} - M_{i,t}^{L}}{M_{i,t} + Q_{i,t} - X_{i,t}}$$

17. To calculate the import penetration from low-wage countries, we classify a country as low-wage if the country was categorized as a low-income country for at least seven years between 1989 and 2006, according to the World Bank standards. As a result we have 47 low-wage countries in our analyses. Table 1 provides a list of the countries, which are classified as low wage in all years of the sample. In addition, imports from Hong Kong to Japan are included in the imports from low-wage countries, as a large share of these imports is likely to have originated in China.

18. The aggregate import penetration $M_{i,t} / (M_{i,t} + Q_{i,t} - X_{i,t})$ for each industry $i$ in year t is constructed using the production, export, and import data reported in the Ministry of Economics, Industry, and Trade's (METI) annually updated input-output table. LWPEN and OTHPEN are subsequently obtained by multiplying the aggregate import penetration variable with the share of imports from low-wage countries and other countries, respectively, as derived from commodity-level trade data.[5] The commodity-level trade data are obtained from UN COMTRADE through the World Integrated Trade Solution (WITS) database provided by the World Bank. The trade data is available for 1988 to 2010. Using the data and concordances compiled by Tomiura (1995), we are able to compute LWPEN and OTHPEN

[5] The aggregate import penetration variable follows the METI input-output table classification; the share of low-wage countries and other countries follows the harmonized system (HS) classification. We concord the latter numbers into IO classifications using available concordances. Finally, we concord LWPEN and OTHPEN to JSIC classifications using the concordances compiled with Tomiura (2005), as explained in more detail below.

for 380 of 485 four-digit Japan Standard Industrial Classification (JSIC) manufacturing industries between 1989 and 2006. These 380 industries encompass 87 percent of manufacturing employment and 85 percent of manufacturing value in 1998, which is in the middle of the period we consider.

19. Table 2 summarizes the two components of LWPEN–the share of imports from low-wage countries and aggregate import penetration – by two-digit JSIC industry and year. The data are reported at 3-year intervals, and the final row of the table summarizes trends for aggregate manufacturing. Both components of LWPEN rise over the sample period. For manufacturing as a whole, the share of imports from low-wage countries increases from 18 percent to 41 percent, while aggregate import penetration rises from 8 percent to 16 percent. For both measures, increases are greater in the second half of the sample period.

20. The rows of Table 2 reveal that shares of imports from low-wage country and overall penetration vary substantially across both industries and time. Both components tend to be higher and to increase more rapidly in some labor-intensive industries such as apparel and leather. Other industries such as food see modest rises in both series. Some industries such as iron and steel and general machinery experience rapid growth of import penetration from low-wage countries while the overall penetration level stays relatively stable. Finally, more capital and skill-intensive sectors such as electronic parts or precision instruments experience rapid growth of import penetration but little increase in the share of imports from low-wage countries.

21. The last column of Table 2 reports the change in employment (computed from the Census of Manufactures as explained below) between 1989 and 2006 by industry. Overall, the number of Japanese manufacturing workers decreases by 25 percent over this period. This aggregate loss, however, obscures the fact that some industries such as transportation equipment have grown substantially even as others have declined.

22. Manufacturing plant data are obtained from the Census of Manufactures conducted by METI. The sampling unit for the Census is a manufacturing establishment, or plant, and the Census covers all plants with four or more employees located in Japan and listed as manufacturing industry. We use the Census data from 1989 to 2006. The Census contains data on shipments, the number of employees, the book values of tangible fixed assets, the wage bill, the intermediate input cost, and so forth. The questionnaires have two formats: one for large plants, which have at least 30 workers and the other for small plants which have less than 30 employees. The questionnaire for large plants is more comprehensive and in each year includes questions about the capital stock and current investment flows.[6]

23. The Census of Manufactures is a cross section, and the city and establishment codes of some plants changed during 1989-2006. In order to panelize the data, we connect prefecture, city and establishment codes of each plant between 1989 and 2006 using the converter provided by the Research Institute of Economy, Trade and Industry (RIETI). We assume that a plant closes if the plant disappears from the Census and does not reappear in

[6] Capital data is also available for plants with 10-29 employees between 1989-2000 and in 2005.

our sample period. In contrast, when a plant disappears in some years of the census but then reappears, we assume that the plant continues to survive.[7]

24. Tables 3 through 6 present statistics on the distribution of plant age and plant survival rates. Table 3 indicates that plant age is relatively high, with over half of the plants lasting more than ten years in our sample period.[8] Moreover, plant survival rates appear to be substantially different across plants of different sizes, with larger plants having a higher probability of survival (Tables 5 and 6). For example, nearly half of the large plants that existed in our dataset in 1989 were still in our dataset in 2006; while over the same time period, only one-quarter of the smaller firms survived. The difference is perhaps most pronounced when one looks at the first year of a plants existence, with nearly one quarter of small plants failing to survive their first year in business.

25. The Census reports all of a plant's output in one four-digit JSIC industry. A multi-product plant that produces in more than one four-digit JSIC industry is assigned to the industry that represents the greatest percentage of the plant's output. After merging the production data with the import penetration data, we are left with around 4.5 million observations encompassing around 450 thousand unique plants over the sample period.

26. Finally, Table 7 presents some key summary statistics. The table indicates that both the number of plants and the total number of employees in the manufacturing sector have been shrinking. This decline also appears most evident amongst small plants, which also make up the largest proportion of our dataset. (Large plants account for a mere 10 to 15 percent of the observations.) Moreover, plant size, defined as the number of workers per plant, and labor productivity, defined as value added per worker, have been increasing over the sample period. These trends are broadly consistent with the aggregate statistics presented in the introduction.

## IV. EMPIRICAL FRAMEWORK

27. Our empirical strategy consists of estimating the effect of low-wage country imports to Japan on, respectively, the survival of plants and the employment growth of surviving plants. Following Bernard, Jensen and Schott (2006), we use the following basic specification for the survival of plants:

$$S_p^{t:t+1} = \alpha_S LWPEN_{i,t} + \varphi_S OTHPEN_{i,t} + V'_{p,t}\beta_S + \tau_t + \tau_{\mathrm{p}} + u_{p,t} \qquad [1]$$

where $p$, $i$, and $t$ denote plant, industry and year, respectively. $S_p^{t:t+1}$ is a survival indicator that equals one if a plant survives from year $t$ to $t+1$, and zero otherwise. $LWPEN_{i,t}$ is the

[7] This could happen if the number of employees temporarily falls below 4 employees or if the plant fails to answer the questionnaire. The survey has a relatively high response rate, however, with, for example, 95 percent of plants responding in 2009.

[8] As we do not observe plant age directly, we consider the first year in which a plant appears in our dataset to be the first year of the plants existence.

import penetration from low-wage countries in industry $i$ – which is the industry where plant $p$ operates – in year $t$. Analogously, $OTHPEN_{i,t}$ is the import penetration from other countries in industry $i$ in year $t$. $V_{pt}$ is a vector of year $t$ characteristics of plant $p$. It includes the plant's log employment and plant age.[9] Finally, $\tau_t$ and $\tau_p$ are year and plant fixed effects, respectively. To simplify the interpretation of the results, we demean all the regressors. We use a linear probability model, as opposed to a probit or logit specification, due to the incidental parameters problem that arises with fixed effect estimation of these non-linear models. Finally, we use heteroscedasticity-consistent standard errors clustered at the plant level.

28. We use the following basic specification for employment growth:

$$\Delta \ln Empl_p^{t:t+1} = \alpha_E LWPEN_{i,t} + \varphi_E OTHPEN_{i,t} + V'_{p,t}\beta_E + \delta_t + \delta_p + \varepsilon_{p,t} \qquad [2]$$

The dependent variable $\Delta \ln Empl_p^{t:t+1}$ is the one-year change in employment for plants that are in the dataset in both years $t$ and $t$+1. We use one-year changes in employment – instead of 5 year changes as in Bernard, Jensen and Schott (2006) – in order not to miss plants that are created or shutdown or both within the 5-year period. These plants would be excluded from the analysis if we used 5-year changes. Table 3 presents the distribution of plants by age in the last year in which they are in the dataset. So, for example, 3.8% of the plants in the dataset die in their first year of operation; 3.1% of the plants in the dataset die in their second year of operation; etc. Thus, Table 7 shows that approximately one-fifth of the plants (20.9%) survive less than five years. Hence, our definition of the dependent variable – based on one-year changes – reduces some of the selection bias arising from plants falling out of the sample. The explanatory variables in the employment growth regressions are defined as in the survival equation. $\delta_t$ and $\delta_p$ are, respectively, year and plant fixed effects. We estimate the employment growth regressions using OLS with heteroscedasticity-consistent standard errors clustered at the plant level.

29. According to the theoretical predictions of the factor endowment model, we do expect to observe imports to Japan from low wage countries. The reason is that Japan and low-wage countries have a comparative advantage in different industries and therefore will have an incentive to trade. In equation 1 we expect $\alpha_S < 0$, i.e. we expect that a higher import penetration from low-wage countries in the industry $i$ where plant $p$ operates is associated with a lower probability of survival. The reason is that industries where the import penetration from low-wage countries is higher are industries at odds with Japan's comparative advantage (i.e., they are most likely unskilled-labor intensive industries). Analogously, in equation 2, we expect $\alpha_E < 0$.

30. Both regressions [1] and [2] are likely to be affected by endogeneity of the industry-level import penetration variable ($LWPEN_{i,t}$). In particular, both demand and supply shocks are likely to give rise to an omitted variable bias. To the extent that demand shocks are

[9] Following the literature on plant employment growth (Hall 1987 and Blonigen and Tomlin 2001), we include initial employment size and plant age as controls.

positively correlated with $LWPEN_{i,t}$ and positively correlated with the plant's survival and employment growth, they are likely to produce a positive omitted variable bias in the estimate of the impact of $LWPEN_{i,t}$ on the two outcome variables. In other words, given demand shocks, the OLS estimates of $\alpha_S$ and $\alpha_E$ should be biased towards zero. On the other hand, if supply shocks are negatively correlated with $LWPEN_{i,t}$ and positively correlated with the plant's survival and employment growth, they are likely to produce a negative omitted variable bias in the estimate of the impact of $LWPEN_{i,t}$ on the two outcome variables. In other words, given supply shocks, the OLS estimates of $\alpha_S$ and $\alpha_E$ should be biased away from zero. Clearly, the latter case is more problematic than the former one (since in the former one our estimates are simply a lower bound of the true estimates). Since we cannot know whether demand or supply shocks, or other omitted variables are at work, we also estimate regressions 1 and 2 using an instrumental-variable (IV) strategy. We instrument Japan's low-wage country import penetration with the U.S. import penetration from the same (low-wage) countries. The rationale for this instrument is that low-wage country import penetration in the U.S. is likely to be correlated with the Japanese one – since both are affected by changes in low-wage countries on the supply side.[10] At the same time, the U.S. low-wage country import penetration should not be affected by Japan-specific shocks. We construct the instrument using U.S. data from Bernard, Jensen and Schott (2006), downloadable from Peter Schott's website[11][12]. Similar considerations lead us to believe that $OTHPEN_{i,t}$ might also be endogeneous. Thus, we instrument it using the U.S. import penetration from other (non low-wage) countries.[13]

31. Finally, given the key role played by China, we also estimate specifications in which we differentiate between imports from China (CHNPEN) vs. imports from other low-wage countries (Other LWPEN).

## V. Basic Empirical Results

32. Table 9 presents the basic results for both the employment growth and survival equations. (Table 8 provides summary statistics for the main dependent and independent variables.) For each equation we present results based on both OLS estimation and IV estimation. We also present the IV estimates of a specification where we differentiate between the effect of Chinese imports (CHNPEN) and of imports from other low-wage countries (Other LWPEN). As explained in the previous section, these specifications include

[10] Two papers in the literature use a similar instrument. Bugamelli et al. (2010) use China import penetration in the U.S. as an instrument for China import penetration in Italy. Autor et al (2011) use the non-U.S. exposure to Chinese imports as an instrument for the U.S. exposure to Chinese imports.

[11] http://faculty.som.yale.edu/peterschott/sub_international.htm

[12] LWPEN of the US is based on NAICS, and was matched to LWPEN of Japan using the converter between NAICS and JSIC provided by the Ministry of Internal Affairs and Communications of Japan.

[13] When we construct the U.S. import penetration from other (non low-wage) countries – which we use as an instrument – we exclude U.S. imports from Japan.

the industry-level trade variables, the plant-level controls, and the plant-level and time fixed effects.

33. The most consistent and striking result in Table 9 is that the coefficient on LWPEN displays the predicted sign (negative) and is significant at the one percent level under all specifications (see columns (1)-(2) and (4)-(5) in Table 9). The size of the coefficient is also large and we believe economically significant. A ten percentage point increase in import penetration from low-wage countries decreases the annual employment growth rate by approximately 2.8 percentage points (column (2)). In the survival equation, the same ten percentage point increase leads to an approximate 2.8 percentage point decrease in the probability of survival (column (5)).

34. To put this in context, in the apparel industry where low wage import penetration increased by approximately 40 percentage points between 1989 and 2005, this would translate into an 11 percentage points decline in the annual employment growth rate on average at the plant level. For example, if the industry was growing at an annual rate of 5 percent in 1989, this model estimates that that same annual growth rate would be negative 6 percent in 2005. Compounded annually these would imply large changes over time.

35. These effects also appear to be larger when we look at longer time horizons (Table 10). The effect on employment growth increases from negative 0.28 in the one-year change model to negative 0.87 in the five-year change model. This last coefficient is double the corresponding number in BJS (2006) for the United States, which was also estimated using employment growth rates over five years.

36. The absolute value of the size of the coefficients, in both the employment growth and survival equations, is significantly larger in the IV estimates. Based on our discussion in the previous section, the (positive) sign of the omitted variable bias suggests that demand shocks are more dominant than supply shocks. In other words, the OLS estimates are characterized by a bias towards zero. An alternative interpretation of the difference in results between the OLS and the IV estimates is measurement error leading to attenuation bias.

37. Finally, the coefficient on the Chinese import penetration variable broadly confirms that the results for LWPEN are mainly driven by imports from China. The coefficient on CHNPEN in columns (3) and (6) are nearly identical to the coefficients on LWPEN in columns (2) and (5). A scatter plot of the two variables (Figure 4) indeed shows a positive and significant correlation (0.97). Moreover, the coefficients on Other LWPEN are larger in absolute sense than the coefficients on CHNPEN under both specifications.

## VI. Differences by Plant Size, Region, and Capital Intensity

38. The specifications estimated in the previous section restricted the effect of LWPEN to be the same across all plants. However, in general, there is no reason to think that this should hold true. Thus, in this section we turn to differences in the effect of LWPEN on employment growth and survival across sub-groups of plants. Specifically, we consider differences that might arise due to variation in plant size, location and, finally, capital intensity.

39. Table 11 presents the results by plant size. The sample is divided into three groups: plants with employees between 4 and 9, plants with employees between 10 and 29, and plants with more than 30 employees. Interestingly, the results for the survival equation and the employment growth equations are the exact opposite. In the survival equation, the marginal effect on survival is more negative for smaller plants while, in the employment growth equation, the marginal effect is more negative for larger plants. One possible interpretation of these results is that large plants and small plants adjust to import competition at different margins. Small plants are less able to adjust employment and therefore choose to exit, while large plants are better able to adjust to competition by reducing employment and possibly by switching to more capital-intensive and skill-intensive techniques.

40. Next, in Tables 12 and 13, we present results by Japan's eight regions, for the employment growth and survival equations, respectively. There is a wide variety of estimates suggesting again that the effect of LWPEN is indeed likely to be heterogeneous. As labor intensive manufacturing is likely to be located in rural regions, one hypothesis is that rural regions would be affected more by low-wage import competition. In table 12 this appears broadly accurate given that the estimates for Tohoku, Chugoku, Shikoku, and Kyushu are larger than the estimates for the two largest urban regions of Kanto and Kinki. However, this result is not consistent across all regions, nor is it totally consistent across the survival equations.

41. In our final sub-grouping of plants, we examine differences across capital intensity at the sector level (Table 14). The results show that the impact of LWPEN is negative and significant. In the employment growth regression, the magnitude of the effects is largest in sectors that are the least capital-intensive, i.e., the sectors that are most likely to be comparative disadvantage sectors. The survival regressions, however, are not consistent with this pattern.

## VII. CONCLUSION

42. The results presented in this paper are preliminary. In particular, our current estimation has not taken into account fully the possibility of selection. The dataset has a large number of small plants whose survival rate is low. As such, the employment equation excludes many of the firms that do not survive in the sample period. Properly accounting for this bias is a priority for the next version of this paper.

43. Still, these initial results are suggestive. The robust finding that the coefficient on LWPEN displays the predicted sign (negative) and is significant at the one percent level under all specifications is significant and is supportive of the factor endowment model interpretation of trade. The size of the coefficient is also economically significant, predicting large changes in the growth rate of employment in the sectors that experienced more pronounced increases in low-wage import penetration. This reallocation of resources away from labor-intensive comparative disadvantage sectors to more skill- and capital-intensive comparative advantage sectors is consistent with how countries gain from trade in standard international trade models.

## TABLES AND FIGURES

**Table 1. Low-wage Countries**

| | | | |
|---|---|---|---|
| Afghanistan | Bangladesh | Benin | Bhutan |
| Burkina Faso | Burundi | Cambodia | Central African Republic |
| Chad | China | Comoros | Congo, Dem. Rep. |
| Equatorial Guinea | Ethiopia | Gambia, The | Ghana |
| Guinea | Guinea-Bissau | Guyana | Haiti |
| Hong Kong | India | Indonesia | Kenya |
| Lao PDR | Lesotho | Liberia | Madagascar |
| Malawi | Mali | Mauritania | Mozambique |
| Myanmar | Nepal | Niger | Nigeria |
| Pakistan | Rwanda | São Tomé and Principe | Sierra Leone |
| Somalia | Sri Lanka | Sudan | Tanzania |
| Togo | Uganda | Vietnam | Zambia |

**Source: World Bank**

**Table 2. Import Penetration**

| Industry | | Share of Imports from low-wage countries (%) | | | | | | Overall import penetration (%) | | | | | | Employment Change (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| JSIC | Name | 1989/91 | 1992/94 | 1995/97 | 1998/00 | 2001/03 | 2004/05 | 1989/91 | 1992/94 | 1995/97 | 1998/00 | 2001/03 | 2004/05 | 1989/06 |
| 900 | Food | 28 | 30 | 32 | 35 | 38 | 38 | 9 | 12 | 15 | 15 | 15 | 15 | 1 |
| 1000 | Beverages | 9 | 6 | 6 | 21 | 8 | 7 | 7 | 8 | 9 | 9 | 9 | 10 | -22 |
| 1100 | Textile mill products | 38 | 42 | 40 | 45 | 48 | 52 | 14 | 14 | 20 | 20 | 24 | 28 | -66 |
| 1200 | Apparel | 39 | 59 | 68 | 76 | 84 | 86 | 17 | 20 | 28 | 35 | 50 | 56 | -69 |
| 1300 | Wood products | 68 | 24 | 24 | 27 | 23 | 40 | 18 | 19 | 24 | 24 | 28 | 30 | -51 |
| 1400 | Furniture | 14 | 21 | 24 | 27 | 40 | 50 | 4 | 5 | 8 | 11 | 16 | 18 | -45 |
| 1500 | Paper | 11 | 14 | 18 | 28 | 29 | 49 | 5 | 4 | 5 | 5 | 5 | 6 | -26 |
| 1600 | Printing | 2 | 2 | 4 | 5 | 12 | 16 | 0 | 0 | 1 | 1 | 0 | 1 | -21 |
| 1700 | Chemical | 7 | 6 | 6 | 5 | 5 | 9 | 9 | 9 | 10 | 11 | 13 | 15 | -12 |
| 1800 | Petroleum and coal products | 0 | 3 | 0 | 0 | 1 | 1 | 15 | 10 | 11 | 11 | 11 | 13 | -28 |
| 1900 | Plastic products | 8 | 16 | 22 | 28 | 34 | 43 | 1 | 2 | 3 | 3 | 5 | 6 | 5 |
| 2000 | Rubber products | 17 | 41 | 53 | 66 | 70 | 73 | 7 | 7 | 10 | 10 | 13 | 13 | -25 |
| 2100 | Leather | 13 | 26 | 38 | 43 | 48 | 52 | 28 | 33 | 44 | 48 | 57 | 64 | -61 |
| 2200 | Ceramic, stone and clay | 11 | 22 | 37 | 34 | 43 | 48 | 4 | 4 | 5 | 6 | 8 | 10 | -37 |
| 2300 | Iron and steel | 9 | 28 | 9 | 22 | 23 | 31 | 4 | 3 | 3 | 3 | 2 | 4 | -35 |
| 2400 | Non-ferrous metals | 10 | 16 | 18 | 21 | 33 | 35 | 24 | 19 | 23 | 24 | 26 | 30 | -14 |
| 2500 | Fabricated metal products | 11 | 17 | 22 | 29 | 38 | 47 | 2 | 2 | 2 | 3 | 4 | 6 | -20 |
| 2600 | General machinery | 3 | 4 | 9 | 14 | 19 | 26 | 4 | 4 | 6 | 7 | 9 | 12 | -11 |
| 2700 | Electrical machinery | 5 | 10 | 18 | 25 | 35 | 44 | 4 | 4 | 9 | 12 | 17 | 21 | -39 |
| 2800 | Communication equipments | 4 | 8 | 11 | 15 | 31 | 49 | 9 | 12 | 22 | 27 | 41 | 48 | -48 |
| 2900 | Electronic parts | 1 | 3 | 6 | 9 | 14 | 19 | 6 | 9 | 15 | 18 | 30 | 35 | -12 |
| 3000 | Transportation equipment | 4 | 6 | 2 | 9 | 6 | 8 | 5 | 5 | 7 | 8 | 8 | 8 | 9 |
| 3100 | Precision instruments | 11 | 14 | 18 | 19 | 20 | 23 | 17 | 18 | 25 | 28 | 35 | 38 | -36 |
| 3200 | Miscellaneous | 24 | 32 | 33 | 43 | 50 | 55 | 19 | 18 | 22 | 23 | 23 | 29 | -36 |
| Average | | 18 | 23 | 24 | 28 | 34 | 41 | 8 | 8 | 11 | 12 | 14 | 16 | -25 |
| Standard Deviation | | 16 | 15 | 17 | 19 | 21 | 21 | 8 | 8 | 10 | 12 | 15 | 17 | - |

**Source: Fund staff calculations**

Note: Figures for each column are averages across the three years.

**Table 3. Distribution of plant age, 1989-2006**

| Age | Freq. | Percent | Cum. |
|---|---|---|---|
| 1 | 242,015 | 3.8 | 3.8 |
| 2 | 196,628 | 3.1 | 6.9 |
| 3 | 186,579 | 2.9 | 9.8 |
| 4 | 195,198 | 3.1 | 12.9 |
| 5 | 514,498 | 8.1 | 20.9 |
| 6 | 496,016 | 7.8 | 28.7 |
| 7 | 460,119 | 7.2 | 35.9 |
| 8 | 433,174 | 6.8 | 42.7 |
| 9 | 410,661 | 6.4 | 49.1 |
| 10 | 368,488 | 5.8 | 54.9 |
| 11 | 354,250 | 5.6 | 60.4 |
| 12 | 328,051 | 5.1 | 65.6 |
| 13 | 307,207 | 4.8 | 70.4 |
| 14 | 289,422 | 4.5 | 74.9 |
| 15 | 264,698 | 4.2 | 79.1 |
| 16 | 249,389 | 3.9 | 83.0 |
| 17 | 222,898 | 3.5 | 86.5 |
| 18 | 200,560 | 3.1 | 89.6 |
| 19 | 189,029 | 3.0 | 92.6 |
| 20 | 169,911 | 2.7 | 95.2 |
| 21 | 163,086 | 2.6 | 97.8 |
| 22 | 141,261 | 2.2 | 100.0 |
| Total | 6,383,138 | 100.0 | |

**Source: Manufacturing Census**

**Table 4. Ratio of Survived Plants in Each Year of Plant's Creation (In percent)**

| Year | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985 | 78 | 77 | 73 | 69 | 67 | 62 | 61 | 58 | 55 | 53 | 49 | 47 | 43 | 39 | 38 | 35 | 35 | 32 |
| 1986 | 71 | 69 | 65 | 61 | 58 | 52 | 51 | 47 | 45 | 42 | 38 | 36 | 33 | 30 | 29 | 27 | 26 | 24 |
| 1987 | 72 | 69 | 64 | 60 | 56 | 51 | 50 | 46 | 44 | 41 | 37 | 35 | 32 | 29 | 28 | 25 | 25 | 23 |
| 1988 | 69 | 70 | 61 | 55 | 55 | 47 | 48 | 42 | 39 | 38 | 33 | 32 | 28 | 25 | 25 | 22 | 22 | 20 |
| 1989 | 100 | 83 | 76 | 71 | 65 | 58 | 57 | 52 | 49 | 46 | 42 | 40 | 36 | 33 | 31 | 29 | 28 | 26 |
| 1990 | | 100 | 72 | 64 | 62 | 52 | 53 | 47 | 45 | 44 | 38 | 37 | 32 | 29 | 29 | 26 | 26 | 24 |
| 1991 | | | 100 | 82 | 74 | 66 | 64 | 59 | 55 | 52 | 47 | 44 | 40 | 36 | 35 | 32 | 32 | 29 |
| 1992 | | | | 100 | 79 | 69 | 67 | 62 | 57 | 53 | 48 | 46 | 41 | 37 | 36 | 33 | 33 | 31 |
| 1993 | | | | | 100 | 68 | 67 | 58 | 53 | 51 | 44 | 43 | 37 | 33 | 33 | 29 | 29 | 26 |
| 1994 | | | | | | 100 | 79 | 71 | 66 | 61 | 55 | 52 | 47 | 42 | 40 | 37 | 36 | 33 |
| 1995 | | | | | | | 100 | 73 | 66 | 62 | 54 | 51 | 45 | 40 | 39 | 35 | 35 | 31 |
| 1996 | | | | | | | | 100 | 81 | 72 | 65 | 61 | 55 | 49 | 47 | 43 | 42 | 38 |
| 1997 | | | | | | | | | 100 | 80 | 72 | 68 | 60 | 53 | 51 | 47 | 47 | 42 |
| 1998 | | | | | | | | | | 100 | 76 | 71 | 62 | 54 | 52 | 46 | 46 | 40 |
| 1999 | | | | | | | | | | | 100 | 74 | 65 | 55 | 53 | 47 | 47 | 42 |
| 2000 | | | | | | | | | | | | 100 | 64 | 54 | 54 | 46 | 48 | 40 |
| 2001 | | | | | | | | | | | | | 100 | 70 | 65 | 57 | 56 | 49 |
| 2002 | | | | | | | | | | | | | | 100 | 79 | 71 | 67 | 60 |
| 2003 | | | | | | | | | | | | | | | 100 | 64 | 64 | 50 |
| 2004 | | | | | | | | | | | | | | | | 100 | 83 | 74 |
| 2005 | | | | | | | | | | | | | | | | | 100 | 67 |
| 2006 | | | | | | | | | | | | | | | | | | 100 |

**Sources: Manufacturing Census and Fund staff calculations.**

**Table 5. Ratio of Survived Large Plants in Each Year of Plant's Creation (In percent)**

| Year | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985 | 90 | 89 | 88 | 86 | 84 | 80 | 79 | 77 | 75 | 72 | 69 | 67 | 63 | 60 | 57 | 55 | 54 | 52 |
| 1986 | 83 | 81 | 78 | 76 | 73 | 67 | 66 | 64 | 61 | 58 | 55 | 52 | 49 | 46 | 44 | 41 | 40 | 38 |
| 1987 | 87 | 85 | 84 | 81 | 78 | 74 | 70 | 68 | 66 | 63 | 59 | 56 | 52 | 49 | 46 | 44 | 43 | 41 |
| 1988 | 94 | 92 | 90 | 86 | 81 | 77 | 76 | 72 | 70 | 66 | 63 | 60 | 56 | 52 | 50 | 47 | 46 | 44 |
| 1989 | 100 | 95 | 93 | 89 | 84 | 79 | 76 | 74 | 71 | 68 | 65 | 62 | 59 | 56 | 53 | 50 | 49 | 46 |
| 1990 | | 100 | 95 | 92 | 89 | 84 | 82 | 79 | 77 | 74 | 71 | 68 | 65 | 60 | 57 | 54 | 54 | 51 |
| 1991 | | | 100 | 93 | 88 | 82 | 80 | 77 | 74 | 71 | 67 | 63 | 60 | 57 | 55 | 53 | 51 | 48 |
| 1992 | | | | 100 | 92 | 87 | 85 | 82 | 79 | 76 | 73 | 70 | 66 | 63 | 60 | 58 | 56 | 54 |
| 1993 | | | | | 100 | 91 | 87 | 85 | 81 | 78 | 75 | 72 | 69 | 63 | 61 | 59 | 58 | 55 |
| 1994 | | | | | | 100 | 89 | 85 | 81 | 77 | 72 | 69 | 63 | 59 | 56 | 54 | 52 | 50 |
| 1995 | | | | | | | 100 | 94 | 90 | 87 | 82 | 77 | 72 | 68 | 64 | 63 | 61 | 58 |
| 1996 | | | | | | | | 100 | 91 | 85 | 80 | 77 | 72 | 66 | 63 | 60 | 58 | 55 |
| 1997 | | | | | | | | | 100 | 92 | 87 | 84 | 78 | 73 | 70 | 66 | 65 | 62 |
| 1998 | | | | | | | | | | 100 | 90 | 86 | 79 | 70 | 66 | 64 | 61 | 58 |
| 1999 | | | | | | | | | | | 100 | 88 | 81 | 73 | 69 | 66 | 64 | 62 |
| 2000 | | | | | | | | | | | | 100 | 89 | 83 | 80 | 79 | 77 | 73 |
| 2001 | | | | | | | | | | | | | 100 | 86 | 82 | 78 | 74 | 70 |
| 2002 | | | | | | | | | | | | | | 100 | 91 | 86 | 82 | 78 |
| 2003 | | | | | | | | | | | | | | | 100 | 92 | 88 | 83 |
| 2004 | | | | | | | | | | | | | | | | 100 | 92 | 88 |
| 2005 | | | | | | | | | | | | | | | | | 100 | 94 |
| 2006 | | | | | | | | | | | | | | | | | | 100 |

**Sources: Manufacturing Census and Fund staff calculations.**

**Table 6. Ratio of Survived Small Plants in Each Year of Plant's Creation (In percent)**

| Year | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1985 | 76 | 75 | 70 | 67 | 65 | 60 | 59 | 55 | 52 | 50 | 46 | 44 | 40 | 36 | 35 | 32 | 32 | 29 |
| 1986 | 70 | 68 | 64 | 60 | 57 | 51 | 50 | 46 | 43 | 41 | 37 | 35 | 32 | 29 | 28 | 25 | 25 | 23 |
| 1987 | 71 | 68 | 63 | 58 | 54 | 49 | 48 | 45 | 42 | 40 | 35 | 34 | 30 | 27 | 27 | 24 | 24 | 21 |
| 1988 | 68 | 69 | 60 | 54 | 54 | 45 | 46 | 41 | 38 | 37 | 32 | 31 | 27 | 24 | 23 | 21 | 21 | 19 |
| 1989 | 100 | 82 | 75 | 69 | 64 | 56 | 55 | 50 | 47 | 44 | 40 | 38 | 34 | 30 | 29 | 27 | 27 | 24 |
| 1990 | | 100 | 71 | 62 | 60 | 50 | 51 | 45 | 42 | 42 | 36 | 35 | 30 | 27 | 27 | 24 | 24 | 22 |
| 1991 | | | 100 | 81 | 73 | 64 | 62 | 58 | 53 | 50 | 45 | 42 | 38 | 34 | 33 | 30 | 30 | 27 |
| 1992 | | | | 100 | 77 | 67 | 65 | 60 | 55 | 51 | 46 | 43 | 39 | 35 | 34 | 31 | 31 | 28 |
| 1993 | | | | | 100 | 67 | 66 | 57 | 51 | 50 | 43 | 41 | 35 | 31 | 31 | 28 | 28 | 25 |
| 1994 | | | | | | 100 | 78 | 70 | 64 | 60 | 54 | 50 | 45 | 41 | 39 | 35 | 34 | 31 |
| 1995 | | | | | | | 100 | 72 | 65 | 61 | 52 | 49 | 43 | 38 | 37 | 33 | 33 | 30 |
| 1996 | | | | | | | | 100 | 80 | 71 | 64 | 60 | 53 | 47 | 45 | 41 | 40 | 36 |
| 1997 | | | | | | | | | 100 | 79 | 70 | 66 | 58 | 51 | 49 | 45 | 45 | 40 |
| 1998 | | | | | | | | | | 100 | 76 | 70 | 61 | 53 | 51 | 45 | 45 | 39 |
| 1999 | | | | | | | | | | | 100 | 73 | 63 | 53 | 51 | 45 | 45 | 39 |
| 2000 | | | | | | | | | | | | 100 | 62 | 52 | 52 | 43 | 46 | 38 |
| 2001 | | | | | | | | | | | | | 100 | 68 | 63 | 54 | 54 | 46 |
| 2002 | | | | | | | | | | | | | | 100 | 77 | 68 | 65 | 57 |
| 2003 | | | | | | | | | | | | | | | 100 | 62 | 62 | 48 |
| 2004 | | | | | | | | | | | | | | | | 100 | 82 | 71 |
| 2005 | | | | | | | | | | | | | | | | | 100 | 65 |
| 2006 | | | | | | | | | | | | | | | | | | 100 |

**Sources: Manufacturing Census and Fund staff calculations.**

**Table 7. Manufacturing Census Summary Statistics**

| Year | 1989 | 1997 | 2006 |
|---|---|---|---|
| Number of Plants | 421,757 | 373,713 | 258,232 |
| (+30) | 59,596 | 55,386 | 46,366 |
| (10-29) | 130,797 | 112,220 | 90,551 |
| (4-9) | 231,364 | 190,640 | 121,626 |
| Number of Workers | 10,942,142 | 9,937,330 | 8,225,442 |
| Plant Size | 26 | 28 | 32 |
| | [123] | [123] | [133] |
| Value added per worker | 644 | 749 | 857 |
| (10,000 yen) | [1820] | [1180] | [1630] |

[ ]: Standard Deviation

**Source: Manufacturing Census**

**Table 8. Summry of Main Dependent and Independent Variables**

| Period | 1989-90 | 1997-98 | 2005-06 |
|---|---|---|---|
| Employment growth | -0.002 | -0.032 | 0.004 |
| | [0.185] | [0.184] | [0.183] |
| Survival Rates | 0.957 | 0.927 | 0.895 |
| | [0.203] | [0.260] | [0.307] |
| **Year** | **1989** | **1997** | **2005** |
| LWPEN | 0.019 | 0.046 | 0.087 |
| | [0.032] | [0.046] | [0.140] |
| OTHPEN | 0.059 | 0.074 | 0.086 |
| | [0.071] | [0.082] | [0.108] |
| CHNPEN | 0.014 | 0.035 | 0.075 |
| | [0.026] | [0.065] | [0.130] |
| Other LWPEN | 0.005 | 0.010 | 0.013 |
| | [0.014] | [0.027] | [0.028] |

[ ]: Standard Deviation

**Source: Manufacturing Census**

**Table 9. Basic Regressions**

| Variable | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Employment Growth | | | Plant Survival | | |
| | OLS | IV | IV | OLS | IV | IV |
| LWPEN | -0.177*** | -0.281*** | | -0.191*** | -0.276*** | |
| | [0.003] | [0.007] | | [0.004] | [0.007] | |
| OTHPEN | 0.021*** | 0.007 | 0.026 | 0.051*** | -0.002 | 0.076*** |
| | [0.003] | [0.018] | [0.016] | [0.003] | [0.019] | [0.017] |
| CHNPEN | | | -0.246*** | | | -0.148*** |
| | | | [0.017] | | | [0.020] |
| Other LWPEN | | | -0.669*** | | | -1.700*** |
| | | | [0.139] | | | [0.162] |
| Log Employment | -0.327*** | -0.328*** | -0.328*** | 0.087*** | 0.086*** | 0.086*** |
| | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] | [0.001] |
| Plant age | -0.003*** | -0.003*** | -0.003*** | -0.013*** | -0.012*** | -0.012*** |
| | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| Observations | 4,174,814 | 4,174,814 | 4,174,814 | 4,645,983 | 4,645,983 | 4,645,983 |
| Plant Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Year Dummy | Yes | Yes | Yes | Yes | Yes | Yes |

**Source: Fund staff calculations**

**Table 10. Regressions over Extended Time Periods**

| Variable | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| | Employment Growth | | | | | Plant Survival | | | | |
| | 1-year | 2-year | 3-year | 4-year | 5-year | 1-year | 2-year | 3-year | 4-year | 5-year |
| LWPEN | -0.281*** | -0.411*** | -0.556*** | -0.767*** | -0.873*** | -0.276*** | -0.448*** | -0.613*** | -0.577*** | -0.684*** |
| | [0.007] | [0.010] | [0.015] | [0.023] | [0.036] | [0.007] | [0.012] | [0.017] | [0.016] | [0.019] |
| OTHPEN | 0.007 | 0.062** | 0.138*** | -0.130** | -0.761*** | -0.002 | 0.027 | 0.050 | 0.001 | -0.045 |
| | [0.018] | [0.028] | [0.040] | [0.059] | [0.118] | [0.019] | [0.032] | [0.045] | [0.047] | [0.060] |
| Log Employment | -0.328*** | -0.480*** | -0.604*** | -0.750*** | -0.871*** | 0.086*** | 0.134*** | 0.157*** | 0.174*** | 0.174*** |
| | [0.001] | [0.001] | [0.002] | [0.002] | [0.003] | [0.001] | [0.001] | [0.001] | [0.001] | [0.002] |
| Plant age | -0.003*** | -0.004*** | -0.005*** | -0.007*** | -0.007*** | -0.012*** | -0.019*** | -0.023*** | -0.023*** | -0.025*** |
| | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| Observations | 4,174,814 | 2,015,192 | 1,244,024 | 766,802 | 488,898 | 4,645,983 | 2,289,113 | 1,496,019 | 1,166,973 | 872,246 |
| Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year Dummy | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

**Source: Fund staff calculations**

**Table 11. Regressions by Plant Size**

| Variable | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Employment Growth | | | Plant Survival | | |
| | 4 - 9 | 10 - 29 | Above 30 | 4 - 9 | 10 - 29 | Above 30 |
| LWPEN | -0.187*** | -0.352*** | -0.367*** | -0.348*** | -0.212*** | -0.164*** |
| | [0.009] | [0.013] | [0.018] | [0.013] | [0.011] | [0.014] |
| OTHPEN | -0.005 | 0.058 | 0.086* | -0.131*** | -0.046 | -0.115*** |
| | [0.021] | [0.035] | [0.051] | [0.030] | [0.031] | [0.041] |
| Log Employment | -0.466*** | -0.326*** | -0.224*** | 0.159*** | 0.055*** | 0.051*** |
| | [0.001] | [0.002] | [0.002] | [0.001] | [0.001] | [0.001] |
| Plant age | -0.003*** | -0.003*** | -0.003*** | -0.018*** | -0.007*** | -0.004*** |
| | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| Observations | 2,112,880 | 1,332,210 | 686,360 | 2,458,910 | 1,419,395 | 718,077 |
| Plant Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Year Dummy | Yes | Yes | Yes | Yes | Yes | Yes |

**Source: Fund staff calculations**

**Table 12. Regressions of Employment Growth by Region**

| Variable | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Eight Regions | | | | | | | |
| | Hokkaido | Tohoku | Kanto | Chubu | Kinki | Chugoku | Shikoku | Kyushu |
| LWPEN | -0.020 | -0.330*** | -0.226*** | -0.357*** | -0.248*** | -0.304*** | -0.318*** | -0.457*** |
| | [0.058] | [0.023] | [0.011] | [0.016] | [0.013] | [0.025] | [0.033] | [0.032] |
| OTHPEN | -0.255** | 0.051 | -0.002 | 0.161*** | -0.070** | -0.054 | -0.228** | 0.122* |
| | [0.116] | [0.095] | [0.030] | [0.042] | [0.034] | [0.091] | [0.100] | [0.074] |
| Log Employment | -0.324*** | -0.300*** | -0.340*** | -0.310*** | -0.359*** | -0.306*** | -0.333*** | -0.324*** |
| | [0.006] | [0.003] | [0.002] | [0.002] | [0.002] | [0.004] | [0.005] | [0.003] |
| Plant age | -0.005*** | -0.003*** | -0.003*** | -0.002*** | -0.003*** | -0.003*** | -0.002*** | -0.003*** |
| | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| Observations | 99,583 | 287,143 | 1,182,595 | 1,097,497 | 850,668 | 231,318 | 128,695 | 297,315 |
| Plant Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year Dummy | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

**Source: Fund staff calculations**

**Table 13. Regressions of Plant Survival by Region**

| Variable | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | Eight Regions | | | | | | | |
| | Hokkaido | Tohoku | Kanto | Chubu | Kinki | Chugoku | Shikoku | Kyushu |
| LWPEN | -0.103* | -0.231*** | -0.238*** | -0.270*** | -0.349*** | -0.332*** | -0.336*** | -0.072** |
| | [0.056] | [0.025] | [0.014] | [0.017] | [0.016] | [0.028] | [0.035] | [0.029] |
| OTHPEN | -0.083 | -0.002 | 0.030 | -0.099** | 0.062* | -0.061 | -0.249** | -0.149** |
| | [0.117] | [0.094] | [0.034] | [0.046] | [0.036] | [0.090] | [0.101] | [0.071] |
| Log Employment | 0.086*** | 0.096*** | 0.090*** | 0.083*** | 0.077*** | 0.086*** | 0.091*** | 0.089*** |
| | [0.004] | [0.002] | [0.001] | [0.001] | [0.001] | [0.002] | [0.003] | [0.002] |
| Plant age | -0.012*** | -0.011*** | -0.014*** | -0.011*** | -0.013*** | -0.011*** | -0.011*** | -0.012*** |
| | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] | [0.000] |
| Observations | 109,219 | 315,044 | 1,325,497 | 1,206,882 | 963,727 | 255,097 | 142,604 | 327,913 |
| Plant Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year Dummy | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

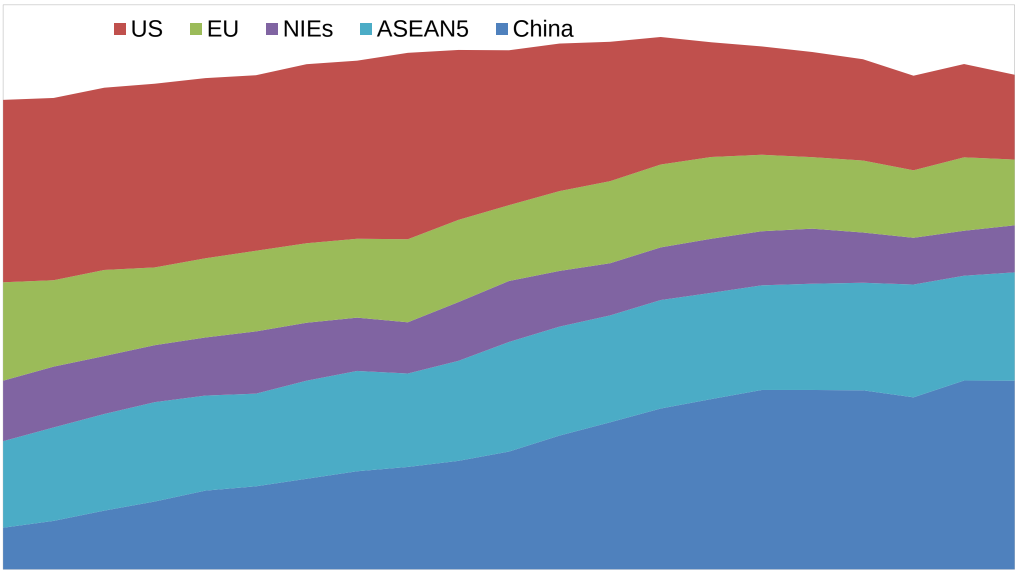
**Source: Fund staff calculations**

**Table 14. Regressions by Capital Intensity**

| Variable | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | Employment Growth | | | Plant Survival | | |
| | Low K/L | Mid K/L | High K/L | Low K/L | Mid K/L | High K/L |
| LWPEN | -0.248*** | -0.249*** | -0.892 | -0.258*** | -0.215*** | -2.165** |
| | [0.007] | [0.044] | [1.813] | [0.008] | [0.043] | [1.037] |
| OTHPEN | -0.422*** | 0.209*** | 0.617 | -0.349*** | 0.114*** | 3.322 |
| | [0.038] | [0.037] | [3.930] | [0.040] | [0.039] | [2.242] |
| Log Employment | -0.348*** | -0.319*** | -0.333*** | 0.091*** | 0.079*** | 0.086*** |
| | [0.001] | [0.002] | [0.005] | [0.001] | [0.001] | [0.004] |
| Plant age | -0.003*** | -0.003*** | -0.003 | -0.013*** | -0.009*** | -0.014*** |
| | [0.000] | [0.000] | [0.005] | [0.000] | [0.000] | [0.003] |
| Observations | 2,582,231 | 1,380,293 | 192,848 | 2,893,957 | 1,516,814 | 211,825 |
| Plant Fixed Effect | Yes | Yes | Yes | Yes | Yes | Yes |
| Year Dummy | Yes | Yes | Yes | Yes | Yes | Yes |

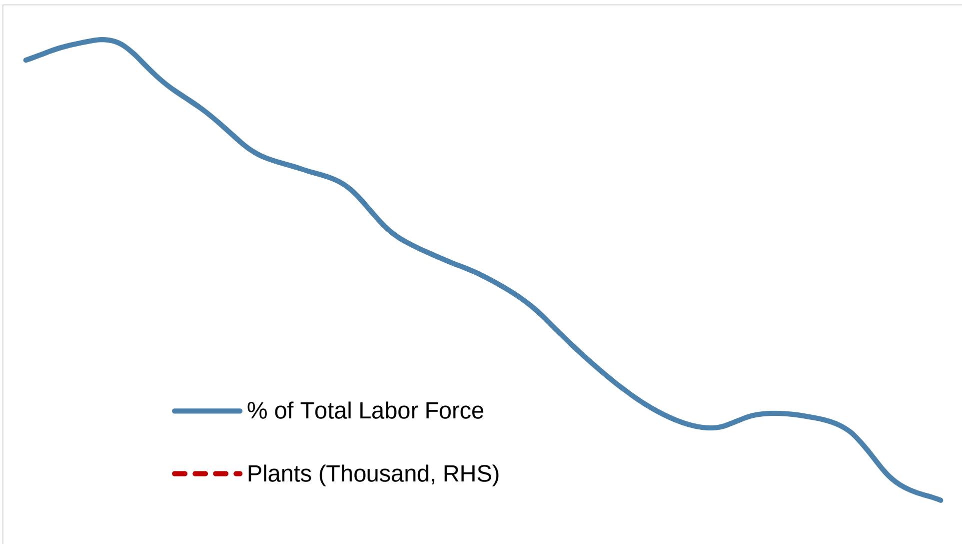
**Source: Fund staff calculations**

**Figure 1. Share of Import Trading Partners in Japan (ex. Middle East countries), 1990-2010**



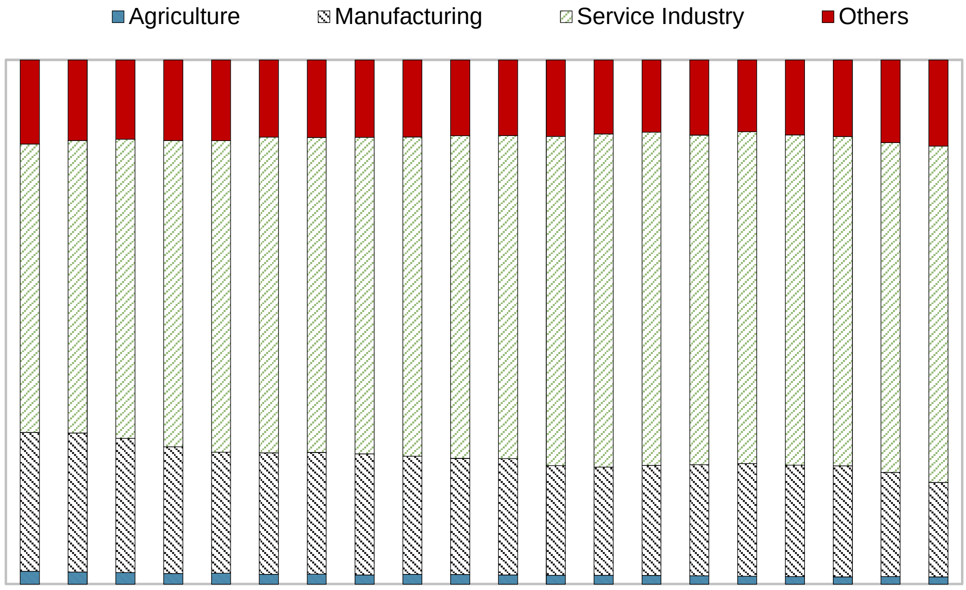

**Source: DOTS, and Fund staff calculations.**

**Figure 2. Share of Labor Force and the Number of Plants in Manufacturing, 1990-2010**



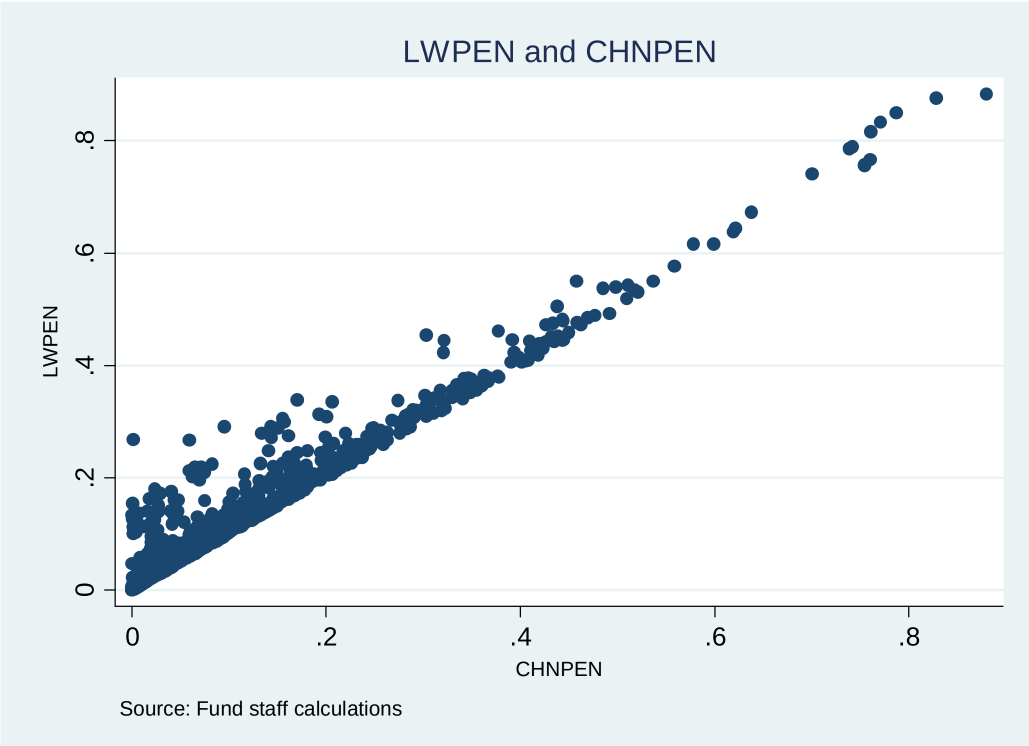

**Sources: Labor Force Survey and Manufacturing Census.**

**Figure 3. GDP by Industry, 1980-2009** (In percent)




**Sources: CEIC and Fund Staff Calculations.**

**Figure 4. LWPEN and CHNPEN, 1988-2008**



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