# ESSAYS ON THE IMPACT OF GLOBALIZATION ON LABOR MARKETS

By

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# Abstract

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My dissertation is motivated to illuminate the impact of globalization on the industry-level labor market outcomes. In particular, I focus on the industry-specific real effective exchange rate (REER) and vertical integration in East Asia, and their effects on Japanese manufacturing employment and wages. I also consider the role of international trade in the inter-industry wage differentials (IIWD) in U.S. manufacturing. The thesis consists of three essays.

The first essay examines how Japanese manufacturing industries with large stock of vertical foreign direct investment (VFDI) adjust employment and wages in response to the industry-specific REER. Using a panel of Japanese manufacturing industries for the years from 1988 to 2000, I find that an increase in the industry-specific REER is associated with a decrease in employment. Industries with larger amounts of VFDI in low income countries experience larger employment losses but those with larger amounts of VFDI in high income countries experience smaller reduction in employment. I also find

that real yen appreciation increases the wage gap between skilled and unskilled Japanese male workers.

The second essay investigates the determinants of vertical integration associated with the relation-specific investment (RSI). For high-skill industries, vertical integration increases where the contracting environment is not favorable. This would suggest that foreign affiliates are not necessarily responsible for production requiring the RSI and import skilled inputs from Japan. Therefore, the "demand crisis" facing keiretsu firms in Japan is not necessarily related to an expansion of vertical integration in those industries, but may be likely linked with outsourcing.

The third essay attempts to explain how international trade affects the U.S. manufacturing IIWD. Using the *Current Population Survey*, I find that net export influences the IIWD for some industries. The data show that there is a positive export-wage premium, and that workers switching from importing industries to exporting industries increase their wages. My switchers sample reveals that the unobserved ability hypothesis is preferred to the efficiency wage hypothesis. Thus, the IIWD should be partly explained by self-selection of industry switchers whose ability is not observed. An industry dynamics approach is also considered to explain how exporting industries pay higher wages.

To my mother and father who always encouraged me to obtain the highest degree

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I would like to express much gratitude to Distinguished Professor Michael Grossman and Professor Emerita Cordelia Reimers for being on my dissertation committee. Professor Grossman provided me with invaluable advice throughout my student life at the Graduate Center. His theoretical comments were so insightful that they required me to deepen my understanding of the original papers on which my study was heavily based. Professor Reimers gave me many helpful and very kind comments and suggestions on each chapter of my dissertation. Whenever I received comments from her, I realized that I had overlooked something important to think about, and immediately started considering it.

I would also like to thank Professor Thom Thurston for his kind support, and wonderful friends I met here in New York City, who encouraged me to pursue my goal.

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# INTRODUCTION

## Motivation, Scope of the Study, and Brief Summary

**Motivation of the study**

Today globalization is faced with a big challenge. More and more people begin to wonder about the benefits of globalization. This might reflect frustrations of the people who observe that the world standard of living does not necessarily improve, in spite of the widespread premise of free trade. Some would argue that globalization has made the poor poorer while benefiting only a disproportionately small number of wealthier people. Since the late 1990s many protests against the World Trade Organization (WTO) meetings or free trade itself have taken place in the world.[1] I think that one of the most important messages of the protests may be that there are winners and losers of free trade even within the OECD countries[2] and thus there is a possibility that globalization could be faced with strong challenges from inside the OECD countries. Therefore, I am very concerned about what is happening within those countries, especially in the U.S. and Japan.[3]

Apart from the validity of theoretical application to the real world without careful examination of the assumptions behind the model, too much emphasis on the negative aspect of globalization can be a potential of making the world worse off. There are economic benefits of globalization: expansion of markets, capital inflow and job creation by multinational corporations (MNCs), and knowledge and technological transfers. Therefore, I believe, as Stiglitz (2003) argues, a question to be asked is about how

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[1] Notably, Seattle in 1999, and Genoa in 2001.

[2] Organization for Economic Co-operation and Development (OECD). The member countries are usually considered as developed countries with high per capita gross domestic product (GDP).

[3] European Union nations are also of concern. In this thesis, however, I do not analyze labor impacts in those countries.

globalization goes on, but not about whether globalization itself is right or wrong.[4] Since the voice is much stronger from the people in situations allegedly deteriorated due to globalization, the benefits of globalization seem to be easily ignored in the debate. It would be a misfortune, however, if the potential benefits were eliminated by protectionist activities pressed too far. Thus, I come to have the feeling that under the on-going globalization debate, it is very important to balance the views about the benefits and problems of globalization. It is necessary to figure out who is winning and who is losing in order to make well-balanced policy decisions. These issues strongly motivated me to start writing this thesis.

Even if globalization harms some sectors of an economy, no country will go back to a completely closed society, like the Edo-era of Japan in the 17th, 18th, and first half of the 19th centuries. This is because some other sectors of the economy may still benefit from globalization. Imperialism or nationalistic responses, therefore, would not be realistic any longer. Instead, it is a capable government that is now required for each country, since such a government is supposed to properly sort out gainers and losers of globalization and to provide appropriate policy prescriptions so as to make the country as a whole better off. It is my greatest hope by writing this thesis to make a tiny contribution to the real world economic problems.

**Scope of the study**

Globalization is inherently a broad notion that covers many aspects of our social and economic life. Even within the economics discipline, a full range of globalization

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[4] Stiglitz (2003) criticizes the "market fundamentalism" overly emphasized in the international institutions, especially International Monetary Fund, The World Bank, and World Trade Organization.

issues should include not only free trade, but also foreign direct investment (FDI), immigration, and technological diffusion.[5] In this thesis, I limit the range of issues to those related to international trade and FDI. This is primarily because the commodity price effects of trade and FDI are very important when discussing free trade and globalization,[6] and also because trade and FDI models with immigration or technology would become more complicated.[7]

Labor impacts are of my greatest concern. International trade theory has implications about the impact of free trade on labor.[8] Moreover, changes in wages and employment are of interest to everyone. In this thesis, I would particularly argue whether the degree of trade and FDI matters in the exchange rate effects on employment and wages, and how international trade affects an inter-industry wage structure.

MNCs based in developed countries are the key players in economic integration.[9] Needless to say, it is a salient problem how both developed and developing countries can economically grow and achieve social stabilization and higher standards of living in the integrated world. However, I do not try to directly address this kind of question. I would rather argue on it, for example, in terms of how a home country of MNCs deals with a hollowing out effect of FDI so as to prevent unnecessary anti-globalization movements from happening inside the home country and to keep economic stimulation through trade

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[5] Freeman (1998).

[6] Williamson (2002).

[7] For example, for decomposition of factor price changes into globalization and technology, see Leamer (1998).

[8] For argument on factor content analysis for the impact of trade on labor, see Leamer (1994), Wood (1995), or Freeman (1998). For an essential discussion about trade and labor, see Freeman and Katz (1991), Borjas, Freeman, and Katz (1992), Lawrence and Slaughter (1993), Krugman and Lawrence (1994), Sachs and Shatz (1994, 1996), Rodrik (1997), Cline (1997), Feenstra (2001), Knetter (2002), for example.

[9] For economic integration and fragmentation by MNCs, see OECD (1996), Feenstra (1998), for example.

and FDI in the host country. Thus again, the economic impact of globalization on developed countries is my focus in this study.

The stock of foreign direct investment and the level of exports and imports vary across industries. To consider trade and FDI effects as one of the industry characteristics, industries attract a main focal point as an analytical unit. It would have been of interest to examine labor market effects of globalization on service industries. However, I emphasize the manufacturing industries, since they still show a lion's share of world trade and play a major part in foreign direct investment.

**Brief summary**

The thesis consists of three chapters. Studies on Japanese economic problems are included in the first two chapters, and study on the U.S. economic problem is included in the third chapter. Particular emphases are placed on vertical foreign direct investment and vertical integration, industry-specific real effective exchange rate, home employment and wage effects especially in terms of skill-intensity, and inter-industry wage differentials.

The first chapter examines how Japanese manufacturing industries with large stock of vertical foreign direct investment (VFDI) adjust employment and wages in response to the industry-specific real effective exchange rate (REER). Using a panel of Japanese manufacturing industries for the years from 1988 to 2000 by Ministry of Economy, Trade and Industry (METI), I find that an increase in the industry-specific REER is associated with a decrease in employment. Industries with larger amounts of VFDI in low income countries experience larger employment losses but those with larger amounts of VFDI in high income countries experience smaller reduction in employment. I also find that real yen appreciation increases the wage gap between skilled and unskilled male workers in Japan.

The second chapter investigates industrial differences in determinants of vertical integration in association with the degree of importance in the relation-specific investment (RSI). For high-skill industries, it is found that vertical integration increases where the contracting environment is not favorable. This would suggest that the foreign affiliates are not necessarily responsible for production that requires the RSI, and they are likely to import skilled inputs by keiretsu firms in Japan. Therefore, the "demand crisis" facing small and medium sized firms in keiretsu networks is not necessarily related to an expansion of vertical integration in these industries, but it seems that the problem could be more likely linked with outsourcing.

The third chapter attempts to explain how international trade affects the inter-industry wage differentials (IIWD) in U.S. manufacturing. Using the *Current Population Survey* (CPS) data, I find that net export influences the IIWD at least for a few industries. Moreover, the data shows that there is a positive export wage premium, and that those workers switching from importing industries to exporting industries increase their wages, while those switching from exporting to importing reduce their wages. Thus, the IIWD should be in part explained by self-selection of the industry switchers who may have higher or lower ability that is not observed. Based on my switchers sample, the unobserved ability versus efficiency wage hypotheses are tested, and I obtain the result that the unobserved ability hypothesis is in favor. An industry dynamics approach is also considered to explain how exporting industries pay higher wages.

# CHAPTER ONE

## Vertical FDI, Real Yen Exchange Rate, and Labor Market Adjustments in Japanese Manufacturing

## 1. Introduction

During the late 1980s and 1990s, Japan experienced substantial increase and decrease in the real effective exchange rate (REER). It has been argued that the impact of fluctuations in exchange rates may differ for industries with significant external exposures. It is the objective of this chapter to investigate the impact of changes in industry-specific REER on employment. I consider how the employment effects vary for industries with large amounts of vertical foreign direct investment (VFDI) in low skill and high skill labor abundant countries.

A distinct feature of my model can be seen in the connection between an increase in VFDI and appreciation of the industry-specific REER. The connection is made possible by considering reverse imports (or re-exports), which means parent firms' imports of finished goods produced by their foreign affiliates at lower costs. Since the imported goods are selling for cheaper prices at home, this price shock can be captured by the movement of the REER, particularly by the average foreign price index. Examining Ministry of Economy, Trade and Industry (METI) data for 9 Japanese manufacturing industries during the period between 1988 and 2000, I find that there is an increasing trend of reverse imports, and that there is a negative correlation between VFDI and average foreign prices.

To derive a labor demand function, I consider a monopolistically competitive firm faced with a global demand. The two countries in the VFDI economy, home and host, are presumed to have very different factor endowments. As factor-proportions theory of international trade suggests, free trade will not equalize factor prices, and thus, there is a reason for a home country based MNC to emerge (Helpman and Krugman (1985)). By assuming *asymmetric* cost for a monopolistic competition model (Dornbusch (1987)), I obtain an optimal labor demand as a negative function of the REER. Although pricing and the decision to invest are made by an individual firm, the REER is exogenous to each firm in my model, since VFDI made by many firms may collectively affect an industry price independently of individual firm's pricing. In econometric analysis, therefore, I would argue that if real appreciation of the industry-specific REER decreases employment, it could be partly a reflection of an increase in VFDI, or rise in reverse imports. This impact should be distinguished from the reduction in employment simply due to the rise in imports and/or decrease in import price caused by yen appreciation at least in two ways. First, reverse imports from low income countries will rise when VFDI increases, while imports from any countries could rise if the yen appreciates. Second, industries with large stock of VFDI can respond to the appreciation by expansion of foreign production, which may give rise to the direct substitution of certain types of labor between the home and host countries, and thus, this case may have stronger effects on domestic employment than when industries just increase imports.

Among the previous studies, Head and Ries (2002) use Japanese firm level data and find that parent firms increase demand for skilled workers at home as they expand operations in low income countries, but this effect diminishes as more FDI are made in high income countries. My study is different from theirs in the sense that based on investment in low or high income countries industry-wide employment effects are examined beyond the employment of parent firms. Dekle (1998) finds for Japanese manufacturing that there is sizable employment sensitivity in response to exchange rates but the degree of openness does not affect sensitivity. In contrast, I find that the degree of external exposure in terms of foreign production does affect the employment responsiveness to exchange rates. Moreover, the direction of the effects is opposite between VFDI in low income countries and VFDI in high income countries. The yen appreciation reduces domestic employment and this effect is accelerated by increasing VFDI in low income countries. However, it can be mitigated by increasing VFDI in high income countries. Since the VFDI effects are introduced as an interaction term in the estimation, the scale effects are not controlled for in the regression. When the yen appreciates, selling price abroad becomes higher, and so that, Japanese MNCs tend to expand foreign production to maintain offshore sales shares, thereby accelerating the pace of decreasing domestic employment that has already been sluggish because of the negative scale effect of the appreciation.

Once scale effects are controlled for in the estimation, VFDI in low income countries has a positive effect on domestic employment and VFDI in high income countries has a negative effect on that. This result is consistent with the prediction for skill intensity. Therefore, I next investigate whether VFDI differentially affects wages between skilled and unskilled depending on the degree of FDI in low/high income countries. Estimation results for male workers show that the real yen appreciation helps expand the wage gap and that this effect is accelerated by increasing VFDI in high income countries. However, growth of the wage gap can be restrained by VFDI raised in low income countries. A similar pattern of wage effects can be observed for female workers. Combined with employment results, it follows that the change in skill intensity by VFDI affects observed industry-wide labor movement in response to the REER.

The next section discusses literature on models of vertical FDI and exchange rate elasticity of labor. In Section 3, I develop a research framework with which one can capture VFDI in an industry-specific REER. Data and some descriptive findings are explained in Section 4. Section 5 deals with empirical analysis of the impact of the REER on employment. Section 6 argues implications for skill intensity by conducting wage analysis. Section 7 concludes.

## 2. Literature

Theoretical and empirical studies of the differential impacts of FDI on skilled and unskilled workers have been made in parallel with the conceptual development of vertical and horizontal FDI (Markusen (1995), Markusen and Maskus (1999), and Head and Ries (2002)). The concept of vertical FDI is overseas investment that relocates stages of production according to the direction of comparative advantage. Horizontal FDI has two types: replication and branching. Replication means overseas investment that replicates all production activities in foreign market, while branching means replication of production of a finished good only (Head and Ries (2002)).

Head and Ries consider that the effect of the vertical FDI on domestic skill intensity depends on the stage of production moved abroad and relative factor abundance between a host and home countries. Presumably, low income countries are relatively abundant in low-skilled workers and therefore low skill intensive activities are likely to move. On the other hand, MNCs leave at home such skill intensive part of production as R&D, design, and management. Hence, vertical FDI in low income countries increases demand for unskilled workers abroad, and increases demand for skilled workers at home.

Similarly, vertical FDI in high income countries may have an opposite implications: namely, increasing demand for skilled workers abroad and increasing demand for unskilled workers at home. In the case of replication of horizontal FDI, there would be no effects on domestic skill intensity when the investment is made independent of home production activity. If the overseas production displaces home exports, it may raise domestic skill intensity by reducing home operations when the investment is dependent on home output. This is suggested by the case of a knowledge capital model.[10] Branching always leads to domestic skill upgrading since home skill intensive activities are increasing as foreign demand for the inputs expands by branching. Therefore, if output is controlled for, replication will no longer affect the domestic skill-intensity, whereas branching will still raise the domestic skill-intensity.

Empirical studies on the relationship between affiliate's production and parent's employment are inconclusive for the U.S. 6 manufacturing industries as shown by Lipsey (1994). He finds that an increase in overseas net sales is correlated with parent employment, positively for some cases, but negatively for others.

Another stream of literature relevant to my study is on the industrial labor responsiveness to exchange rate fluctuations with the degree of openness to trade and imported input shares (Burgess and Knetter (1998), Campa and Goldberg (2001), Dekle (1998)). Research on the Japanese labor market with this emphasis, however, do not really obtain the conclusion that the higher degree of "external exposure" makes Japanese wage and employment adjustments more sensitive to yen movements. The main reasons

[10] As Head and Ries (2002) explain, in a knowledge capital model, demand for skilled workers will not increase as output expands since initial investment in knowledge capital contributes to further increase in output of knowledge: that is, the number of high skilled workers per unit of output is very close to zero. Therefore, when output decreases, demand for skilled workers can increase.

are summarized by the empirical fact of relatively stable gross trade shares and relatively lower proportion of the imported inputs to total imports (Campa and Goldberg (1997)[11]), or by such market structures, regulations, or implicit practices as bonuses and life-time employment systems that have made the labor market more rigid (Burgess and Knetter (1998), Dekle (1998)). The three channels, in which exchange rate affects domestic employment, are considered in Campa and Goldberg (2001): export orientation, import penetration, and dependence of imported intermediate inputs. Real appreciation weakens competitiveness of exporters and thus may restrain employment growth. For industries heavily dependent on imports, domestic currency depreciation slows down employment growth.

The exchange rate pass-through elasticity is also a related subject. Studies find that Japan and Germany do not perfectly pass-through exchange rate fluctuations on to their selling price and point to imperfectly competitive strategy by the firms (Mann (1986)). Even under home currency appreciation, those firms can keep prices from rising abroad by reducing the price-cost markups. Therefore, the literature suggests that Japanese firms have more often changed product prices rather than adjusted employment when yen appreciates.

## 3. The Model of Vertical FDI and Industry-Specific Real Effective Exchange Rate

*Definition and Interpretation of the Industry-Specific REER in the Context of VFDI*

The industry-specific REER for Japanese industry $i$ at time $t$, $Q_{it}$, is defined as

[11] They report that in 1993 (1995 for the U.S.), the import shares for four countries are: 16.3 for the U.S., 46.7 for Canada, 33.8 for the U.K., and 6.3 for Japan (all in percentages). The imported input shares are: 8.2 for the U.S., 20.2 for Canada, 21.7 for the U.K., and 4.1 for Japan (all in percentages).

$$Q_{it} = \frac{P_{it}^{JP}}{Z_{it}}, \quad Z_{it} = \sum_j \left[ s_{it}^j \cdot e_t^j \cdot P_{it}^j \right], \quad (1\text{-}1)$$

where $P_{it}^{JP}$ is the Japanese price level of industry $i$ at time $t$. $Z_{it}$ is the yen price level of industry $i$ in foreign countries at time $t$, which is weighted over the bilateral nominal exchange rates times foreign price levels with $s_{it}^j$ as an export weight of country $j$ in industry $i$ at time $t$. $e_t^j$ is a bilateral nominal exchange rate (yen per country $j$'s currency) at time $t$, and $P_{it}^j$ is an industry $i$'s price level in country $j$ at time $t$. The weights are time-varying export shares.[12] For convenience, the direction of value and the direction of magnitude are the same in this definition of $Q_{it}$.

For a bilateral relationship between Japan and country $j$ in industry $i$, one can rewrite the above equation to a difference form in a log: $dq_i^j = dp_i^{JP} - ds_i^j - de^j - dp_i^j$, where $d$ is a first-difference operator (in discrete time), and lower case variables represent the logarithm of the corresponding upper case variables. Based on this, all else being equal, a decrease in foreign price ($dp_i^j < 0$) gives rise to the real yen appreciation ($dq_i^j > 0$) in industry $i$. Recall that VFDI is an activity involved in transactions with lower income countries. It follows that the foreign price index ($Z_{it}$) of industries significantly carrying out VFDI is relatively lower than the domestic price in equation (1-1). Hence, one can predict a negative correlation between VFDI and average foreign

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[12] The country $j$'s export weight is defined as the Japanese exports to country $j$ out of its total exports to the 17 countries within industry $i$: that is, $s_{it}^j = Exports_{it}^{JP,j} \Big/ \sum_k Exports_{it}^{JP,k}$, where $Exports_{it}^{JP,j}$ represents Japan's industry $i$'s exports to country $j$. In my context, however, import shares are also important for the weight. Fixed-year weights are also used in the empirical section. It turns out, however, that the weighting system does not change estimation results very much. See Section 6, and Tables 1-7a, b, and c.

price. In other words, it should be likely that industries with a plenty of VFDI experience encounter real appreciation of their industry-specific REER.

*Global Demand*[13]

Consider a global demand function facing monopolistically competitive firms in an international trade economy when production costs are significantly different between countries and markets are separated (Dornbusch (1987)). It is assumed that there are n firms in the home country and m firms in the foreign country. Suppose that foreign wage costs are lower than domestic wage costs ($w > ew^*$).[14] Assuming that all firms in both domestic and foreign countries follow the same markup-cost pricing, one can obtain the higher average price of a product in the domestic than in the foreign country: $n^{-1}\sum_i p_i > m^{-1}\sum_j p_j^* \Rightarrow \overline{P} > \overline{P^*}$, $p_i = \pi w, and\ p_j^* = \pi e w^*$, and $\pi$ is the price-cost markup ratio. For convenience, I assume that the foreign wages can be perceived to be lower than the domestic wages without converting into the same currency. Instead, the foreign product price is converted into home currency. Therefore,

$$\overline{P} > e\overline{P^*}. \quad (1\text{-}2)$$

This price relationship describes a vertically integrated economy, where home-country-based multinational corporations seek the cost advantage and relocate labor intensive stage of production to the foreign country. Firms at home may produce some

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[13] Much of the discussion in this section and next one are greatly owing to the comments by Professor Michael Grossman.

[14] An asterisk denotes the variable associated with the foreign country, and $e$ shows home currency units per foreign currency.

varieties while foreign firms will produce more varieties, since home firms have comparative advantage in *headquarter services* rather than in manufacturing finished products (Helpman and Krugman (1985)).[15]

Since the inequality (1-2) suggests that the product prices produced by monopolistically competitive firms are separable between home and foreign markets, one can rewrite a Dixit and Stiglitz (1977) type demand function as follows.

$$x_i = v\left(\frac{P}{p_i}\right)^{\varepsilon} = v\left(\frac{\overline{P} \cdot e\overline{P^*}}{p_i}\right)^{\varepsilon}.$$

A particular variety domestically produced would be valued differently when it is selling in the foreign market. Thus, I specify the demand function by

$$x_i = v\left(\frac{\overline{P}}{p_i}\right)^{\eta}\left(\frac{e\overline{P^*}}{p_i}\right)^{\sigma},$$

$$\text{where } \eta + \sigma = \varepsilon = \frac{1}{1-\rho} > 1,\ \eta > 0,\ \sigma > 0, \text{ and } 0 < \rho < 1. \quad \text{(1-3)}$$

The variable $x_i$ is the world-wide residual demand for variety $i$. $P$ is the utility-based price index of the product, and $v$ is the utility-based quantity index of the product. $\overline{P}$ and $\overline{P^*}$ are the average prices of varieties within the same product in the home country and in the foreign country, respectively. $e$ is the exchange rate. $\varepsilon$ is the price elasticity of demand for variety $i$ relative to the average product price in an absolute term, and $\rho$ is the substitution parameter. $\eta$ and $\sigma$ are parts of the elasticity of demand ( $\varepsilon$ ),

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[15] The law of one price (LOP) may be unlikely to hold because of the cost differences rather than differences in bundle of varieties. The original monopolistic competition model suggests that even if commodity bundles are different between countries, the LOP should hold for an aggregate level due to the symmetric assumption.

representing the elasticity of relative price of the variety to the domestic average product price and to the foreign average product price in an absolute term.

Multiplying both sides of equation (1-3) by $\left(p_i / \overline{P}\right)^{\sigma}$, the following relation is obtained.

$$x_i = v\left(\frac{\overline{P}}{p_i}\right)^{\varepsilon}\left(\frac{e \cdot \overline{P^*}}{\overline{P}}\right)^{\sigma} = v\left(\frac{\overline{P}}{p_i}\right)^{\varepsilon}\left(\frac{1}{Q}\right)^{\sigma}. \quad (1\text{-}4)$$

Equation (1-4) now represents the global demand for variety $i$ as a function of the relative price to domestic average price and of the real effective exchange rate ($Q$). Thus, $\sigma$ can be interpreted as the elasticity of demand with respect to the REER.

*The Simple Labor Adjustment Model*

It is assumed that there are many firms in industry $i$ in both domestic and foreign markets, who can differentiate their own varieties but cannot influence the average price. Based on equation (1-4), a representative Japanese firm $k$ is assumed to be faced with the following global demand function,[16]

$$x_{kt}^D = \mathrm{B}_t\left(\frac{p_{kt}}{P_{it}^{JP}}\right)^{-\varepsilon} Q_{it}^{-\sigma}, \; k \in i, \; \varepsilon > 1, \text{ and } \sigma > 0, \quad (1\text{-}5)$$

where $x_{kt}^D$ is the worldwide residual demand facing the firm $k$ at time $t$, $\mathrm{B}_t$ is a time-variant demand shifter common to all industries,[17] $p_{kt}$ is the price of variety $k$ and $p_{it}^{JP}$

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[16] The Dekle's (1998) specification does not include the first term of the right-hand side in equation (1-5) because of the symmetric assumption. Aizenman (1988) introduces a specification of the demand function similar to equation (1-3) by invoking the law of one price (LOP).

[17] The term corresponds to the utility-based quantity index, $v$, in equation (1-3) or (1-4).

is the average price of varieties of the product (industry) $i$ in Japan, and $\varepsilon$ and $\sigma$ are the elasticities as defined earlier.

The firm in the monopolistically competitive industry sets its own price and must sell part of the output in foreign markets. It produces a variety with the following Cobb-Douglas production technology. (The industry subscript is suppressed.)

$$x_{kt} = A_k L_{kt}^{\alpha} K_{kt}^{1-\alpha}, \quad (1\text{-}6)$$

where $x_{kt}$ is the firm $k$'s output at time $t$, $A_k$ is the firm-specific technological factor, $L_{kt}$ is $k$'s labor input, $K_{kt}$ is the capital input, and $\alpha$ is the labor share of income distribution. It is assumed that each firm can access this production technology without any cost and produce its own brand. The equation exhibiting the constant returns to scale does not seem to represent any advantage in investing abroad. However, the technological parameter $A_k$, in part, captures firm-specific factors, which are considered as intangible assets, or "knowledge capital", but give the firm productive advantage over other firms, and so that the term can be the source of economies of scale (Markusen and Maskus (1999)).

Firm $k$ has a market power on its own brand and charge the same price, $p_{kt}$, both in domestic and foreign markets. Therefore, its maximization problem becomes,

$$\Pi_{kt} = p_{kt} x_{kt} - (w_{it} L_{kt} + r_t K_{kt}), \quad (1\text{-}7)$$

where $w_{it}$ is the industry-specific wage rate, and $r_t$ is the economy-wide capital price.[18,19]

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[18] This can be justified by considering the case where the low of one price (LOP) holds for the variety $k$ between the countries. The profit function can be written as $\Pi_{kt} = p_{kt} x_{kt}^{d} + e \cdot p_{kt}^{*} x_{kt}^{*} - (w_{it} L_{kt} + r_t K_{kt})$,

The derived labor demand ($\ln L_{kt}^{*}$) for firm $k$ is a function of $w_{it}$, $r_t$, $A_k$, $B_t$, $P_{it}^{JP}$, and $Q_{it}$ in a log.

$$\ln L_{kt}^{*} = \xi \ln w_{it} + \phi \ln r_t + (\varepsilon - 1)\ln A_k + \ln B_t + \varepsilon \ln P_i^{JP} - \sigma \ln Q_{it} + \nu ,$$

where $\varepsilon - 1 > 0$, $\sigma > 0$, $1 > \alpha > 0$, $\xi = (1-\varepsilon)\alpha - 1 < 0$, $\phi = (\alpha - 1)(\varepsilon - 1) < 0$,

$$\text{and } \nu = \ln[\frac{\alpha^{\alpha\varepsilon - \alpha + 1}}{(1-\alpha)^{\alpha\varepsilon - \alpha + 1 - \varepsilon}}]. \quad (1\text{-}8)$$

The optimal labor demand is negatively affected by wage rate and capital price, suggesting that labor and capital are complementary in production. The domestic average price, $P_{it}^{JP}$, is positively related to labor demand. The price of a variety produced by the firm becomes relatively lower as the industry average price rises, and thus, the firm's output demand expands, causing labor inputs to increase. The real appreciation, on the contrary, decreases domestic employment, since domestic product becomes relatively more expensive, the world demand will shift away from the domestic varieties to foreign varieties.

In my model, the real exchange rate ($Q_{it}$) is exogenously given to each firm.[20] Whenever the exchange rate changes, firm's optimal labor demand also changes. In the short run, however, there is a discrepancy between a new optimal labor demand and

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where $x_{kt}^{d}$ is the domestic demand and $x_{kt}^{*}$ is the foreign demand, $e$ is the exchange rate in terms of domestic currency, and $p_{kt}^{*}$ is the price of the variety in the foreign market. But, since $x_{kt} = x_{kt}^{d} + x_{kt}^{*}$ and if LOP holds for the variety, $p_{kt}/e = p_{kt}^{*}$, then I can rewrite $p_{kt}x_{kt}^{d} + e \cdot p_{kt}^{*}x_{kt}^{*} = p_{kt}x_{kt}$.

[19] I consider from the producers' viewpoint that wages are industry-specific costs.

[20] Dekle (1998) points out that the real exchange rate is endogenous since the representative firm in the monopolistically competitive industry sets domestic price. However, it is the price of the variety produced by the particular firm that it determines, and the firm takes the aggregate price as given in the model. Thus, the domestic price is not really endogenous, nor is the real exchange rate.

actual employment. Because of the existence of adjustment costs, a firm can adjust only part of the discrepancy during a particular period of time. I assume that this partial adjustment path to the optimal labor demand is described in the following way. The operator $d$ takes a first difference of a variable (in discrete time).[21]

$$d \ln L_{kt} = \lambda(\ln L_{kt}^{*} - \ln L_{k,t-1}), \ \lambda \in (0, 1). \quad (1\text{-}9)$$

The adjustment parameter, $\lambda$, captures the proportion of the discrepancy that is adjusted from $t-1$ to $t$. Plugging (1-8) into (1-9), I obtain the labor adjustment function in the presence of adjustment costs.

$$\begin{aligned} d \ln L_{kt} &= \lambda v - \lambda \ln L_{k,t-1} + \lambda \xi \ln w_{it} + \lambda \phi \ln r_t + \lambda(\varepsilon - 1) \ln \mathrm{A}_k \\ &+ \lambda \ln \mathrm{B}_t + \lambda \varepsilon \ln P_{it}^{JP} - \lambda \sigma \ln Q_{it} \end{aligned} . \quad (1\text{-}10)$$

## 4. Data Source and Observation

*Data Sources*

The data set consists of a panel of 10 manufacturing industries times 5 years: 1988, 1991, 1994, 1997, and 2000.[22] Wages and employment data are obtained from *Basic Survey on Wage Structure* by Ministry of Health, Labor and Welfare (MHLW), Japan. These are survey data on full-time workers for firms with 10 or more employees. Employment is the industry total "number of employees" ages 25 to 64. Wages are the

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[21] Hamermesh (1993). The main sources of the adjustment costs are the hiring and firing costs. I do not allow the second period lag for employment in this specification.

[22] The 10 industries are: Food, Textiles, Chemicals, Iron and Steel, Non-ferrous metals, Metal products, Machinery, Electrical machinery, Transportation equipments, and Precision instruments.

"scheduled cash earnings", the industry average per man-hour for workers ages 25 to 64.[23]

To construct the industry-specific REER, 17 countries' nominal effective bilateral exchange rates are collected from the International Monetary Fund, *International Financial Statistics* (IFS), and industry GDP deflators are obtained from the OECD Structural Analysis (STAN) database.[24] For those countries whose sectoral deflators are not available, I use the aggregate GDP deflators from the IFS. Manufacturing exports by-industry-by-country are collected from *Summary Report on Trade of Japan*, by the Japan Tariff Association. The data on foreign direct investment comes from the Ministry of Economy, Trade and Industry (METI), Japan, *Survey of Overseas Business Activities*. There are 10 manufacturing industries available by the METI, but one of them is not classified in the MHLW data. This gives rise to elimination of one industry in estimation.[25]

*Increasing Trend of Reverse Imports, and Employment and Wage Growth*

Table 1-1 shows the ratio of exports to Japan relative to total sales for affiliates located in Asia, based on the METI data from 1988 to 2000. There are variations across

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[23] This wage rate does not include either bonus or overtime work compensation. Such wages should reveal the longer-run effect of an exogenous shock, since negative effects of temporary shocks have been often absorbed by changing bonuses in Japanese firms.

[24] Those 17 countries (areas) are: The U.S., Canada, Australia, China, Hong Kong, Korea, Taiwan, Singapore, Indonesia, Malaysia, The Philippines, Thailand, The U.K., France, Germany, Italy, and The Netherlands. The shares of exports to 17 countries out of total Japanese exports to the world account for 80 to 90% for each industry-year pair. See Appendix Table 1-1. Some of the data for Taiwan are from *Key Economic Indicators*, Asian Development Bank.

[25] The METI data does not include metal products industry. Although both METI and MHLW include wood and pulp industry, export data are not available in the Japan Tariff Association data. Thus, the REER cannot be calculated for the wood and pulp industry, either. Accordingly, my data set consists of 9 industries in the estimation.

industries and over time, but it is noticeable that in recent years the ratio is generally high. In 2000, the manufacturing average reaches 24.7%, an increase from 8.9% in 1988. Many industries experienced drastic increases in the late 1990s.

Table 1-2 summarizes industrial employment and real wage growth of Japanese manufacturing during the same period, based on the MHLW data. It shows that 9 out of 10 industries experienced declining employment and there are also large sectoral variations. Only food industry increased employment from 1988 to 2000. Textiles and iron and steel industries were hit by severe job decreases (-43.7%, and -37.1%, respectively), and their declining tendency had already started during the period, 1988-1997, when other industries rather increased employment. Turning to the wage growth, it is found that all of the 10 industries experienced real wage increase in this period. There are large variations across sectors. Workers in electrical machinery experienced a wage increase of 179.1%, while workers in transportation equipment gained only 15.1%.[26] Large part of the wage increase had been obtained before 1997. However, more than half of the industries actually decreased real wages between 1997 and 2000. The non-ferrous metal industry was struck by a large decrease in real wage (-9.3%).

Although the long-standing sluggish economic conditions had severely affected all industries in this decade, combined with the industrial variations of reverse imports, the significant sectoral differences in both real wage and employment growth may suggest

[26] In Table 1-2, The real wage growth is calculated by using sectoral GDP deflators rather than an aggregate GDP deflator (or CPI, Consumer Price Index). This is because of representing the production cost differentials across industries from the firms' perspective. In addition, GDP deflators should be a better measure than the CPI, since it is free from the double counting problem. The extremely high growth rate of wages in the electrical machinery industry is due to the drastic decline in the industry price level measured by the industry GDP deflator. The real wage growth rate is 24.4 percent for the industry when the aggregate CPI is used (see Appendix Table 1-4).

that industry specific factors play an important role in their own wage and employment determinations.

*The Industry-Specific REER and VFDI*

Since the OECD STAN database allows researchers to use manufacturing industry GDP deflators only for 8 countries including Japan.[27] For the other countries, I use the aggregate GDP deflators. For this reason, there may be a possible bias in the calculated REERs, depending on whether or not a country has a comparative advantage in a particular industry over Japan. For example, according to the observed labor and capital endowment differentials between China and Japan, China should have a comparative advantage in labor-intensive textile industry over Japan, and it is followed by the premise that the price level of textile industry is supposed to be relatively lower than the aggregate price level in China. Therefore, using the aggregate price index instead of textile price index would give rise to undervaluation of the textile-industry REER. In my sample, however, most of the countries, for which aggregate deflators are used, are the countries with lower per capita GDP than Japan. Thus, the REER may systematically be undervalued across industries.

Table 1-3 presents changes in the industry-specific REERs during the period between 1988 and 2000. It shows that just a half of the industries experienced real appreciation and the other half experienced real depreciation. The faster appreciation industries are non-electrical machinery and textiles (77.5% and 53.7%, respectively). On the other hand, chemicals and electrical machinery industries are the faster depreciation

[27] The other seven countries are the U.S., Canada, Korea, the U.K., France, Germany, and Italy. In some cases, sectoral GDP is not available for year 2000. I used percentage changes in aggregate GDP deflators to extend sectoral GDP deflators from year 1997 to 2000.

industries (-37.8% and -26.2%, respectively). Before 1997, only 4 industries were faced with real appreciation, whereas after that year, 8 industries were faced with real appreciation. The Asian currency crises may have affected the REER strongly, due to the huge currency devaluations of those crisis-hit-countries but also by changes in industry prices and trade patterns.

The coefficient of variation (c.v.) of the table suggests that there is a large variation of REER movements across industries. Machinery industry has the largest variation over the 12 years, while transport equipment industry has the smallest. The figures of the coefficient of correlation with the nominal U.S. dollar-yen exchange rate reveal that the industry-specific REERs for the real appreciation industries show relatively higher correlations with the nominal rate, while those of the real depreciation industries show relatively lower correlations with the nominal rate.

Figure 1-1 plots the measure of vertical FDI together with the foreign price index ($Z$) for five selected industries. The VFDI measure is calculated by the employment ratio of affiliates located in low income countries relative to the total industry employment in Japan. I include China, Indonesia, Malaysia, The Philippines, and Thailand in the low income country group.[28] Higher ratio of the measure for a particular industry would mean that vertical FDI in low income countries is relatively more important than the other types of FDI for that industry. As the model predicts, foreign prices are going down as vertical FDI in low income countries become increasingly more important. This would suggest that MNCs' foreign production activities influence real exchange rate, and thereby

[28] Fukao (2002) reports that there are industry studies presenting that part of negative effects on domestic employment of export-oriented FDI has been canceled out by positive effects of market-oriented FDI in Asia. I consider, however, the share of market oriented FDI in those countries is still low, especially compared with Japanese FDI in North America and Europe.

affecting domestic industry-wide labor market as well, but most notably, this is the impact beyond the parent companies.

## 5. Vertical FDI and Impact of Real Exchange Rate Fluctuations on Employment

*Empirical Specifications*

This study deals with industry data, and thus, equation (1-10) is not directly estimated. As a proxy for demand shifter $B_t$, I use an industry-specific real GDP. This variable may also capture other sector-specific shocks, particularly technological progress of production function ($A_k$) when it is common to all firms within an industry. Capital costs are time-varying but common to all industries. I use year dummies to control for them together with other time-specific shocks, for instance, world-wide energy price changes.

To investigate the role of vertical FDI, I introduce an interaction term of the exchange rate and the VFDI measure.[29]

The final estimation equation becomes,

$$d\ln L_{it} = \alpha_0 + \alpha_1 \ln L_{i,t-1} + \alpha_2 \ln w_{it} + \alpha_3 \ln GDP_{it}$$

$$+ \alpha_4 \ln ER_{it} + \alpha_5 \ln ER_{it} * VFDI_{it} + \sum_{l=6}^{l=9} \alpha_l YD_t + \omega_{it}. \quad (1\text{-}11)$$

Parameter estimates are denoted by $\alpha's$. Expected signs are: $\alpha_1 = -\lambda < 0$, $\alpha_2 = \lambda\xi < 0$, $\alpha_3 = \lambda > 0$, and $\alpha_4 = -\lambda\sigma < 0$. For $\alpha_5$, the sign is not certain since industry total

[29] Formal derivation of interaction terms are in Campa and Goldberg (2001). Dekle (1998) multiplies optimal labor demand by openness index so that he has more than one interaction terms in the estimation. However, with export-production or import-penetration ratios for 1993 as a measure of industry's openness to trade, the estimates of the interaction terms are not statistically significant, particularly of the term interacted with foreign prices ($Z_{it}$). Dekle points to the importance of institutional aspects, such as implicit long-term employment practices.

employment are the mixture of both parent firms' workers and non-MNCs' workers, and also by consisting of both skilled and unskilled workers. $VFDI_{it}$ is some measure of the degree of vertical FDI in industry $i$ year $t$, and $YD_t$ is a year dummy in $t$. $\omega_{it}$ is a well-behaved error term. The coefficient $\alpha_1$ is one of the concerned parameters. It shows how fast/slowly Japanese industries adjust employment. The coefficients $\alpha_4$ and $\alpha_5$ are the main parameters. Real appreciation decreases industry-wide employment. This relationship tells a story that as MNCs are increasingly involved in vertical FDI in low income countries, reverse imports surge. Real exchange rate, therefore, likely appreciates, and then, the real appreciation tends to contract industrial-wide employment at home. The sign of the coefficient of the interaction term ($\alpha_5$) is thus important. If it is negative, the negative effect of yen appreciation will be accelerated by vertical FDI, while if it is positive, the negative effect of yen appreciation will be mitigated by vertical FDI. I would argue on this by the types of VFDI: namely, vertical FDI in low income countries (LFDI), and vertical FDI in high income countries (HFDI).

*Estimation Results*

Table 1-4a presents the OLS estimation results of equation (1-11) (with time subscript suppressed).[30] The data set is a panel of 9 industries times 4 years (1991, 1994, 1997, and 2000). The first column shows the estimation results without a VFDI interaction term. The coefficient of the lagged employment is negative and statistically

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[30] Previous studies use non-linear least squares (NLS) method instead of OLS to estimate the equation since the adjustment parameter, $\lambda$, is included as a multiplicative form with the other independent variables (Dekle (1998), Burgess and Knetter (1998)). In this study, however, I estimate it by OLS. This is mainly because of the limited sample size. I have attempted the NLS estimation for an original model with sample size of 30, but the results are highly sensitive to initial numbers given to the parameters. Thus, I report the OLS estimation results only.

significant. Estimated adjustment parameter is 0.158, which suggests that the speed of employment adjustment in Japanese manufacturing is relatively slow but in the similar range obtained by Dekle (1998). Estimate for wages is negative, but not significant. Sectoral GDP positively affects industrial employment and the estimate is statistically significant. As expected, the industry-specific real effective exchange rate negatively affects industrial employment and the estimate is statistically significant. The raw estimate is -0.126, and so the exchange rate elasticity of employment becomes -0.797. This result reconfirms the idea that the yen appreciation has negative scale effect on Japanese manufacturing labor. It would also imply that the more the industry engages in VFDI, the higher the industry-specific REER is. Hence, the exchange rate changes due to the MNCs' global activities may have broader impact on the domestic industry-wide employment beyond the MNCs' parent workers.

Direct effects of VFDI on the employment are examined in the following columns. In model (2), VFDI is measured by the ratio of affiliates' employment in low income countries relative to total affiliates' employment abroad (LFDI). Estimate of the interaction term is negative and statistically significant. It is implied that the negative effect of real yen appreciation on Japanese labor is deteriorated by increasing VFDI in low income countries. Model (4) includes the interaction term defined by the ratio of affiliates' employment in high income countries relative to overseas total affiliates' employment (HFDI). I include the U.S. and European Union nations in the high income country group. Appendix Table 1-2 shows the total numbers of affiliates' employment in low income countries (LICs), high income countries (HICs), and all regions in 2000.

Surprisingly, the estimate is now positive, but not significant. Increase in VFDI in high income countries rather helps counteract the negative effect of the yen appreciation.

If it is the fact that Japanese manufacturing has been increasing skilled workers at home as a result of expansion of foreign production in Asia, one may see the above results as describing an opposite picture to the theoretical prediction, in which VFDI in low income countries raises domestic skill-intensity whereas VFDI in high income countries lowers domestic skill-intensity. It should be noted, however, that what the interaction term captures is the VFDI effect without output fixed. The yen appreciation induces MNCs to increase overseas production, and this accelerates the pace of decreasing employment that has already been sluggish by the reduction of exports. Even if the demand for skilled workers increased, it may not be fast enough to offset the decease in the demand for unskilled workers assuming that demand for unskilled is more sensitive with respect to output since the proportion of the unskilled in total labor force in Japanese manufacturing is still far larger than that of the skilled (See Appendix Table 1-3 for the skill-intensity of Japanese manufacturing). On the contrary, if MNCs expand operations in high income countries under the yen appreciation, then the demand for unskilled workers would increase in Japan, and this is likely to offset the decrease in skilled workers because of the difference in responsiveness.

In models (3) and (5), the VFDI impacts on industry-wide employment are examined with output being fixed (that is, by controlling for industry-specific REER in the estimation).[31] Now, LFDI has a positive and statistically significant estimate while HFDI has a negative but insignificant estimate. Once scale effect is controlled for, an increase in VFDI in low income countries contributes to an increase in industry-wide

[31] Output change due to the industry-specific REER is controlled for.

employment. In contrast, an increase in VFDI in high income countries has no effect on industry-wide employment. The industry-wide employment effect is a result of the rise in skilled demand exceeding the decrease in unskilled demand in the case of VFDI in low income countries. This suggests that MNCs' foreign operations may have a spill-over employment effect, which influences well beyond the MNCs boundary.

Models (6) through (9) reproduce models (2) through (5) changing the definition of VFDI. It is defined as the total sales ratio of affiliates located in Asia relative to all affiliates' total sales abroad (ATSALES) in the case of VFDI in low income countries. It is the total sales ratio of affiliates located in the U.S. and EU nations relative to all affiliates' total sales abroad (HTSALES) in the case of VFDI in high income countries. Since the sales data are not available for China in some years, I use Asia as a low income country group. This is a broader group than before in the sense of including NIEs countries, especially. Estimates are tracing the similar patterns to those of the previous models, and all VFDI terms, with and without interacting, are statistically significant. The fact that the VFDI measured by the affiliates sales share in high income countries significantly affects Japanese employment would imply that labor required in affiliates production may be substituted for domestic labor.

In section 4, the industry-specific real wages of the electrical machinery industry showed far larger growth rate than those of any other industries. This is due to the drastic decline of sectoral GDP deflator of the industry, and thus, if an aggregate CPI is used instead, the growth rate falls in a moderate range. Accordingly, there may be a bias in the estimation because of some outliers in the data. Table 1-4b reports the results of the electrical machinery industry bias captured by the industry dummy. For all of the models, the dummy for electrical machinery is not statistically significant. Estimates, significance, and sign patterns are all very close to the results without the dummy variable. Thus, even though the real wage growth in the electrical machinery industry is so drastic, the real wages do not affect the estimation results obtained by the previous regressions. This result is also consistent with the fact that the correlation coefficient between the real wages deflated by the sectoral GDP and either the nominal wages or the real wages deflated by the aggregate CPI is very high for the industry as can be seen in Appendix Table 1-4.

## 6. Vertical FDI and Impact of Real Exchange Rate Fluctuations on Wages

The last section has suggested that once output effect is controlled for, employment effects of VFDI in low income countries and VFDI in high income countries appear to follow the theoretical prediction for skill-intensity. In this section, therefore, I would investigate this point by conducting wage analysis by-gender-by skill.[32]

*Analytical Framework*

To the extent that VFDI is negatively correlated with foreign price index, those industries, where VFDI is significant, are considered to have the Stolper-Samuelson (S-S) type effects on skilled and unskilled workers.[33] Suppose that a home country is skilled labor abundant while a foreign country is unskilled labor abundant. Under the

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[32] In the literature, wage impacts have been discussed in terms of trade versus technological progress. (Leamer (1998)). Although I know the importance of the technological factor, I do not consider it in this study to keep my analytical framework simple.

[33] See Appendix Table 1-3 for the changes in skill-intensity for Japanese manufacturing.

assumptions for the usual Heckscher-Ohlin model satisfied,[34] the S-S theorem can predict that due to the lower price of reverse imports as a result of an increase in VFDI, domestic skilled workers increase wages whereas domestic unskilled workers decrease wages. Then, it follows that real appreciation of the industry-specific REER should be associated with larger difference in wages between skilled and unskilled workers.

Negative effects on Japanese average wages due to increasing imports from Asia are obtained by Tachibanaki, Morikawa, and Nishimura (1995). They also find that higher import penetration ratios widened wage differentials between skilled and unskilled workers.[35] After controlling for the price-cost markup, Higuchi (1989) shows that aggregate yen appreciation against the U.S. dollars restrained wage increase of senior workers while it did not affect wages of younger workers, pointing to the differences in the turnover costs.[36] For a reference of the U.S. literature, see Revenga (1992), and for a Mexican case, see Feliciano (2001).

*Empirical Specification*

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[34] The assumptions are: (i) two countries, two products, and two factors, (ii) factors are perfectly mobile within a country but immobile between countries, (iii) all markets for products and factors are perfectly competitive, (iv) production technology sets are available to everybody, and represents constant returns to scale with diminishing marginal product of each factor, (v) incomplete specialization, namely factor endowments of countries are not very different, and (vi) identical and homothetic preferences for both countries.

[35] For the U.S. cases, there have been so many arguments about the effects of globalization on wage inequalities. Some of them do not emphasize the role of external factors. Slaughter and Swagel (1997, p.22), for instance, show that outsourcing appears to have had only a modest effect on wages of unskilled workers in the U.S. For the Japanese cases, Thygesen, Kosai, and Lawrence (1996) obtain rather slightly declining wage disparity between college graduates and high-school graduates, thereby giving fewer credits on international factors. These results seem contradictory with theory, and thus, I regard this issue as worth reconsidering.

[36] Higuchi (1989) also considered that the yen's appreciation facilitated FDI, and thereby reducing the wage negotiation power at home. This union effect of FDI on wages, however, is not the venue on which I focus in this paper, since the reverse import effects are of significant concern.

My empirical specification for wage analysis is analogous to the employment model in the previous section. Theoretical prediction is a rise in skilled wages and a decrease in unskilled wages under the real yen appreciation. Thus, I first examine the effect of the REER on the wage gap between skilled and unskilled workers. Then, I examine the REER effects on wage levels. A dependent variable for the current purpose is constructed by log wage differences between skilled and unskilled workers: $d\ln w_{igt}^{su} = \ln w_{igt}^{s} - \ln w_{igt}^{u}$. As an explanatory variable, included are the log differences of employment between skilled and unskilled workers ($d\ln L_{igt}^{su}$), log of the industry-specific GDP, the industry-specific real effective exchange rate in a log, the interaction term of the exchange rate and the VFDI measure, and year dummies. The estimation equation is,

$$d\ln w_{igt}^{su} = \beta_0 + \beta_1 d\ln L_{igt}^{su} + \beta_2 \ln GDP_{it} + \beta_3 \ln ER_{it}$$

$$+ \beta_4 \ln ER_{it} * VFDI_{it} + \sum_{l=5}^{l=8} \beta_l YD_t + \chi_{igt}. \quad (1\text{-}12)$$

Parameter estimates are denoted by $\beta's$. Subscript $g$ indicates gender: male or female, while superscript $su$ indicates subtraction of a variable for unskilled workers from the same variable for skilled workers. $\chi_{igt}$ is a well-behaved error term.

The skilled workers are those who graduated from either professional (vocational) school, junior college, or college (equivalent to having 14 or 16 years of schooling), and the unskilled workers are either junior or senior high school graduates (equivalent to having 9 or 12 years of schooling).

*Estimation Results*

Table 1-5a reports the OLS estimation results of equation (1-12) for male workers. The data set consists of 9 industries times 5 years. Column (1) shows estimates without the interaction term. The coefficient of the industry-specific REER is positive and statistically significant. The yen appreciation increases the wage gap between skilled and unskilled male workers in Japanese manufacturing industries. This is consistent with the theoretical prediction.

Models (2) and (4) of the table show results with the interaction terms. The VFDI measure is based on affiliates' employment. The effect on the wage gap of VFDI in low income countries is negative but the effect of VFDI in high income countries has no effect. Under the yen appreciation, an increase in VFDI in the low income countries holds down the expansion of the skill-wage gap. Estimates with VFDI based on affiliates' total sales are shown in models (6) and (8). They indicate that VFDI in low income countries has no impact on domestic labor while VFDI in high income countries has positive and significant effect on the wage gap.

Table 1-5b represents the female estimates. Coefficient of the exchange rate for female workers in column (1) is negative and insignificant, so that, the yen appreciation, or an increase in VFDI, does not seem to affect the female skill-wage gap. Industry-specific GDP rather helps increase the wage differentials. The industry-specific REER is negative and significant with the HFDI interaction term, but insignificant with the LFDI interaction term. For female workers, therefore, the real yen appreciation decreases the skill-wage gap and this effect is accelerated by increasing VFDI in low income countries, while the effect is reduced by increasing VFDI in high income countries. These results imply that VFDI in high income countries is in favor of skilled wages. This appears to be contrary to the prediction. However, the VFDI effects on the skill-wage gap with output fixed are statistically significant and consistent with the theory (in models (3), (5), (7), and (9)). VFDI in low income countries expands the wage gap while VFDI in high income countries decreases the wage gap. Unlike the male skill-wage regression, VFDI has direct impact on the female skill-wage gap.

Tables 1-5c and 1-5d present the results of testing the electrical machinery industry bias. For male workers, the industry dummy is not statistically significant. Inclusion of the dummy does not change the goodness of fit very much, but turns many of the VFDI interaction terms insignificant or just marginally significant. For female workers, coefficient of the electrical machinery dummy is now positive and significant (in model (1)). Overall, goodness of fit is slightly better than the estimations without the dummy. In those models with VFDI interaction terms based on the affiliates total sales, the electrical machinery dummy is positive and significant. Unlike the male wage models, the electrical machinery industry affects female skill-wage gaps.

Tables 1-6a through 1-6e represent the results of the wage level regression analysis for the REER and VFDI impact. The dependent variable is defined as the first difference of log wages, and regression is conducted by-gender-by-skill. I use one period lagged employment level as one of the independent variables. Although the results for all workers show mixed effects, there are some patterns that can be observed by disaggregate data. Without the VFDI interaction term, the industry-specific REER positively affects skilled wages for both male and female (in models (1) of Tables 1-6b and 1-6d), whereas the REER has no effect on unskilled wages (in models (1) of Tables 1-6c and 1-6e). With the interaction terms, the REER is positive and significant in all models for male, and in some models for female. However, no VFDI or VFDI interaction terms are significant. On the contrary, for the unskilled wage regressions, VFDI in low income countries matters, especially for female wages. With output constant, an increase in affiliates' employment in low income countries raises female unskilled workers' wages in Japan (in model (3) of Table 1-6e).

So far in the estimation, I use the industry-specific REER calculated by the time-varying export weights. This weighting system is used by Dekle (1998) and has advantage of reflecting changes in the trade patterns of Japanese firms over time. However, the weighting system is also suffering from contemporaneous bias between trade shares and bilateral exchange rate. To investigate the possible effect of this bias, I conduct the robustness check on employment and wage regressions by using the industry-specific REER based on fixed year export weights: the weights are fixed to either 1988 or 2000. Tables 1-7a through 1-7c represent the results. Overall, estimates, significance, and sign patterns are very similar among three alternative weighting systems. Therefore, it is suggested that whether weights are time-varying or fixed does not matter for my data set.

## 7. Conclusion

This chapter has examined Japanese labor market adjustments in response to the industry-specific real effective exchange rate by incorporating two types of vertical FDI. VFDI in low income countries facilitates reverse imports at lower prices, and this does affect foreign price index for industries, like machinery and electrical machinery industries. The industry-specific REER of those industries, where VFDI in low income countries is significant, tends to appreciate, and thus, firms who are not multinationals also respond to the exchange rate changes. Consequently, industry-wide employment is affected. The literature has focused on the employment relationship between foreign affiliates and parents, but it is evidenced that MNCs' activities do affect the industry-wide economy at home.

I find that the real yen appreciation decreases industry-wide employment. But, the estimates of the VFDI interaction term reveal that industries with larger amounts of VFDI in low income countries experience larger employment losses, while industries with larger amounts of VFDI in high income countries experience smaller reduction in employment. However, decomposition of skilled and unskilled contributions to the overall employment would be a difficult task. Instead, the wage estimation implies that the real yen appreciation is in favor of skilled workers. Further increase in VFDI in low income countries, however, holds down the expansion of the skill-wage gap, while increase in VFDI in high income countries rather facilitates the wage gap. The evidence is strong for female workers, but the impact on male workers is not significant.

There are differential impacts of the industry-specific REER on employment and wages for industries investing in low and high income countries. However, it is possible that industries with large amounts of VFDI in low income countries do so because of the industry characteristics. Similarly, industries with large amounts of VFDI in high income countries engage in investment in high income countries because of their industry characteristics. Therefore, it may be unclear if the differential impact is due to VFDI per se, or if it is due to the differences in the types of industries. This is a point that cannot be clarified in the study, but will be analyzed by incorporating demand elasticity of a good for each industry.

Although my data spans from late 1980s to 2000, it does not show any significant difference in the adjustment speed of Japanese manufacturing employment. As the previous studies have emphasized, the adjustment cost in Japan may still seem to be high.

This study suggests that the Japan's relationship with East Asian economies through VFDI will continue since industries can deal with exchange rate fluctuations by VFDI. However, as globalization goes on this way, demand for skilled workers is expected to rise in Japan. Therefore, flexible labor markets that warrant the good skill-match will be necessary to increase Japanese welfare.

**Table 1-1. Increasing Trend of Reverse Imports from Asian Affiliates: 1988FY – 2000FY, (%)**

| Industry | 1988FY | 1991FY | 1994FY | 1997FY | 2000FY |
|---|---|---|---|---|---|
| Food | 13.29 | 16.42 | 7.16 | 19.33 | 14.33 |
| Textile | 9.35 | 6.40 | 16.98 | 41.63 | 21.75 |
| Wood, paper and pulp | 39.11 | 19.75 | 2.00 | 35.89 | 20.68 |
| Chemicals | 1.86 | 2.12 | 2.09 | 7.76 | 9.58 |
| Iron and Steel products | 4.09 | 3.80 | 2.09 | 3.01 | 3.05 |
| Non-ferrous metals | 13.28 | 1.28 | 6.34 | 16.85 | 13.73 |
| Machinery | 12.13 | 7.17 | 19.49 | 41.58 | 36.35 |
| Electrical machinery | 14.67 | 16.32 | 14.48 | 33.82 | 31.82 |
| Transportation equipments | 0.72 | 1.63 | 1.02 | 6.86 | 11.16 |
| Precision instruments | 13.12 | 9.35 | 25.47 | 59.05 | 51.71 |
| Manufacturing total | 8.93 | 8.84 | 9.89 | 25.26 | 24.74 |
| Non-manufacturing total | 6.90 | 4.46 | 8.26 | 18.26 | 23.24 |
| TOTAL | 7.93 | 6.54 | 9.10 | 21.92 | 24.06 |

**Sources:** METI, *Survey of Overseas Business Activities*, 1990, 1993, 1996, 2000, and 2003.
**Notes:** Reverse imports are defined as the ratio of exports to Japan to total sales for affiliates located in Asian countries. Asian Countries include China, ASEAN 4 countries, NIEs 4 countries and other Asian countries. Manufacturing total includes oil and coal, and others, as well as those 10 industries of the table. FY stands for a fiscal year from April to March in Japan.

**Table 1-2. Sectoral Growth Rates of Employment and Wages: 1988 - 2000**

| | Employment Growth (%) | | | Real Wage Growth (%) | | |
|---|---|---|---|---|---|---|
| | 1988-1997 | 1997-2000 | 1988-2000 | 1988-1997 | 1997-2000 | 1988-2000 |
| Food | 4.0 | -2.4 | 1.4 | 22.3 | -1.3 | 20.7 |
| Textiles | -23.1 | -26.8 | -43.7 | 30.7 | -0.4 | 30.3 |
| Chemicals | 4.6 | -10.3 | -6.2 | 65.1 | 3.5 | 71.0 |
| Iron and Steel products | -22.7 | -18.6 | -37.1 | 58.5 | 3.5 | 64.1 |
| Non-ferrous metals | 2.3 | -12.9 | -10.9 | 48.6 | -9.3 | 34.8 |
| Metal products | -7.3 | -3.0 | -10.1 | 26.8 | 0.9 | 28.0 |
| Machinery | 6.9 | -6.7 | -0.3 | 20.6 | -3.4 | 16.5 |
| Electrical machinery | 4.5 | -15.1 | -11.3 | 173.5 | 2.1 | 179.1 |
| Transportation equipments | 12.5 | -17.3 | -7.0 | 18.5 | -2.8 | 15.1 |
| Precision instruments | -7.5 | -5.7 | -12.8 | 35.6 | -2.4 | 32.4 |

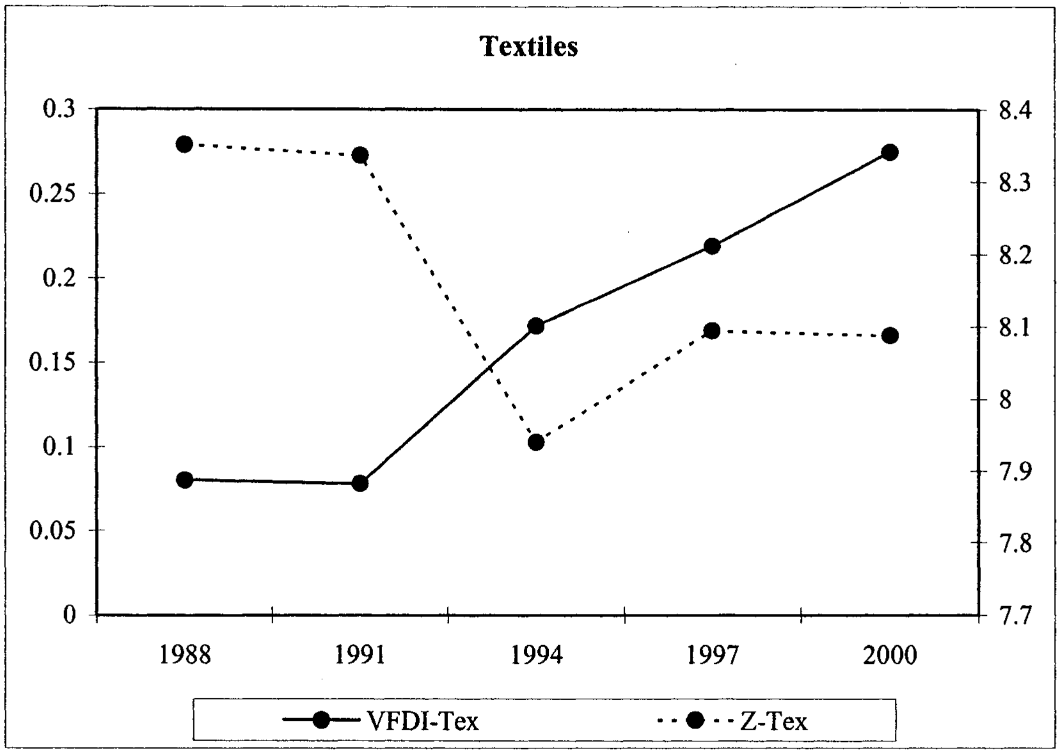
**Sources:** MHLW, *Basic Survey on Wage Structure*, 1989, 1992, 1995, 1998, and 2001.
**Notes:** The sample consists of all full-time workers in firms with 10 or more employees and at the ages from 25 to 64 years old. The nominal wage per person-hour is computed as an industry average, by dividing total "scheduled cash earnings" by total of the "actual number of scheduled hours worked," for the relevant age groups. This wage, therefore, does not include bonuses or overtime compensation. The nominal wages are deflated by the sectoral GDP deflators (1995 basis). Employment is the sum of the "number of employees" for the relevant age groups.

**Table 1-3. Change in the Industry-Specific Real Effective Exchange Rate (REER): 1988 - 2000**

| | Change in REER (%) | | | c.v. | corr. | Real Appreciation |
|---|---|---|---|---|---|---|
| | 1988-1997 | 1997-2000 | 1988-2000 | 1988-2000 | 1988-2000 | or Depreciation? |
| Food | 1.6 | -9.5 | -8.1 | 0.131 | 0.64 | Depreciation |
| Textiles | 45.9 | 5.3 | 53.7 | 0.218 | 0.91 | Appreciation |
| Chemicals | -37.9 | 0.1 | -37.8 | 0.209 | -0.24 | Depreciation |
| Iron and Steel products | -7.7 | 35.3 | 24.9 | 0.132 | 0.83 | Appreciation |
| Non-ferrous metals | -1.0 | 40.9 | 39.4 | 0.197 | 0.87 | Appreciation |
| Metal products | 3.2 | 9.5 | 13.1 | 0.132 | 0.79 | Appreciation |
| Machinery | 45.5 | 22.0 | 77.5 | 0.238 | 0.82 | Appreciation |
| Electrical machinery | -37.2 | 17.6 | -26.2 | 0.179 | 0.02 | Depreciation |
| Transportation equipments | -4.1 | 0.6 | -3.6 | 0.086 | 0.76 | Depreciation |
| Precision instruments | -14.6 | -2.5 | -16.8 | 0.157 | 0.44 | Depreciation |

**Notes:** C.v. means the coefficient of variation. Corr. means the correlation coefficient between the $/yen nominal exchange rate and the industry-specific REER. Since the REER is the ratio of Japanese price relative to the weighted average of foreign prices in terms of yen, the yen is said to be appreciated when the REER increases (showing a positive growth rate). 1997 is the year when a series of currency crises happened in Asia, which may have impacted Japanese economy too.

**Figure 1-1. Negative Relationship between Vertical FDI (VFDI, Left-Hand Scale) and Average Foreign Price Index (Z, Right-Hand Scale): Five Selected Industries**



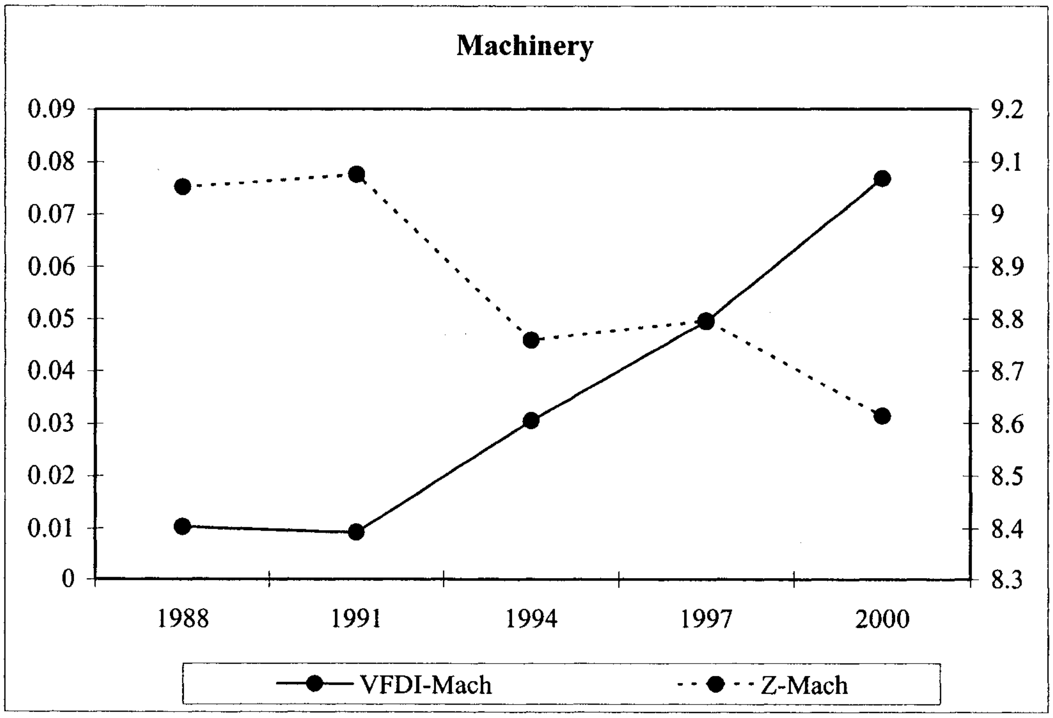
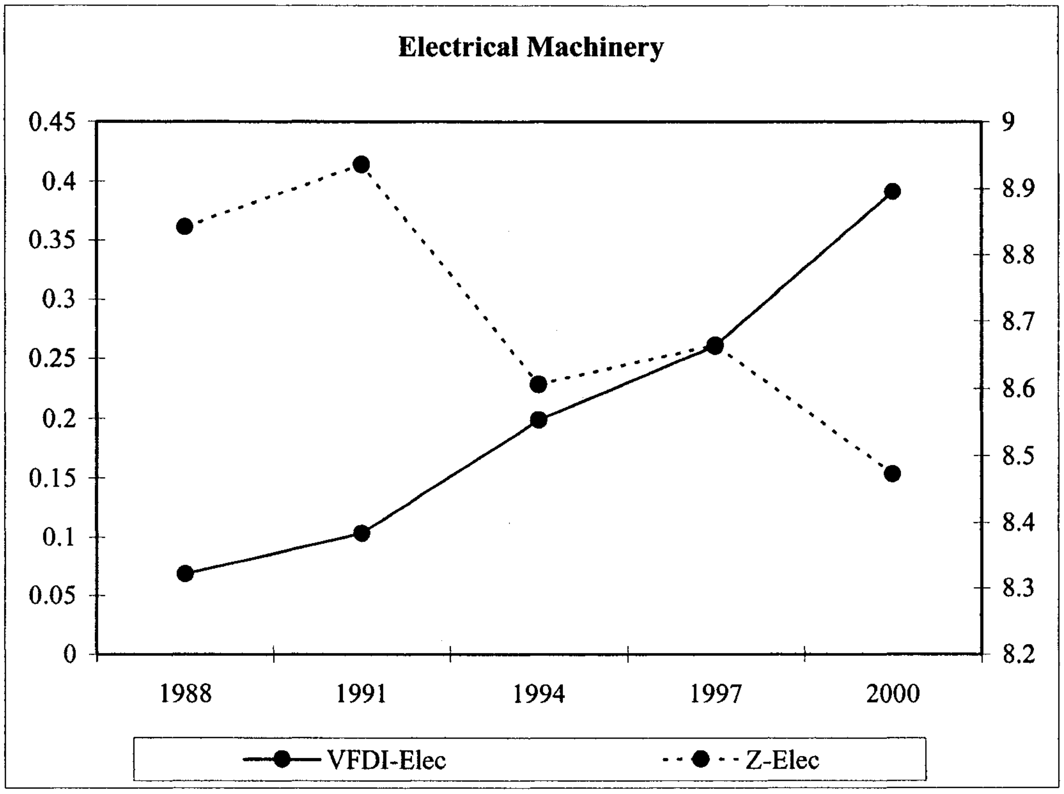



**Figure 1-1. (Continued)**



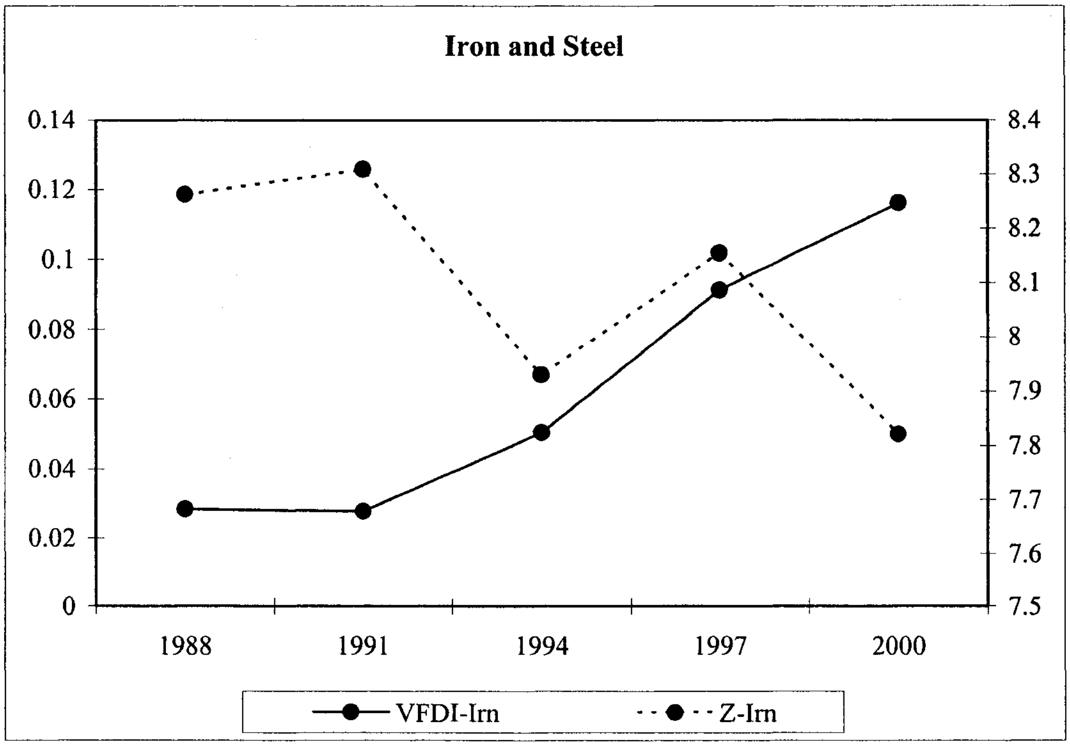
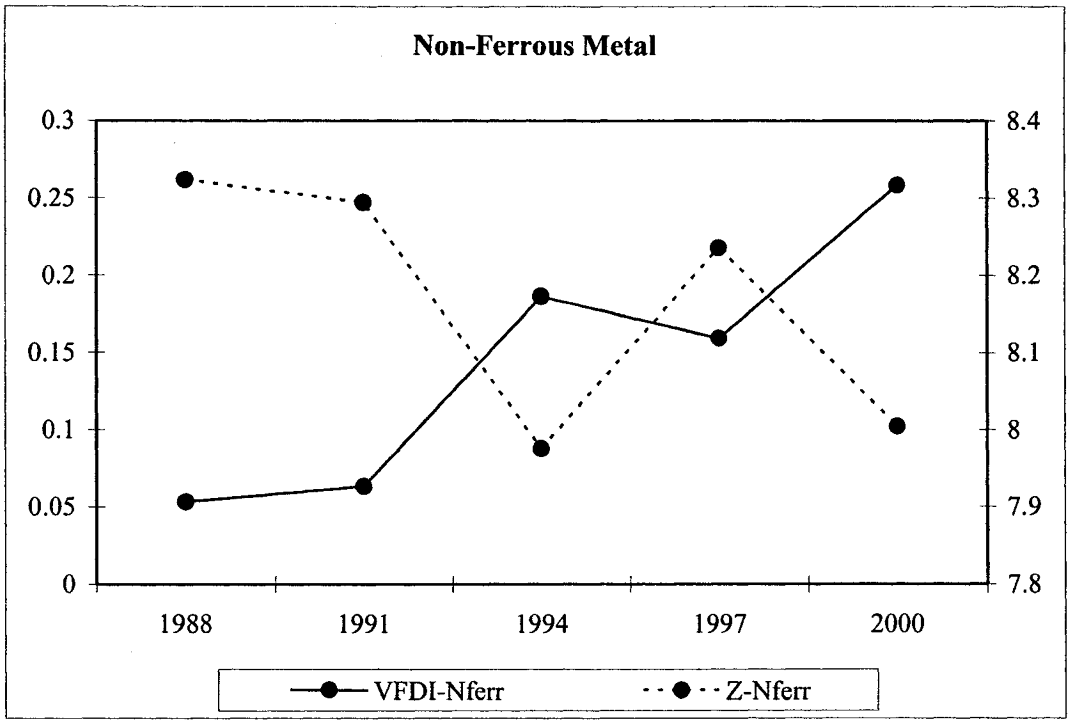



**Figure 1-1. (Continued)**




**Sources:** METI, *Survey of Overseas Business Activities*, 1990, 1993, 1996, 2000, and 2003, MHLW, *Basic Survey on Wage Structure*, 1989, 1992, 1995, 1998, and 2001, and author's calculation.

**Notes:** VFDI is the employment ratio of affiliates located in low income countries (LICs) relative to domestic industry total, that is, the denominator is not parents' employment.

**Table 1-4a. Exchange Rate Elasticity of Employment and Vertical FDI Effects on Domestic Industry-Wide Employment**

| | Dependent Variable = dlnLi (First difference of log employment). | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Measure for FDI | No FDI | Affiliates' Employment | | | | Affiliates' Total Sales | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Intercept | 1.409 | 2.945 | 2.681 | 1.806 | 1.760 | 2.58 | 2.29 | 1.84 | 1.87 |
| | (1.29) | (2.46)** | (2.29)** | (1.61)* | (1.55)* | (2.22)** | (2.00)** | (1.72)** | (1.70)** |
| lnLi(-1) | -0.158 | -0.322 | -0.322 | -0.223 | -0.214 | -0.313 | -0.301 | -0.256 | -0.250 |
| | (-2.42)** | (-3.53)*** | (-3.36)*** | (-2.73)*** | (-2.56)*** | (-3.31)*** | (-3.06)*** | (-3.12)*** | (-2.94)*** |
| lnWi | -0.139 | -0.276 | -0.262 | -0.168 | -0.159 | -0.257 | -0.234 | -0.188 | -0.175 |
| | (-1.19) | (-2.26)** | (-2.14)** | (-1.43)* | (-1.35)* | (-2.10)** | (-1.91)** | (-1.63)* | (-1.51)* |
| lnGDPi | 0.133 | 0.278 | 0.278 | 0.196 | 0.187 | 0.286 | 0.273 | 0.237 | 0.230 |
| | (2.54)*** | (3.59)*** | (3.41)*** | (2.77)** | (2.58)*** | (3.32)*** | (3.05)*** | (3.15)*** | (2.94)*** |
| lnERi | -0.126 | -0.175 | -0.215 | -0.169 | -0.151 | -0.178 | -0.202 | -0.072 | -0.188 |
| | (-2.81)*** | (-3.79)*** | (-3.71)*** | (-3.06)*** | (-3.00)*** | (-3.67)*** | (-3.44)*** | (-3.27)*** | (-3.26)*** |
| lnERi*LFDI | | -0.096 | | | | | | | |
| | | (-2.40)** | | | | | | | |
| LFDI | | | 0.377 | | | | | | |
| | | | (2.23)** | | | | | | |
| lnERi*HFDI | | | | 0.049 | | | | | |
| | | | | (1.30) | | | | | |
| HFDI | | | | | -0.165 | | | | |
| | | | | | (-1.07) | | | | |
| lnERi*ATSALES | | | | | | -0.078 | | | |
| | | | | | | (-2.16)** | | | |
| ATSALES | | | | | | | 0.279 | | |
| | | | | | | | (1.89)** | | |
| lnERi*HTSALES | | | | | | | | 0.072 | |
| | | | | | | | | (1.86)** | |
| HTSALES | | | | | | | | | -0.257 |
| | | | | | | | | | (-1.63)* |
| Adj. R-squared | 0.582 | 0.643 | 0.634 | 0.592 | 0.584 | 0.631 | 0.617 | 0.616 | 0.606 |
| F Value | 7.97 | 8.87 | 8.57 | 7.36 | 7.15 | 8.47 | 8.06 | 8.01 | 7.72 |
| n | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| d.f. | 28 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 |

**Notes to Table 1-4a**

Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. The data set is a panel of 9 industries times 4 years: 1991, 1994, 1997, and 2000. Metal industry is excluded, whose affiliate-employment/total sales data are not available in the METI source. $\ln L_i(-1))$ is a period-lagged industrial employment in log. $\ln W_i$ is the log of industry-varying real wages by industry GDP deflators. $\ln GDP_i$ is the sectoral GDP in log. $\ln ER_i$ is the log of the industry-specific real effective exchange rate ($REER_i$).

The definitions of the four FDI measures are in the followings.

(1) LFDI (Vertical FDI in low income countries, measured by affiliates' employment): employment ratio of affiliates located in low income countries (LICs: China and ASEAN 4 countries) relative to overseas total employment within an industry.

(2) HFDI (Vertical FDI in high income countries, measured by affiliates' employment): employment ratio of affiliates located in high income countries (HICs: the U.S. and EU countries) relative to overseas total employment within an industry.

(3) ATSALES (Vertical FDI in low income countries, measured by affiliates' total sales): total sales ratio of affiliates located in Asian countries (LICs plus NIEs 4 countries and other Asian countries) relative to overseas total sales within an industry.

(4) HTSALES (Vertical FDI in high income countries, measured by affiliates' total sales): total sales ratio of affiliates located in HICs relative to overseas total sales within an industry. The employment-based FDI measure can be constructed for LICs. However, due to the data availability, the total sales-based FDI measure includes NIEs and other Asian countries in a low income country group.

**Table 1-4b. Testing Electrical Machinery Bias: Vertical FDI Effects on Domestic Employment**

| | Dependent Variable = dlnLi (First difference of log employment). | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Measure for FDI | No FDI | Affiliates' Employment | | | | Affiliates' Total Sales | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Intercept | 2.311 | 2.917 | 2.759 | 2.285 | 2.325 | 3.02 | 2.87 | 2.52 | 2.61 |
| | (1.71)** | (2.22)** | (2.09)** | (1.68)* | (1.70)* | (2.25)** | (2.12)** | (1.92)** | (1.95)** |
| lnLi(-1) | -0.211 | -0.322 | -0.324 | -0.242 | -0.237 | -0.332 | -0.327 | -0.291 | -0.289 |
| | (-2.62)*** | (-3.44)*** | (-3.29)*** | (-2.76)*** | (-2.65)*** | (-3.34)*** | (-3.15)*** | (-3.20)*** | (-3.07)*** |
| lnWi | -0.217 | -0.274 | -0.268 | -0.211 | -0.211 | -0.294 | -0.282 | -0.246 | -0.239 |
| | (-1.60)* | (-2.09)** | (-2.02)** | (-1.55)* | (-1.54)* | (-2.17)** | (-2.07)** | (-1.86)** | (-1.79)** |
| lnGDPi | 0.163 | 0.279 | 0.277 | 0.201 | 0.193 | 0.292 | 0.283 | 0.254 | 0.249 |
| | (2.78)*** | (3.51)*** | (3.33)*** | (2.79)*** | (2.63)*** | (3.34)*** | (3.11)*** | (3.26)*** | (3.08)*** |
| lnERi | -0.147 | -0.174 | -0.215 | -0.172 | -0.159 | -0.186 | -0.210 | -0.237 | -0.201 |
| | (-3.04)*** | (-3.66)*** | (-3.64)*** | (-3.07)*** | (-3.07)*** | (-3.69)*** | (-3.51)*** | (-3.35)*** | (-3.39)*** |
| lnERi*LFDI | | -0.098 | | | | | | | |
| | | (-2.04)** | | | | | | | |
| LFDI | | | 0.364 | | | | | | |
| | | | (1.85)** | | | | | | |
| lnERi*HFDI | | | | 0.038 | | | | | |
| | | | | (0.91) | | | | | |
| HFDI | | | | | -0.116 | | | | |
| | | | | | (-0.69) | | | | |
| lnERi*ATSALES | | | | | | -0.072 | | | |
| | | | | | | (-1.91)** | | | |
| ATSALES | | | | | | | 0.256 | | |
| | | | | | | | (1.69)* | | |
| lnERi*HTSALES | | | | | | | | 0.067 | |
| | | | | | | | | (1.70)* | |
| HTSALES | | | | | | | | | -0.240 |
| | | | | | | | | | (-1.51)* |
| Electrical Mach | 0.060 | -0.003 | 0.008 | 0.038 | 0.045 | 0.036 | 0.043 | 0.048 | 0.051 |
| | (1.12) | (-0.06) | (0.14) | (0.64) | (0.76) | (0.68) | (0.82) | (0.91) | (0.97) |
| Adj. R-squared | 0.586 | 0.629 | 0.620 | 0.583 | 0.578 | 0.623 | 0.613 | 0.613 | 0.605 |
| F Value | 7.19 | 7.60 | 7.35 | 6.44 | 6.32 | 7.43 | 7.15 | 7.16 | 6.95 |
| n | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| d.f. | 27 | 26 | 26 | 26 | 26 | 26 | 26 | 26 | 26 |

**Notes:** Electrical Mach is a dummy variable for the electrical machinery industry. Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. Also see notes to Table 1-4a.

**Table 1-5a. Exchange Rate Elasticity of Wages and Vertical FDI Effects on Domestic Skill-Based Wage Differentials: Male Employees**

| | Dependent Variable = dlnWigt (First difference of log wages between skilled and unskilled workers: lnWigst - | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Gender | Male (g = m) | | | | | | | | |
| Measure for FDI | No FDI | Affiliates' Employment | | | | Affiliates' Total Sales | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Intercept | 0.527 | 0.491 | 0.475 | 0.499 | 0.512 | 0.480 | 0.474 | 0.469 | 0.492 |
| | (8.74)*** | (7.77)*** | (7.00)*** | (7.70)*** | (8.31)*** | (6.70)*** | (6.22)*** | (6.78)*** | (7.77)*** |
| dlnLig | 0.008 | 0.007 | 0.007 | 0.009 | 0.009 | 0.006 | 0.007 | 0.010 | 0.011 |
| | (0.78) | (0.64) | (0.72) | (0.86) | (0.90) | (0.62) | (0.67) | (1.00) | (1.02) |
| lnGDPi | 0.0008 | 0.003 | 0.003 | 0.003 | 0.003 | 0.004 | 0.004 | 0.005 | 0.005 |
| | (0.15) | (0.62) | (0.61) | (0.61) | (0.58) | (0.73) | (0.68) | (0.93) | (0.91) |
| lnERi | 0.055 | 0.055 | 0.050 | 0.051 | 0.054 | 0.054 | 0.052 | 0.044 | 0.050 |
| | (4.83)*** | (4.90)*** | (4.33)*** | (4.21)*** | (4.68)*** | (4.77)*** | (4.41)*** | (3.38)*** | (4.30)*** |
| lnERi*LFDI | | -0.013 | | | | | | | |
| | | (-1.61)* | | | | | | | |
| LFDI | | | 0.049 | | | | | | |
| | | | (1.57)* | | | | | | |
| lnERi*HFDI | | | | 0.009 | | | | | |
| | | | | (1.15) | | | | | |
| HFDI | | | | | -0.035 | | | | |
| | | | | | (-1.10) | | | | |
| lnERi*ATSALES | | | | | | -0.008 | | | |
| | | | | | | (-1.20) | | | |
| ATSALES | | | | | | | 0.027 | | |
| | | | | | | | (1.11) | | |
| lnERi*HTSALES | | | | | | | | 0.011 | |
| | | | | | | | | (1.62)* | |
| HTSALES | | | | | | | | | -0.041 |
| | | | | | | | | | (-1.54)* |
| Adj. R-squared | 0.564 | 0.582 | 0.580 | 0.568 | 0.566 | 0.569 | 0.567 | 0.582 | 0.579 |
| F Value | 9.12 | 8.64 | 8.60 | 8.22 | 8.18 | 8.25 | 8.19 | 8.65 | 8.57 |
| n | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| d.f. | 37 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Notes to Table 1-5a**

Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. The data set is a panel of 9 industries times 5 years: 1988, 1991, 1994, 1997, and 2000. Metal industry is excluded, whose affiliate-employment/total sales data are not available in the METI source. dlnLig is the first difference of log wages between skilled and unskilled workers: lnLigs - lnLigu. lnGDPi is the sectoral GDP in log, and lnERi is the industry-specific real effective exchange rate (REERi) in log. The definitions of the four FDI measures are in the followings. (1) LFDI (Vertical FDI in low income countries, measured by affiliates' employment): employment ratio of affiliates located in low income countries (LICs: China and ASEAN 4 countries) relative to overseas total employment within an industry. (2) HFDI (Vertical FDI in high income countries, measured by affiliates' employment): employment ratio of affiliates located in high income countries (HICs: the U.S. and EU countries) relative to overseas total employment within an industry. (3) ATSALES (Vertical FDI in low income countries, measured by affiliates' total sales): total sales ratio of affiliates located in Asian countries (LICs plus NIEs 4 countries and other Asian countries) relative to overseas total sales within an industry. (4) HTSALES (Vertical FDI in high income countries, measured by affiliates' total sales): total sales ratio of affiliates located in HICs relative to overseas total sales within an industry. The employment-based FDI measure can be constructed for LICs. However, due to the data availability, the total sales-based FDI measure includes NIEs and other Asian countries in the low income country group.

## Table 1-5b. Exchange Rate Elasticity of Wages and Vertical FDI Effects on Domestic Skill-Based Wage Differentials: Female Employees

| | Dependent Variable = dlnWig (First difference of log wages between skilled and unskilled workers: lnWigs - l | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Gender | Female (g = f) | | | | | | | | |
| Measure for FDI | No FDI | Affiliates' Employment | | | | Affiliates' Total Sales | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Intercept | -0.170 | -0.235 | -0.349 | -0.311 | -0.169 | -0.371 | -0.419 | -0.444 | -0.293 |
| | (-0.72) | (-1.04) | (-1.45)* | (-1.39)* | (-0.76) | (-1.49)* | (-1.55)* | (-1.75)** | (-1.25) |
| dlnLig | 0.004 | 0.043 | 0.047 | 0.065 | 0.063 | 0.034 | 0.033 | 0.042 | 0.041 |
| | (0.15) | (1.33)* | (1.39)* | (1.90)** | (1.75)** | (1.09) | (1.04) | (1.33)* | (1.25) |
| lnGDPi | 0.040 | 0.048 | 0.047 | 0.058 | 0.055 | 0.059 | 0.057 | 0.061 | 0.060 |
| | (1.88)** | (2.33)** | (2.29)** | (2.80)*** | (2.63)*** | (2.60)*** | (2.49)*** | (2.76)*** | (2.64)*** |
| lnERi | -0.020 | -0.028 | -0.061 | -0.092 | -0.058 | -0.029 | -0.047 | -0.105 | -0.066 |
| | (-0.45) | (-0.67) | (-1.33)* | (-1.93)** | (-1.32)* | (-0.69) | (-1.05) | (-1.88)** | (-1.38)* |
| lnERi*LFDI | | -0.082 | | | | | | | |
| | | (-2.19)** | | | | | | | |
| LFDI | | | 0.324 | | | | | | |
| | | | (2.11)** | | | | | | |
| lnERi*HFDI | | | | 0.108 | | | | | |
| | | | | (2.75)*** | | | | | |
| HFDI | | | | | -0.390 | | | | |
| | | | | | (-2.41)** | | | | |
| lnERi*ATSALES | | | | | | -0.055 | | | |
| | | | | | | (-1.94)** | | | |
| ATSALES | | | | | | | 0.192 | | |
| | | | | | | | (1.74)** | | |
| lnERi*HTSALES | | | | | | | | 0.071 | |
| | | | | | | | | (2.26)** | |
| HTSALES | | | | | | | | | -0.252 |
| | | | | | | | | | (-2.01)** |
| Adj. R-squared | 0.064 | 0.151 | 0.143 | 0.205 | 0.171 | 0.129 | 0.112 | 0.157 | 0.135 |
| F Value | 1.43 | 1.98 | 1.92 | 2.42 | 2.13 | 1.81 | 1.69 | 2.02 | 1.86 |
| n | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| d.f. | 37 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Notes:** Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. Also see notes to Table 1-5a.

**Table 1-5c. Testing Electrical Machinery Bias: Vertical FDI Effects on Domestic Male Skill-Wage Differentials**

| | Dependent Variable = dlnWigt (First difference of log wages between skilled and unskilled workers: lnWigst - l | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Gender | Male (g = m) | | | | | | | | |
| Measure for FDI | No FDI | Affiliates' Employment | | | | Affiliates' Total Sales | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Intercept | 0.533 | 0.492 | 0.478 | 0.507 | 0.518 | 0.491 | 0.488 | 0.477 | 0.499 |
| | (8.77)*** | (7.26)*** | (6.44)*** | (7.23)*** | (8.02)*** | (6.54)*** | (6.09)*** | (6.62)*** | (7.63)*** |
| dlnLig | 0.003 | 0.006 | 0.007 | 0.007 | 0.007 | 0.004 | 0.004 | 0.007 | 0.007 |
| | (0.27) | (0.52) | (0.56) | (0.53) | (0.52) | (0.30) | (0.32) | (0.62) | (0.62) |
| lnGDPi | -0.002 | 0.003 | 0.003 | 0.002 | 0.001 | 0.002 | 0.002 | 0.004 | 0.003 |
| | (-0.29) | (0.44) | (0.40) | (0.24) | (0.20) | (0.30) | (0.25) | (0.53) | (0.50) |
| lnERi | 0.053 | 0.055 | 0.050 | 0.051 | 0.053 | 0.053 | 0.051 | 0.044 | 0.050 |
| | (4.56)*** | (4.71)*** | (4.26)*** | (4.16)*** | (4.52)*** | (4.55)*** | (4.28)*** | (3.34)*** | (4.18)*** |
| lnERi*LFDI | | -0.013 | | | | | | | |
| | | (-1.29) | | | | | | | |
| LFDI | | | 0.047 | | | | | | |
| | | | (1.25) | | | | | | |
| lnERi*HFDI | | | | 0.008 | | | | | |
| | | | | (0.76) | | | | | |
| HFDI | | | | | -0.027 | | | | |
| | | | | | (-0.70) | | | | |
| lnERi*ATSALES | | | | | | -0.006 | | | |
| | | | | | | (-0.94) | | | |
| ATSALES | | | | | | | 0.022 | | |
| | | | | | | | (0.86) | | |
| lnERi*HTSALES | | | | | | | | 0.010 | |
| | | | | | | | | (1.39)* | |
| HTSALES | | | | | | | | | -0.037 |
| | | | | | | | | | (-1.31)* |
| Electrical Mach | 0.014 | 0.001 | 0.002 | 0.006 | 0.007 | 0.009 | 0.010 | 0.008 | 0.008 |
| | (0.92) | (0.07) | (0.13) | (0.33) | (0.37) | (0.56) | (0.60) | (0.48) | (0.51) |
| Adj. R-squared | 0.562 | 0.570 | 0.569 | 0.557 | 0.556 | 0.560 | 0.559 | 0.573 | 0.570 |
| F Value | 8.05 | 7.47 | 7.44 | 7.14 | 7.11 | 7.23 | 7.19 | 7.55 | 7.49 |
| n | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| d.f. | 36 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |

**Notes:** Electrical Mach is a dummy variable for the electrical machinery industry. Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. Also see notes to Table 1-5a.

**Table 1-5d. Testing Electrical Machinery Bias: Vertical FDI Effects on Domestic Female Skill-Wage Differentials**

| | Dependent Variable = dlnWig (First difference of log wages between skilled and unskilled workers: lnWigs - ln | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Gender | Female (g = f) | | | | | | | | |
| Measure for FDI | No FDI | Affiliates' Employment | | | | Affiliates' Total Sales | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Intercept | 0.015 | -0.098 | -0.165 | -0.189 | -0.056 | -0.172 | -0.195 | -0.251 | -0.114 |
| | (0.06) | (-0.38) | (-0.59) | (-0.74) | (-0.23) | (-0.63) | (-0.66) | (-0.94) | (-0.47) |
| dlnLig | 0.013 | 0.035 | 0.038 | 0.057 | 0.053 | 0.033 | 0.032 | 0.045 | 0.044 |
| | (0.47) | (1.09) | (1.11) | (1.63)* | (1.44)* | (1.07) | (1.02) | (1.46)* | (1.40)* |
| lnGDPi | 0.019 | 0.032 | 0.031 | 0.043 | 0.038 | 0.038 | 0.035 | 0.041 | 0.039 |
| | (0.85) | (1.31) | (1.27) | (1.73)** | (1.53)* | (1.45)* | (1.35)* | (1.69)** | (1.60)* |
| lnERi | -0.022 | -0.027 | -0.048 | -0.079 | -0.049 | -0.028 | -0.041 | -0.096 | -0.062 |
| | (-0.53) | (-0.64) | (-1.04) | (-1.58)* | (-1.12) | (-0.68) | (-0.94) | (-1.78)** | (-1.35)* |
| lnERi*LFDI | | -0.055 | | | | | | | |
| | | (-1.25) | | | | | | | |
| LFDI | | | 0.215 | | | | | | |
| | | | (1.22) | | | | | | |
| lnERi*HFDI | | | | 0.087 | | | | | |
| | | | | (1.92)** | | | | | |
| HFDI | | | | | -0.291 | | | | |
| | | | | | (-1.59)* | | | | |
| lnERi*ATSALES | | | | | | -0.040 | | | |
| | | | | | | (-1.38)* | | | |
| ATSALES | | | | | | | 0.138 | | |
| | | | | | | | (1.22) | | |
| lnERi*HTSALES | | | | | | | | 0.062 | |
| | | | | | | | | (2.03)** | |
| HTSALES | | | | | | | | | -0.222 |
| | | | | | | | | | (-1.82)** |
| Electrical Mach | 0.111 | 0.070 | 0.074 | 0.057 | 0.068 | 0.088 | 0.092 | 0.096 | 0.099 |
| | (2.12)** | (1.13) | (1.23) | (0.97) | (1.17) | (1.60)* | (1.69)** | (1.88)** | (1.93)** |
| Adj. R-squared | 0.144 | 0.157 | 0.155 | 0.204 | 0.179 | 0.165 | 0.156 | 0.212 | 0.196 |
| F Value | 1.93 | 1.91 | 1.90 | 2.25 | 2.07 | 1.97 | 1.90 | 2.32 | 2.19 |
| n | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| d.f. | 36 | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |

**Notes:** Electrical Mach is a dummy variable for the electrical machinery industry. Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. Also see notes to Table 1-5a.

**Table 1-6a. Exchange Rate Elasticity of Wages and Vertical FDI Effects on Domestic Wage Level: All Employees**

| | Dependent Variable = dlnWi (First difference of log wages: lnWit - lnWit-1). | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | All Workers (dlnWi) | | | | | | | | |
| Measure for FDI | No FDI | Affiliates' Employment | | | | Affiliates' Total Sales | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Intercept | 0.001 | 0.385 | 0.216 | 0.163 | 0.208 | 0.079 | 0.016 | -0.003 | 0.048 |
| | (0.00) | (1.19) | (0.69) | (0.46) | (0.53) | (0.24) | (0.05) | (-0.01) | (0.13) |
| lnLi(-1) | -0.002 | -0.137 | -0.147 | -0.066 | -0.058 | -0.078 | -0.068 | -0.039 | -0.027 |
| | (-0.04) | (-2.22)** | (-2.17)** | (-0.98) | (-0.80) | (-1.08) | (-0.86) | (-0.55) | (-0.36) |
| lnGDPi | 0.032 | 0.159 | 0.166 | 0.097 | 0.087 | 0.115 | 0.102 | 0.075 | 0.060 |
| | (0.82) | (2.89)*** | (2.76)*** | (1.54)* | (1.31)* | (1.61)* | (1.31) | (1.04) | (0.78) |
| lnERi | 0.031 | 0.011 | -0.049 | -0.013 | 0.008 | 0.014 | -0.003 | -0.013 | 0.014 |
| | (0.72) | (0.27) | (-0.99) | (-0.24) | (0.15) | (0.30) | (-0.06) | (-0.17) | (0.22) |
| lnERi*LFDI | | -0.127 | | | | | | | |
| | | (-2.97)*** | | | | | | | |
| LFDI | | | 0.504 | | | | | | |
| | | | (2.75)*** | | | | | | |
| lnERi*HFDI | | | | 0.061 | | | | | |
| | | | | (1.30) | | | | | |
| HFDI | | | | | -0.196 | | | | |
| | | | | | (-1.02) | | | | |
| lnERi*ATSALES | | | | | | -0.059 | | | |
| | | | | | | (-1.37)* | | | |
| ATSALES | | | | | | | 0.184 | | |
| | | | | | | | (1.04) | | |
| lnERi*HTSALES | | | | | | | | 0.035 | |
| | | | | | | | | (0.70) | |
| HTSALES | | | | | | | | | -0.086 |
| | | | | | | | | | (-0.42) |
| Adj. R-squared | 0.282 | 0.435 | 0.414 | 0.299 | 0.283 | 0.303 | 0.284 | 0.269 | 0.261 |
| F Value | 3.29 | 4.85 | 4.54 | 3.13 | 2.97 | 3.17 | 2.98 | 2.84 | 2.76 |
| n | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| d.f. | 29 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |

**Notes:** A variable $\ln L_i(-1)$ is one-period lagged employment. Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. Also see notes to Table 1-5a.

**Table 1-6b. Exchange Rate Elasticity of Wages and Vertical FDI Effects on Domestic Wage Level: Male Skilled Employees**

| | Dependent Variable = dlnWigl (First difference of log wages by-gender-by-skill: lnWiglt - lnWiglt-1). | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male Skilled (dlnWims) | | | | | | | | |
| Measure for FDI | No FDI | Affiliates' Employment | | | | Affiliates' Total Sales | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Intercept | -0.147 | -0.179 | -0.180 | -0.134 | -0.129 | -0.034 | 0.043 | -0.022 | -0.036 |
| | (-0.69) | (-0.79) | (-0.71) | (-0.57) | (-0.58) | (-0.13) | (0.15) | (-0.08) | (-0.15) |
| lnLims(-1) | 0.094 | 0.085 | 0.090 | 0.095 | 0.096 | 0.110 | 0.114 | 0.098 | 0.099 |
| | (1.82)** | (1.54)* | (1.63)* | (1.78)** | (1.81)** | (1.96)** | (2.06)** | (1.87)** | (1.90)** |
| lnGDPi | -0.045 | -0.035 | -0.040 | -0.047 | -0.049 | -0.068 | -0.073 | -0.058 | -0.061 |
| | (-1.03) | (-0.71) | (-0.82) | (-0.99) | (-1.06) | (-1.29) | (-1.43)* | (-1.21) | (-1.29) |
| lnERi | 0.100 | 0.095 | 0.094 | 0.103 | 0.104 | 0.113 | 0.128 | 0.125 | 0.119 |
| | (1.72)** | (1.58)* | (1.47)* | (1.63)* | (1.72)** | (1.86)** | (2.00)** | (1.79)** | (1.91)** |
| lnERi*LFDI | | -0.015 | | | | | | | |
| | | (-0.44) | | | | | | | |
| LFDI | | | 0.033 | | | | | | |
| | | | (0.25) | | | | | | |
| lnERi*HFDI | | | | -0.004 | | | | | |
| | | | | (-0.13) | | | | | |
| HFDI | | | | | 0.038 | | | | |
| | | | | | (0.31) | | | | |
| lnERi*ATSALES | | | | | | 0.023 | | | |
| | | | | | | (0.78) | | | |
| ATSALES | | | | | | | -0.112 | | |
| | | | | | | | (-1.03) | | |
| lnERi*HTSALES | | | | | | | | -0.022 | |
| | | | | | | | | (-0.66) | |
| HTSALES | | | | | | | | | 0.106 |
| | | | | | | | | | (0.87) |
| Adj. R-squared | 0.278 | 0.257 | 0.254 | 0.253 | 0.255 | 0.268 | 0.279 | 0.264 | 0.272 |
| F Value | 3.25 | 2.73 | 2.70 | 2.69 | 2.71 | 2.83 | 2.94 | 2.79 | 2.87 |
| n | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| d.f. | 29 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |

**Notes:** A variable $\ln L_{ims}(-1)$ is one-period lagged employment. Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. Also see notes to Table 1-5a.

## Table 1-6c. Exchange Rate Elasticity of Wages and Vertical FDI Effects on Domestic Wage Level: Male Unskilled Employees

| | Dependent Variable = dlnWigl (First difference of log wages by-gender-by-skill: lnWiglt - lnWiglt-1). | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male Unskilled (dlnWimu) | | | | | | | | |
| Measure for FDI | No FDI | Affiliates' Employment | | | | Affiliates' Total Sales | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Intercept | 0.190 | 0.157 | 0.108 | 0.190 | 0.217 | 0.118 | 0.141 | 0.148 | 0.184 |
| | (0.50) | (0.42) | (0.29) | (0.50) | (0.56) | (0.29) | (0.34) | (0.37) | (0.48) |
| lnLimu(-1) | -0.057 | -0.081 | -0.082 | -0.075 | -0.071 | -0.061 | -0.060 | -0.064 | -0.060 |
| | (-0.79) | (-1.13) | (-1.12) | (-0.99) | (-0.93) | (-0.84) | (-0.82) | (-0.85) | (-0.79) |
| lnGDPi | 0.076 | 0.106 | 0.105 | 0.098 | 0.093 | 0.087 | 0.083 | 0.088 | 0.082 |
| | (1.34)* | (1.81)** | (1.75)** | (1.54)* | (1.43)* | (1.43)* | (1.35)* | (1.35)* | (1.23) |
| lnERi | 0.012 | 0.010 | -0.010 | -0.006 | 0.004 | 0.011 | 0.034 | -0.003 | 0.008 |
| | (0.26) | (0.22) | (-0.21) | (-0.11) | (0.08) | (0.24) | (0.15) | (-0.05) | (0.15) |
| lnERi*LFDI | | -0.049 | | | | | | | |
| | | (-1.60)* | | | | | | | |
| LFDI | | | 0.166 | | | | | | |
| | | | (1.35)* | | | | | | |
| lnERi*HFDI | | | | 0.026 | | | | | |
| | | | | (0.79) | | | | | |
| HFDI | | | | | -0.071 | | | | |
| | | | | | (-0.56) | | | | |
| lnERi*ATSALES | | | | | | -0.015 | | | |
| | | | | | | (-0.57) | | | |
| ATSALES | | | | | | | 0.034 | | |
| | | | | | | | (0.33) | | |
| lnERi*HTSALES | | | | | | | | 0.013 | |
| | | | | | | | | (0.38) | |
| HTSALES | | | | | | | | | -0.021 |
| | | | | | | | | | (-0.17) |
| Adj. R-squared | 0.280 | 0.316 | 0.299 | 0.270 | 0.262 | 0.263 | 0.257 | 0.258 | 0.255 |
| F Value | 3.26 | 3.31 | 3.14 | 2.85 | 2.78 | 2.78 | 2.73 | 2.74 | 2.71 |
| n | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| d.f. | 29 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |

**Notes:** A variable $\ln L_{imu}(-1)$ is one-period lagged employment. Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. Also see notes to Table 1-5a.

**Table 1-6d. Exchange Rate Elasticity of Wages and Vertical FDI Effects on Domestic Wage Level: Female Skilled Employees**

| | Dependent Variable = dlnWigl (First difference of log wages by-gender-by-skill: lnWiglt - lnWiglt-1). | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Female Skilled (dlnWifs) | | | | | | | | |
| Measure for FDI | No FDI | Affiliates' Employment | | | | Affiliates' Total Sales | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Intercept | 0.067 | -0.074 | -0.061 | 0.047 | 0.092 | 0.061 | 0.268 | 0.253 | 0.272 |
| | (0.18) | (-0.18) | (-0.12) | (0.11) | (0.23) | (0.11) | (0.42) | (0.45) | (0.59) |
| lnLifs(-1) | -0.003 | -0.031 | -0.018 | -0.006 | 0.003 | -0.003 | 0.018 | 0.012 | 0.022 |
| | (-0.06) | (-0.53) | (-0.31) | (-0.10) | (0.06) | (-0.05) | (0.26) | (0.22) | (0.40) |
| lnGDPi | 0.060 | 0.098 | 0.080 | 0.064 | 0.050 | 0.061 | 0.028 | 0.032 | 0.014 |
| | (1.15) | (1.34)* | (1.09) | (0.92) | (0.72)* | (0.61) | (0.28) | (0.40) | (0.17) |
| lnERi | 0.098 | 0.105 | 0.088 | 0.095 | 0.101 | 0.098 | 0.109 | 0.130 | 0.124 |
| | (1.33)* | (1.40)* | (1.12) | (1.17) | (1.32) | (1.31) | (1.36)* | (1.26) | (1.51)* |
| lnERi*LFDI | | -0.057 | | | | | | | |
| | | (-0.75) | | | | | | | |
| LFDI | | | 0.120 | | | | | | |
| | | | (0.40) | | | | | | |
| lnERi*HFDI | | | | 0.007 | | | | | |
| | | | | (0.10) | | | | | |
| HFDI | | | | | 0.054 | | | | |
| | | | | | (0.20) | | | | |
| lnERi*ATSALES | | | | | | -0.001 | | | |
| | | | | | | (-0.02) | | | |
| ATSALES | | | | | | | -0.113 | | |
| | | | | | | | (-0.38) | | |
| lnERi*HTSALES | | | | | | | | -0.033 | |
| | | | | | | | | (-0.45) | |
| HTSALES | | | | | | | | | 0.205 |
| | | | | | | | | | (0.74) |
| Adj. R-squared | -0.003 | -0.019 | -0.033 | -0.039 | -0.037 | -0.039 | -0.034 | -0.032 | -0.019 |
| F Value | 0.98 | 0.91 | 0.84 | 0.81 | 0.82 | 0.81 | 0.84 | 0.85 | 0.91 |
| n | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| d.f. | 29 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |

**Notes:** A variable $\ln L_{ifs}(-1)$ is one-period lagged employment. Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. Also see notes to Table 1-5a.

## Table 1-6e. Exchange Rate Elasticity of Wages and Vertical FDI Effects on Domestic Wage Level: Female Unskilled Employees

| | Dependent Variable = dlnWigl (First difference of log wages by-gender-by-skill: lnWiglt - lnWiglt-1). | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Female Unskilled (dlnWifu) | | | | | | | | |
| Measure for FDI | No FDI | Affiliates' Employment | | | | Affiliates' Total Sales | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| Intercept | 0.015 | -0.166 | -0.375 | -0.090 | -0.012 | -0.241 | -0.241 | -0.132 | -0.029 |
| | (0.06) | (-0.77) | (-1.47)* | (-0.37) | (-0.05) | (-0.81) | (-0.67) | (-0.39) | (-0.11) |
| lnLifu(-1) | -0.005 | -0.052 | -0.052 | -0.026 | -0.022 | -0.034 | -0.027 | -0.016 | -0.011 |
| | (-0.29) | (-2.41)** | (-2.27)** | (-1.11) | (-0.92) | (-1.26) | (-0.94) | (-0.65) | (-0.42) |
| lnGDPi | 0.033 | 0.096 | 0.095 | 0.065 | 0.059 | 0.084 | 0.071 | 0.055 | 0.045 |
| | (1.37)* | (3.21)*** | (3.01)*** | (1.87)** | (1.64)* | (1.88)** | (1.51)* | (1.26) | (0.99) |
| lnERi | 0.028 | 0.032 | -0.025 | -0.005 | 0.015 | 0.023 | 0.005 | -0.007 | 0.018 |
| | (0.62) | (0.81) | (-0.56) | (-0.10) | (0.32) | (0.53) | (0.10) | (-0.10) | (0.32) |
| lnERi*LFDI | | -0.135 | | | | | | | |
| | | (-3.00)*** | | | | | | | |
| LFDI | | | 0.509 | | | | | | |
| | | | (2.71)*** | | | | | | |
| lnERi*HFDI | | | | 0.061 | | | | | |
| | | | | (1.26) | | | | | |
| HFDI | | | | | -0.191 | | | | |
| | | | | | (-0.98) | | | | |
| lnERi*ATSALES | | | | | | -0.066 | | | |
| | | | | | | (-1.35)* | | | |
| ATSALES | | | | | | | 0.185 | | |
| | | | | | | | (0.94) | | |
| lnERi*HTSALES | | | | | | | | 0.033 | |
| | | | | | | | | (0.62) | |
| HTSALES | | | | | | | | | -0.065 |
| | | | | | | | | | (-0.31) |
| Adj. R-squared | 0.213 | 0.383 | 0.354 | 0.229 | 0.212 | 0.235 | 0.210 | 0.196 | 0.188 |
| F Value | 2.58 | 4.11 | 3.74 | 2.49 | 2.35 | 2.54 | 2.33 | 2.22 | 2.16 |
| n | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| d.f. | 29 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 |

**Notes:** A variable $\ln L_{ifu}(-1)$ is one-period lagged employment. Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. Also see notes to Table 1-5a.

## Table 1-7a. Robustness Check for the REER with Time-Fixed Export Weights: Employment Regression

| | Dependent Variable = dlnLi (First difference of log employment). | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Measure for FDI | No FDI | | Affiliates' Employment | | | | | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Intercept | 0.890 | 1.600 | 1.798 | 3.197 | 1.510 | 2.916 | 1.154 | 2.030 | 1.102 | 1.999 |
| | (0.90) | (1.49)* | (1.73)** | (2.78)*** | (1.48)* | (2.60)*** | (1.15) | (1.86)** | (1.08) | (1.80)** |
| lnLi(-1) | -0.152 | -0.164 | -0.285 | -0.330 | -0.268 | -0.330 | -0.215 | -0.232 | -0.201 | -0.226 |
| | (-2.38)** | (-2.61)*** | (-3.23)*** | (-3.87)*** | (-2.99)*** | (-3.71)*** | (-2.66)*** | (-2.97)*** | (-2.48)*** | (-2.82)*** |
| lnWi | -0.089 | -0.153 | -0.165 | -0.291 | -0.146 | -0.274 | -0.105 | -0.183 | -0.096 | -0.174 |
| | (-0.83) | (-1.35)* | (-1.54)* | (-2.52)*** | (-1.36)* | (-2.38)** | (-0.99) | (-1.62)* | (-0.90) | (-1.54)* |
| lnGDPi | 0.137 | 0.133 | 0.261 | 0.277 | 0.245 | 0.276 | 0.200 | 0.198 | 0.186 | 0.191 |
| | (2.58)*** | (2.66)*** | (3.33)*** | (3.88)*** | (3.09)*** | (3.72)*** | (2.75)*** | (2.96)*** | (2.56)*** | (2.79)*** |
| lnER88i | -0.132 | | -0.174 | | -0.196 | | -0.175 | | -0.154 | |
| | (-2.83)*** | | (-3.58)*** | | (-3.40)*** | | (-3.04)*** | | (-2.97)*** | |
| lnER00i | | -0.128 | | -0.170 | | -0.212 | | -0.172 | | -0.153 |
| | | (-3.14)*** | | (-4.21)*** | | (-4.17)*** | | (-3.40)*** | | (-3.38)*** |
| lnER88i*LFDI | | | -0.079 | | | | | | | |
| | | | (-2.06)** | | | | | | | |
| lnER00i*LFDI | | | | -0.101 | | | | | | |
| | | | | (-2.62)*** | | | | | | |
| LFDI | | | | | 0.287 | 0.391 | | | | |
| | | | | | (1.77)** | (2.46)** | | | | |
| lnER88i*HFDI | | | | | | | 0.046 | | | |
| | | | | | | | (1.25) | | | |
| lnER00i*HFDI | | | | | | | | 0.053 | | |
| | | | | | | | | (1.43)* | | |
| HFDI | | | | | | | | | -0.150 | -0.184 |
| | | | | | | | | | (-0.98) | (-1.24) |
| Adj. R-squared | 0.583 | 0.603 | 0.627 | 0.672 | 0.613 | 0.664 | 0.592 | 0.618 | 0.583 | 0.611 |
| F Value | 8.00 | 8.60 | 8.34 | 9.97 | 7.93 | 9.64 | 7.33 | 8.06 | 7.11 | 7.86 |
| n | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| d.f. | 28 | 28 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 27 |

**Notes:** A variable $\ln ER88_i$ is the industry-specific real effective exchange rate of industry $i$, which is calculated with export weights fixed to year 1988, while a variable $\ln ER00_i$ is the industry-specific REER, calculated with export weights fixed to year 2000. Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. Also see notes to Table 1-4a.

**Table 1-7b. Robustness Check for the REER with Time-Fixed Export Weights: Male Wage-Differential Regression**

| | Dependent Variable = dlnWigt (First difference of log wages between skilled and unskilled workers: lnWigst - lnWigut). | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gender | Male (g = m) | | | | | | | | | |
| Measure for FDI | No FDI | | Affiliates' Employment | | | | | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Intercept | 0.566 | 0.494 | 0.524 | 0.462 | 0.505 | 0.446 | 0.533 | 0.469 | 0.550 | 0.480 |
| | (8.50)*** | (8.52)*** | (7.79)*** | (7.46)*** | (7.17)*** | (6.70)*** | (7.68)*** | (7.42)*** | (8.28)*** | (8.05)*** |
| dlnLig | 0.003 | 0.013 | 0.002 | 0.011 | 0.003 | 0.011 | 0.005 | 0.013 | 0.005 | 0.014 |
| | (0.30) | (1.14) | (0.24) | (0.95) | (0.34) | (1.03) | (0.46) | (1.19) | (0.52) | (1.22) |
| lnGDPi | -0.003 | 0.003 | 0.0004 | 0.005 | 0.0004 | 0.005 | 0.0002 | 0.005 | 0.000 | 0.005 |
| | (-0.64) | (0.58) | (0.08) | (0.91) | (0.07) | (0.93) | (0.04) | (0.91) | (0.03) | (0.90) |
| lnER88i | 0.057 | | 0.058 | | 0.053 | | 0.053 | | 0.057 | |
| | (4.75)*** | | (5.02)*** | | (4.53)*** | | (4.29)*** | | (4.76)*** | |
| lnER00i | | 0.053 | | 0.052 | | 0.048 | | 0.049 | | 0.051 |
| | | (4.58)*** | | (4.56)*** | | (4.01)*** | | (3.93)*** | | (4.39)*** |
| lnER88i*LFDI | | | -0.015 | | | | | | | |
| | | | (-2.01)** | | | | | | | |
| lnER00i*LFDI | | | | -0.012 | | | | | | |
| | | | | (-1.36)* | | | | | | |
| LFDI | | | | | 0.063 | 0.047 | | | | |
| | | | | | (2.07)** | (1.44)* | | | | |
| lnER88i*HFDI | | | | | | | 0.011 | | | |
| | | | | | | | (1.44)* | | | |
| lnER00i*HFDI | | | | | | | | 0.009 | | |
| | | | | | | | | (0.99) | | |
| HFDI | | | | | | | | | -0.046 | -0.032 |
| | | | | | | | | | (-1.47)* | (-0.98) |
| Adj. R-squared | 0.558 | 0.546 | 0.591 | 0.556 | 0.594 | 0.559 | 0.571 | 0.546 | 0.572 | 0.546 |
| F Value | 8.93 | 8.56 | 8.96 | 7.89 | 9.04 | 7.96 | 8.31 | 7.61 | 8.34 | 7.60 |
| n | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| d.f. | 37 | 37 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Notes:** A variable $\ln ER88_i$ is the industry-specific real effective exchange rate of industry $i$, which is calculated with export weights fixed to year 1988, while a variable $\ln ER00_i$ is the industry-specific REER, calculated with export weights fixed to year 2000. Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. Also see notes to Tables 1-5a.

## Table 1-7c. Robustness Check for the REER with Time-Fixed Export Weights: Female Wage-Differential Regression

| | Dependent Variable = dlnWig (First difference of log wages between skilled and unskilled workers: lnWigs - lnWigu). | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gender | Female (g = f) | | | | | | | | | |
| Measure for FDI | No FDI | | Affiliates' Employment | | | | | | | |
| Coefficients | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| Intercept | -0.127 | -0.160 | -0.221 | -0.207 | -0.315 | -0.319 | -0.306 | -0.281 | -0.161 | -0.135 |
| | (-0.50) | (-0.72) | (-0.89) | (-0.97) | (-1.20) | (-1.42)* | (-1.25) | (-1.35)* | (-0.67) | (-0.65) |
| dlnLig | 0.002 | 0.004 | 0.041 | 0.044 | 0.045 | 0.049 | 0.065 | 0.067 | 0.063 | 0.066 |
| | (0.08) | (0.16) | (1.17) | (1.37)* | (1.22) | (1.45)* | (1.74)** | (1.98)** | (1.61)* | (1.83)** |
| lnGDPi | 0.043 | 0.039 | 0.052 | 0.045 | 0.051 | 0.044 | 0.061 | 0.055 | 0.059 | 0.052 |
| | (2.07)** | (1.77)** | (2.53)*** | (2.16)** | (2.49)*** | (2.10)** | (2.96)*** | (2.64)*** | (2.80)*** | (2.46)*** |
| lnER88i | -0.001 | | -0.016 | | -0.043 | | -0.079 | | -0.045 | |
| | (-0.02) | | (-0.33) | | (-0.82) | | (-1.43)* | | (-0.89) | |
| lnER00i | | -0.021 | | -0.028 | | -0.064 | | -0.098 | | -0.062 |
| | | (-0.51) | | (-0.73) | | (-1.45)* | | (-2.12)** | | (-1.49)* |
| lnER88i*LFDI | | | -0.070 | | | | | | | |
| | | | (-1.89)** | | | | | | | |
| lnER00i*LFDI | | | | -0.087 | | | | | | |
| | | | | (-2.26)** | | | | | | |
| LFDI | | | | | 0.292 | 0.338 | | | | |
| | | | | | (1.87)** | (2.18)** | | | | |
| lnER88i*HFDI | | | | | | | 0.099 | | | |
| | | | | | | | (2.51)*** | | | |
| lnER00i*HFDI | | | | | | | | 0.116 | | |
| | | | | | | | | (2.85)*** | | |
| HFDI | | | | | | | | | -0.371 | -0.409 |
| | | | | | | | | | (-2.23)** | (-2.50)*** |
| Adj. R-squared | 0.058 | 0.065 | 0.120 | 0.158 | 0.118 | 0.151 | 0.176 | 0.216 | 0.150 | 0.181 |
| F Value | 1.39 | 1.44 | 1.75 | 2.03 | 1.73 | 1.98 | 2.18 | 2.52 | 1.97 | 2.22 |
| n | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| d.f. | 37 | 37 | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Notes:** A variable $\ln ER88_i$ is the industry-specific real effective exchange rate of industry $i$, which is calculated with export weights fixed to year 1988, while a variable $\ln ER00_i$ is the industry-specific REER, calculated with export weights fixed to year 2000. Estimation method is OLS, and all specifications include year dummies. The numbers in parentheses are t-ratios, not standard errors. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. Also see notes to Tables 1-5a.

**Appendix Table 1-1. Share of Exports to 17 Countries in Total Exports to the World: 10 Japanese Manufacturing Industries (%)**

| | 1988 | 1991 | 1994 | 1997 | 2000 |
|---|---|---|---|---|---|
| Food | 82.7 | 80.3 | 86.3 | 87.7 | 88.5 |
| Textiles | 77.1 | 80.6 | 83.8 | 84.9 | 85.9 |
| Chemicals | 84.7 | 85.8 | 87.1 | 87.9 | 87.8 |
| Iron and Steel Products | 75.3 | 80.7 | 85.6 | 83.9 | 84.1 |
| Non-Ferrous Metals | 92.9 | 92.8 | 95.1 | 94.7 | 93.4 |
| Metal Products | 81.3 | 81.5 | 86.1 | 87.2 | 86.1 |
| Machinery | 83.6 | 84.7 | 87.1 | 87.7 | 88.2 |
| Electrical Machinery | 87.7 | 88.4 | 92.6 | 89.8 | 90.8 |
| Transport Equipments | 72.5 | 67.7 | 67.1 | 67.8 | 71.9 |
| Precision Instruments | 83.3 | 83.4 | 89.7 | 92.3 | 92.9 |

**Sources:** Japan Tariff Association, *Summary Report on Trade of Japan.*

**Appendix Table 1-2. Overseas Employment and Total Sales of Japanese Multinational Corporations in 2000FY: Low Income (or Asian), High Income, and All Countries**

| Industry | Overseas Employment (in persons) | | |
|---|---|---|---|
| | Low Income Countries | High Income Countries | Total (All Regions) |
| Food | 47,403 | 29,226 | 99,672 |
| Textile | 134,820 | 13,879 | 181,046 |
| Wood, paper and pulp | 15,539 | 2,547 | 29,346 |
| Chemicals | 60,766 | 74,364 | 166,288 |
| Iron and Steel products | 24,553 | 21,253 | 55,492 |
| Non-ferrous metals | 41,480 | 9,229 | 60,653 |
| Machinery | 56,948 | 61,738 | 142,953 |
| Electrical machinery | 719,072 | 181,457 | 1,048,486 |
| Transportation equipment | 207,160 | 227,431 | 625,082 |
| Precision instruments | 60,373 | 14,634 | 86,727 |
| Manufacturing total | 1,514,248 | 761,643 | 2,805,898 |
| Non-manufacturing total | 147,604 | 350,161 | 646,970 |
| TOTAL | 1,661,852 | 1,111,804 | 3,452,868 |

**Appendix Table 1-2. (Continued)**

| Industry | Overseas Total Sales (in millions of yen) | | |
|---|---|---|---|
| | Asian Countries | High Income Countries | Total (All Regions) |
| Food | 396,469 | 812,998 | 1,428,958 |
| Textile | 872,376 | 237,094 | 1,176,074 |
| Wood, paper and pulp | 92,541 | 81,906 | 553,553 |
| Chemicals | 1,654,557 | 3,113,797 | 5,009,121 |
| Iron and Steel products | 605,975 | 1,176,851 | 2,034,805 |
| Non-ferrous metals | 443,434 | 305,563 | 893,599 |
| Machinery | 990,394 | 2,261,339 | 3,405,577 |
| Electrical machinery | 9,422,590 | 9,104,679 | 19,605,229 |
| Transportation equipment | 3,496,457 | 9,740,105 | 16,618,209 |
| Precision instruments | 576,910 | 621,718 | 1,233,610 |
| Manufacturing total | 19,897,915 | 30,259,143 | 56,218,878 |
| Non-manufacturing total | 16,478,208 | 47,336,862 | 72,796,101 |
| TOTAL | 36,376,123 | 77,596,005 | 129,014,979 |

**Sources:** METI, *Survey of Overseas Business Activities*, 1990, 1993, 1996, 2000, and 2003.
**Notes:** The sum of low income (Asian) countries and high income countries is not equalized to the country total, since there are countries left out from this table, which are significant recipients of Japanese FDI, such as Canada, Brazil, Mexico, Australia, and New Zealand. Numbers are only for the fiscal year 2000. China and ASEAN (Association of South East Asian Nations) 4 countries constitute the low income country (LIC) group, while the U.S. and EU (European Union) nations constitute the high income country (HIC) group. ASEAN 4 countries are: Indonesia, Malaysia, The Philippines, and Thailand. Due to the data availability, NIEs are included in the low income country group for total sales data. Manufacturing total includes oil and coal, and others, as well as those 10 industries of the table.

## Appendix Table 1-3. Total Number of Employees (10 persons) and Skill-Intensity by Gender: Japanese Manufacturing

| | Food | Textiles | Chemicals | Iron & Ste | Non-ferrou | Metal prod | Machinery | Electrical | Transport | Precision |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total Number of Employees** | | | | | | | | | | |
| 1988 | 65748 | 63026 | 39283 | 29669 | 13323 | 45331 | 68421 | 125365 | 68726 | 19536 |
| 1991 | 61502 | 61346 | 39297 | 27744 | 13490 | 47075 | 71190 | 131693 | 77056 | 19022 |
| 1994 | 64336 | 51367 | 39048 | 24082 | 11463 | 40758 | 67924 | 123473 | 68572 | 17203 |
| 1997 | 65371 | 48401 | 39595 | 22877 | 13561 | 41909 | 72836 | 131748 | 77154 | 17941 |
| 2000 | 63770 | 35197 | 35516 | 18619 | 11809 | 40590 | 67919 | 130701 | 72655 | 16931 |
| **Male-Skilled** | | | | | | | | | | |
| 1988 | 0.12 | 0.06 | 0.30 | 0.11 | 0.20 | 0.13 | 0.22 | 0.23 | 0.16 | 0.21 |
| 1991 | 0.14 | 0.06 | 0.31 | 0.13 | 0.16 | 0.13 | 0.22 | 0.24 | 0.17 | 0.24 |
| 1994 | 0.15 | 0.07 | 0.30 | 0.16 | 0.21 | 0.15 | 0.25 | 0.27 | 0.21 | 0.29 |
| 1997 | 0.16 | 0.09 | 0.34 | 0.18 | 0.23 | 0.16 | 0.28 | 0.30 | 0.21 | 0.31 |
| 2000 | 0.17 | 0.10 | 0.35 | 0.19 | 0.24 | 0.18 | 0.28 | 0.31 | 0.22 | 0.31 |
| **Male-Unskilled** | | | | | | | | | | |
| 1988 | 0.45 | 0.30 | 0.55 | 0.83 | 0.68 | 0.66 | 0.66 | 0.47 | 0.71 | 0.50 |
| 1991 | 0.46 | 0.30 | 0.54 | 0.81 | 0.70 | 0.66 | 0.65 | 0.46 | 0.71 | 0.47 |
| 1994 | 0.44 | 0.28 | 0.51 | 0.77 | 0.66 | 0.64 | 0.62 | 0.45 | 0.67 | 0.44 |
| 1997 | 0.42 | 0.27 | 0.46 | 0.74 | 0.63 | 0.63 | 0.60 | 0.45 | 0.67 | 0.43 |
| 2000 | 0.42 | 0.29 | 0.47 | 0.73 | 0.62 | 0.62 | 0.59 | 0.43 | 0.65 | 0.43 |
| **Female-Skilled** | | | | | | | | | | |
| 1988 | 0.01 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| 1991 | 0.02 | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.01 | 0.02 |
| 1994 | 0.03 | 0.03 | 0.06 | 0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 0.01 | 0.02 |
| 1997 | 0.04 | 0.05 | 0.08 | 0.02 | 0.02 | 0.02 | 0.02 | 0.04 | 0.01 | 0.03 |
| 2000 | 0.05 | 0.05 | 0.07 | 0.02 | 0.02 | 0.02 | 0.02 | 0.04 | 0.02 | 0.03 |
| **Female-Unskilled** | | | | | | | | | | |
| 1988 | 0.41 | 0.63 | 0.13 | 0.05 | 0.11 | 0.20 | 0.11 | 0.29 | 0.12 | 0.28 |
| 1991 | 0.39 | 0.62 | 0.13 | 0.06 | 0.13 | 0.20 | 0.11 | 0.29 | 0.12 | 0.28 |
| 1994 | 0.38 | 0.62 | 0.13 | 0.06 | 0.12 | 0.19 | 0.11 | 0.25 | 0.11 | 0.25 |
| 1997 | 0.37 | 0.60 | 0.12 | 0.06 | 0.12 | 0.19 | 0.10 | 0.22 | 0.11 | 0.23 |
| 2000 | 0.35 | 0.56 | 0.11 | 0.06 | 0.12 | 0.17 | 0.11 | 0.21 | 0.11 | 0.23 |

**Sources:** MHLW, *Basic Survey on Wage Structure*, 1989, 1992, 1995, 1998, and 2001.
**Notes:** The sample consists of all full-time workers in firms with 10 or more.

**Appendix Table 1-4. Nominal and Real Wage Growth Comparison and Correlation: 1988 and 2000**

| | (1) Wn | (2) Wi | (3) Wcpi | Corr[Wi, Wn] | Corr[Wi, Wcpi] |
|---|---|---|---|---|---|
| Food | 37.0 | 20.7 | 19.6 | 0.982 | 0.962 |
| Textiles | 53.9 | 30.3 | 34.4 | 0.983 | 0.987 |
| Chemicals | 31.1 | 71.0 | 14.5 | 0.984 | 0.993 |
| Iron and Steel Products | 31.8 | 64.1 | 15.1 | 0.949 | 0.949 |
| Non-Ferrous Metals | 36.6 | 34.8 | 19.3 | 0.897 | 0.909 |
| Metal Products | 37.3 | 28.0 | 19.9 | 0.877 | 0.900 |
| Machinery | 33.5 | 16.5 | 16.6 | 0.990 | 0.995 |
| Electrical Machinery | 42.4 | 179.1 | 24.4 | 0.956 | 0.968 |
| Transport Equipment | 36.2 | 15.1 | 19.0 | 0.826 | 0.773 |
| Precision Instruments | 34.5 | 32.4 | 17.5 | 0.993 | 0.983 |

**Notes:** The growth rate is the percentage change between the two-endpoint years: 1988 and 2000. Column (1), $W_n$, shows the nominal wage growth rates. Column (2), $W_i$, shows the real wage growth rates deflated by the sectoral GDP deflators. Column (3), $W_{cpi}$, shows the real wage growth rates deflated by the aggregate CPI. In the last two columns, $Corr[W_i, W_n]$ means the correlation coefficient between $W_i$ in column (2) and $W_n$ in column (1), and $Corr[W_i, W_{cpi}]$ means the correlation coefficient between $W_i$ in column (2) and $W_{cpi}$ in column (3).

# CHAPTER TWO

## Determinants of Vertical Integration and Skill-Intensity: Implications for the Demand Crisis of Keiretsu Firms in Japanese Manufacturing

## 1. Introduction

Developing a vertical supply chain becomes an increasingly important part of global strategies for multinational corporations (MNCs). The driving force is the cost incentive and the chain is internationally spread out in line with comparative advantages. There is, however, a growing fear of bypassing domestic supplies for small and medium sized firms in keiretsu networks in Japan. In the course of Japanese economic growth after the Second World War, contributions by keiretsu suppliers have been recognized as the success in developing skills to produce quality parts specific to their customers. However, due to this tradition, they now encounter the difficulty in finding new customers to sell their skills in the face of old customers switching away from them to suppliers in a foreign country (Asanuma (1989), and Cowling and Tomlinson (2000)). Skilled works by keiretsu firms are supposedly better substituted with works by suppliers in relatively skill-abundant countries. Yet, integration of firms alone may not result in the "demand crisis", since it is possible that assembly factories are established in a foreign country because of the cost advantage and still continue to import parts from keiretsu firms. The problem will happen, however, if the factories procure parts in the local market. This chapter, therefore, empirically examines the determinants of vertical integration and proposes the possible links between the determinants and effects on keiretsu firms.

Theoretical literature suggests that vertical integration is an alternative form to outsourcing in which *relation-specific investments* (RSI) [37] for customization are

[37] The RSI is the investment in the relation-specific skills, which is described by Asanuma as "the skill required on the part of the supplier to respond efficiently to the specific needs of the core firm", and peculiar to Japan (Asanuma (1989), p.21).

particularly important (Asanuma (1989),[38] and Grossman and Helpman (2002a, b, and c)). A manufacturer outsources to specialists a part-production that needs the relation-specific investment because outside specialists can produce it at lower marginal cost than the manufacturer. Since the relationship between the supplier and the manufacturer based on the relation-specific investment is governed by a contract, completeness of a contract should be a positive factor of outsourcing but a negative factor of vertical integration for the manufacturer. To the extent that contracting environment depends on the legal structure of each country, geographical variations of contracting environment should affect the MNCs' locational choice of vertical integration (Sazanami (1993)). Therefore, I would argue that under the unfavorable contractual circumstances, if MNCs increase vertical integration, it would not necessarily be harmful to keiretsu firms. Foreign affiliates are not expected to be responsible for production requiring the relation-specific investment, and most likely to import intermediate inputs from keiretsu firms in Japan. If, however, MNCs increase vertical integration in the favorable environment, it would be implied that the foreign affiliates might procure skilled works in the local market (outsourcing), leading to the decrease in the demand for keiretsu firms' production.

Degree of the efficacy of the relation-specific investment depends on the characteristics of parts (Head, Ries, and Spencer (2002)). Presumably, production of quality-sensitive parts, like electronic devices, engines, and brakes, tends to require more relation-specific investment. I consider this tendency to be captured by skill-intensity of an industry. It is, thus, considered that a high-skill industry may have to engage in more relation-specific investment while a low-skill industry may have less. Empirical analysis

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[38] Asanuma's (1989) study is based on a field research on two major industries: Automobile and electric machinery industries.

is, therefore, conducted for individual industries as well as all industries, and high-skill or low-skill industry groups.

Data set is a panel of 10 industries by 7 regions for five years: 1986, 1989, 1992, 1995, and 1998.[39] I calculate the vertical integration measure by the share of foreign affiliates' sales within the same corporate groups out of total sales. I use democracy scores as a proxy for the contracting environment, and adult literacy tare as a proxy for basic skills of labor force. My empirical results for individual industry regressions reveal that in the high-skill industries, such as machinery, electrical machinery, and precision instruments industries, vertical integration increases under unfavorable contracting environment measured by democracy scores, and with sufficient level of basic skills measured by adult literacy rates. Results of the low-skill industry group, on the other hand, suggest that the basic skills alone are considered to be the most important factor of vertical integration. Hence, vertical integration is not really a ground of the "demand crisis" facing small and medium sized firms in keiretsu networks in Japan, but rather outsourcing seems to be more closely linked with this problem.

## 2. Analytical Framework

*Determinants of Vertical Integration*

The objective of this section is to clarify the determinant factors of vertical integration. Grossman and Helpman (2002c) develop a theoretical model to analyze the relative prevalence of outsourcing against vertical integration in industry equilibrium.

[39] One limitation of this study, however, is that outsourcing cannot really be dealt with, since for some years METI does not provide parent firms' total imports by region, which prevents me from calculating the intra-firm import ratio by region. As a result, I focus on the determinants of vertical integration, leaving out the study of the determinants of outsourcing in the future.

The essence of their model is as follows. A final producer of consumer goods searches for a specialized intermediate input supplier whose marginal cost is lower than the producer's and the vertically integrated firm's marginal costs. The type of the input by the supplier is, however, not necessarily exactly the same as what the producer requires, and therefore, it is important for the producer to govern the relation-specific investment by a contract to make the supplier succeed in skills to develop a prototype. As long as the input made by the supplier is close enough to the prototype, the producer would choose to outsource the input to the supplier. However, if the input is very different from the prototype, the producer would choose to engage in vertical integration and make it by itself. There must be a threshold on which the producer is indifferent between "make" and "buy". One important factor affecting this threshold is a contracting environment since the relation-specific investment is governed by a contract. If a manufacturer knows that contracting environment is favorable in a country by a reliable third party responsible for the completeness of the contract, then it is indicative of outsourcing working well. Therefore, the favorable contracting environment would be a factor of reducing the number of firms committing vertical integration.

Grossman and Helpman discuss other variables that affect the threshold. A relative increase in productivity advantage held by the specific-input suppliers over the subsidiaries of MNCs in a foreign market will lead to more outsourcing firms, since manufacturing a part becomes relatively more costly for a producer. An increase in the industry size will also raise the fraction of firms engaging in outsourcing within the industry. Since as more suppliers enter the market, it becomes easier for a producer to find a partner in the "thicker" market. An increase in the Southern wages relative to

Northern wages, however, will lead to the higher cost of input production by specialists, thereby decreasing the number of suppliers, and so that, fewer producers can find suppliers. Hence, outsourcing will decrease. Firms in a country with advanced technology are likely to engage in innovative activities, making outsourcing prevailed (Acemogle, Aghion, and Zilibotti (2002)). Therefore, in the dichotomous model, vertical integration should be a negative function of productivity of a host economy, the industry size, and technological level, but a positive function of wages. The last result of positive function of wages in the Grossman and Helpman model is, however, at odds with the existing theory and empirical regularities. The sufficiently large difference in factor endowments motivates firms of a relatively capital-abundant country to get involved in vertical integration, or FDI, in a relatively labor-abundant country (Helpman and Krugman (1985)), and much of the empirical literature has examined that the low wages are one of the significant determinants of FDI. Hence, I consider that the wages should also negatively affect vertical integration.

The bilateral negotiation seems particularly important for the intermediate input production that requires capital more intensively than labor. The capital-intensive inputs are generally more quality-sensitive. Take for example an automobile industry. Auto production requires a lot of parts and semi-finished goods in addition to raw materials. Engines and brakes are typically considered as a capital-intensive semi-finished good, and their quality is recognizable even by ordinary drivers. It is inferred that a capital-intensive good production is highly affected by the degree of technological advancement (capital-labor ratio) of a country. For example, Japanese automobile makers procure unexpectedly more auto parts from the U.S. (Head, Ries, and Spencer (2002)). It follows that demand for capital-intensive inputs would be much stronger in capital-abundant countries while labor-intensive inputs or assembly stage of production processes would be integrated in labor-abundant countries. Therefore, vertical integration can be seen as a negative function of the relative capital abundance.[40]

*Implications for Keiretsu Firms*

To analyze the effects of vertical integration on small and medium sized firms in keiretsu networks, the Grossman and Helpman model provides a useful framework. Keiretsu firms are considered to have spent much of the relation-specific investment. Their primal role in the network has been tailoring quality parts to manufacturers. They are also assumed to supply some general parts as well. Japanese large corporations used to purchase inputs mainly from those firms. But now, they have a choice: make intermediate inputs by in-house plants (vertical integration abroad), outsource to subcontractors in a foreign country, or simply imports (by arm's length transactions). The last choice is not explored in this study since these types of inputs are considered more general so that it can have only little effect on keiretsu firms. In the case of outsourcing, a perfect substitution would hurt keiretsu firms. Large corporations seek a foreign specialist who can produce a prototype efficiently. Since the keiretsu firms are "locked into" the specialized products as the demand decreases but have less room for diversity, a "hold-up problem" as well as the "demand crisis" would result in. This is the worst case for firms in keiretsu networks.

[40] In the connection between FDI and the pattern of trade, the direction of comparative advantage should play an important role particularly for the locational decision of investment among Asia, North America, and Europe. Feliciano and Lipsey (2002) find that foreign firms' new establishments and takeovers in the U.S. are largely in industries, in which the U.S. does not have a comparative advantage but the investing countries have a comparative advantage.

When large corporations integrate foreign suppliers, on the other hand, the effect on keiretsu firms would be less severe. It is likely that foreign affiliates are responsible for labor-intensive production stages and not expected to engage in work that needs the relation-specific investment. Thus, they would likely continue to import skilled inputs from keiretsu firms in Japan. In this case, therefore, neither the negative effect on demand for keiretsu production nor the "hold-up problem" takes place. If the foreign affiliates procure inputs in the local market, however, there would be a decrease in the demand for supplies by keiretsu firms, but still no "hold-up" problem is expected since those goods are general inputs that can be sold to any manufacturer.

It is rational only if a manufacturer procures special-inputs to foreign suppliers while it makes by themselves general parts and inputs that do not require the relation-specific investment, since the efficacy of the relation-specific investment is maximized when the specific part is produced by the specialist under favorable contractual circumstances. This should be the basis of MNCs' decision making at the industry level as well. I consider industrial skill-intensity as revealing the importance of the production with the relation-specific investment. Then, the rationality should be carried over in such a way that high-skill industries are involved in more relation-specific investment and thus engage more in outsourcing to suppliers in foreign countries where the contracting environment is favorable. On the other hand, low-skill industries are not much involved in the work with the relation-specific investment, and so that, vertical integration would be prevalent regardless of the favorableness of contracting environment. Analogous to the comparative advantage principle in the traditional trade theory, it is implied that if a host country is relatively more endowed with favorable contracting environment than labor, it would have a comparative advantage in outsourcing, whereas if the country is relatively more endowed with labor than a legal system, it has a comparative advantage in vertical integration. Hence, it is predicted that MNCs in a high-skill industry increase outsourcing and decrease vertical integration in countries with favorable contracting environment, and that MNCs in a low-skill industry increase vertical integration in countries regardless of the situations of the legal system but with definitely lower production costs.

One particular case should be noted. If vertical integration increases in a country where contracting environment is favorable, it would be suggested that foreign affiliates procure an input that requires the relation-specific investment in the local market, which gives rise to the "hold-up problem" as well as the "demand crisis" to the small and medium sized firms in keiretsu networks.

Table 2-1 summarizes the causes and consequences of international vertical integration and international outsourcing discussed above. Propositions can be derived in the followings.

*Propositions:*

*(1) For high-skill industries, the relation-specific investment (RSI) is important, and so that, a favorable contracting environment decreases vertical integration (but increases outsourcing). Vertical integration may increase in a country where contracting environment is not very favorable, but this increase should not harm keiretsu firms since foreign affiliates established in that country are not responsible for the RSI and are more likely to continue imports from keiretsu suppliers. If vertical integration expands in a*

*country with a favorable contracting environment, however, it is implied that affiliates are likely to procure the RSI-type inputs in the local market, and thereby imposing harmful output effects on firms in keiretsu networks.*

*(2) For low-skill industries, since the relation-specific investment is not very important, MNCs tend to integrate suppliers in a country where production costs are lower regardless of the situation of contracting environment.*

## 3. Vertical Integration and Skill-Intensity Measures

*Data Sources*

I use data for 10 manufacturing industries and 7 regions for 5 years from the *Survey of Overseas Business Activities*, by Ministry of Economy, Trade and Industry (METI), Japan. These data have information on sales, procurement, employment, assets and other information about both parent firms and their foreign affiliates. Affiliates are defined by firms whose 10 percent or more of the stocks are held by the parent firm. The survey reports only aggregated numbers that are classified by major industry categories of both manufacturing and non-manufacturing. It is available annually, but the detailed survey has been conducted every three years. Some of the necessary data for calculation of my vertical integration measure is only available from the detailed survey. As a result, my data set is constrained to those years, specifically 1986, 1989, 1992, 1995, and 1998.[41] Since Japanese FDI surged in the late 1980s under the drastic yen appreciation, I started the analysis in 1986.[42]

[41] The percentage that the firms returned survey sheets to METI varies from year to year: 33.4% in 1986, 46.9% in 1989, 47.2% in 1992, 60.4% in 1995, and 56.0% in 1998. The number of parent firms (foreign

METI also publishes the *Census of Manufacturers*, which covers all firms in manufacturing industries. One advantage of these data is that it allows one to distinguish cost of subcontracting orders from other variable costs comprising cost of raw materials, fuels and electricity consumed. The subcontracting costs are defined by "payments made and accounts payable to subcontractors for consigned manufacture and/or processing, supplying raw materials or semi-finished works to them" (METI (1999)).[43] The sum of those subcontracting and other costs constitute total (variable) costs, and thus, I take a ratio of the subcontracting cost to the total costs (subcontracting ratio) to indicate the importance of outsourcing for each industry. However, since this subcontracting cost includes both domestic purchases and imports, the ratio should be regarded as a rough measure of outsourcing unlike a measure defined elsewhere in the literature.[44] The data points correspond to those of the METI survey data set.

Wages and employment data are taken from the *Basic Survey on Wage Structure*, by Ministry of Health, Labor, and Welfare (MHLW), Japan. Following Berman, Bound, and Griliches (1994), I define the demand for skilled workers as the male college graduates' payment share of the total wage bill.[45] Since data on female college graduates are not always available in earlier years, I collected data only for male employees. Again, the data points correspond to those of the METI survey data set.

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affiliates) answered also varies from 1,144 (4,213) in 1986, to 1,563 (6,362) in 1989, to 1,594 (7,108) in 1992, to 2,390 (10,416) in 1995, and to 2,151 (13,017) in 1998.

[42] The 1998 survey is the latest possible year at the time of this research.

[43] "*Itaku seisan-hi*" in Japanese.

[44] The data source does not allow me to decompose input purchases into domestic or imports, nor into purchases within the same industry or from other industries. See Feenstra (1998) or Feenstra and Hanson (1996) for the standard treatment of outsourcing in empirical literature.

[45] That is, the demand depends on relative wages and relative quantities.

*The Measure of Vertical Integration*

In empirical analysis, since data are not available to construct a reliable measure of outsourcing, I concentrate solely on explaining the determinants of vertical integration. My measure of vertical integration is defined as the share of foreign affiliates' sales within the same corporate groups to their total sales. It represents the importance of sales to the parent company and to other related firms abroad. In the METI data, sales shares of affiliates located in each country/region are classified by three types: local sales, sales back to Japan, and sales to other countries/regions than Japan. It also reports affiliates' sales shares within the same corporate groups out of their total sales by the three sales locations. Thus, I multiply the sales share within the same corporate groups by the sales share for each sales location, and add them to obtain the share of sales within the same corporate groups relative to the total sales (vertical integration measure: VI).[46] Affiliates exports to the parent company are the parent company's imports from the integrated firms. As this index rises, the degree of integration becomes higher. Although the expression, "corporate group", is used in the survey, it is a slightly different concept from

[46] Let the three types of sales values (in million yen, for instance) for affiliates in industry $i$ in region $r$ be $S_1$, $S_2$, and $S_3$, for local, back to Japan, and to other countries than Japan, respectively. Also let the sales values within the same corporate groups be $C_1$, $C_2$, and $C_3$, for the respective destinations, with $C_d \leq S_d$ ($d = 1, 2, or\, 3$) satisfied. Then in region $r$, the total sales $TS$, is the sum of $S's$, and the total sales within the same corporate groups, $TC$ is the sum of $C's$. My vertical integration measure in industry $i$ region $r$ ($VI_i^r$) is defined as $TC/TS$ in $i$ and in $r$. Although $C's$ are not available, METI provides the share of corporate sales ($C_d/S_d = x_d$) together with the sales share by destination ($S_d/TS = y_d$). Therefore, I calculate the integration measure by $VI = \sum_d \left[ C_d/S_d \cdot S_d/TS \right] = \sum_d \left[ x_d \cdot y_d \right]$, for each industry $i$ in each region $r$.

a *keiretsu* group. It rather means that an affiliate sells to other affiliates invested by the same parent firm, and those affiliates can be located in different countries.

*Evidence of Declining Outsourcing to Domestic Suppliers, and Trends of Vertical Integration and Skill-Intensity: 1986 – 1998*

Table 2-2a reports the amount of spending on subcontracting orders by 10 Japanese manufacturing industries (in billions of yen). During the period between 1986 and 1992, all of the industries drastically increased subcontracting spending: 66.1 percent in food industry and 61.3 percent in chemical products industry. The average increase is 42.3 percent. In contrast, during the period between 1992 and 1998, all industries but chemicals and electrical machinery industries decreased their spending. The average decrease is 9.5 percent, and one can particularly note the biggest decrease in the textile industry with a 42.0 percent decline. Although the data cannot identify what portion of the subcontracting spending directed to domestic suppliers, one can think that the portion should be relatively large since the data covers all firms within an industry whether MNCs or non-MNCs, and thus, the table supports evidence of the declining tendency of subcontracting orders to the small and medium sized firms in keiretsu networks.

Table 2-2b represents the share of subcontracting costs to total costs. Textile, machinery, electrical machinery, and precision instruments industries show relatively higher ratio of subcontracting. As long as these industries can be viewed as an *outsourcing industry*, the "demand crisis" must be of concern for these industries' small firms. Food and chemical industries, on the other hand, show relatively lower subcontracting ratio. Transportation equipment industry also shows the relatively lower ratio. It should be pointed out that the subcontracting value of textile industry plunged during the 1990s but the ratio over the total costs did not change so drastically, maintaining about 23 to 24 percent. The transportation equipment and precision instruments industries are, on the other hand, gradually decreasing the subcontracting ratio over the time period between 1989 and 1998.

The calculated measure of vertical integration for all regions is presented in Table 2-3.[47] It is interesting to see that the vertical integration measures for the *outsourcing industry* all increased between 1986 and 1998. For textile industry, the measure increased from 9.3% to 29.8%; for machinery industry, it rose from 16.5% to 35.2%; for electrical machinery industry, it increased from 21.4% to 35.0%; and for precision instruments industry, the measure jumped up from 18.2% to 46.1%. Transportation equipment industry has also expanded vertical integration from 21.4% to 35.0%.

Table 2-3 also reports an increasing tendency of skill-intensity of the 10 Japanese manufacturing industries. In 1998, chemical products industry shows the highest share of skilled employees: 39.0%. It is followed by electrical machinery (36.1%) and precision instruments industry (35.2%). Textile industry shows 22.9%, which had risen from 16.1% in 1986. The industry rankings of the skill-intensity of the table show that machinery, electrical machinery, and precision instruments are considered to be high-skill industries along with chemical and food industries. Combined with the trends of vertical integration and subcontracting ratio, it is found that those three high-skill industries are expanding

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[47] Later in the empirical section, I construct the cross-regional data set comprising seven regions: the U.S., Central and South America, NIEs, ASEAN, China, EU, and Oceania. Other regions and countries than those, such as Canada, India, Myanmar, Middle East, Africa, and Europe outside EU, are excluded in the empirical analysis, but included in the data of this section shown as *all regions*. In addition, Except for the U.S. and China, each region consists of selected countries leaving out some other countries: for example, Chile and Argentina in Central and South America, Fiji in Oceania, and so on.

vertical integration and being outsourcing industries, and that textile and transportation equipment are low-skill industries and expanding vertical integration but textile is an outsourcing industry while transportation is not really an outsourcing industry.

Figure 2-1 plots the vertical integration and the skill-intensity measures for textile, machinery, electrical machinery, transportation equipment, and precision instruments by industry. It can be seen that the two variables move in parallel and upward, which implies that highly vertically integrated industries are more likely related to domestic skill upgrading. Head and Ries (2002) show the positive relationship between offshore employment and domestic non-production share of the wage bill by using Japanese manufacturing micro-firm data.[48] My data reveals that at the industry level, there is a clear correlation between vertical integration and domestic skill-upgrading, particularly for the textile and electrical machinery industries.[49]

## 4. Empirical Specification

The purpose of the empirical analysis of this section is to examine if there are industrial differences in the determinants of vertical integration. Particular focus is placed on identifying the differences in determinants between high-skill industries and low-skill industries. An empirical study of the determinants of outsourcing, however, will be left for future study. Based on the theoretical dichotomy, one may think of it possible to derive implications for outsourcing from the results of vertical integration; yet, further

[48] Head and Ries find that an increase in offshore employment in low income countries raises domestic skill-intensity, but the effect diminishes as investment increases in high income countries. In my model, vertical integration will increase in countries with not very favorable contracting environment. Therefore, income levels should not be the only factor of the domestic skill-upgrading.

[49] It should be noted, though, that the integration measure is calculated for MNCs only, whereas the skill-intensity measure is calculated based on all of the employees of the relevant firms in manufacturing.

investigations using some outsourcing measure will be necessary to obtain any conclusion.

*Model Specifications*

Equation (2-1) represents the relationship between the international organizational form and the main factors discussed in Section 2.

$$\rho_{ij}^{X} = f\left(\omega_{j,JP}, E_{j,W}, \gamma_j, \lambda_{ij}, \delta_j, Q_i\right), \quad (2\text{-}1)$$

where $\rho_{ij}^{X}$ is the measure of dominance of either outsourcing ( $X = OS$ ) or vertical integration ( $X = VI$ ) in industry $i$ in country $j$, $\omega_{j,JP}$ is the wage ratio between country $j$ and Japan, and $E_{j,W}$ is the country $j$'s capital-labor ratio relative to the world capital-labor ratio. $\gamma_j$ is some measure representing the contracting environment of a country, $j$. $\lambda_{ij}$ is the productivity condition in industry $i$ in country $j$ (labor per output). $\delta_j$ is the technology level of country $j$. $Q_i$ is the size of industry $i$.

Cross-regional data is constructed for the vertical integration measure (VI). Since, by construction, my measure, VI, does not represent the degree of outsourcing, I have to interpret equation (2-1) in terms of vertical integration. As much of FDI literature suggests, vertical integration should be a negative function of the relative wages. Given that labor-abundant countries have a comparative advantage in producing labor-intensive inputs, more MNCs will choose integration in labor-abundant countries. Thus, VI is a negative function of capital-labor ratio. A favorable contracting environment increases outsourcing in industry equilibrium, and therefore, VI is a negative function of contracting environment. Grossman and Helpman investigate the impact of an increase in the productivity (labor per output) of a part-exporting country and the industry size effects. I consider that the effect of productivity can be at least partly captured by the relative wage term, and that technological levels can also be in part captured by the term of the capital-labor ratio. Therefore, I do not explicitly include these variables. Conducting by-industry regression, I avoid dealing with the size effects and other differences in industrial characteristics.

My estimation equation becomes,

$$\rho_{rt}^{VI} = \alpha_0 + \alpha_1 WAGE_{rt} + \alpha_2 GFCF_{rt} + \alpha_3 DEMOC_{rt} + \alpha_4 LIT_{rt}$$

$$+ \sum_{l=5}^{l=8} \alpha_l YT_t + \varepsilon_{rt}, \quad (2\text{-}2)$$

for each industry $i$. Estimation is conducted first by pooling all industries, then by separating high-skill and low-skill industry groups, and finally by an individual industry. The variables are all regional data including the U.S. and China. In this study, the difference between ASEAN and EU attracts more attention than the differences between Indonesia and Malaysia or between France and Germany.

The dependent variable, $\rho_{rt}^{VI}$, is the measure of vertical integration (VI) in region $r$ in year $t$.[50] The estimated parameters are the $\alpha$'s. $WAGE_{rt}$ is the wage ratio between region $r$ and Japan in year $t$. $GFCF_{rt}$ is the relative capital spending per person of region $r$ to Japan in year $t$. $DEMOC_{rt}$ is the average democracy measure in region $r$ in year $t$. Similarly, $LIT_{rt}$ is the average adult literacy rate in region $r$ in year $t$. The estimation includes year dummies ($YT_t$) for industry analyses, and region-specific time

[50] For the U.S. and China, country data are simply used. The same thing is applied to the other variables.

trends for aggregate analyses. An error term, $\varepsilon_{rt}$, is assumed to be well behaved. The regional aggregation is obtained by the weighted average of the relevant countries within the region, by the sales share of affiliates in the country out of the total sales within the region as the weights.

To construct the variable, $WAGE_{rt}$, I obtained "wages in manufacturing (men and women)" from the International Labour Office (ILO), the *Yearbook of Labour Statistics*, 1996 and 2002 issues.[51] These wages are originally shown in national currencies. I convert them into U.S. dollars and calculate each country's wage ratio relative to Japan. Period average exchange rates are taken from the International Monetary Fund, *International Financial Statistics* (IFS), CD-ROM 2001, and used for the conversion. As to $GFCF_{rt}$, I divide each country's gross fixed capital formation (GFCF) by its population, and so, the variable is a rough proxy for country's capital-labor (endowment) ratio.[52] The GFCF and mid-year population are obtained from the IFS. The original values of GFCF are measured in national currencies, and so that, they are converted into U.S. dollars.

The key determinant in the theory, "contracting completeness", may be best represented by the number of lawyers of a country, for example. Due to the data availability, however, I use the democracy score as a proxy. The regional democracy measure, $DEMOC_{rt}$, is created based on "Combined Polity Score" reported by the Polity

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[51] Data sources of the independent variables for Taiwan are *Statistical Yearbook of the Republic of China 2002*, by Directorate General of Budget, Accounting and Statistics Executive Yuan, Republic of China, and *Key Indicators of Developing Asian and Pacific Countries 2001*, by Asian Development Bank.

[52] Capital stock should be used for an endowment variable, and the number of total labor force should be used for labor. Also, the variable should be constructed so as to show the direction of comparative advantage by the country's endowment ratio relative to the world total endowment ratio.

IV Project, Integrated Network for Social Conflict Research (INSCR) Program, University of Maryland, College Park.[53] Each country is rated by one out of 21 points between –10, "strongly autocratic", and +10, "strongly democratic". The score is calculated based on indicators of democracy and autocracy, such as openness of political institutions, and authority characteristics, such as competitiveness of executive recruitment. Therefore, higher numbers with this score indicate that countries are electorally competitive, which implies that the countries are endowed with more favorable contracting environment, presumed that electoral competitiveness is supported by people's highly legally oriented attitude.

The adult literacy rate, $LIT_{rt}$, is the regional average of the country's literacy rates taken from the *Human Development Report* by the United Nations Development Programme (UNDP).[54] The literacy rate best indicates the availability of labor force with basic skills. To some extent, it may also imply the degree of contracting environment of a country, but as a better proxy for this purpose, some measure for higher education should be used.

Appendix Table 2-1 reports these independent variables by-industry-by-region for 1998.

*Econometric Issues*

The explanatory variables of my panel data set are varying across industries. However, these variations are created by weighting country variables according to the importance of the country within a region to a particular industry. Therefore, these

[53] The Polity IV Project reports democracy score of Taiwan, but does not report that of Hong Kong.

[54] Data points are 1985, 1990, 1992, 1995, and 1998.

industry-varying variables do not really capture industrial characteristics, such as, capital-labor ratio, R&D spending, GDP size, and scale economy. Without controlling for them, pooled estimation of equation (2-2) will give rise to biased and inconsistent results due to unobserved industry effects. This problem may be dealt with by fixed-effect or random-effect models.

Since the estimation does not include the industry specific variables on the right-hand side, it may be natural to think that the unobserved industry effects are systematically correlated with the right-hand side variables. This may serve as a logical ground to use a fixed-effects model for my data set. I examine this reasoning by the Hausman's specification test (Hausman (1978)).

More peculiar thing to the data set should be considered. When it is pooled, there are two cross-sectional dimensions (industry by region) and one time-series. The model identifies an industry as a unit of decision making, and so that, region-specific factors can be controlled for by dummies in estimation. In this case, whether regional fixed (or random) effects are important should be worth considering. Since explanatory variables are region specific, regional effects might not be very influential in a way, but they could be time-varying. Thus, I include region-specific time trends in the model to deal with this issue.

## 5. Estimation Results

The results of pooled and separate estimations for sub-samples, high-skill and low-skill industry groups, are reported first, and then, the results of individual industry regressions are presented. The high-skill industries are chemicals, electrical machinery, precision instruments, machinery, and food, whose skill-intensity rankings range from first to fifth. The low-skill industries are non-ferrous metals, transportation equipment, textile, iron and steel, and wood, paper and pulp, whose skill-intensity rankings range from sixth to tenth. The average skill-intensity rankings are reported in Table 2-3. For the industry regressions, two models, with and without year dummies, are estimated.

*Aggregate Level Analysis*

Table 2-4 reports the results of pooled regression analysis of the determinants of vertical integration. The estimation includes region-specific time-trends instead of year dummies. The dependent variable is measured by the affiliates' sales share within the same corporate groups out of total sales. Overall, wages are negative but not statistically significant. Capital spending per capita is positive but not significant. The democracy variable is positive and statistically significant when the variable alone is entered in estimation (Model 1), and the literacy variable is also positive and significant when the variable alone is entered in estimation (Model 2). Model 3 includes both democracy and literacy variables, and these coefficients are positive and statistically significant at the 10 percent level, except for the democracy in the fixed-effects model. It is, therefore, implied that the contracting environment represented by the level of democracy and the adult literacy rate of host countries increases vertical integration. Based on the Hausman test for the null hypothesis that there is no systematic correlation between an error term and the right-hand side variables, suggesting that a random effect model is correct, the small number of the test statistics of the table shows that the null hypothesis cannot be rejected. Hence, all specifications in the aggregate level are in favor of a random-effects model.

Table 2-5 presents the regression results for high–skill and low-skill industry groups, separately. For the high-skill industry group, the democracy variable is positive but not always statistically significant. It is significant at 10% level in the random effects model, but the specification test is in favor of the fixed-effects model. It is interesting to see that the coefficient of the literacy rate is negative but not significant in the fixed-effects model. To the extent that it is a proxy for the contracting environment, the negative sign can be considered as a consistent result with the theoretical prediction, but as long as the literacy rate indicates basic skills of labor force, it should be a positive factor of vertical integration rather than a negative factor of that. For the low-skill industry group, the literacy variable alone is the most significant with a positive sign. MNCs in the low-skill industries consider the basic skills as very important in their decision of vertical integration. The democracy variable is positive but not significant. As a proxy for contracting environment, the insignificant democracy coefficient rather be consistent with the prediction. As for the model specification, the Hausman test statistics cannot reject the null hypothesis at the 10% significance level.

*Industry Level Analysis*

Table 2-6 presents the results of the by-industry determinant model of vertical integration. The table captures conceivable industrial differences. The democracy variable is negative and statistically significant for five industries: textile, iron and steel, machinery, electrical machinery, and precision instruments. But in the food industry, the democracy variable is positive and significant. For the rest of the industries, the estimates are not significant. In six industries, the adult literacy rate is a good indicator of where to invest. As to the estimates of other variables, the relative wages are negative for seven industries, but not all of them are statistically significant. In the iron and steel industry, wages are positive and significant. The capital spending per capita does not explain the vertical integration very well for most of the industries but precision instruments. This might be because of the use of capital flow data rather than stock data.

In the textile, machinery, electrical machinery, and precision instruments industries, vertical integration increases in those regions where the contracting environment is not favorable. This is consistent with the prediction for a high-skill industry group, in which keiretsu firms are not inflicted with harmful effects of vertical integration since affiliates production does not substitute for their products. On the other hand, in the food industry, a democracy term is positive and significant. This might be the case where MNCs increase affiliates' activities in the regions where the contracting environment is favorable and so that the affiliates are suspected to procure skilled-inputs in the local markets. Therefore, keiretsu firms in the food industry may be suffering from a "hold-up" problem as well as the "demand crisis". As Table 2-2b shows, however, food is the least subcontracting industry, and therefore, fewer subcontractors are expected to be faced with the decrease in demand even when vertical integration expands. Textile is a low-skill industry with a significantly negative democracy estimate, and neither wages nor literacy rate are significant. This may be explained by the fact that the textile industry is an outsourcing industry that expands vertical integration, as shown by Tables 2-2b and 2-

3. Accordingly, it shows a high-skill industry behavior: that is, vertical integration increases in a region where the contracting environment is not favorable.

The estimates for chemicals and transportation equipment industries show only poor fits of the model. Automobile industry is one of the few industries that have well established subcontracting systems, and much attention is paid to keiretsu firms of the industry. Thus, my model should better explain the industry's behavior. The automobile industry, however, constitutes the transportation equipment industry with other industries, such as, aircraft, and railway industries. As a result, the aggregate data appears to just reveal mixed effects of those heterogeneous behaviors within the industry.

## 6. Conclusion

This chapter has examined industrial differences in determinants of vertical integration. To the extent that the relation-specific investment varies across industries, the variations in determinants observed in the by-industry regressions can be connected with the industrial differences in the importance of the relation-specific investment. For the low-skill industries, since the relation-specific investment is not very important, the contracting environment is not a significant factor of vertical integration, but the literacy rate and wages are more important. However, there are some exceptions.

For the high-skill industries, it is found that vertical integration increases when the contracting environment is not favorable. This would suggest that the foreign affiliates are not necessarily responsible for production that requires the relation-specific investment, and they are likely to import skilled inputs by keiretsu firms in Japan. Therefore, the "demand crisis" facing small and medium sized firms in keiretsu networks is not necessarily related to an expansion of vertical integration in these industries, but it seems that outsourcing could be more likely linked with the problem. To be certain about this point, further research is required to investigate the determinants of outsourcing.

In the by-industry analysis, estimation is conducted with the small sample. Therefore, the results may suffer from the sample bias, since year effects may have significantly varied during the 1990s. Thus, more rigorous examinations based on larger samples in a time series direction will be necessary.

**Table 2-1. International Vertical Integration and International Outsourcing: Causes and Consequences**

| | Vertical Integration (VI) | Outsourcing (OS) | |
|---|---|---|---|
| Formed by | Foreign Direct Investment | Contracts | Arm's length transaction (no contract) |
| Types of Parts Suppliers | In-house plants | Subcontractors | General suppliers |
| Relation-Specific Investment (RSI) | Not necessary | Highly necessary | Not necessary |
| Host Country's Comparative Advantage | Wages (-) over contracts (-) | Contracts (+) over wages (-) | Ambiguous |
| Home Country's Skill-Intensity | Upgrading | Downgrading | Undetermined |
| Keiretsu firms faced with "demand crisis" | Likely, if foreign affiliates procure intermediates in the local market | Highly likely, aggravated by a "hold-up" problem | Undetermined |

**Notes:** Types of parts suppliers are based on Figure 1 in Asanuma (1989). This table explains a particular situation where large corporations at home make a decision about how to procure intermediate inputs: either by integrating a foreign supplier or by outsourcing to a foreign supplier. Keiretsu network can be considered as the relationship that requires the RSI to the extent that the network is based on cross-holdings of shares and exchange of engineers between firms. Thus, outsourcing to a foreign supplier with a contract will be a potential substitute for keiretsu firms, causing a "hold-up" problem as well as the "demand crisis". Keiretsu firms are assumed to supply general intermediate inputs as well, which do not require the RSI. When a foreign supplier is integrated, the "demand crisis" will happen to keiretsu firms if the foreign affiliate purchases intermediate inputs in the local market instead of importing from Japan. However, there would not be a "hold-up" problem, since general inputs can be selling for any manufacturers.

**Table 2-2a. Subcontracting Costs in Japanese Manufacturing (Billions of Yen)**

| Industry | 1986 | 1989 | 1992 | 1995 | 1998 | Growth Rate (%) 1986 - 1992 | 1992 - 1998 |
|---|---|---|---|---|---|---|---|
| Food | 137.5 | 170.5 | 228.4 | 213.7 | 223.3 | 66.12 | -2.22 |
| Textile | 819.9 | 918.8 | 1003.8 | 745.8 | 582.2 | 22.43 | -42.00 |
| Wood, paper and pulp | 209.5 | 281.5 | 303.3 | 295.7 | 287.5 | 44.73 | -5.21 |
| Chemicals | 152.6 | 195.7 | 246.1 | 258.7 | 308.1 | 61.27 | 25.19 |
| Iron and steel | 395.0 | 462.1 | 534.4 | 448.3 | 420.8 | 35.30 | -21.25 |
| Non-ferrous metal | 304.6 | 366.3 | 410.0 | 390.9 | 373.3 | 34.61 | -8.95 |
| Machinery | 2466.9 | 3388.9 | 3722.9 | 3277.9 | 3500.6 | 50.91 | -5.97 |
| Electrical machinery | 3317.7 | 4385.7 | 4911.2 | 4791.1 | 5054.7 | 48.03 | 2.92 |
| Transportation equipment | 1905.7 | 2464.7 | 2687.9 | 2278.9 | 2249.6 | 41.04 | -16.31 |
| Precision instruments | 457.4 | 540.5 | 541.1 | 373.8 | 429.2 | 18.30 | -20.69 |

**Table 2-2b. Subcontracting Ratio (Subcontracting costs over total costs, %)**

| Industry | 1986 | 1989 | 1992 | 1995 | 1998 |
|---|---|---|---|---|---|
| Food | 1.03 | 1.25 | 1.52 | 1.50 | 1.52 |
| Textile | 19.95 | 21.76 | 23.78 | 24.51 | 23.26 |
| Wood, paper and pulp | 4.43 | 5.18 | 5.46 | 5.66 | 5.95 |
| Chemicals | 1.71 | 2.10 | 2.44 | 2.81 | 3.23 |
| Iron and steel | 4.72 | 5.13 | 6.34 | 6.22 | 6.33 |
| Non-ferrous metal | 9.05 | 8.16 | 9.84 | 10.07 | 9.83 |
| Machinery | 22.25 | 23.36 | 23.50 | 22.56 | 23.50 |
| Electrical machinery | 14.20 | 15.18 | 15.75 | 15.08 | 15.14 |
| Transportation equipment | 8.01 | 8.60 | 7.80 | 7.77 | 7.50 |
| Precision instruments | 22.58 | 22.99 | 20.89 | 18.56 | 18.87 |

**Sources:** Research and Statistics Department, Economic and Industrial Policy Bureau, Ministry of Economy, Trade and Industry [METI], Japan, *Census of Manufactures*, 1986, 1989, 1992, 1995, and 1998.

**Notes:** Data on subcontracting costs are the cost of subcontracting orders available in the METI source. Their definition is "payments made and accounts payable to subcontractors for consigned manufacture and/or processing, supplying raw materials or semi-finished works to them". Subcontracting ratio is calculated by subcontracting cost divided by total (variable) cots comprising raw materials costs, fuels and electricity consumed, and costs of the subcontracting orders. It should be fully noted that the number of this table is referred to all firms in an industry, whether multinationals or non-multinationals.

**Table 2-3. Vertical Integration and Skill-Intensity of Japanese Manufacturing**

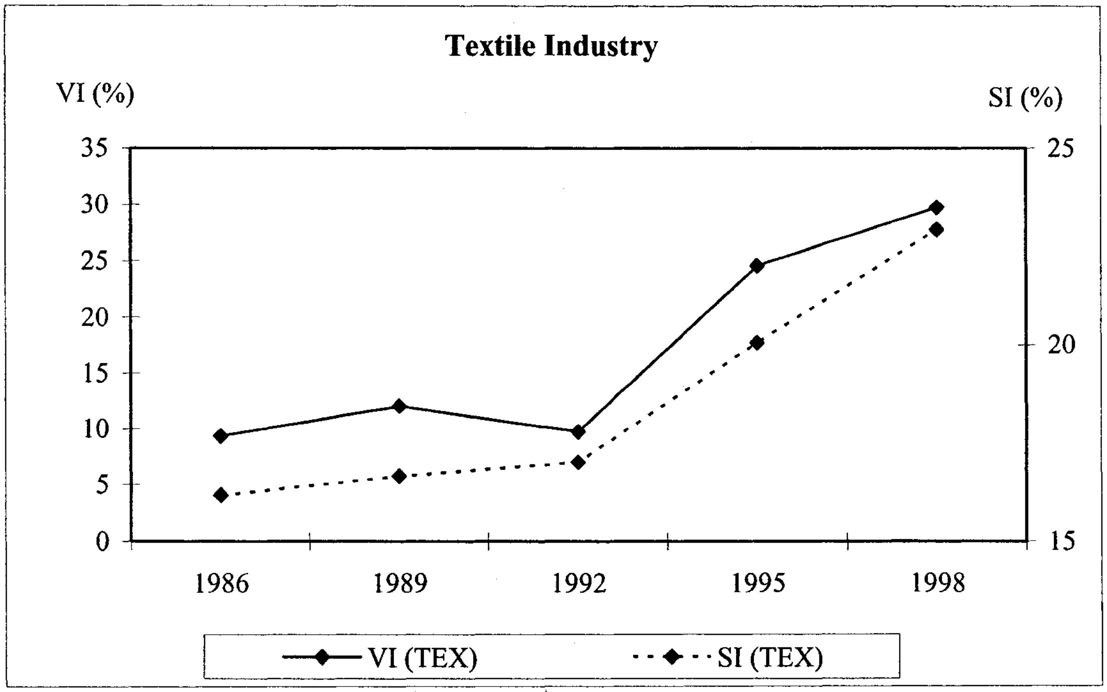
| Industry | VI: Vertical Integration of Japanese MNCs | | | | |
|---|---|---|---|---|---|
| | 1986 | 1989 | 1992 | 1995 | 1998 |
| Food | 17.0 | 30.3 | 22.7 | 15.1 | 20.4 |
| Textile | 9.3 | 12.0 | 9.7 | 24.6 | 29.8 |
| Wood, paper and pulp | 23.7 | 24.2 | 27.4 | 30.8 | 36.1 |
| Chemicals | 12.4 | 13.0 | 16.0 | 8.7 | 21.6 |
| Iron and steel | 5.6 | 1.8 | 0.2 | 6.8 | 4.6 |
| Non-ferrous metal | 32.8 | 14.0 | 26.4 | 21.8 | 40.2 |
| Machinery | 16.5 | 33.8 | 32.9 | 29.8 | 35.2 |
| Electrical machinery | 13.1 | 20.7 | 29.9 | 28.6 | 39.5 |
| Transportation equipment | 21.4 | 11.6 | 26.0 | 39.7 | 35.0 |
| Precision instruments | 18.2 | 14.3 | 28.5 | 63.1 | 46.1 |

| Industry | SI: Skill-Intensity of Japanese Manufacturing | | | | | Average Ranking | High or Low Skill? |
|---|---|---|---|---|---|---|---|
| | 1986 | 1989 | 1992 | 1995 | 1998 | | |
| Food | 20.2 | 21.8 | 23.7 | 23.5 | 28.6 | 5.2 | **High** |
| Textile | 16.1 | 16.6 | 17.0 | 20.1 | 22.9 | 8.0 | Low |
| Wood, paper and pulp | 13.9 | 14.0 | 15.0 | 15.5 | 17.3 | 9.8 | Low |
| Chemicals | 33.8 | 37.1 | 36.4 | 40.6 | 39.0 | 1.0 | **High** |
| Iron and steel | 13.7 | 14.9 | 16.2 | 18.8 | 18.0 | 9.2 | Low |
| Non-ferrous metal | 20.9 | 21.1 | 21.8 | 25.7 | 27.1 | 5.6 | Low |
| Machinery | 21.6 | 22.7 | 24.8 | 27.1 | 27.6 | 4.2 | **High** |
| Electrical machinery | 27.5 | 29.0 | 31.9 | 34.7 | 36.1 | 2.2 | **High** |
| Transportation equipment | 17.3 | 17.5 | 19.2 | 21.7 | 23.0 | 7.0 | Low |
| Precision instruments | 26.2 | 29.9 | 31.3 | 32.8 | 35.2 | 2.8 | **High** |

**Sources:** Ministry of Economy, Trade and Industry [METI], Japan, *Survey of Overseas Business Activities*, 1986, 1989, 1992, 1995, and 1998. Ministry of Health, Labor, and Welfare [MHLW], Japan, *Basic Survey on Wage Structure*, 1986, 1989, 1992, 1995, and 1998.

**Notes:** VI (vertical integration measure) = share of affiliates' sales within the same corporate groups relative to their total sales. SI (skill-intensity measure) = share of the male college graduates' wage bill in the total workers' wage bill. Average rankings in the table are 5-year arithmetic averages of rankings in terms of skill-intensity (SI). According to this ranking, those industries ranked from first to fifth are considered as a "High Skill" industry, and those ranked from sixth to tenth are considered as a "Low Skill" industry.

**Figure 2-1. Vertical Integration (VI) and Domestic Skill-Intensity (SI): Five Japanese Manufacturing Industries**



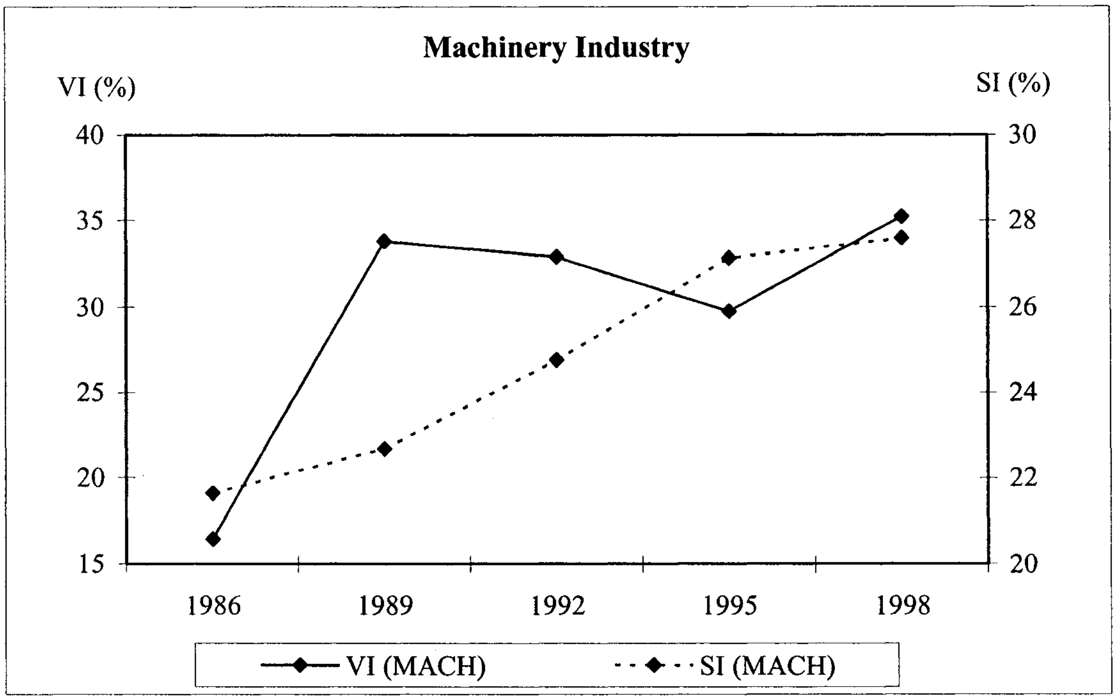
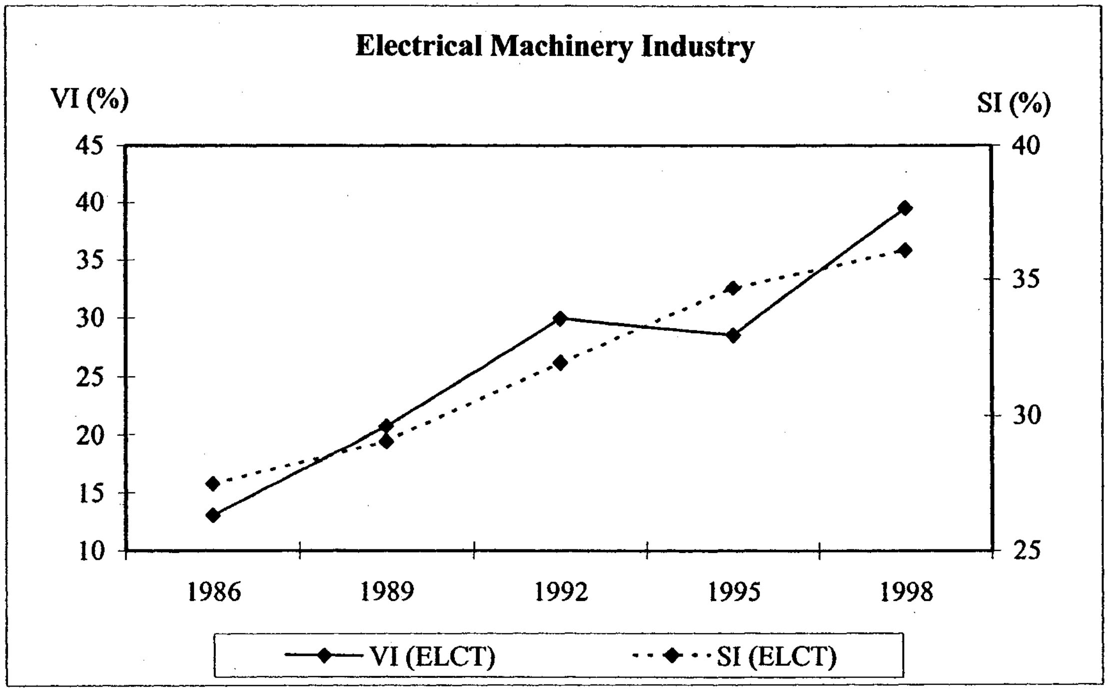



**Figure 2-1. (Continued)**



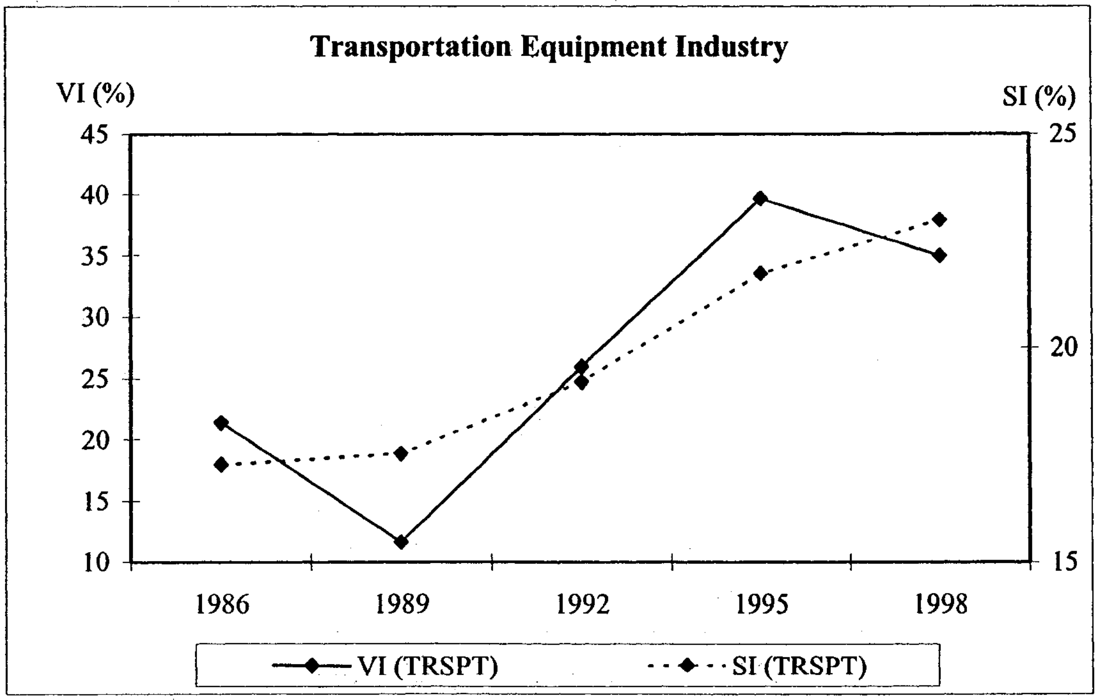
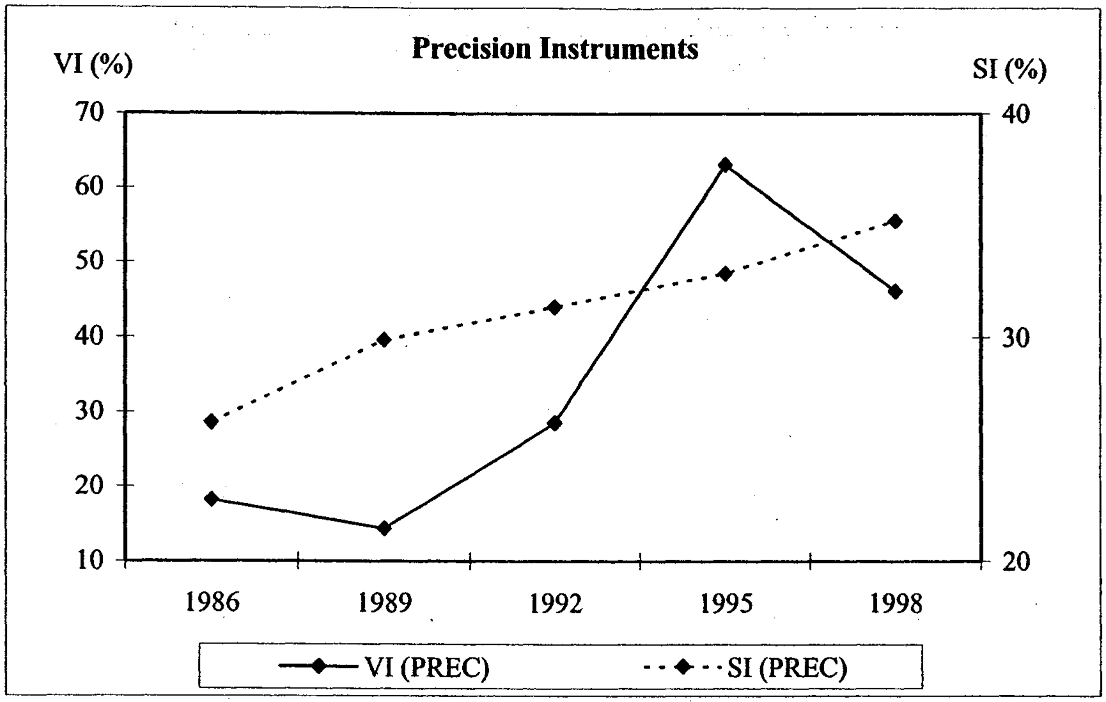



**Figure 2-1. (Continued)**




**Sources:** Ministry of Economy, Trade and Industry [METI], Japan, *Survey of Overseas Business Activities*, 1986, 1989, 1992, 1995, and 1998. Ministry of Health, Labor, and Welfare [MHLW], Japan, *Basic Survey on Wage Structure*, 1986, 1989, 1992, 1995, and 1998.

**Notes:** VI (vertical integration measure) = share of affiliates' sales within a same corporate group relative to their total sales. SI (skill-intensity measure) = share of the male college graduates' wage bill in the total workers' wage bill.

## Table 2-4. Determinants of Vertical Integration: All Industries

| | Dependent Variable = VI (the degree of vertical integration calculated by the share of affiliates' sales within the same corporate groups relative to their total sales) | | | | | |
|---|---|---|---|---|---|---|
| | Model 1 | | Model 2 | | Model 3 | |
| Independent Variable | Fixed Effects | Random Effects | Fixed Effects | Random Effects | Fixed Effects | Random Effects |
| Intercept | 0.114 | 0.116 | -0.494 | -0.471 | -0.339 | -0.317 |
| | (0.0495)** | (0.0613)** | (0.3103)* | (0.3093)* | (0.3335) | (0.3320) |
| WAGE | -0.159 | -0.160 | -0.110 | -0.110 | -0.205 | -0.204 |
| | (0.1792) | (0.1779) | (0.1657) | (0.1646) | (0.1820) | (0.1805) |
| GFCF | 0.151 | 0.149 | 0.012 | 0.012 | 0.097 | 0.098 |
| | (0.2008) | (0.1993) | (0.1927) | (0.1916) | (0.2042) | (0.2025) |
| DEMOC | 0.012 | 0.012 | | | 0.008 | 0.008 |
| | (0.0059)** | (0.0059)** | | | (0.0065) | (0.0064)* |
| LIT | | | 0.008 | 0.008 | 0.006 | 0.005 |
| | | | (0.0038)** | (0.0037)** | (0.0041)* | (0.0041)* |
| Hausman test statistic for no-correlation | m = 0.16 (Chi2 (9)) | | m = 0.39 (Chi2 (9)) | | m = 0.25 (Chi2 (10)) | |
| R-squared (Overall) | 0.130 | 0.130 | 0.123 | 0.124 | 0.131 | 0.131 |
| F value | 5.41 | | 5.45 | | 5.07 | |
| F value for induvidual effects | 6.92 | | 7.23 | | 7.07 | |
| Wald Statistic | | 49.42 | | 49.31 | | 51.43 |
| n | 294 | 294 | 294 | 294 | 294 | 294 |
| d.f. | 275 | 284 | 275 | 284 | 274 | 283 |

**Notes to Table 2-4**

Estimation method is OLS for fixed effects model, and GLS for random effects model. All models include region-specific time-trends. Numbers in parentheses are standard errors. Statistical significances are represented by *** being at 1 percent, ** being at 5 percent, and * being at 10 percent.

(1) Data are pooled over 7 regions for 5 years: 1986, 1989, 1992, 1995, and 1998. The 7 regions (countries) are the U.S., Central and South America, ASEAN, NIEs, China, EU, and Oceania. Included countries for each region are: Brazil and Mexico for Central and South America; Hong Kong, Korea, Singapore, and Taiwan for NIEs; Indonesia, Malaysia, the Philippines, and Thailand for ASEAN; the U.K., France, Germany, Italy, the Netherlands, Belgium, and Spain for EU; and Australia and New Zealand for Oceania.

(2) All independent variables are by-industry-by-region aggregations of country data weighted by total sales of Japanese affiliates in each industry located in the country. Weights are fixed with 1992. For Australia and New Zealand, 1989 data is used. Since the original METI data reports Hong Kong as one of the NIEs prior to 1998, and as a part of China with its own numbers from 1998, the dependent variables, VI-2 and VI-3, are constructed in such a way that China still does not include Hong Kong numbers. For China's VI-2 in 1998, I assumed that sales proportions within the same corporate groups are the same as those in 1995, and for VI-3, I simply subtract Hong Kong's employment from China's employment. The NIEs weights are also calculated by four countries up to 1995, and are calculated by three for 1998.

(3) Variable definitions and data sources are in the followings. WAGE = Manufacturing Wages: Men and Women relative to Japan. [ILO, *Yearbook of Labour Statistics*, and *Statistical Yearbook of the Republic of China* for Taiwan] GFCF = Relative Per Capita Gross Fixed Capital Formation over Japan: obtained by gross fixed capital formation divided by population. [IMF-*IFS*, and ADB-*Key Indicators of Developing Asian and Pacific Countries* for Taiwan] DEMOC = Combined Polity Score reported by POLITY IV (POLITY index, -10 ~ +10). [Integrated Network for Social Conflict Research (INSCR) Program, University of Maryland, College Park 20742. Downloaded from the web site: www.bsos.umd.edu/cidcm/inscr/polity.] DEMOC variables indicate "strongly democratic" for +10 and "strongly autocratic" for –10. Wages in national currencies are converted into U.S. dollars, and some are compared in terms monthly pay, other are compared in terms of hourly rate. Data on gross fixed capital formation in national currencies are also converted into U.S. dollars. Exchange rates (period average) are obtained from IMF-IFS and the ADB-Key Indicators. LIT = Adult Literacy Rate (%). [UNDP, *Human Development Report*, and *Statistical Yearbook of the Republic of China* for Taiwan]

**Table 2-5. Determinants of Vertical Integration: High-Skill Versus Low-Skill Industries**

| | Dependent Variable = VI (the degree of vertical integration calculated by the share ( affiliates' sales within the same corporate groups relative to their total sales) | | | |
|---|---|---|---|---|
| | High-Skill Industries | | Low-Skill Industries | |
| Independent Variable | Fixed Effects | Random Effects | Fixed Effects | Random Effects |
| Intercept | 0.741 | 1.383 | -0.939 | -1.053 |
| | (0.5075)* | (0.5223)*** | (0.4236)** | (0.4288)*** |
| WAGE | 0.141 | 0.227 | -0.237 | -0.216 |
| | (0.2753) | (0.2943) | (0.2334) | (0.2488) |
| GFCF | -0.173 | -0.147 | 0.140 | 0.030 |
| | (0.2976) | (0.3216) | (0.2681) | (0.2833) |
| DEMOC | 0.011 | 0.020 | 0.003 | 0.001 |
| | (0.0117) | (0.0125)* | (0.0078) | (0.0084) |
| LIT | -0.008 | -0.016 | 0.013 | 0.014 |
| | (0.0064) | (0.0065)*** | (0.0052)*** | (0.0052)*** |
| Hausman test statistic for no-correlation | m = 84.59 (Chi2 (10)) | | m = 14.95 (Chi2 (10)) | |
| R-squared (Overall) | 0.330 | 0.338 | 0.098 | 0.102 |
| F value | 7.37 | | 1.68 | |
| F value for induvidual effects | 7.49 | | 6.11 | |
| Wald Statistic | | 69.42 | | 15.42 |
| n | 147 | 147 | 147 | 147 |
| d.f. | 132 | 136 | 132 | 136 |

**Notes:** Estimation method is OLS for fixed effects model, and GLS for random effects model. All models include region-specific time-trends. Numbers in parentheses are standard errors. Statistical significances are represented by *** being at 1 percent, ** being at 5 percent, and * being at 10 percent. The five "High Skill" industries are: Food, Chemical products, Machinery, Electrical machinery, and Precision instruments industries. The five "Low Skill" industries are: Textile, Wood, paper, and pulp, Iron and steel, Non-ferrous metal, and Transportation equipment industries. This classification is based on the industry rankings in terms of skill-intensity in Table 2-3. Also see notes to Table 2-4.

**Table 2-6. Industrial Determinants of Vertical Integration: Cross-Regional Regression**

| Independent Variable | Dependent Variable = VI (the degree of vertical integration calculated by the share of affiliates' sales within the same corporate groups relative to their total sales) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Food | | Textile | | Wood | | Chemicals | | Iron and steel | |
| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
| Intercept | 1.688 | -0.844 | 11.140 | -0.620 | 23.706 | -2.308 | 2.609 | -0.185 | 0.937 | 0.562 |
| | (0.20) | (-1.29) | (1.13) | (-0.75) | (2.33)** | (-2.46)** | (0.56) | (-0.34) | (0.20) | (1.42)* |
| WAGE | -49.295 | -0.580 | 16.906 | -0.108 | -46.051 | -1.014 | 24.264 | 0.231 | 20.165 | 0.347 |
| | (-1.77)** | (-2.07)** | (0.38) | (-0.26) | (-0.71) | (-1.66)* | (1.18) | (1.09) | (1.55)* | (2.11)** |
| GFCF | 40.478 | 0.302 | 4.644 | 0.045 | 53.590 | 0.484 | -20.004 | -0.241 | -14.213 | -0.106 |
| | (1.26) | (0.93) | (0.08) | (0.08) | (0.69) | (0.71) | (-0.74) | (-0.81) | (-0.95) | (-0.71) |
| DEMOC | 2.198 | 0.018 | -2.657 | -0.025 | 2.088 | 0.013 | -0.493 | -0.006 | -0.632 | -0.006 |
| | (2.66)*** | (2.02)** | (-2.29)** | (-2.15)** | (1.19) | (0.83) | (-0.89) | (-0.95) | (-1.33)* | (-1.30) |
| LIT | | 0.011 | | 0.011 | | 0.032 | | 0.003 | | -0.007 |
| | | (1.33)* | | (1.06) | | (2.73)*** | | (0.39) | | (-1.41)* |
| year dummies? | yes | yes | yes | no | no | no | yes | yes | yes | yes |
| Adj. R-squared | 0.188 | 0.217 | 0.181 | 0.174 | -0.030 | 0.203 | 0.012 | -0.026 | 0.153 | 0.189 |
| F value | 1.93 | 1.97 | 1.88 | 2.47 | 0.76 | 2.59 | 1.05 | 0.91 | 1.75 | 1.84 |
| n | 29 | 29 | 29 | 29 | 26 | 26 | 31 | 31 | 30 | 30 |
| d.f. | 21 | 20 | 21 | 24 | 22 | 21 | 23 | 22 | 22 | 21 |

**Table 2-6. (Continued)**

| Independent Variable | Dependent Variable = VI (the degree of vertical integration calculated by the share of affiliates' sales within the same corporate groups relative to their total sales) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Non-ferrous metals | | Machinery | | Electrical machinery | | Transportation equipmer | | Precision instruments | |
| | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 | Model 1 | Model 2 |
| Intercept | 26.414 | -1.554 | 26.844 | -1.548 | 30.807 | -2.671 | 13.029 | -0.438 | 79.920 | 0.655 |
| | (3.15)*** | (-1.62)* | (2.44)** | (-1.61)* | (2.75)*** | (-2.27)** | (2.55)*** | (-0.31) | (11.01)*** | (0.65) |
| WAGE | -95.453 | -1.146 | 43.617 | 0.253 | 3.614 | -0.616 | -10.530 | -0.148 | -162.719 | -1.653 |
| | (-1.41)* | (-1.75)** | (1.10) | (0.65) | (0.09) | (-1.37)* | (-0.36) | (-0.47) | (-3.77)*** | (-3.47)*** |
| GFCF | 120.677 | 0.779 | -44.647 | -0.632 | -17.193 | -0.294 | 18.741 | 0.194 | 180.972 | 1.785 |
| | (1.52)* | (0.98) | (-0.92) | (-1.35)* | (-0.35) | (-0.67) | (0.43) | (0.44) | (3.19)*** | (2.95)*** |
| DEMOC | 1.301 | 0.012 | -3.076 | -0.040 | -1.871 | -0.028 | 1.040 | 0.005 | -2.621 | -0.026 |
| | (0.95) | (0.95) | (-2.63)*** | (-3.32)*** | (-1.50)* | (-2.36)** | (1.11) | (0.35) | (-1.97)** | (-1.89)** |
| LIT | | 0.022 | | 0.022 | | 0.038 | | 0.007 | | 0.002 |
| | | (1.90)** | | (1.91)** | | (2.54)*** | | (0.41) | | (0.14) |
| year dummies? | no | no | yes | yes | yes | yes | no | no | no | no |
| Adj. R-squared | -0.006 | 0.083 | 0.314 | 0.390 | 0.213 | 0.364 | 0.022 | -0.009 | 0.690 | 0.676 |
| F value | 0.94 | 1.68 | 2.83 | 3.24 | 2.16 | 3.15 | 1.23 | 0.93 | 20.29 | 14.57 |
| n | 31 | 31 | 29 | 29 | 31 | 31 | 31 | 31 | 27 | 27 |
| d.f. | 27 | 26 | 21 | 20 | 23 | 22 | 27 | 26 | 23 | 22 |

**Notes:** Estimation method is OLS. Numbers in parentheses are t-ratios, not standard errors. Statistical significances are represented by *** being at 1 percent, ** being at 5 percent, and * being at 10 percent. For each industry regression, two specifications, with and without year dummies, are conducted. However, the only better results are reported in the table. Also see notes to Table 2-4.

## Appendix Table 2-1. Explanatory Variables By-Industry-By-Region: 1998

| | Relative Wage to Japan: Men and Women, 1998 | | | | | | |
|---|---|---|---|---|---|---|---|
| Industry\Region | U.S. | C & S | NIEs | ASEAN | CHINA | EU | Oceania |
| Food | 0.915 | 0.276 | 0.647 | 0.085 | 0.032 | 0.887 | 0.715 |
| Textile | 0.915 | 0.268 | 0.447 | 0.060 | 0.032 | 0.861 | 0.742 |
| Wood, paper and pulp | 0.915 | 0.280 | 0.579 | 0.083 | 0.032 | 1.040 | 0.594 |
| Chemicals | 0.915 | 0.228 | 0.527 | 0.067 | 0.032 | 0.960 | 0.742 |
| Iron and steel | 0.915 | 0.280 | 0.667 | 0.133 | 0.032 | 1.094 | 0.742 |
| Non-ferrous metal | 0.915 | 0.280 | 0.515 | 0.033 | 0.032 | 0.795 | 0.729 |
| Machinery | 0.915 | 0.244 | 0.595 | 0.077 | 0.032 | 0.930 | 0.742 |
| Electrical machinery | 0.915 | 0.235 | 0.597 | 0.112 | 0.032 | 0.912 | 0.740 |
| Transportation equipment | 0.915 | 0.124 | 0.499 | 0.066 | 0.032 | 0.926 | 0.718 |
| Precision instruments | 0.915 | 0.280 | 0.487 | 0.134 | 0.032 | 1.015 | 0.742 |

| | Relative Per Capita Gross Fixed Capital Formation to Japan, 1998 | | | | | | |
|---|---|---|---|---|---|---|---|
| Industry\Region | U.S. | C & S | NIEs | ASEAN | CHINA | EU | Oceania |
| Food | 0.755 | 0.114 | 0.740 | 0.061 | 0.032 | 0.551 | 0.513 |
| Textile | 0.755 | 0.114 | 0.287 | 0.045 | 0.032 | 0.494 | 0.553 |
| Wood, paper and pulp | 0.755 | 0.114 | 0.559 | 0.059 | 0.032 | 0.648 | 0.337 |
| Chemicals | 0.755 | 0.113 | 0.462 | 0.047 | 0.032 | 0.589 | 0.553 |
| Iron and steel | 0.755 | 0.114 | 0.780 | 0.100 | 0.032 | 0.574 | 0.553 |
| Non-ferrous metal | 0.755 | 0.114 | 0.405 | 0.028 | 0.032 | 0.536 | 0.535 |
| Machinery | 0.755 | 0.113 | 0.603 | 0.056 | 0.032 | 0.583 | 0.553 |
| Electrical machinery | 0.755 | 0.113 | 0.619 | 0.081 | 0.032 | 0.537 | 0.550 |
| Transportation equipment | 0.755 | 0.110 | 0.363 | 0.043 | 0.032 | 0.488 | 0.517 |
| Precision instruments | 0.755 | 0.114 | 0.363 | 0.100 | 0.032 | 0.641 | 0.553 |

| | Combined Polity Score reported by POLITY IV (POLITY, -10 ~ +10), 1998 | | | | | | |
|---|---|---|---|---|---|---|---|
| Industry\Region | U.S. | C & S | NIEs | ASEAN | CHINA | EU | Oceania |
| Food | 10.00 | 7.96 | 1.04 | 6.88 | -7.00 | 9.82 | 10.00 |
| Textile | 10.00 | 7.87 | 8.34 | 2.20 | -7.00 | 9.81 | 10.00 |
| Wood, paper and pulp | 10.00 | 8.00 | 4.93 | 0.46 | -7.00 | 10.00 | 10.00 |
| Chemicals | 10.00 | 7.40 | 5.68 | 3.89 | -7.00 | 9.92 | 10.00 |
| Iron and steel | 10.00 | 8.00 | 0.58 | 3.18 | -7.00 | 10.00 | 10.00 |
| Non-ferrous metal | 10.00 | 8.00 | 7.74 | -2.07 | -7.00 | 9.40 | 10.00 |
| Machinery | 10.00 | 7.58 | 3.96 | 6.10 | -7.00 | 9.77 | 10.00 |
| Electrical machinery | 10.00 | 7.47 | 3.26 | 4.42 | -7.00 | 9.86 | 10.00 |
| Transportation equipment | 10.00 | 6.16 | 8.57 | 5.92 | -7.00 | 9.95 | 10.00 |
| Precision instruments | 10.00 | 8.00 | 7.66 | 3.49 | -7.00 | 9.96 | 10.00 |

| | Adult Literacy Rate (%), 1998 | | | | | | |
|---|---|---|---|---|---|---|---|
| Industry\Region | U.S. | C & S | NIEs | ASEAN | CHINA | EU | Oceania |
| Food | 99.0 | 84.6 | 92.7 | 92.4 | 82.8 | 98.9 | 99.0 |
| Textile | 99.0 | 84.9 | 94.5 | 89.6 | 82.8 | 98.8 | 99.0 |
| Wood, paper and pulp | 99.0 | 84.5 | 90.8 | 87.1 | 82.8 | 99.0 | 99.0 |
| Chemicals | 99.0 | 86.4 | 93.4 | 90.8 | 82.8 | 98.9 | 99.0 |
| Iron and steel | 99.0 | 84.5 | 92.1 | 86.9 | 82.8 | 99.0 | 99.0 |
| Non-ferrous metal | 99.0 | 84.5 | 90.5 | 87.2 | 82.8 | 99.0 | 99.0 |
| Machinery | 99.0 | 85.8 | 91.3 | 92.1 | 82.8 | 99.0 | 99.0 |
| Electrical machinery | 99.0 | 86.2 | 92.5 | 89.1 | 82.8 | 98.8 | 99.0 |
| Transportation equipment | 99.0 | 90.3 | 90.2 | 92.7 | 82.8 | 98.7 | 99.0 |
| Precision instruments | 99.0 | 84.5 | 92.7 | 87.1 | 82.8 | 99.0 | 99.0 |

**Notes to Appendix Table 2-1**

C & S stands for Central and South America, which consists of Brazil and Mexico; NIEs consists of Korea, Singapore, and Taiwan for 1998, and plus Hong Kong for years prior to 1998; ASEAN consists of Indonesia, Malaysia, The Philippines, and Thailand; EU consists of The U.K., France, Germany, Italy, The Netherlands, Belgium, and Spain; and Oceania consists of Australia and New Zealand.

# CHAPTER THREE

## Inter-Industry Wage Differentials in U.S. Manufacturing: In Search of the Role of International Trade

**1. Introduction**

Empirical studies have shown that there is a relationship between international trade and the inter-industry wage differentials (IIWD) in the U.S. (Katz and Summers (1989), Gaston and Trefler (1994), and Lovely and Richardson (2000)). While those studies point out the relationship, they leave an important question unanswered about how trade affects the inter-industry wage structure. Therefore, an objective of this chapter is to try to spell out the underpinning economic reasoning, focusing on advantages of exports.

The inter-industry wage differential is the wage residual left out after controlling for individual workers and job characteristics. Variations of wages across industries, however, can be generated by firms' heterogeneity as well as workers characteristics. Thus, I first interact industry dummies with net exports, so that the wage residual can capture some aspect of firms' heterogeneity. Using the U.S. March *Current Population Survey* (CPS), I estimate the wage premium that is reduced for some industries once the net-export wage premium is separately estimated. Next, I classify industries into broader categories: exporting, importing, intra-industry trading (IIT), or non-manufacturing. With these categories, I calculate the wage differentials (Export-Import Wage Differentials, EIWD), which shows the existence of positive export-industry wage premium.

In explaining the inter-industry wage differentials, there are two competing hypotheses in the literature: an unobserved ability and efficiency wages (Dickens and Katz (1987a, b), Krueger and Summers (1988), and Gibbons and Katz (1992)). As a new attempt for this debate, I conduct the hypothesis testing by limiting the CPS data to those individuals who are male households in their 30s, and who switch industries between the above four categories. With this switchers' sample, I estimate the cross-section and first-difference regression models, and find that the unobserved ability hypothesis is in favor. This is a finding different from the result obtained by many of the past studies.

More explicit treatment of both firms and workers characteristics is theoretically attempted in a framework of industry dynamics. An important message is that productive firms are owned by able entrepreneurs and tend to be large. Thus, they pay higher wages to attract able workers, thereby reducing the monitoring costs. The productive firms, at the same time, more likely enter the export market and survive. As a result, an industry with high share of exports represents, on average, higher wages.

## 2. Inter-Industry Wage Differentials (IIWD): Literature Survey

*Empirical Puzzle: Definition of the Inter-Industry Wage Differentials*

The inter-industry wage differentials (IIWD) are captured by the coefficients of industry dummy variables in a human capital model of the wage determination in equation (3-1). At time $t$, the log wages of individual $i$ are determined by the individual and job characteristics in a matrix, $X_{ijt}$, and an industry dummy, $D_{ijt}$, which takes one if individual $i$ belongs to industry $j$. A vector $\beta$ is the estimates of $X_{ijt}$, and the parameter $\alpha_j$ represents the wage premium of industry $j$. $\varepsilon_{it}$ is a well-behaved error term.

$$\ln w_{it} = \beta' X_{ijt} + \sum_j \alpha_j D_{ijt} + \varepsilon_{it} . \quad (3\text{-}1)$$

In the basic human capital model, the log wages should be determined by the individual and job characteristics only. However, many studies have shown that the estimates of $\alpha's$ turn out to be statistically significant for most industries. It is, therefore, puzzling in a way that a scientifically identical person would earn different level of wages just by changing an industry attachment.[55] In explaining the puzzle, or existence, of the IIWD, the literature has focused on competitive and non-competitive models. Therefore, I look at the main arguments from both sides and some trade-related empirical studies below.

*Competitive versus Non-Competitive Explanations*

The competitive explanations assume that firms have no power to control prices of products as well as productive factors. Therefore, typical arguments are based on the differences in working conditions or abilities of workers that may systematically be reflected on the industrial wage distributions. Compensating wage differentials suggest that if workers are under uncomfortable working conditions, they must be compensated for the bad conditions. Empirical studies using the information about working conditions, however, have shown that the compensating wage differentials do not explain the inter-industry wage differentials.

High-ability workers are paid higher wages than low-ability workers because of their high productivity. Since worker's ability is not completely measurable, researchers cannot completely control for it. But, if one collects data on the same worker in different industries at different points in time, it is possible to eliminate the ability effects on wages by taking a first-difference between the two time points (fixed effect model). Some studies adopting this kind of method reject the hypothesis of unobserved ability (Krueger

[55] A famous example is that a secretary who used to work for a university increased her wages by changing to a secretary job in a computer company. (Thaler (1989)).

and Summers (1988), Gibbons and Katz (1992), Kim, Dae Il, (1998), for example), and others cannot (Murphy and Topel (1990), for example). Another way to look at the cause of the inter-industry wage differentials is the short-run immobility of labor. When output demand expands in some industries, labor demand for production will also increase. But, the supply of labor may not immediately fully meet the increase in demand due to the short-run immobility, resulting in discrepancies in wages across industries. The finding that the inter-industry wage differentials are fairly stable over a long period of time implies that the short-run labor immobility hypothesis is not really convincing.

The non-competitive explanations, on the other hand, focus on a rent-sharing model and efficiency wage hypothesis. If workers have bargaining power due to union or union threats, they may be able to share part of the product market rents through higher wages than expected in a competitive model. Krueger and Summers (1988) show that union status does not give rise to any significant differences in industrial wage premium. Efficiency wages may be set to avoid loss from shirking when monitoring costs are large. Testing the hypothesis by regressing the length of tenure or quit rate on industry wage premiums reveals that higher industry wages are associated with longer tenure and lower quit rate (Krueger and Summers (1988)). However, if all of the firms are completely identical, efficiency wages do not generate any industrial wage dispersions. This suggests that firms should be heterogeneous and pay efficiency wages depending on their ability-to-pay. To the extent that the ability-to-pay varies across firms and industries, the degree of the ability determines the optimal wage structure across industries (Dickens and Katz (1987a)).

*Trade and the IIWD*

One of the empirical regularities worth emphasizing is that in the U.S. the relative wages of the manufacturing sector are, on average, higher than those of the non-manufacturing sector.[56] I do not pursue why there is this difference, since the nature of service goods is inherently different from that of manufacturing goods. However, as the manufacturing sectors account for a "lion's share of American trade",[57] the empirical regularity itself implies some productivity advantage of international trade.

Within the manufacturing sectors, Katz and Summers (1989) and Gaston and Trefler (1994) relate industrial wage distributions to the U.S. strategic trade policy. Katz and Summers (1989) distinguish the manufacturing sector either by an export industry or an import industry. It is pointed out that the industry wage premiums are lower in those industries with higher import penetration ratio, but higher in the industries with higher export supply ratio. In their two-sector model, a primary sector is assumed to pay higher wages than a secondary sector. Their analysis, however, is directed to show the differential effects of government policies, like subsidies to the primary sector, between a closed economy and an open economy. Therefore, more complete analysis of international trade as a possible source of the IIWD is required. Gaston and Trefler (1994) model the wage premium equation so as to include trade factors, such as a trade protection index, exports, and imports, as independent variables. Their results show that the exports are positively correlated with wage premiums both in the single OLS estimation and in the two-stage-least-squares (2SLS) estimation. They conclude that

[56] Krueger and Summers (1988) estimate that in 1984 the average wage premium is 10.1% for 20 manufacturing industries while it is −1.8% for 20 non-manufacturing industries on the basis of CIC 2-digit classifications (Census Industry Code).

[57] Katz and Summers (1989), p.261.

export-oriented industries without any trade policy pay higher wages, while import-oriented industries with tariff protection pay lower wages.

Lovely and Richardson (1998) also deal with the relationship between international trade and wage premiums within the manufacturing industries. Their particular emphases are on the skill differences in country origins of imports, and the effect of intra-industry trade (IIT) on returns to skills. The wage premium is decomposed into a labor-premium part and a skill-premium part by distinguishing trade flows based on the country groups: industrialized, newly industrialized, and primary producing countries. They find that trading partner matters for the inter-industry wage differentials through the skill differences in the products traded. This model assumes that the economy is in a so-called *non-integrated* world and thus they can allow relative wage differences. The Lovely and Richardson model resorts to compensating wage differentials to explain the industrial wage dispersions rather than to the unobserved ability or efficiency wage approaches. Thus, the model does not provide any implications on why some firms pay higher wages and others do not.

The literature points out that there is no single theory to fully explain the existence of the inter-industry wage differentials, and more importantly, it suggests that international trade does play some role in generating the differentials. However, no models really describe the economic reasons of why exporting industries are paying higher wages than importing or non-manufacturing industries. The debate about the competitive or unobserved ability hypothesis versus non-competitive or efficiency wage hypothesis in the inter-industry wage differentials continues. Therefore, in the following sections, I first observe the data, and then, try to spell out new approaches to consider the role of exports, export market, or exporting industries affecting the inter-industry wage differentials, focusing on industry-level net export, worker's self-selection, firm's ability-to-pay efficiency wages, and industry dynamics.

### 3. Relative Industrial Wages and Trade Structures: U.S. Manufacturing in the Long Run and Short Run (1991 – 1994)

Examining the previous literature, I found that some studies derive empirical regularity of increasing industrial wage dispersions, while others regard wage differentials as fairly stable over time. This contradiction seems originated in the use of different data sources, or in other words, dependent of whether the job and individual characteristics are controlled for. Bell and Freeman (1991), for example, use establishment data from the *Census of Manufactures* (COM) and report the increasing wage dispersions as an empirical regularity. Stable industrial wage differentials, on the other hand, are obtained from the research based on household survey data, such as the *Current Population Survey* (CPS). Dickens and Katz (1987a, b), Krueger and Summers (1987, 88), and Katz and Summers (1989) all use the CPS data and find stable wage differentials. Borjas and Ramey (2000) use *Public Use Microdata Samples* (PUMS) and obtain the rigid inter-industry wage differences. In this section, I use both types of data since each has its own merits.[58] The data sets are, therefore, comprised of industrial and individual data from three sources. The NBER establishment-base industry data and the manufacturing exports and imports data provided by UC Davis are used to examine the industrial wage and trade structures for longer period of time. The CPS individual level

[58] For example, the NBER Productivity Database is very convenient when making a consistent time-series data set. The CPS is particularly useful when controlling for personal and job characteristics in a wage equation.

data is used to estimate the inter-industry wage differentials in the U.S. manufacturing from 1991 to 1994.

*Data Sources*

The first source, the NBER Manufacturing Productivity Database, is establishment-based data and contains information on annual payroll, employment, shipment, and capital stock.[59] One of the most useful variables available in this data set is the total factor productivity (TFP). These data are available at the four-digit Standard Industry Classification (SIC). They span every five years between 1960 and 1995, including all years from 1991 to 1994. The second source is the UC Davis database of U.S. manufacturing trade.[60] Those data are aggregated into two (three)-digit SIC level in a consistent manner with the two (three)-digit Census Industry Code (CIC) classification. The third one is household survey data, from the U.S. March *Current Population Survey* (CPS), 1992, 1993, 1994, and 1995. I restrict the sample to individuals who are 18 years to 64 years old with minimum weekly wages of US$10 in manufacturing sectors. Using these samples, the inter-industry wage differentials are estimated.[61] The actual years of the observed inter-industry wage differentials, therefore, correspond to 1991, 1992, 1993, and 1994.[62] In Section 4, I match the trade data with the CPS, and in Section 5, I truncate a sub-sample from CPS 1992 and 1993 so as to create industry switchers sample. The

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[59] The data is downloaded from the NBER web site created by Bartelsman, Becker, and Gray. (Bartelsman and Gray (1996).)

[60] The Center for International Data at UC Davis (Feenstra (1996)).

[61] The sample size changes from 2671 in 1992, to 2622 in 1993, to 2415 in 1994, and to 2268 in 1995.

[62] The CPS data is also downloaded from the CPS home page. For more details about the data set, refer to the Data Appendix.

Data Appendix describes the CPS data and matching with trade data in detail. Appendix Table 3-2 describes variable definitions on the CPS data set, and Appendix Table 3-3 summarizes concordance between CIC and SIC manufacturing industries based on the 2-digit level. Appendix Table 3-4 reposts concordance of industries between CIC 3-digit and SIC.

*Industrial Relative Wage Structure*

Using the NBER establishment data, I first look at the long-term trend of manufacturing average wage variations and relative structures. In Table 3-1, Panel (A) presents coefficient of variation (c.v.) of annual payroll per employee across 21 SIC two-digit industries.[63] The c.v. increased from 0.22 in 1960 to 0.28 in 1995, indicating that sectoral wage dispersion has been slightly expanding over the 35 years, a finding consistent with Bell and Freeman (1991). In Panel (C), however, the correlation of the payroll per worker between 1980 and 1990 is 0.942 within SIC four-digit industries, indicating that the relative wage structure has not changed very much during the 10-year period. Although the wage dispersion is moderately increasing over time, the relative wage structure remains fairly stable.

Table 3-2 presents the estimates of equation (3-1) for U.S. manufacturing workers. The inter-industry wage differentials are clearly observed, since many of the industry coefficients are statistically significantly different from zero. Standard deviations move from 0.121 in 1991, to 0.114 in 1992, 0.128 in 1993, and to 0.126 in 1994. These

[63] The total number 21 is obtained based on the Census Industry Classification (CIC) two-digit categories. There are 20 manufacturing industries on the basis of SIC two-digit classifications. By the concordance table, some of the SIC three-digit industries are included in the CIC two-digit industry group, like motor vehicles, and thus, there are more than 20 industries in the CIC two-digit classifications.

magnitudes are similar in range to those Krueger and Summers found for all U.S. industries in 1974, 1979, and 1984, based on the CIC 2-digit classifications.[64] Therefore, the industrial wage structure can be considered as very stable in the long run, once individual and job characteristics are controlled for.

*Industrial Trade Structure*

Panel (C) of Table 3-1 presents the long-term relationships of U.S. exports and imports, respectively. The correlation coefficients between 1980 and 1990 suggest that the U.S. export and import structures remain fairly stable over time (correlation of exports is 0.905 and correlation of imports is 0.888). Since the relative wage structure is very stable for long periods of time, it is implied that international trade may contribute to the stable industrial wage structure.

*Non-Production Worker's Ratio*

In explaining the relationship between trade and wages, it is often emphasized that skill-differences among workers are important. This approach, however, is not directly applicable to the question of industrial wage premiums. Skills are in fact controlled for in a wage regression by educational parameters and personal characteristics in equation (3-1). Studies based on the factor-content of trade, alternatively, have attributed the increase in skilled-unskilled wage inequalities to the expansion of the U.S. low-skill intensive imports from developing countries during the late 1980s onward. However, the surge of

[64] Table II in Krueger and Summers (1988) reports that weighted adjusted standard deviation of premiums are 0.132 in 1974, 0.108 in 1979, and 0.140 in 1984.

such imports cannot have very significant implications on the inter-industry wage differentials. This is evident from the stable wage differentials.

Berman, Bound, and Griliches (1994) argue that a skill-biased technological progress can be a significant factor in the widening of skilled-unskilled wage inequalities. Panel (B) of Table 3-1 shows the long-term trend of the non-production employment to total employment ratio on the basis of SIC two-digit classifications. The industry means increased from 23% in 1960 to 28% in 1995. The industrial variations of wage premiums have been found to be very stable over long periods of time, so that the skill-biased technological progress may not be very influential on them. A sequence of coefficient of variations (c.v.) in Panel (B) of the table reveals that the industrial dispersions of the ratio have hardly changed (0.41 in 1960 and 0.38 in 1995). As pointed out by Berman, et al (1994), within-industry changes have dominated between-industry changes in the proportion of non-production workers. Figures 3-1a and 3-1b plot the non-production – total workers ratios within the SIC two-digit industries. The figures make it clearer that most of the industries experienced an upward trend of the ratio within an industry.[65] Therefore, an increasing demand for skilled-workers due to the skill-biased technological progress (proliferation of computer use, for example) might not have been the most significant factor of explaining the existence of the inter-industry wage differentials in U.S. manufacturing because those differentials are stable.

### 4. Evidence of Net-Export Effects on Wages from the CPS Data, 1992

[65] In Figures 3-1a and b, I calculate the proportion of non-production workers on the basis of SIC four-digit levels within the SIC 2-digit industries.

The descriptive analysis of the previous section suggests that there must be some relationship between industrial wage differences and international trade. In this section, I directly investigate the effects of exports on wage premiums. I use the CPS data to control for individual and job characteristics. To separate pure industry wage premiums from trade effects, I carry out a wage regression by including industry dummy variables interacted with trade performance index. The index is the logarithm of export-import ratio: that is, a log of "net-export" ($E_{ijkt} = \ln EX_k - \ln IM_k$).

The estimation equation is as follows.

$$\ln w_{it} = \delta' X_{ijt} + \sum_j \eta_j D_{ijt} + \sum_j \mu_j E_{ijkt} D_{ijt} + e_{it}. \qquad (3\text{-}2)$$

The difference from equation (3-1) is an inclusion of the interaction term. $D_{ijt}$ is an industry dummy based on the CIC (SIC) two-digit industry classifications, and $E_{ijkt}$ is the log of export-import ratio for industry $k$ within industry $j$, that is, based on the SIC (CIC) three-digit industry level. The coefficient $\mu_j$ now captures the effect of being a net exporter on wage premium of industry $j$, while the coefficient $\eta_j$ can be considered as a pure industry premium free from trade effects. $\delta$ is a vector of parameter estimates of $X_{ijt}$, and $e_{it}$ is a well-behaved error term.

Table 3-3 presents the estimation results. Model 1 shows the estimates of equation (3-2), while Model 2 is estimated by excluding the interacted dummy variables. Based on the F-statistics, industry dummy variables are jointly, and statistically significantly different from zero, suggesting that the inter-industry wage differentials still exit in 1992. Moreover, the Wald test rejects the null hypothesis that those interacted terms in Model 1 (unrestricted model) are jointly insignificant against the restricted model (Model 2).[66] About a half of the pure industry effects in Model 1 represent a similar magnitude of wage premiums in Model 2, which in turn implies that the wage premiums of the other half of the industries are somehow affected by net exports.

Among the industries, printing and publishing has a positive and statistically significant estimate of the interaction term. This implies that the net export status strongly affects the wage premium of the industry. Lumber and rubber also have positive estimates with marginal significance. But paper and allied products are negative and significant. Compared with Model 1, the pure industry wage premium in Model 2 tends to be overestimated.

Hence, although with a different approach, results obtained in this section are consistent with the findings by Katz and Summers (1989), Gaston and Trefler (1994), and Lovely and Richardson (2000): namely, for some manufacturing industries exports are associated with positive wage premiums.

## 5. Partial Resolution? Testing the Unobserved Ability vs. Efficiency Wage Hypothesis in the Export-Import Wage Differentials (EIWD)

This section is concerned with the unobserved ability versus efficiency wage argument in explaining the inter-industry wage differentials. A new attempt to tackle this argument is made by an estimation of export-import wage differentials.

*Hypothesis*

[66] The computed F-statistic (F[16, 2446]) is 2.387, which is greater than the critical F-statistic (F[15, infinity] = 2.04) at the 1% significance level.

The industrial variations of wages are considered as a reflection of both firm's and household's characteristics. Productive firms are likely to pay higher wages, and able workers can earn higher salaries. Able workers perceive that productive firms are concentrated in exporting industries and so they would like to move into those industries. When this match is successful, actual wages would be relatively higher due to the higher productivity in the exporting sector. For example, assume that importing industries are lower paid, one can predict that the wages of switchers from importing to exporting industries must increase by self-selection. If this mechanism contributes to the industry-wide wage differentials, the reason of existing inter-industry wage differentials can be recognized by the switcher's behavior: therefore, the unobserved ability hypothesis should be in favor.

*Exporter, Importer, and IIT*

Based on the NBER Productivity Database, export per shipment ratio and import penetration ratio are calculated for each of the 23 manufacturing industries on the basis of CIC 2-digit classifications in 1991 and 1992. The import penetration ratio is defined as the ratio of imports relative to the domestic demand (shipments minus exports plus imports). Then, balance of trade is derived by subtracting the import penetration ratio from the export-shipment ratio. When the trade balance is sufficiently larger than zero, an industry is denoted by an exporter, while the trade balance is sufficiently smaller than zero, the industry is denoted by an importer. If the balance is very close to zero, whether positive or negative, with the difference less than 1%, then the industry is denoted by an intra-industry trader (IIT): that is, those industries export and import the same good.

Table 3-4 shows these trade balance positions for each industry: an exporter, importer, or intra-industry trader (IIT).

*Industry Switchers*

For the purpose of analyzing industry movers, I limit the CPS sample to male households in their 30s. This can be justified by pointing to that inclusion of the younger and older workers could make the sample noisier. Young workers frequently change jobs until they have stable ones, and senior workers consider retirement insurance policies seriously for their labor supply. However, workers in their 40s and 50s could have been in the sample, though many of them may not move as casually as do workers in their 30s. Appendix Table 3-1 shows descriptive statistics of this data set. Movers are identified between the two years: 1991 and 1992. First, the CPS 1992 and 1993 are used to match the same individual by his household identifier. The total number of observations is 609 for each year. The 609 individuals are then attached with the new industry information: either of an exporter, importer, intra-industry trader, or non-manufacturer. Out of the 609 workers, 155 workers are identified to be a mover between the "detailed" industries, and 71 workers are the mover between industries in my definition. Among the 71 individuals, five workers are identified as a switcher from importing industries to exporting industries, and their wages had grown by about 24% (Table 3-5).

*Estimations*

With the 609 sample (with some elimination), export-import premiums are calculated by export, import, and non-manufacturing dummies in equation (3-3).

$$\ln w_{it} = \theta' X_{ijt} + \sum_j \chi_j TD_{ijt} + \varepsilon_{it} . \quad (3\text{-}3)$$

Control variables are age, schooling, marital status, race, geography, and occupational dummies. Unlike equation (3-1), $TD_{ijt}$ represents industry dummies classified as either exporting ($EXDUMMY$), importing ($IMDUMMY$), or non-manufacturing ($NONMFG$) with the intra-industry trader is the base industry. A vector $\theta$ represents the parameter estimates. Columns (1) and (2) of Table 3-6 present the results. The export premium is positive and statistically significant in both years. Workers in exporting industries are paid higher on average by 19% in 1991 and 21% in 1992 than workers in the IIT industries. Estimates of importing industry dummy are not significant. Estimates of non-manufacturing industry dummy is, on the other hand, negative and significant or marginally significant. The results confirm that there is an export industry wage premium.

Using the sample of 71 industry switchers, I first test the unobserved ability hypothesis. When there are observed industrial wage differentials in a cross-sectional estimation, it is possible that the differences are caused by an unobserved ability that cannot be measured by an econometrician. Thus, if one can correctly measure the ability, the wage differentials should be eliminated. Since perfect measure of ability is not attainable, the first difference approach is often used for this purpose. Following the previous studies, like Krueger and Summers (1988) and Gibbons and Katz (1992), I use the model specification as,

$$\Delta \ln w_{it} = \zeta' \Delta X_{ijt} + \sum_j \lambda_j \Delta TD_{ijt} + \Delta\varepsilon_{it} . \quad (3\text{-}4)$$

The symbol $\Delta$ is the first-difference operator. Equation (3-4) is the first-difference form of equation (3-3). A vector $\zeta$ represents the parameter estimates. Time-invariant terms are eliminated.

If the individual's unobserved ability does not affect the inter-industry wage differentials, the estimate $\lambda_j$ is statistically significantly different from zero, and shows very similar magnitude to the cross-sectional estimate $\chi_j$. Krueger, Summers, Gibbons, and Katz have attempted the analysis by using the *Displaced Workers Survey* (DWS). Those studies overall conclude that the unobserved ability hypothesis is not strongly supported. In the DWS, data on workers faced with plant closures are available. For those workers, switching is exogenous. In my sample, movers are either endogenous or exogenous, but I assume that they self-select.

Columns (3) and (4) of Table 3-6 present the cross-section and first-difference estimates for 71 movers. These results show that there are clearly cross-sectional industry wage differentials, while the estimates of the first difference model are no longer statistically significantly different from zero. It follows that the observed wage differentials can be explained by the unobserved ability. Since the sample size of the switchers is very small, however, the results cannot be free from the small sample bias. Therefore, more rigorous examination has to be conducted for future study by constructing much larger samples including male and female of all ages, or using the CPS Merged Outgoing Rotation series.

The test of the efficiency wage hypothesis is, then, carried out by a probability model. Following Goldberg, Tracy, and Aaronson (1999), my model is,

$$\Pr(I_{ijt} = 1) = \Phi\left(\xi' X_{ijt} + \gamma EP_{t-1}\right). \quad (3\text{-}5)$$

The variable $I_{ijt}$ takes one if a worker $i$ in industry $j$ changes industry in period $t$. The matrix $X_{ijt}$ includes individual characteristics: age, schooling, marital status, race, and geography. $EP_{t-1}$ represents the export-import wage premiums at time $t-1$ (from estimates of export, import, and non-manufacturing industry dummies in the first column of Table 3-6). A vector $\xi$ and a parameter $\gamma$ are to be estimated. Using the sample of 609 individuals (effectively 595 individuals), I estimate equation (3-5) by a linear probability model and a probit model. If efficiency wages are paid so as to generate loyalty in workers, for instance, it is predicted that higher export-wage premium should reduce the probability of the workers switching an industry. Table 3-7, however, reports that the export-import wage premiums (EIWD) actually increase the probability of the switching.

In conclusion, since the unobserved ability hypothesis cannot be rejected and the efficiency wage hypothesis is not supported, my switchers sample shows that the export-import wage differentials (EIWD) can be attributed to the able worker's self-selectivity. To the extent that the structure of the inter-industry wage differentials (IIWD) is related to the structure of the export-import wage differentials, the IIWD should also be explained by the self-selectivity. Hence, the unobserved ability hypothesis may better explain than the efficiency wage hypothesis in my data set.

### 6. The Industry-Dynamics Model of Heterogeneous Firms, Efficiency Wages, and Catalyst Role of Exports: Theoretical Approach

Firms' heterogeneity and industry dynamics are theoretically discussed by Hopenhayn (1992). Aw, Chen, and Roberts (1997) apply this framework to empirically analyze whether firms-turnover enhanced the aggregate productivity of Taiwanese manufacturing sectors. Melitz (1999) extends the Hopenhayn's original framework to a monopolistically competitive setting and refers as a "catalyst role of trade" to the reallocation of resources among firms in an industry.[67] An Oi's (1983) heterogeneous firms' model based on entrepreneurial abilities can serve as an important basis of the industry dynamics. He argues that firms owned by able entrepreneurs, who can manage more employees, tend to be large, and therefore, wages are also likely to be set at a higher level to attract able workers and to reduce monitoring costs.[68] At the firm level, Bernard and Jensen (1999) show empirically that exporters are ex ante more productive than non-exporters, and that export premium is associated with higher average wages.

An essence of my argument is that industries with large export shares are concentrated, on average, by more productive firms because of the reallocation of sales from less efficient firms to more efficient ones within an industry,[69] and thereby raising the industry productivity and average wages than other industries with small or no shares of exports. In this section, I first review the efficiency wage model, and next, following the Oi's model, I describe heterogeneous firm's behavior. Then, I discuss industry aggregation and effects of exporting (catalyst role of exports).

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[67] In this study, I follow the Melitz's use of expression, "a catalyst role". Melitz (1999), on page 2, is saying, ..... *to analyze the role of international trade as a catalyst for inter-firm reallocations within an industry.*

[68] This argument is consistent with the efficiency wage hypothesis of inter-industry wage differentials, especially the self-selection and sociological consideration (gift exchange or internal equity hypothesis) version of the efficiency wage theories (Yellen (1984)). This is also compatible with the empirical evidence in the study by Dickens and Katz (1987b), where there is significantly positive correlation between wage premiums of different occupations across industries. (For example, from their Table 3, the correlation between managers and sales personnel is 0.84; managers and craftsmen is 0.89; managers and technicians is 0.60.)

[69] Firms' entry and exit do not necessarily take place for the sales reallocation to happen. Within an industry, more efficient firms expand their sales shares and less efficient firms contract theirs.

*Efficiency Wage Arguments*

The basic idea of the efficiency wage hypothesis is that workers will put more effort when they are paid better, and firms can after all make more profit by paying higher wages but by reducing the monitoring costs or loss from worker's shirking. The specific reasons can be summarized in the following four ways (Yellen (1984), Krueger and Summers (1988), and Thaler (1989)).

(1) If worker's turnover decreases as firms pay higher wages, there may be an incentive for firms to raise wages to minimize turnover costs. (Turnover cost)

(2) By raising wages, firms may be able to make the cost of job loss larger for workers, and thereby to discourage shirking but encourage good performance. (Incentive/shirking)

(3) With being paid higher wages, workers may have feelings of loyalty to employer and become more productive. (Gift exchange)

(4) Those firms that pay high wages will be able to attract a higher quality pool of job applicants. (Self-selection)

A conventional efficiency wage model assumes that firms are identical and perfectly competitive. The firms are maximizing profits with a production function of efficiency unit of labor, where the effort level is a function of wage rate. The first-order condition implies that firms will hire workers until marginal product in efficiency term is equalized to the real wage. Now, suppose that exporting firms are by and large more productive than domestic firms. This can be depicted in a wage-labor dimension by drawing a downward sloping marginal product (MP) curve for exporting firms in a higher place than the domestic firms' MP curve. Then, even with higher employment level, the exporting firms can offer higher (efficiency) wages than the domestic firms can.

The recent development in the firm's turnover literature brings about interesting connection into this context. For example, firms in the export market are more productive than are those firms that supply only in the domestic market. Since exporting is so costly, only very productive firms can survive in the export market. In this sense, an export market is a tougher screen than a domestic market, where reallocation of sales among firms is going on in such a way that the shares of less efficient firms are replaced by more efficient firms. As a result, exporting industries as a whole become more productive (Aw, Chen, and Roberts (1997), and Melitz (1999)).

*Individual Firm's Behavior: Entrepreneurial Abilities and Efficiency Wages*

Following the Oi's model, I assume that an individual firm produces output q by constant returns to scale technique with labor input ($N$) and time input for managerial efforts ($T$).[70] I also assume that the labor input requires managerial input. No capital is assumed.[71] All time left after monitoring employees can be used for management. Therefore, able entrepreneurs can combine coordination and supervision efforts with labor inputs to produce higher levels of output than less-able entrepreneurs can. The able entrepreneurs can also manage more employees but must incur the cost of monitoring

[70] Melitz (1999) assumes that each firm has increasing-returns-to-scale production technique in a monopolistically competitive market.

[71] The model prediction will not change when I include capital in the production function.

those workers. Thus, the entrepreneur's ability determines firm's heterogeneity in productivity, and eventually in size.

A firm's production function is described by the followings.

$$q = f(N, T), \text{ where } f_N > 0,\ f_T > 0, \text{ and } T = \lambda H = \lambda(\Omega - hN). \quad (3\text{-}6)$$

Here $q$ is the output produced by the firm (or entrepreneur), and $\lambda$ is an ability parameter. An entrepreneur with bigger $\lambda$ uses time more efficiently in coordinating production. $H$ is the available amount of time for managerial input. $f_N$ and $f_T$ are the first derivatives of a production function with respect to $N$ and $T$, respectively. $\Omega$ is the fixed amount of time given to the entrepreneur. $h$ means hours to monitor per worker and $N$ is the total number of employees. I assume h to be the same for all entrepreneurs.

Product and labor markets are assumed to be perfectly competitive. Now, an individual firm's profit maximization problem is,

$$\max \Pi = Pq - wN, \text{ with respect to } N, \text{ that is,}$$

$$\max \Pi = Pf(N, \lambda(\Omega - hN)) - wN.$$

Then, the first-order condition becomes,

$$Pf_N = w + P\lambda h f_T, \text{ or}$$

$$Pf_N = w + \delta, \text{ where } \delta = P\lambda h f_T.$$

$P$ is the product price, w is the wage, and I call $\delta$ the implicit cost of monitoring. This condition tells us that in equilibrium, each worker is paid less than his/her marginal value product by the amount of monitoring cost ($P\lambda h f_T$).

If an entrepreneur hires more workers and is able enough to increase marginal product of labor, then he/she can cover the accompanying increase in the monitoring costs, resulting the positive relationship between firm's productivity and firm size.

Next, I introduce workers' ability. Since workers self-select based on his/her ability, able workers command higher wages. Thus, employers must offer higher wages if they want to hire a more able worker:

$w = w(\mu)$, and $w'(\mu) > 0$, where $\mu$ is the worker's ability measure.

Since the labor input ($N$) is measured in an efficiency unit ($N = \mu M$), where $M$ is the number of employment, the profit function is maximized with respect to the labor input ($M$) and ability ($\mu$).

$$\max \Pi = Pq - w(\mu)M \text{, or}$$

$$\max \Pi = Pf(\mu M, \lambda(\Omega - hM)) - w(\mu)M .$$

The first-order conditions become,

$$\text{for } M: \; Pf_N \mu = w(\mu) + Pf_T \lambda h ,$$

$$\text{for } \mu: \; Pf_N = w'(\mu).$$

Combining these two conditions, I have

$$w(\mu) + \delta = \mu w'(\mu), \text{ where } \delta = P\lambda h f_T . \quad \text{(3-7)}$$

The first-order condition (3-7) tells us that an able entrepreneur (with bigger $\lambda$) tends to hire more workers and pay better to attract able workers (with bigger $\mu$) to reduce monitoring costs. Figure 3-2 describes the condition, where a more-able manager 2 demands a worker with higher ability level $\mu_2$ by paying higher wages than a less-able manager 1 does, where he/she has comparative advantage in monitoring lower productive workers with $\mu_1$. It is also shown that the able manager 2 pays higher wages to able worker 2, and that the ratio of monitoring costs to the full labor costs $[\delta_2/(w(\mu_2)+\delta_2)]$ is lower compared with the less-able manager 1.

I now extend the model to an international trade, especially exporting, situation. It would be fairy plausible that I argue that there must be significant extra costs incurred by a firm when a manager decides to export. The costs will come mainly from investigation of foreign markets, modification of a product to conform the foreign standards, advertisement, and transportation costs. Thus, to survive in the foreign market, a firm must be productive enough to cover those extra costs. Using the Oi's condition, I can derive the cut-off ability level for exporters ($\lambda^e$) that must be higher than the cut-off ability for non-exporters ($\lambda^d$) in the following way.

Denote the extra costs of exporting by T in US$. Then, I have an exporter's profit,

$$\Pi^{EX} = Pq - wM - T.$$

Assuming that the production function is homogenous of degree one, I apply the Euler's theorem for $q$, and substitute the first-order condition for $M$ into w in the equation. Then, I obtain a profit function for exporters as

$$\Pi^{EX} = Pf_T\lambda^e\Omega - T.$$

Similarly a profit function for non-exporters is

$$\Pi^d = Pf_T\lambda^d\Omega.$$

Firms will enter the export market as long as $\Pi^{EX}$ exceeds $\Pi^d$. Therefore, the cut-off ability level is $\lambda$ such that $\Pi^{EX} = \Pi^d$. Equating the two profit functions, I have

$$\lambda^e - \lambda^d = T/(Pf_T\Omega) > 0.$$

Hence, the threshold ability of exporters is always higher than that of non-exporters.[72]

*Industry Aggregation and Effects of Exporting Market: A Catalyst Role of Exports*

Next, I consider industry-level aggregation of individual firm's behavior. As Oi (1983) explains, the equilibrium threshold ability, number of employment, and industry price are determined by equating the aggregate demand [ $D(P)$ ] with the aggregate supply [ $S(P)$ ] in the industry market. If there is no trade, the equilibrium condition becomes

$$D(P) = \int_{\lambda^d}^{\infty}[q(P,\lambda)\phi(\lambda)]d\lambda = S(P), \quad \text{(3-8)}$$

where $q$ is a firm's supply, $P$ is the industry price, and $\lambda^d$ is the threshold ability above which all of the entrepreneurs supply the domestic market. In equation (3-8), I assume that the firm's productivity has a distribution and its density function is written by $\phi(\lambda)$.

Turn to the industry-level aggregation when some firms export. I start with the industry total demand that consists of domestic and foreign consumption, that is, $D = D^d + D^*$, where D is the total demand, $D^d$ is the domestic demand, and $D^*$ is the foreign demand. Thus, the total demand is affected by both domestic and foreign shocks. In figure 3-3, I assume that initially the economy is in equilibrium at point 1. Now suppose that for some reasons, foreign demand for the domestic products increased ($D^*$), which rotates the total demand curve from D to D'. To restore the equilibrium, industry supply must increase as demand rises. The short-run impact of this shock will be an increase in

[72] Oi (1983) shows the threshold ability such that $\lambda$ satisfies the equality between profit ($\Pi$) and wage rate ($w$). It is a threshold to distinguish individuals either becoming an entrepreneur earning the profit or becoming a worker earning the wage. But in my situation, firms are already sufficiently productive by choosing to be an entrepreneur in the Oi's model, and the problem is who will decide to export.

industry price, which leads the threshold ability to go down and more less-productive firms may enter the market. However, this is the export market that requires firms to be more productive, and thus, lower productive firms will not maintain the supply and soon make a decision to exit or reduce sales in the market, while more productive firms will continue to enter the export market and existing productive firms will increase their sales. This is the dynamic situation that I consider as a catalyst role of exports, and Figure 3-4 depicts the simplified situation of the dynamics with two firms in an industry.

In Figure 3-4, I assume that both firms, $k$ and $l$, are productive enough to make a decision to export at time t – 1 (their total factor productivities (TFPs) are higher than the industry average TFP ($TFP_{avg}$), for instance). In the beginning of time t, therefore, both firms supply the export market. However, since exporting is so costly and TFP of firm $l$ is lower than TFP of firm $k$, during the period t, it would be possible that firm $l$ decreases its export sales, while firm $k$ increases its sales. Therefore, the majority of the increase in foreign demand will be satisfied by the supply from firms with higher TFPs. As a result, the average industry productivity would be higher in exporting industries, since it is calculated as a weighted average of TFPs with sales shares as a weight.

In the case of exports, therefore, industry dynamics gives rise to productivity increase due to the reallocation of sales from less efficient firms to more efficient firms. Essentially, the demand expansion could cause price to rise faster than the threshold ability to adjust, but since the world market has more elastic demand as depicted in Figure 3, quantity adjustment dominates price adjustment. This is done by a group of highest productive firms that increase the supply to the market with holding down the price increase to remain competitive abroad.

Due to the expansion of exports, concentration of efficient firms takes place within the industry. Since these firms are all demanding for more productive workers, the labor supply curve becomes steeper, like $\overline{w(\mu)}$ in Figure 3-2, helping wages to further increase. As a result, the average wage of this industry becomes higher.

## 7. Conclusion

This chapter has examined how international trade plays a part in determining the inter-industry wage differentials in U.S. manufacturing. I do not consider trade effects as the only essential factor contributing to the wage dispersions, but it would be wrong to ignore this venue, since there is evidence of connection between U.S. wage structure and international trade.

Using the CPS, I first observe the inter-industry wage differentials in U.S. manufacturing in 1991, 1992, 1993, and 1994. My empirical results also show that net-exports affect the inter-industry wage structures, which implies that exporting may play a particularly important role.

The industry-switchers sample reveals that wages of movers from importing industries to exporting industries grew significantly. This may suggest that the exporting industry has more productive firms and able workers than importing or non-manufacturing industries. There is actually exporting industry premium, and the premium is eliminated in the first difference estimation for the switchers sample. Therefore, the export-import wage differentials can be explained by the mover's self-selection, or by the unobserved ability. Hence, it is implied that the observed inter-industry wage differentials can also be, at least partly, explained by the unobserved ability hypothesis.

By considering heterogeneity in entrepreneurial abilities in an industry-dynamics framework, I have established a model explaining how exporting industries pay higher wages. Productive firms set efficiency wages to attract able workers. They tend to enter exporting market, where a re-allocation of sales shares from less efficient firms to more efficient firms within an industry is taking place. As a result, industry-level productivity will get higher in the long run. This concentration of efficient firms in exporting industries also implies higher industrial average wages, attained by the successful match between able entrepreneurs and capable workers.

I would point out some missing aspects of the current study for future research. There have been many attempts to consider the relationship between exports and productivity. Previous studies have dealt with market concentration, R&D spending, computer usage, and import price effects on TFP (Lawrence (2000)). Those aspects are all missing in this study, and so that, further research agenda lies in developing a more rigorous model linking trade and productivity.

Oi (1983) originally developed the model to explain the employer-size-wage-differentials. I do not really consider the effect of firm size in industry dynamics. Some would argue that smaller firms are footloose enough that they can enter and exit the export market more casually than larger firms (Taiwanese manufacturing case by Aw, Chen, and Roberts (1997)). In addition, as pointed out by Borjas and Ramey (1994), for exporting industries, foreign market conditions would be more important in a rent-wage model. In the direction of firm size and rent models, therefore, the efficiency wages for the inter-industry wage differentials can be better dealt with in terms of market structures.

**Table 3-1. Long-Term Structures of Wages and Non-Production Workers Ratio, and Correlations between 1980 and 1990: SIC Two/Four-Digit Industries**

**Panel (A) Payroll per Employment (Thousand Dollars): SIC 2-digit**

| | 1960 | 1965 | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 |
|---|---|---|---|---|---|---|---|---|
| s.d. | 1.12 | 1.33 | 1.57 | 2.41 | 4.15 | 5.90 | 7.27 | 9.00 |
| mean | 5.13 | 6.06 | 7.61 | 10.90 | 16.31 | 22.53 | 27.05 | 32.00 |
| coefficient of variation (c.v.) | 0.22 | 0.22 | 0.21 | 0.22 | 0.25 | 0.26 | 0.27 | 0.28 |

**Panel (B) Non-Production to Total Employment Ratio: SIC 2-digit**

| | 1960 | 1965 | 1970 | 1975 | 1980 | 1985 | 1990 | 1995 |
|---|---|---|---|---|---|---|---|---|
| s.d. | 0.09 | 0.10 | 0.10 | 0.09 | 0.09 | 0.10 | 0.11 | 0.10 |
| mean | 0.23 | 0.23 | 0.24 | 0.25 | 0.26 | 0.28 | 0.28 | 0.28 |
| coefficient of variation (c.v.) | 0.41 | 0.42 | 0.40 | 0.38 | 0.36 | 0.38 | 0.38 | 0.38 |

**Panel (C) Correlation Coefficients between 1980 and 1990, SIC Four-digit Level: Payroll per Employee, Non-production Workers Share, Export, and Import**

| | Corr(pay80, pay90) | Corr(nprd80, nprd90) | Corr(ex80, ex90) | Corr(im80, im90) |
|---|---|---|---|---|
| | 0.942 | 0.936 | 0.905 | 0.888 |

**Sources:** NBER Manufacturing Productivity Database created by Eric J. Bartelsman, Randy A. Becker, and Wayne B. Gray. (Web Site: http://www.nber.org/nberces/) Trade data comes from the database: The Center for International Data at UC Davis. (Web Site: http://data.econ.ucdavis.edu/international/)

# Table 3-2. Inter-Industry Wage Differentials: U.S. Manufacturing, 1991-1994

Dependent Variable: LNWKLWGE (log of weekly wages, greater than or equal to US$10)

| | Independent Variable | IIWD 1991 (CPS92) Parameter Estimate | s.e. | IIWD 1992 (CPS93) Parameter Estimate | s.e. | IIWD 1993 (CPS94) Parameter Estimate | s.e. | IIWD 1994 (CPS95) Parameter Estimate | s.e. |
|---|---|---|---|---|---|---|---|---|---|
| | INTERCEPT | 4.674 | 0.082 *** | 4.775 | 0.081 *** | 4.827 | 0.082 *** | 4.870 | 0.095 *** |
| | SEX | -0.265 | 0.018 *** | -0.258 | 0.018 *** | -0.273 | 0.018 *** | -0.234 | 0.021 *** |
| | RACE | -0.070 | 0.023 *** | -0.098 | 0.023 *** | -0.074 | 0.023 *** | -0.115 | 0.026 *** |
| | UNION | 0.103 | 0.020 *** | 0.109 | 0.021 *** | 0.154 | 0.022 *** | 0.186 | 0.024 *** |
| | SCHL | 0.062 | 0.003 *** | 0.060 | 0.004 *** | 0.064 | 0.004 *** | 0.059 | 0.004 *** |
| | EXPR | 0.045 | 0.006 *** | 0.047 | 0.006 *** | 0.042 | 0.007 *** | 0.037 | 0.007 *** |
| | EXPR*2 | -0.0015 | 0.0003 *** | -0.002 | 0.0003 *** | -0.001 | 0.0003 *** | -0.001 | 0.0004 *** |
| | EXPR*3 | 0.000016 | 0.000004 *** | 0.000019 | 0.000004 *** | 0.000015 | 0.000005 *** | 0.00001 | 0.000005 ** |
| | WIDOW | -0.016 | 0.059 | -0.194 | 0.063 *** | -0.163 | 0.066 *** | -0.127 | 0.070 ** |
| | DIVORCE | -0.038 | 0.022 ** | -0.036 | 0.026 * | -0.046 | 0.026 ** | -0.025 | 0.026 |
| | SINGLE | -0.108 | 0.021 *** | -0.099 | 0.022 *** | -0.120 | 0.023 *** | -0.072 | 0.026 *** |
| | MIDWEST | -0.012 | 0.021 | 0.008 | 0.022 | -0.011 | 0.022 | -0.050 | 0.024 ** |
| | SOUTH | -0.097 | 0.021 *** | -0.082 | 0.022 *** | -0.092 | 0.022 *** | -0.072 | 0.024 *** |
| | WEST | -0.025 | 0.023 | -0.041 | 0.025 ** | -0.054 | 0.025 ** | -0.015 | 0.029 |
| occ1 | Executive, Admin, & Mana | 0.634 | 0.044 *** | 0.674 | 0.044 *** | 0.619 | 0.044 *** | 0.599 | 0.051 *** |
| occ2 | Professional Specialty Occs | 0.472 | 0.047 *** | 0.608 | 0.046 *** | 0.548 | 0.046 *** | 0.501 | 0.053 *** |
| occ3 | Technicians And Related S | 0.388 | 0.052 *** | 0.458 | 0.051 *** | 0.357 | 0.055 *** | 0.308 | 0.064 *** |
| occ4 | Sales Occs | 0.436 | 0.054 *** | 0.469 | 0.057 *** | 0.492 | 0.059 *** | 0.496 | 0.063 *** |
| occ5 | Admin. Support Occs, Incl. | 0.199 | 0.043 *** | 0.236 | 0.043 *** | 0.207 | 0.043 *** | 0.228 | 0.051 *** |
| occ6 | Private Household Occs | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| occ7 | Protective Service Occs | 0.042 | 0.120 | -0.171 | 0.143 | 0.242 | 0.222 | -0.044 | 0.241 |
| occ8 | Service Occs, Exc. Protecti | 0.015 | 0.073 | -0.058 | 0.075 | -0.035 | 0.080 | -0.034 | 0.105 |
| occ9 | Precision Prod., Craft & Re | 0.246 | 0.039 *** | 0.271 | 0.038 *** | 0.253 | 0.039 *** | 0.231 | 0.046 *** |
| occ10 | Machine Opers, Assembler | 0.093 | 0.038 *** | 0.096 | 0.036 *** | 0.083 | 0.037 ** | 0.028 | 0.044 |
| occ11 | Transportation And Materi | 0.050 | 0.052 | 0.112 | 0.052 ** | 0.096 | 0.055 ** | 0.105 | 0.060 ** |
| occ12 | Handlers,equip Cleaners,he | *base* | *base* | *base* | *base* | *base* | *base* | *base* | *base* |
| cic5 | LUMBER AND WOOD PR | 0.059 | 0.066 | -0.054 | 0.064 | -0.091 | 0.059 * | 0.038 | 0.066 |
| cic6 | FURNITURE AND FIXTU | *base* | *base* | *base* | *base* | *base* | *base* | *base* | *base* |
| cic7 | STONE, CLAY, AND GLA | 0.162 | 0.063 *** | 0.065 | 0.059 | -0.046 | 0.056 | 0.140 | 0.070 ** |
| cic8 | PRIMARY METAL INDU | 0.149 | 0.060 *** | 0.085 | 0.055 * | 0.102 | 0.056 ** | 0.201 | 0.064 *** |
| cic9 | FABRICATED METAL PR | 0.112 | 0.056 *** | 0.031 | 0.050 | 0.101 | 0.048 ** | 0.149 | 0.059 *** |
| cic11 | INDUSTRIAL MACHINE | 0.198 | 0.052 *** | 0.072 | 0.046 * | 0.099 | 0.044 ** | 0.214 | 0.054 *** |
| cic12 | ELECTRONIC AND OTH | 0.192 | 0.052 *** | 0.106 | 0.047 ** | 0.020 | 0.046 | 0.149 | 0.056 *** |
| cic13 | Motor vehicles and equipm | 0.316 | 0.056 *** | 0.178 | 0.050 *** | 0.182 | 0.050 *** | 0.305 | 0.058 *** |
| cic14 | Aircraft and parts | 0.248 | 0.069 *** | 0.207 | 0.070 *** | 0.244 | 0.070 *** | 0.292 | 0.081 *** |
| cic15 | TRANSPORTATION EQU | 0.246 | 0.063 *** | 0.193 | 0.059 *** | 0.133 | 0.057 *** | 0.189 | 0.069 *** |
| cic16 | Photographic equipment an | 0.190 | 0.061 *** | 0.169 | 0.060 *** | 0.114 | 0.056 ** | 0.109 | 0.067 * |
| cic17 | Toys and sporting goods | 0.008 | 0.102 | 0.064 | 0.097 | -0.013 | 0.091 | 0.101 | 0.113 |
| cic18 | MISCELLANEOUS MAN | -0.057 | 0.076 | -0.175 | 0.061 *** | -0.041 | 0.062 | 0.035 | 0.079 |
| cic19 | FOOD AND KINDRED PR | 0.111 | 0.053 ** | 0.011 | 0.047 | -0.017 | 0.047 | 0.039 | 0.056 |
| cic20 | TOBACCO PRODUCTS | 0.067 | 0.223 | 0.349 | 0.153 ** | 0.182 | 0.175 | -0.070 | 0.189 |
| cic21 | TEXTILE MILL PRODUC | 0.118 | 0.059 ** | 0.044 | 0.055 | 0.072 | 0.055 * | 0.120 | 0.067 ** |
| cic22 | APPAREL AND OTHER T | -0.069 | 0.056 | -0.120 | 0.049 *** | -0.127 | 0.051 *** | -0.106 | 0.061 ** |
| cic23 | PAPER AND ALLIED PRO | 0.252 | 0.059 *** | 0.134 | 0.055 *** | 0.200 | 0.056 *** | 0.227 | 0.065 *** |
| cic24 | PRINTING AND PUBLISH | 0.058 | 0.054 | -0.034 | 0.049 | 0.011 | 0.047 | 0.019 | 0.057 |
| cic25 | CHEMICALS AND ALLIE | 0.274 | 0.055 *** | 0.186 | 0.050 *** | 0.232 | 0.048 *** | 0.255 | 0.058 *** |
| cic26 | PETROLEUM AND COAL | 0.421 | 0.090 *** | 0.110 | 0.100 | 0.395 | 0.099 *** | 0.384 | 0.105 *** |
| cic27 | RUBBER AND MISCELL | 0.072 | 0.060 | 0.043 | 0.053 | 0.009 | 0.053 | 0.093 | 0.063 * |
| cic28 | LEATHER AND LEATHE | -0.024 | 0.088 | 0.003 | 0.098 | -0.109 | 0.095 | -0.100 | 0.110 |
| | R-Squared | 0.553 | | 0.555 | | 0.556 | | 0.511 | |
| | Adjusted R-Squared | 0.545 | | 0.548 | | 0.547 | | 0.501 | |
| | F-statistic | 72.1 | | 71.5 | | 65.8 | | 51.6 | |
| | Sample Size | 2671 | | 2622 | | 2415 | | 2268 | |

**Notes:** Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance.

**Table 3-2. (Continued)**

| | IIWD 1991 (CPS92) | IIWD 1992 (CPS93) | IIWD 1993 (CPS94) | IIWD 1994 (CPS95) |
|---|---|---|---|---|
| Standard Deviation of Wage Premiums | 0.121 | 0.114 | 0.128 | 0.126 |
| Coefficient of Correlation (IIWD) | | [91, 92] 0.626   [92, 94] 0.429 | [91, 93] 0.851   [92, 93] 0.707 | [91, 94] 0.902   [93, 94] 0.786 |

**Figure 3-1a. Within Industry Non-Production Worker – Total Worker Ratio: Unskilled Labor Intensive Industries, Average**

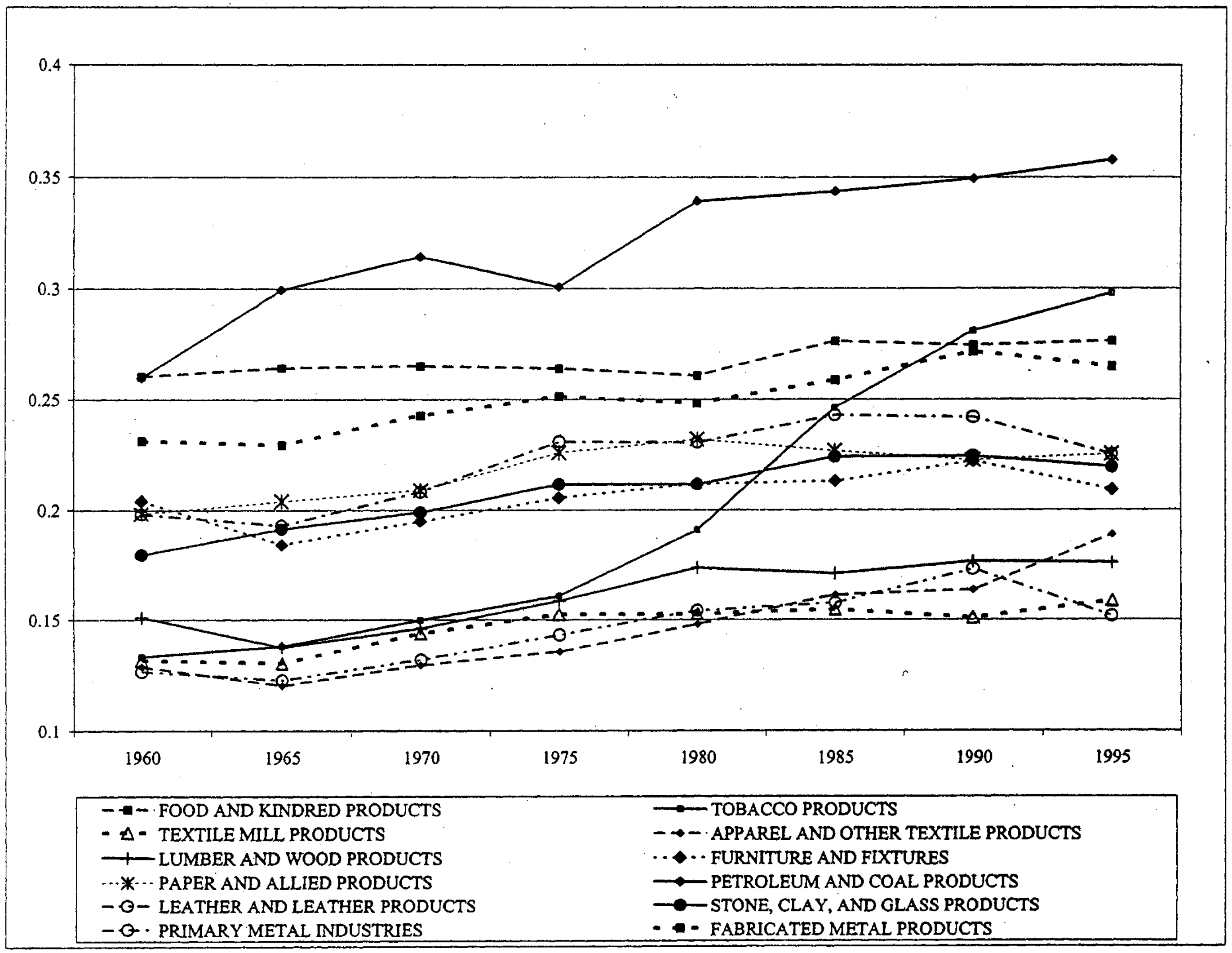

**Figure 3-1b. Within Industry Non-Production Worker – Total Worker Ratio: Skilled Labor Intensive Industries, Average**

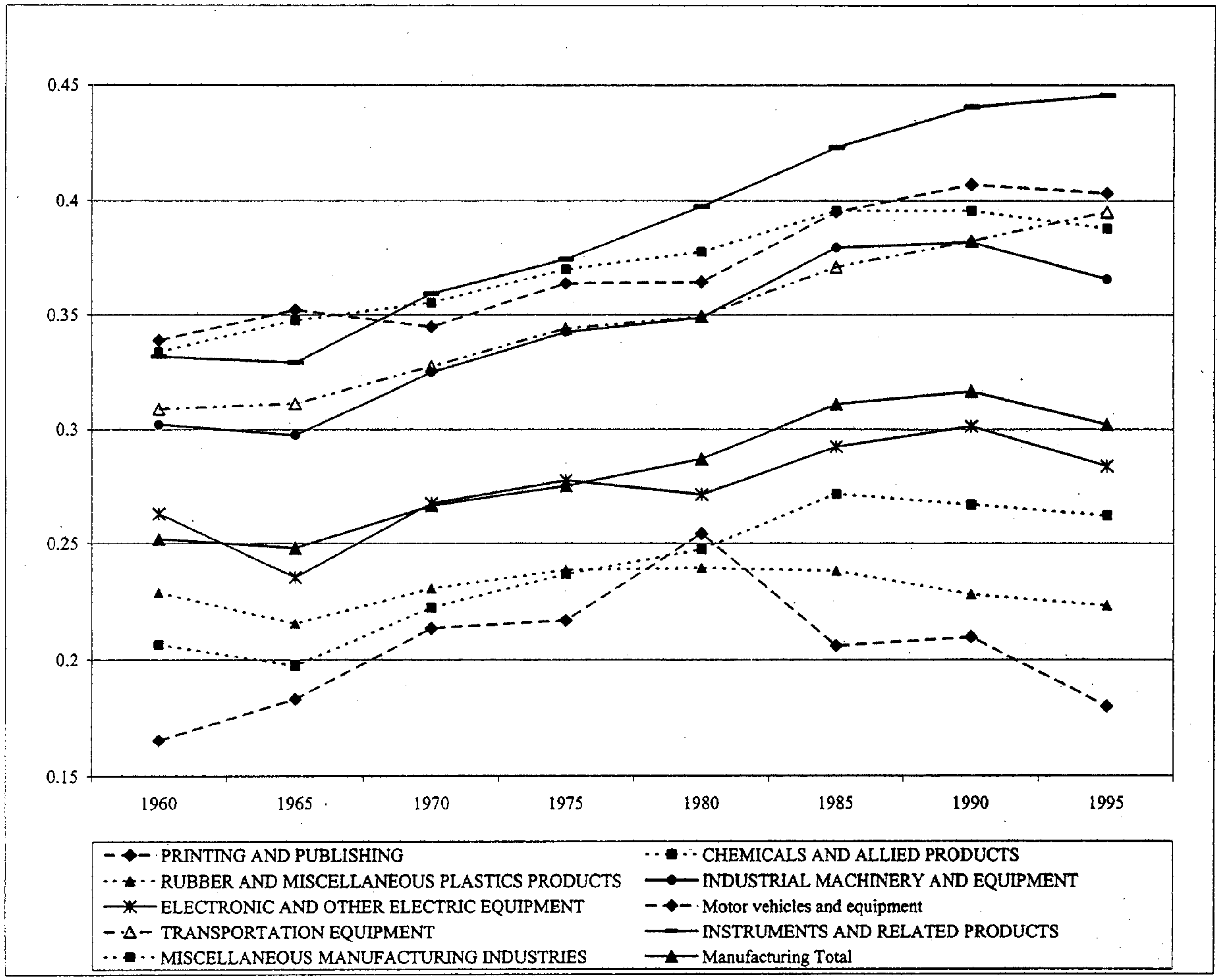

**Table 3-3. Inter-Industry Wage Differentials: Pure Industry Effect Versus Trade Effect, CPS 1992**

| | Dependent Variable: LNWKLWGE (log of weekly wages, greater than or equal to $10) | | | | |
|---|---|---|---|---|---|
| | | Model 1 | | Model 2 | |
| | Independent Variable | Parameter Estimate | Standard Error | Parameter Estimate | Standard Error |
| | INTERCEPT | 4.856 | 0.076 *** | 4.856 | 0.076 *** |
| | SEX | -0.279 | 0.018 *** | -0.275 | 0.018 *** |
| | RACE | -0.100 | 0.023 *** | -0.099 | 0.023 *** |
| | UNION | 0.122 | 0.021 *** | 0.120 | 0.021 *** |
| | SCHL | 0.059 | 0.004 *** | 0.059 | 0.004 *** |
| | EXPR | 0.049 | 0.006 *** | 0.048 | 0.006 *** |
| | EXPR*2 | -0.002 | 0.0003 *** | -0.002 | 0.0003 *** |
| | EXPR*3 | 0.00002 | 0.000004 *** | 0.00002 | 0.000004 *** |
| | WIDOW | -0.176 | 0.063 *** | -0.185 | 0.063 *** |
| | DIVORCE | -0.036 | 0.026 * | -0.040 | 0.026 * |
| | SINGLE | -0.094 | 0.023 *** | -0.090 | 0.023 *** |
| | MIDWEST | 0.021 | 0.022 | 0.017 | 0.021 |
| | SOUTH | -0.090 | 0.022 *** | -0.090 | 0.021 *** |
| | WEST | -0.043 | 0.025 ** | -0.039 | 0.025 * |
| occ1 | Executive, Admin, & Managerial Occs | 0.701 | 0.045 *** | 0.695 | 0.045 *** |
| occ2 | Professional Specialty Occs | 0.639 | 0.047 *** | 0.630 | 0.047 *** |
| occ3 | Technicians And Related Support Occs | 0.472 | 0.052 *** | 0.484 | 0.052 *** |
| occ4 | Sales Occs | 0.491 | 0.057 *** | 0.476 | 0.057 *** |
| occ5 | Admin. Support Occs, Incl. Clerical | 0.254 | 0.044 *** | 0.247 | 0.044 *** |
| occ6 | Private Household Occs | n.a. | n.a. | n.a. | n.a. |
| occ7 | Protective Service Occs | -0.160 | 0.140 | -0.161 | 0.141 |
| occ8 | Service Occs, Exc. Protective & Hhld | -0.030 | 0.075 | -0.033 | 0.075 |
| occ9 | Precision Prod., Craft & Repair Occs | 0.278 | 0.039 *** | 0.274 | 0.039 *** |
| occ10 | Machine Opers, Assemblers & Inspectors | 0.124 | 0.037 *** | 0.119 | 0.037 *** |
| occ11 | Transportation And Material Moving Occs | 0.140 | 0.053 *** | 0.125 | 0.053 *** |
| occ12 | Handlers,equip Cleaners,helpers,laborrs | *base* | *base* | *base* | *base* |

**Table 3-3. (Continued)**

| | Independent Variable | Model 1 Parameter Estimate | Model 1 Standard Error | Model 2 Parameter Estimate | Model 2 Standard Error |
|---|---|---|---|---|---|
| cic5 | LUMBER AND WOOD PRODUCTS | -0.067 | 0.073 | -0.152 | 0.053 *** |
| cic6 | FURNITURE AND FIXTURES | *base* | *base* | *base* | *base* |
| cic7 | STONE, CLAY, AND GLASS PRODUCTS | -0.011 | 0.054 | -0.036 | 0.048 |
| cic8 | PRIMARY METAL INDUSTRIES | -0.030 | 0.059 | -0.020 | 0.042 |
| cic9 | FABRICATED METAL PRODUCTS | -0.095 | 0.039 *** | -0.072 | 0.036 ** |
| cic11 | INDUSTRIAL MACHINERY AND EQUIPMENT | -0.018 | 0.030 | -0.028 | 0.030 |
| cic12 | ELECTRONIC AND OTHER ELECTRIC EQUIPI | 0.067 | 0.057 | 0.011 | 0.031 |
| cic15 | TRANSPORTATION EQUIPMENT | 0.127 | 0.055 ** | 0.094 | 0.047 ** |
| cic16 | Photographic equipment and supplies, and watches | 0.061 | 0.049 | 0.073 | 0.048 * |
| cic19 | FOOD AND KINDRED PRODUCTS | -0.091 | 0.033 *** | -0.086 | 0.032 *** |
| cic21 | TEXTILE MILL PRODUCTS | -0.032 | 0.066 | -0.047 | 0.043 |
| cic22 | APPAREL AND OTHER TEXTILE PRODUCTS | -0.255 | 0.144 ** | -0.212 | 0.035 *** |
| cic23 | PAPER AND ALLIED PRODUCTS | 0.093 | 0.050 ** | 0.065 | 0.048 * |
| cic24 | PRINTING AND PUBLISHING | -0.169 | 0.036 *** | -0.132 | 0.034 *** |
| cic25 | CHEMICALS AND ALLIED PRODUCTS | 0.150 | 0.057 *** | 0.087 | 0.036 *** |
| cic27 | RUBBER AND MISCELLANEOUS PLASTICS P | 0.657 | 0.312 ** | -0.012 | 0.065 |
| cic28 | LEATHER AND LEATHER PRODUCTS | -0.273 | 0.211 * | -0.092 | 0.090 |
| | | | | | |
| lexp*cic5 | LUMBER AND WOOD PRODUCTS | 0.137 | 0.080 ** | | |
| lexp*cic6 | FURNITURE AND FIXTURES | *base* | *base* | | |
| lexp*cic7 | STONE, CLAY, AND GLASS PRODUCTS | 0.088 | 0.085 | | |
| lexp*cic8 | PRIMARY METAL INDUSTRIES | -0.013 | 0.073 | | |
| lexp*cic9 | FABRICATED METAL PRODUCTS | 0.082 | 0.058 * | | |
| lexp*cic1 | INDUSTRIAL MACHINERY AND EQUIPMENT | -0.105 | 0.064 ** | | |
| lexp*cic1 | ELECTRONIC AND OTHER ELECTRIC EQUIPI | 0.185 | 0.164 | | |
| lexp*cic1 | TRANSPORTATION EQUIPMENT | -0.062 | 0.060 | | |
| lexp*cic1 | Photographic equipment and supplies, and watches | 0.096 | 0.069 * | | |
| lexp*cic1 | FOOD AND KINDRED PRODUCTS | 0.032 | 0.036 | | |
| lexp*cic2 | TEXTILE MILL PRODUCTS | 0.020 | 0.071 | | |
| lexp*cic2 | APPAREL AND OTHER TEXTILE PRODUCTS | -0.024 | 0.073 | | |
| lexp*cic2 | PAPER AND ALLIED PRODUCTS | -0.232 | 0.093 *** | | |
| lexp*cic2 | PRINTING AND PUBLISHING | 0.175 | 0.055 *** | | |
| lexp*cic2 | CHEMICALS AND ALLIED PRODUCTS | -0.130 | 0.091 * | | |
| lexp*cic2 | RUBBER AND MISCELLANEOUS PLASTICS P | 0.689 | 0.314 ** | | |
| lexp*cic2 | LEATHER AND LEATHER PRODUCTS | -0.084 | 0.089 | | |
| | R-Squared | 0.567 | | 0.561 | |
| | Adjusted R-Squared | 0.558 | | 0.554 | |
| | F-statistic | 58.3 | | 80.5 | |
| | Sample Size | 2502 | | 2502 | |

**Sources:** *Current Population Survey*, (CPS), March, 1992. Downloaded from the web site of BLS-CPS home page by FERRET (web site: http://www.bls.census.gov/cps/). Trade data are downloaded from the UC Davis web site.

**Notes:** Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. The variable, lexp, represents logarithm of export-import ratio: lexp = log(EX) - log(IM). I use this variable as a proxy for Eijk (industry net export). Estimates are raw values: namely, they represent positive (or negative) differences from the base industry, whose wage premium is assumed to be 0. The base-industry is Furniture and Fixtures.

**Table 3-4. Classification of Industries to Exporters, Importers, or Intra-Industry Traders (IIT): The U.S. Major Manufacturing Industries, 1991 and 1992**

| | SIC 2-digit or | | CPS | | TRADE: NBER Productivity Database and UC Davis Web Site by Feenstra | | | | | | Exporter or Importer | | EXPORTER, MPORTER, or | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | CPS92 | CPS93 | EX/Ship | | IM/(Ship-EX+IM) | | Trade Balance | | | | | |
| CIC | CIC | Detailed Industry (CPS) | 1991 | 1992 | a | a | b | b | a-b | a-b | | | IIT? | CIC |
| '2-digit' | 3-digit | Industry | **IIWD91** | **IIWD92** | **1991** | **1992** | **1991** | **1992** | **1991** | **1992** | 1991 | 1992 | | "2-digit" |
| cic5 | 24 | LUMBER AND WOOD P | 0.059 | -0.054 | 0.093 | 0.083 | 0.090 | 0.096 | 0.003 | -0.013 | EXPORTER | IMPORTER | IIT | cic5 |
| cic6 | 25 | FURNITURE AND FIXT | *base* | *base* | 0.054 | 0.059 | 0.116 | 0.116 | -0.062 | -0.057 | IMPORTER | IMPORTER | IMPORTER | cic6 |
| cic7 | 32 | STONE, CLAY, AND GL | 0.162 | 0.065 | 0.061 | 0.064 | 0.097 | 0.096 | -0.036 | -0.032 | IMPORTER | IMPORTER | IMPORTER | cic7 |
| cic8 | 33 | PRIMARY METAL INDU | 0.149 | 0.085 | 0.110 | 0.103 | 0.162 | 0.157 | -0.052 | -0.054 | IMPORTER | IMPORTER | IMPORTER | cic8 |
| cic9 | 34 | FABRICATED METAL P | 0.112 | 0.031 | 0.065 | 0.067 | 0.066 | 0.069 | -0.001 | -0.001 | IMPORTER | IMPORTER | IIT | cic9 |
| cic11 | 35 | INDUSTRIAL MACHINE | 0.198 | 0.072 | 0.272 | 0.269 | 0.250 | 0.261 | 0.022 | 0.008 | EXPORTER | EXPORTER | **EXPORTER** | cic11 |
| cic12 | 36 | ELECTRONIC AND OTH | 0.192 | 0.106 | 0.239 | 0.237 | 0.296 | 0.299 | -0.058 | -0.062 | IMPORTER | IMPORTER | IMPORTER | cic12 |
| cic13 | 351 | Motor vehicles and equipm | 0.316 | 0.178 | 0.148 | 0.149 | 0.297 | 0.278 | -0.149 | -0.128 | IMPORTER | IMPORTER | IMPORTER | cic13 |
| cic14 | 352 | Aircraft and parts | 0.248 | 0.207 | 0.402 | 0.402 | 0.158 | 0.156 | 0.244 | 0.246 | EXPORTER | EXPORTER | **EXPORTER** | cic14 |
| cic15 | *360* | TRANSPORTATION EQU | 0.246 | 0.193 | 0.083 | 0.100 | 0.067 | 0.082 | 0.016 | 0.018 | EXPORTER | EXPORTER | **EXPORTER** | cic15 |
| cic16 | *380* | Photographic equipment ar | 0.190 | 0.169 | 0.161 | 0.158 | 0.277 | 0.289 | -0.116 | -0.131 | IMPORTER | IMPORTER | IMPORTER | cic16 |
| cic17 | 390 | Toys and sporting goods | 0.008 | 0.064 | 0.152 | 0.168 | 0.462 | 0.504 | -0.310 | -0.337 | IMPORTER | IMPORTER | IMPORTER | cic17 |
| cic18 | *371* | MISCELLANEOUS MAN | -0.057 | -0.175 | 0.128 | 0.131 | 0.154 | 0.159 | -0.026 | -0.028 | IMPORTER | IMPORTER | IMPORTER | cic18 |
| cic19 | 20 | FOOD AND KINDRED P | 0.111 | 0.011 | 0.050 | 0.053 | 0.042 | 0.042 | 0.008 | 0.011 | EXPORTER | EXPORTER | IIT | cic19 |
| cic20 | 21 | TOBACCO PRODUCTS | 0.067 | 0.349 | 0.143 | 0.128 | 0.007 | 0.009 | 0.135 | 0.119 | EXPORTER | EXPORTER | **EXPORTER** | cic20 |
| cic21 | 22 | TEXTILE MILL PRODUC | 0.118 | 0.044 | 0.071 | 0.071 | 0.127 | 0.129 | -0.056 | -0.058 | IMPORTER | IMPORTER | IMPORTER | cic21 |
| cic22 | 23 | APPAREL AND OTHER | -0.069 | -0.120 | 0.053 | 0.061 | 0.294 | 0.315 | -0.242 | -0.255 | IMPORTER | IMPORTER | IMPORTER | cic22 |
| cic23 | 26 | PAPER AND ALLIED PR | 0.252 | 0.134 | 0.072 | 0.076 | 0.081 | 0.079 | -0.009 | -0.003 | IMPORTER | IMPORTER | IIT | cic23 |
| cic24 | 27 | PRINTING AND PUBLIS | 0.058 | -0.034 | 0.023 | 0.023 | 0.014 | 0.014 | 0.010 | 0.009 | EXPORTER | EXPORTER | IIT | cic24 |
| cic25 | 28 | CHEMICALS AND ALLI | 0.274 | 0.186 | 0.139 | 0.134 | 0.079 | 0.084 | 0.059 | 0.050 | EXPORTER | EXPORTER | **EXPORTER** | cic25 |
| cic26 | 29 | PETROLEUM AND COA | 0.421 | 0.110 | 0.050 | 0.049 | 0.087 | 0.088 | -0.037 | -0.039 | IMPORTER | IMPORTER | IMPORTER | cic26 |
| cic27 | 30 | RUBBER AND MISCELL | 0.072 | 0.043 | 0.067 | 0.067 | 0.107 | 0.108 | -0.040 | -0.041 | IMPORTER | IMPORTER | IMPORTER | cic27 |
| cic28 | 31 | LEATHER AND LEATHI | -0.024 | 0.003 | 0.145 | 0.150 | 0.579 | 0.580 | -0.434 | -0.429 | IMPORTER | IMPORTER | IMPORTER | cic28 |

## Table 3-4. (Continued)

| CIC '2-digit' | SIC 2-digit or CIC 3-digit | Detailed Industry (CPS) Industry | Aggregated Shipment (Mill. $) (Ship) 1991 | Aggregated Shipment (Mill. $) (Ship) 1992 | Exports (Mill. $) (EX) 1991 | Exports (Mill. $) (EX) 1992 | Imports (Mill. $) (IM) 1991 | Imports (Mill. $) (IM) 1992 |
|---|---|---|---|---|---|---|---|---|
| cic5 | 24 | LUMBER AND WOOD P | 70569.1 | 81764.9 | 6574.9 | 6805.6 | 6336.7 | 7939.6 |
| cic6 | 25 | FURNITURE AND FIXTU | 40027.2 | 43689.6 | 2152.8 | 2582.0 | 4973.7 | 5419.9 |
| cic7 | 32 | STONE, CLAY, AND GL | 59611.0 | 62383.9 | 3650.4 | 3975.8 | 5996.3 | 6179.5 |
| cic8 | 33 | PRIMARY METAL INDU | 132836.6 | 138209.4 | 14664.4 | 14273.5 | 22886.0 | 23165.1 |
| cic9 | 34 | FABRICATED METAL P | 157077.1 | 167055.7 | 10227.8 | 11249.0 | 10432.9 | 11461.1 |
| cic11 | 35 | INDUSTRIAL MACHINE | 243479.9 | 258336.3 | 66324.4 | 69384.0 | 59204.3 | 66666.7 |
| cic12 | 36 | ELECTRONIC AND OTH | 197879.5 | 216229.5 | 47237.3 | 51289.0 | 63451.2 | 70433.9 |
| cic13 | 351 | Motor vehicles and equipm | 206100.9 | 239120.3 | 30509.3 | 35741.4 | 74165.9 | 78156.8 |
| cic14 | 352 | Aircraft and parts | 102380.8 | 104783.9 | 41151.2 | 42143.2 | 11492.5 | 11554.8 |
| cic15 | *360* | TRANSPORTATION EQU | 55550.3 | 55952.9 | 4584.6 | 5574.3 | 3634.3 | 4477.3 |
| cic16 | *380* | Photographic equipment ar | 22775.2 | 22961.4 | 3665.7 | 3628.6 | 7305.2 | 7840.9 |
| cic17 | 390 | Toys and sporting goods | 11342.8 | 12003.6 | 1719.8 | 2012.9 | 8263.0 | 10160.0 |
| cic18 | *371* | MISCELLANEOUS MAN | 130172.9 | 139499.4 | 16638.6 | 18229.1 | 20644.4 | 22883.7 |
| cic19 | 20 | FOOD AND KINDRED P | 387600.8 | 407157.2 | 19250.4 | 21774.9 | 16038.8 | 17050.1 |
| cic20 | 21 | TOBACCO PRODUCTS | 32031.7 | 35198.4 | 4574.1 | 4509.4 | 203.1 | 288.1 |
| cic21 | 22 | TEXTILE MILL PRODUC | 65706.0 | 70517.6 | 4634.3 | 5003.2 | 8857.0 | 9715.0 |
| cic22 | 23 | APPAREL AND OTHER | 65345.2 | 71546.4 | 3455.5 | 4343.8 | 25829.1 | 30955.2 |
| cic23 | 26 | PAPER AND ALLIED PR | 128824.1 | 133062.5 | 9277.8 | 10058.3 | 10604.1 | 10516.4 |
| cic24 | 27 | PRINTING AND PUBLIS | 156684.7 | 166797.5 | 3644.1 | 3865.9 | 2134.3 | 2327.7 |
| cic25 | 28 | CHEMICALS AND ALLI | 292325.9 | 305371.5 | 40556.0 | 41043.9 | 21687.7 | 24321.4 |
| cic26 | 29 | PETROLEUM AND COA | 158076.4 | 149941 | 7962.7 | 7330.6 | 14383.8 | 13762.9 |
| cic27 | 30 | RUBBER AND MISCELL | 100668.0 | 113611.3 | 6759.4 | 7581.2 | 11242.9 | 12845.3 |
| cic28 | 31 | LEATHER AND LEATHE | 9142.3 | 9667.8 | 1329.4 | 1453.7 | 10747.6 | 11333.3 |

**Sources:** NBER Manufacturing Productivity Database created by Eric J. Bartelsman, Randy A. Becker, and Wayne B. Gray (web site: http://www.nber.org/nberces/).

**Table 3-5. Average Wage Growth of Industry-Switchers: between 1991 and 1992**

| | Average Wage Growth of Switchers (over a 91-92 period) | | | |
|---|---|---|---|---|
| | All into Exporting | All out from Exporting | from Importing to Exporting | from Exporting to Importing |
| Sample Size | 13 | 15 | 5 | 4 |
| Relative Wage (W92/W91) | 1.1199 | 1.0979 | 1.2365 | 0.8926 |

**Notes:** Samples are taken for those individuals who are male in their 30s. The total number of observations in the matched sample is 609. Out of the 609 individuals, 155 workers changed industries based on the detailed industry categories of CPS. Out of the 155 workers, 71 workers changed industries defined in this study: Exporting, Importing, IIT, and Non-Manufacturing.

**Table 3-6. Export-Import Wage Differentials and Test of the Unobserved Ability Hypothesis**

| | Exporting-Industry Wage Premiums: 1991 and 1992 | | Unobserved Ability Hypothesis (1991) | |
|---|---|---|---|---|
| | Dep. Var = log of wages | | Dep. Var = log of wages | Dep. Var = log of (W92/W91) |
| Coefficients | EIWD91 Estimates (t-ratios) | EIWD92 Estimates (t-ratios) | Cross-Sectoin Estimates (t-ratios) | Fixed-Effect Estimates (t-ratios) |
| AGE | -0.141 | 0.319 | 0.297 | |
| | (-0.64) | (1.41)* | (0.51) | |
| AGE#2 | 0.002 | -0.004 | -0.004 | |
| | (0.71) | (-1.38)* | (-0.44) | |
| SCHOOLING | 0.071 | 0.067 | 0.051 | |
| | (8.18)*** | (7.40)*** | (2.04)** | |
| MARRIED | 0.123 | 0.187 | 0.094 | |
| | (2.71)*** | (4.04)*** | (0.86) | |
| NONWHITE | -0.185 | -0.078 | -0.702 | |
| | (-2.86)*** | ( -1.19) | (-3.78)*** | |
| NORTHEAST | 0.06432 | 0.105 | 0.032 | |
| | (1.49)* | (2.46)*** | (0.30) | |
| EXDUMMY | 0.191 | 0.211 | 0.313 | 0.031 |
| | (2.12)** | (2.36)*** | (1.90)** | (0.30) |
| IMDUMMY | 0.029 | -0.035 | 0.056 | -0.060 |
| | (0.36) | (-0.43) | (0.38) | (-0.61) |
| NONMFG | -0.083 | -0.112 | 0.111 | -0.014 |
| | (-1.24) | (-1.65)** | (0.83) | (-0.17) |
| Adj. R-squared | 0.314 | 0.320 | 0.491 | -0.042 |
| F-statistic | 16.96 | 17.54 | 5.21 | 0.72 |
| n | 595 | 598 | 71 | 71 |
| d.f. | 577 | 580 | 54 | 60 |

**Notes:** The numbers in parentheses are t-statistics. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. The first three estimations include an intercept and 7 occupational dummies. The fourth equation is estimated by a first-difference form, and the estimation includes intercept and *differences* in the 7 occupational dummies.

**Table 3-7. Testing the Efficiency Wage Hypothesis**

| | Efficiency Wage Hypothesis (1991) | |
|---|---|---|
| | Dep. Var = binary number (Takes 1 if switched; 0, otherwise.) | |
| Coefficients | Linear Probability Model Estimates (t-ratios) | Probit Model Estimates [standard errors] |
| INTERCEPT | -0.045 | 1.662 |
| | (-0.17) | [0.830]** |
| EIWD | 0.712 | -2.070 |
| | (3.20)*** | [0.665]*** |
| AGE | 0.011 | -0.037 |
| | (1.60)* | [0.023]* |
| SCHOOLING | -0.001 | 0.005 |
| | (-0.18) | [0.021] |
| MARRIED | -0.061 | 0.185 |
| | (-1.40)* | [0.134]* |
| NONWHITE | 0.052 | -0.164 |
| | (0.84) | [0.188] |
| NORTHEAST | 0.003 | -0.013 |
| | (0.08) | [0.131] |
| Adj. R-squared | 0.015 | |
| F-statistic | 2.52 | |
| log likelihood | | -331.95 |
| n | 595 | 595 |
| d.f. | 588 | |

**Notes:** EIWD stands for Export-Import Wage Differentials. Asterisks, *** indicate 1% level of significance, ** indicate 5% level of significance, and * indicates 10% level of significance. Proc Probit procedure in SAS is modeling the probabilities of lower ordered value for the dependent variable: that is, my model is calculating the effect on the probability of staying in the same industry. This is the reason why the estimated signs are systematically opposite to those from the linear probability model.

**Figure 3-2. Oi Model (1983): Allocation of Workers to Heterogeneous Firms**

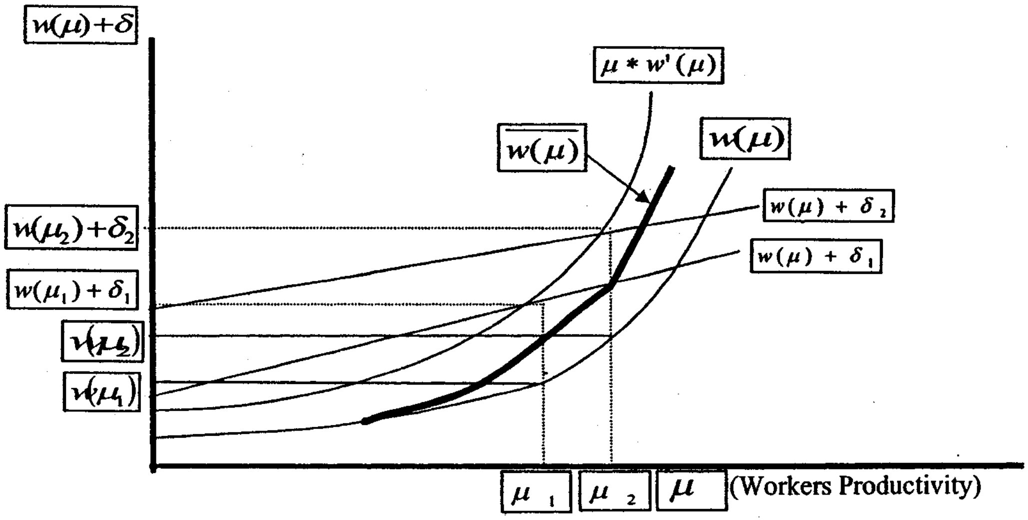

**Figure 3-3. Industry Level Effect of Increase in Exports**

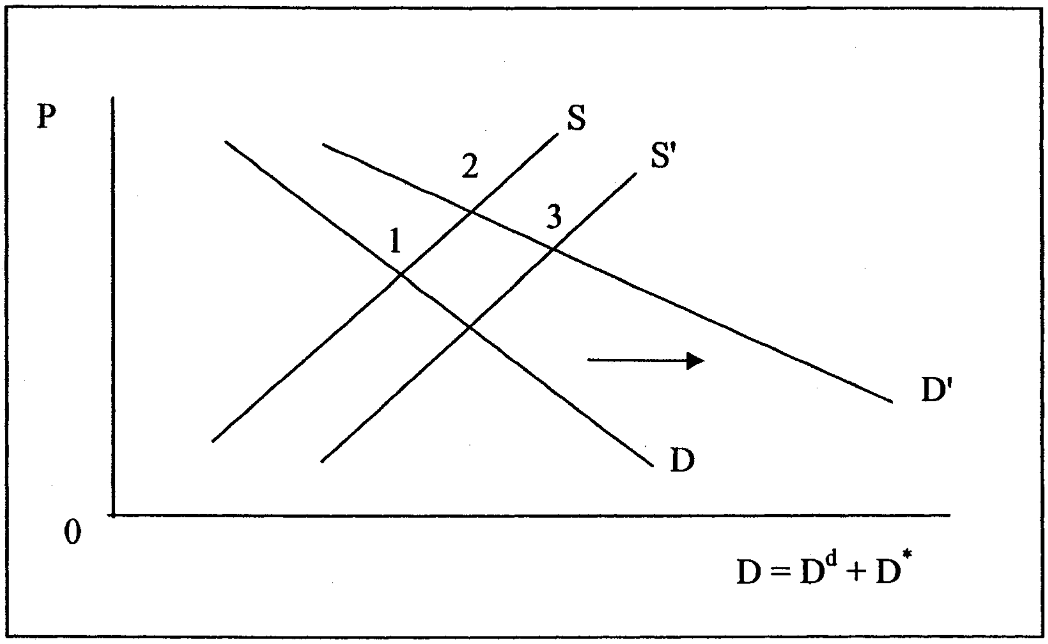

**Figure 3-4. Decision to Export and Catalyst Role of Export**

| Period | t - 1 | t | |
|---|---|---|---|
| | | beginning of t | end of t |
| | Autarky | Trade I | Trade II |
| firm k | domestic | export | expansion |
| | $TFP_k > TFP_l > TFP_{avg}$ | | |
| firm l | domestic | export | contraction |
| | **decision to export** | **catalyst role of export** | |

**Data Appendix**

The micro data is collected from U.S. *Current Population Survey* (CPS), March Supplement of the years: 1992, 1993, 1994, and 1995. Data are all downloaded from the web site of the Census of Bureau, CPS home page. CPS industry classifications are based on the Census Industry Classifications (CIC). I restrict the sample for those who are 18 years old or older up to 64 years old with minimum weekly wages of US$10. The sample is first split into traded and non-traded industries for each year. The traded industries are shown by the CPS codes (CIC two-digit classifications) 5 – 28, and non-traded sectors are by the codes 1 – 4 and 29 – 52. Control variables are individual's weekly earnings, age, sex, race, marital status, region, union membership, education attainment, industry, occupation, and indicators for a civilian labor force and a full-time worker. The total numbers of observations for the traded sectors are then 2751, 2692, 2519, and 2368 for the years of 1992, 1993, 1994, and 1995, respectively. From the data set, I further eliminate those observations that are not for a full-time worker or civilian labor force. Any individuals' data belonging to CIC industries 0, 10, 51, and 52 are also deleted (CIC-0, 51, and 52 are not in the traded sectors, though). Individuals without any schooling are not included. Finally, I obtain the sample sizes: from 2671 in 1992, to 2622 in 1993, to 2415 in 1994, and to 2268 in 1995, respectively.

U.S. manufacturing exports and imports for the years 1991 through 1994 are obtained from the UC Davis web site. Industry classifications are available based on the four-digit Standard Industry Classifications (SIC). In the CPS, the finest category of individual's industry classification is given by CIC three-digit. Using the concordance between SIC and CIC, I need to add some of SIC three-digit industries to the CIC two-digit group. For this reason, two things should be noted. One is that the total number of SIC two-digit industries is 20 while the number for CIC is 23, and the other thing is that I have to eliminate some of industries when estimating the trade-free industry premiums due to the lack of variations within the CIC "two-digit" group. Motor vehicles and equipment (CIC=13, SIC371), aircraft and parts (CIC= 14, SIC=372), and toys (CIC=17, SIC=394) are the ones. (Photographic equipment (CIC=16, SIC=386 and 7) can have variations, but CIC two-digit industries like miscellaneous mfg. (CIC=18), tobacco (CIC=20), and petroleum (CIC=26) cannot have variations.)

**Appendix Table 3-1. Descriptive Statistics of Variables in the Data Set for Male Employees in Their 30s**

| Variable | N | Mean | Standard Deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| id | 595 | 303.311 | 175.952 | 1.000 | 609.000 |
| mmyy | 595 | 31992.000 | 0.000 | 31992.000 | 31992.000 |
| hhnum | 595 | 419025027065.000 | 331301660272.000 | 1007368433.000 | 999359701608.000 |
| wage | 595 | 626.948 | 347.913 | 100.000 | 1923.000 |
| age | 595 | 34.124 | 2.516 | 30.000 | 38.000 |
| schl | 595 | 13.906 | 2.681 | 0.000 | 22.000 |
| marrd | 595 | 0.782 | 0.414 | 0.000 | 1.000 |
| nonwhite | 595 | 0.092 | 0.290 | 0.000 | 1.000 |
| neast | 595 | 0.247 | 0.432 | 0.000 | 1.000 |
| ind | 595 | 27.867 | 13.756 | 1.000 | 50.000 |
| switch | 595 | 0.257 | 0.437 | 0.000 | 1.000 |
| eiwd | 595 | -0.039 | 0.080 | -0.083 | 0.191 |
| exdum | 595 | 0.082 | 0.275 | 0.000 | 1.000 |
| imdum | 595 | 0.118 | 0.322 | 0.000 | 1.000 |
| neither | 595 | 0.000 | 0.000 | 0.000 | 0.000 |
| nonmfg | 595 | 0.703 | 0.458 | 0.000 | 1.000 |
| mocc | 595 | 5.830 | 3.670 | 1.000 | 12.000 |
| occ1 | 595 | 0.145 | 0.352 | 0.000 | 1.000 |
| occ2 | 595 | 0.203 | 0.403 | 0.000 | 1.000 |
| occ3 | 595 | 0.188 | 0.391 | 0.000 | 1.000 |
| occ4 | 595 | 0.045 | 0.208 | 0.000 | 1.000 |
| occ5 | 595 | 0.035 | 0.185 | 0.000 | 1.000 |
| occ6 | 595 | 0.193 | 0.395 | 0.000 | 1.000 |
| occ7 | 595 | 0.077 | 0.267 | 0.000 | 1.000 |
| occ8 | 595 | 0.071 | 0.256 | 0.000 | 1.000 |
| lwage | 595 | 6.300 | 0.539 | 4.605 | 7.562 |
| age2 | 595 | 1170.790 | 171.503 | 900.000 | 1444.000 |
| expr | 595 | 14.218 | 3.663 | 4.000 | 29.000 |
| expr2 | 595 | 215.563 | 106.290 | 16.000 | 841.000 |
| expr3 | 595 | 3446.980 | 2554.970 | 64.000 | 24389.000 |

**Notes:** The descriptive statistics are computed by the SAS, "proc means" procedure.

## Appendix Table 3-2. Variable Definitions

| Variable | Definition | | |
|---|---|---|---|
| SCHL | Years in schooling completed. | | |
| | CPS Code | Education Attained | Converted Years (SCH*) |
| | 0 | Children | deleted |
| | 31 | Less than 1st grade | 0 |
| | 32 | 1st,2nd,3rd,or 4th grade | 4 |
| | 33 | 5th or 6th grade | 6 |
| | 34 | 7th and 8th grade | 8 |
| | 35 | 9th grade | 9 |
| | 36 | 10th grade | 10 |
| | 37 | 11th grade | 11 |
| | 38 | 12th grade no diploma | 12 |
| | 39 | High school graduate-high school diploma | 12 |
| | 40 | Some college but no degree | 14 |
| | 41 | Assc degree-occupation/vocation | 14 |
| | 42 | Assc degree-academic program | 14 |
| | 43 | Bachelor's degree (BA,AB,BS) | 16 |
| | 44 | Master's degree (MA,MS,MENG,MED,MSW,MB | 18 |
| | 45 | Professional school degree (MD,DDS,DVM,L | 20 |
| | 46 | Doctorate degree (PHD,EDD) | 22 |
| EXPR | Years in experience calculated by: EXPR = AGE - 6 - SCH*. SCH* shows the converted years above. | | |
| OCCMJR | Occupational dummies based on the CPS major industry classifications | | |
| | CPS Code | Occupational Description | Converted Dummy |
| | 0 | Not in univ for children or Armed Forces | deleted |
| | 1 | Executive, Admin, & Managerial Occs | occ1 |
| | 2 | Professional Specialty Occs | occ2 |
| | 3 | Technicians And Related Support Occs | occ3 |
| | 4 | Sales Occs | occ4 |
| | 5 | Admin. Support Occs, Incl. Clerical | occ5 |
| | 6 | Private Household Occs | occ6 deleted |
| | 7 | Protective Service Occs | occ7 |
| | 8 | Service Occs, Exc. Protective & Hhld | occ8 |
| | 9 | Precision Prod., Craft & Repair Occs | occ9 |
| | 10 | Machine Opers, Assemblers & Inspectors | occ10 |
| | 11 | Transportation And Material Moving Occs | occ11 |
| | 12 | Handlers,equip Cleaners,helpers,laborrs | occ12 *base* |
| | 13 | Farming, Forestry And Fishing Occs | deleted |
| | 14 | Armed Forces | deleted |

## Appendix Table 3-2. (Continued)

| | |
|---|---|
| AGE | Individual's age. |
| **SEX** | Female dummy. Takes one if an individual is female, otherwise 0. |
| **RACE** | Non-white dummy. Takes one if an individual is not white, otherwise 0. |
| **UNION** | Union dummy. Takes one if an individual is a member of a labor union, otherwise 0. |

MARSTA Marital status dummies.

| CPS Code | Marital Status | Converted Dummy | |
|---|---|---|---|
| 1 | Marr-civ sp present | mar | *base* |
| 2 | Marr-AF spo present | mar | *base* |
| 3 | Marr-spouse absent | mar | *base* |
| 4 | Widowed | WIDOW | |
| 5 | Divorced | DIVORCE | |
| 6 | Separated | DIVORCE | |
| 7 | Never married | SINGLE | |

REGION Region dummies.

| CPS Code | Region | Converted Dummy | |
|---|---|---|---|
| 1 | Northeast | ne | *base* |
| 2 | Midwest | MIDWEST | |
| 3 | South | SOUTH | |
| 4 | West | WEST | |

# Appendix Table 3-3. Industry Concordance: CIC (SIC) 2-digit Classifications

| CPS Code Number ("CIC 2-digit") | SIC 2-digit | Manufacturing Industry | |
|---|---|---|---|
| 0 Not in univ for children or Armed Forces | | | |
| 1 Goods Producing-Agricultural Services | | | |
| 2 Goods producing-Other Agricultural | | | |
| 3 Mining | | | |
| 4 Construction | | | |
| 5 Mfg-Lumber & Wood Prods, Ex Furnitur | 24 | LUMBER AND WOOD PRODUCTS | |
| 6 Mfg-Furniture & Fixtures | 25 | FURNITURE AND FIXTURES | *base* |
| 7 Mfg-Stone, Clay, Concrete, Glass Prods | 32 | STONE, CLAY, AND GLASS PRODUCTS | |
| 8 Mfg-Primary Metals | 33 | PRIMARY METAL INDUSTRIES | |
| 9 Mfg-Fabricated Metals | 34 | FABRICATED METAL PRODUCTS | |
| 10 Mfg-Not Specified Metal Industries | | | deleted |
| 11 Mfg-Machinery, Ex Electrical | 35 | INDUSTRIAL MACHINERY AND EQUIPMENT | |
| 12 Mfg-Electrical Machinery,equip Supplies | 36 | ELECTRONIC AND OTHER ELECTRIC EQUIPMENT | |
| 13 Mfg-Motor Vehicles & Equip | 371 | Motor vehicles and equipment | |
| 14 Mfg-Aircraft & Parts | 372 | Aircraft and parts | |
| 15 Mfg-Other Transportation Equipment | 37 | **TRANSPORTATION EQUIPMENT** | |
| 16 Mfg-Professional & Photo Equip, Watch | 386, 387 | Photographic equipment and supplies, and watches | |
| 17 Mfg-Toys,amusement & Sporting Goods | 394 | Toys and sporting goods | |
| 18 Mfg-Misc & Nec Mfg Industries | 38+39 | **MISCELLANEOUS MANUFACTURING INDUSTRIES** | |
| 19 Mfg-Food & Kindred Prods | 20 | FOOD AND KINDRED PRODUCTS | |
| 20 Mfg-Tobacco Prods | 21 | TOBACCO PRODUCTS | |
| 21 Mfg-Textile Mill Prods | 22 | TEXTILE MILL PRODUCTS | |
| 22 Mfg-Apparel & Other Finished Textile P | 23 | APPAREL AND OTHER TEXTILE PRODUCTS | |
| 23 Mfg-Paper & Allied Products | 26 | PAPER AND ALLIED PRODUCTS | |
| 24 Mfg-Printing, Publishing & Allied Inds | 27 | PRINTING AND PUBLISHING | |
| 25 Mfg-Chemicals & Allied Prods | 28 | CHEMICALS AND ALLIED PRODUCTS | |
| 26 Mfg-Petroleum & Coal Prods | 29 | PETROLEUM AND COAL PRODUCTS | |
| 27 Mfg-Rubber & Misc Plastic Prods | 30 | RUBBER AND MISCELLANEOUS PLASTICS PRODUC | |
| 28 Mfg-Leather & Leather Prods | 31 | LEATHER AND LEATHER PRODUCTS | |
| 29 Transportation | | | |
| 30 Communications | 37 | **TRANSPORTATION EQUIPMENT** | |
| 31 Utilities & Sanitary Services | 371 | *Motor vehicles and equipment* | |
| 32 Wholesale Trade | 372 | *Aircraft and parts* | |
| 33 Eating And Drinking Places | 38 | **INSTRUMENTS AND RELATED PRODUCTS** | |
| 34 Other Retail Trade | 386 | *Photographic equipment and supplies* | |
| 35 Banking And Other Finance | 387 | *Watches, clocks, watchcases, and parts* | |
| 36 Insurance And Real Estate | 39 | **MISCELLANEOUS MANUFACTURING INDUSTRIES** | |
| 37 Private Household Services | 394 | *Toys and sporting goods* | |
| 38 Business Services | | | |
| 39 Automobile And Repair Services | | | |
| 40 Personal Serv Exc Private Households | | | |
| 41 Entertainment & Recreation Services | | | |
| 42 Hospitals | | | |
| 43 Health Services, Exc. Hospitals | | | |
| 44 Educational Services | | | |
| 45 Social Services | | | |
| 46 Other Professional Services | | | |
| 47 Forestry & Fisheries | | | |
| 48 Justice, Public Order & Safety | | | |
| 49 Admin Of Human Resource Programs | | | |
| 50 National Security & Internal Affairs | | | |
| 51 Other Public Administration | | | |
| 52 Armed Forces | | | |

## Appendix Table 3-4. Concordance of Industries between CIC 3-digit and SIC

| CIC Industry Name (SIC) | CIC Industry Name (SIC) |
|---|---|
| 0 Not in univ for children or Armed Forces | 192 Industrial and miscellaneous chemicals (281, 286, 289) |
| 10 Agricultural production, crops (01) | 200 Petroleum refining (291) |
| 11 Agricltrl production, livestock (02) | 201 Miscellaneous petroleum and coal products (295, 299) |
| 12 Veterinary services (074) | 210 Tires and inner tubes (301) |
| 20 Landscape and horticultural services (078) | 211 Other rubber products, and plastics footwear and belting (302-306) |
| 30 Agricultural services, n.e.c. (071, 072, 075, 076) | 212 Miscellaneous plastics products (308) |
| 31 Forestry (08) | 220 Leather tanning and finishing (311) |
| 32 Fishing, hunting, and trapping (09) | 221 Footwear, except rubber and plastic (313, 314) |
| 40 Metal mining (10) | 222 Leather products, except footwear (315-317, 319) |
| 41 Coal mining (12) | 230 Logging (241) |
| 42 Oil and gas extraction (13) | 231 Sawmills, planing mills, and millwork (242, 243) |
| 50 Nonmetallic mining and quarrying, except fuel (14) | 232 Wood buildings and mobile homes (245) |
| 60 CONSTRUCTION (15, 16, 17) | 241 Miscellaneous wood products (244, 249) |
| 100 Meat products (201) | 242 Furniture and fixtures (25) |
| 101 Dairy products (202) | 250 Glass and glass products (321-323) |
| 102 Canned, frozen and preserved fruits and vegetables (203) | 251 Cement, concrete, gypsum, and plaster products (324, 327) |
| 110 Grain mill products (204) | 252 Structural clay products (325) |
| 111 Bakery products (205) | 261 Pottery and related products (326) |
| 112 Sugar and confectionery products (206) | 262 Miscellaneous nonmetallic mineral and stone products (328, 329) |
| 120 Beverage industries (208) | 270 Blast furnaces, steelworks, rolling and finishing mills (331) |
| 121 Miscellaneous food preparations and kindred products (207, 209) | 271 Iron and steel foundries (332) |
| 122 Not specified food industries | 272 Primary aluminum industries (3334, part 334, 3353-3355, 3363, 3365) |
| 130 Tobacco manufactures (21) | 280 Other primary metal industries (3331, 39, part 334, 3351, 56, 57, 64, 66, 69, and 339) |
| 132 Knitting mills (225) | 281 Cutlery, handtools, and general hardware (342) |
| 140 Dyeing and finishing textiles, except wool and knit goods (226) | 282 Fabricated structural metal products (344) |
| 141 Carpets and rugs (227) | 290 Screw machine products (345) |
| 142 Yarn, thread, and fabric mills (221-224, 228) | 291 Metal forgings and stampings (346) |
| 150 Miscellaneous textile mill products (229) | 292 Ordnance (348) |
| 151 Apparel and accessories, except knit (231-238) | 300 Misc fabricated metal products (341, 343, 347, 349) |
| 152 Miscellaneous fabricated textile products (239) | 301 Not specified metal industries |
| 160 Pulp, paper, and paperboard mills (261-263) | 310 Engines and turbines (351) |
| 161 Miscellaneous paper and pulp products (267) | 311 Farm machinery and equipment (352) |
| 162 Paperboard containers and boxes (265) | 312 Construction and material handling machines (353) |
| 171 Newspaper publishing and printing (271) | 320 Metalworking machinery (354) |
| 172 Printing, publishing, and allied industries, except newspapers (272-279) | 321 Office and accounting machines (3578, 3579) |
| 180 Plastics, synthetics, and resins (282) | 322 Computers and rel. equipment (3571-3577) |
| 181 Drugs (283) | 331 Machinery, except electrical, n.e.c. (355, 356, 358, 359) |
| 182 Soaps and cosmetics (284) | 332 Not specified machinery |
| 190 Paints, varnishes, and rel. products (285) | 340 Household appliances (363) |
| 191 Agricultural chemicals (287) | 341 Radio, TV, and communication equipment (365, 366) |

# Appendix Table 3-4. (Continued)

| CIC Industry Name (SIC) | CIC Industry Name (SIC) |
|---|---|
| 342 Electrical machinery, equipment, and supplies, n.e.c. (361, 362, 364, 367, 369) | 521 Hardware, plumbing and heating supplies (507) |
| 350 Not specified electrical machinery, equipment, and supplies | 530 Machinery, equipment, and supplies (508) |
| 351 Motor vehicles and motor vehicle equipment (371) | 531 Scrap and waste materials (5093) |
| 352 Aircraft and parts (372) | 532 Miscellaneous wholesale, durable goods (509 except 5093) |
| 360 Ship and boat building and repairing (373) | 540 Paper and paper products (511) |
| 361 Railroad locomotives and equipment (374) | 541 Drugs, chemicals and allied products (512, 516) |
| 362 Guided missiles, space vehicles, and parts (376) | 542 Apparel, fabrics, and notions (513) |
| 370 Cycles and miscellaneous transportation equipment (375, 379) | 550 Groceries and related products (514) |
| 371 Scientific and controlling instruments (381, 382 except 3827) | 551 Farm-product raw materials (515) |
| 372 Medical, dental, and optical instruments and supplies (3827, 384, 385) | 552 Petroleum products (517) |
| 380 Photographic equipment and supplies (386) | 560 Alcoholic beverages (518) |
| 381 Watches, clocks, and clockwork operated devices (387) | 561 Farm supplies (5191) |
| 390 Toys,.amusement, and sporting goods (394) | 562 Misc wholesale, nondurable goods (5192-5199) |
| 391 Miscellaneous manufacturing industries (39 except 394) | 571 Not specified wholesale trade |
| 392 Not spec manufacturing industries | 580 Lumber and building material retailing (521, 523) |
| 400 Railroads (40) | 581 Hardware stores (525) |
| 401 Bus service and urban transit (41, except 412) | 582 Stores, Retail nurseries and garden (526) |
| 402 Taxicab service (412) | 590 Mobile home dealers (527) |
| 410 Trucking service (421, 423) | 591 Department stores (531) |
| 411 Warehousing and storage (422) | 592 Variety stores (533) |
| 412 U.S. Postal Service (43) | 600 Stores, misc general merchandise (539) |
| 420 Water transportation (44) | 601 Grocery stores (541) |
| 421 Air transportation (45) | 602 Stores, dairy products (545) |
| 422 Pipe lines, except natural gas (46) | 610 Retail bakeries (546) |
| 432 Services incidental to transportation (47) | 611 Food stores, n.e.c. (542, 543, 544, 549) |
| 440 Radio and television broadcasting and cable (483, 484) | 612 Motor vehicle dealers (551, 552) |
| 441 Telephone communications (481) | 620 Stores, Auto and home supply (553) |
| 442 Telegraph and miscellaneous communications services (482, 489) | 621 Gasoline service stations (554) |
| 450 Electric light and power (491) | 622 Miscellaneous vehicle dealers (555, 556, 557, 559) |
| 451 Gas and steam supply systems (492, 496) | 623 Stores, apparel and accessory, except shoe (56, except 566) |
| 452 Electric and gas, and other combinations (493) | 630 Shoe stores (566) |
| 470 Water supply and irrigation (494, 497) | 631 Stores, furniture and home furnishings (571) |
| 471 Sanitary services (495) | 632 Stores, household appliance (572) |
| 472 Not specified utilities | 633 Stores, radio, TV, and computer (5731, 5734) |
| 500 Motor vehcls and equipment (501) | 640 Music stores (5735, 5736) |
| 501 Furniture and home furnishings (502) | 641 Eating and drinking places (58) |
| 502 Lumber and construction materials (503) | 642 Drug stores (591) |
| 510 Professional and commercial equipment and supplies (504) | 650 Liquor stores (592) |
| 511 Metals and minerals, except petroleum (505) | 651 Stores, sporting goods, bicycles, and hobby (5941, 5945, 5946) |
| 512 Electrical goods (506) | 652 Stores, Book and stationery (5942, 5943) |

## Appendix Table 3-4. (Continued)

| CIC Industry Name (SIC) | CIC Industry Name (SIC) |
|---|---|
| 660 Jewelry stores (5944) | 810 Miscellaneous entertainment and recreation services (791, 794, 799) |
| 661 Gift, novelty, and souvenir shops (5947) | 812 Physicians offices and clinics (801, 803) |
| 662 Sewing, needlework and piece goods stores (5949) | 820 Dentists offices and clinics (802) |
| 663 Catalog and mail order houses (5961) | 821 Chiropractors offices and clinics (8041) |
| 670 Vending machine operators (5962) | 822 Optometrists offices and clinics (8042) |
| 671 Direct selling establishments (5963) | 830 Health practitioners offices and clinics, n.e.c. (8043, 8049) |
| 672 Fuel dealers (598) | 831 HOSPITALS (806) |
| 681 Retail florists (5992) | 832 Nursing and personal care facilities (805) |
| 682 Stores, Miscellaneous retail (593, 5948, 5993-5995, 5999) | 840 Health services, n.e.c. (807, 808, 809) |
| 691 Not specified retail trade | 841 Legal services (81) |
| 700 Banking (60 except 603 and 606) | 842 Elementary and secondary schools (821) |
| 701 Savings institutions, including credit unions (603, 606) | 850 Colleges and universities (822) |
| 702 Credit agencies, n.e.c. (61) | 851 Vocational schools (824) |
| 710 Security, commodity brokerage, and investment companies (62, 67) | 852 Libraries (823) |
| 711 Insurance (63, 64) | 860 Educational services, n.e.c. (829) |
| 712 Real estate, including real estate-insurance offices (65) | 861 Job training and vocational rehabilitation services (833) |
| 721 Advertising (731) | 862 Child day care services (part 835) |
| 722 Services to dwellings and other buildings (734) | 863 Family child care homes (part 835) |
| 731 Personnel supply services (736) | 870 Residential care facilities, w/out nursing (836) |
| 732 Computer and data processing services (737) | 871 Social services, n.e.c. (832, 839) |
| 740 Detective and protective services (7381, 7382) | 872 Museums, art galleries, and zoos (84) |
| 741 Business services, n.e.c. (732, 733, 735, 7383-7389) | 873 Labor unions (863) |
| 742 Automotive rental and leasing, w/out drivers (751) | 880 Religious organizations (866) |
| 750 Automotive parking and carwashes (752, 7542) | 881 Membership organizations, n.e.c. (861, 862, 864, 865, 869) |
| 751 Automotive repair and rel. services (753, 7549) | 882 Engineering, architectural, and surveying services (871) |
| 752 Electrical repair shops (762, 7694) | 890 Accounting, auditing, and bookkeeping services (872) |
| 760 Misc repair services (763, 764, 7692, 7699) | 891 Research, development, and testing services (873) |
| 761 PRIVATE HOUSEHOLDS (88) | 892 Management and public relations services (874) |
| 762 Hotels and motels (701) | 893 Miscellaneous professional and rel. services (899) |
| 770 Lodging places, except hotels and motels (702, 703, 704) | 900 Executive and legislative offices (911-913) |
| 771 Laundry, cleaning, and garment services (721 except part 7219) | 901 General government, n.e.c. (919) |
| 772 Beauty shops (723) | 910 Justice, public order, and safety (92) |
| 780 Barber shops (724) | 921 Public finance, taxation, and monetary policy (93) |
| 781 Funeral service and crematories (726) | 922 Human resources programs administration(94) |
| 782 Shoe repair shops (725) | 930 Environmental quality and housing programs administration(95) |
| 790 Dressmaking shops (part 7219) | 931 Economic programs administration(96) |
| 791 Misc personal services (722, 729) | 932 National security and international affairs (97) |
| 800 Theaters and motion pictures (781-783, 792) | 991 Assigned to persons whose labor force status is unemployed and whose last job was Armed Forces |
| 801 Video tape rental (784) | |
| 802 Bowling centers (793) | |

# CONCLUSIONS

A single most important message becomes clear: globalization in international trade and foreign direct investment does affect the domestic labor market of developed countries, especially Japan and the U.S.

Main findings are that the exchange rate's effects on employment in Japanese manufacturing vary across industries depending on how large the stock of vertical foreign direct investment is in low or high income countries. Small and medium sized firms in keiretsu networks in Japan are, on the other hand, inflicted with a demand decrease. This may not be due to an increase in vertical integration by Japanese MNCs, but may rather be due to an increase in outsourcing by the MNCs.

The U.S. inter-industry wage structure can also be affected by international trade, especially exports. Able workers move to exporting industries where able entrepreneurs own firms, and the good match between them makes possible an equilibrium wage rate determined at a higher level than the wage rates determined in other industries. In this case, the role of export can be seen as a catalyst, which means that able entrepreneurs are more concentrated in the exporting industries because exporting is costly and the export market is a tougher screen, facilitating sales re-allocation to efficient firms from less efficient firms.

Based on these findings, some policy implications can be derived. As globalization goes on in East Asia, demand for skilled workers is expected to rise in Japan. This implies that a more flexible labor market that can warrant the skill-match will be necessary to increase Japanese welfare. Vertical integration may not be a cause of the demand crisis for keiretsu firms, yet it should be very important for the firms to reduce costs, expand product diversity, and explore new markets for their products.

International trade does play a role in the inter-industry wage differentials in U.S. manufacturing. Exporting is especially associated with higher wages. Therefore, it will be important to keep in mind the benefits when discussing the impacts of globalization. If government assistance is necessary for adjustment costs of declining industries, for instance, income redistribution from those who benefit will be one of the possible policy choices that may least affect on-going globalization.

It is obvious that there are both gainers and losers from globalization within Japan and the U.S. I strongly believe that it is a very important task for each government to take care of those losers in its economy so as to moderate the discontents of globalization. As long as it keeps going, there is always a chance of benefit spillover across sectors and beyond countries. Lest the world dismantle the benefits of globalization.

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