The Yen and The Competitiveness of Japanese Industries and Firms

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(preliminary draft)

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I. Introduction.

In September 1985, representatives of the U.S., Japan, Germany, the United Kingdom, and France met at the Plaza Hotel in New York, to engineer a depreciation of the dollar, to help eliminate the continuing trade deficits of the U.S. As a consequence of these policies, by February 1986, the yen-dollar exchange rate approached 180, from about 250 before the Plaza Accord. The yen continued to appreciate, reaching 120 in early 1988. There was another spurt of appreciation in early 1995, with the yen momentarily touching below 100. Subsequently, the yen weakened to as much as 130, although it has been mostly in the 110-120 range during the last decade.

That is, the yen appreciation has been quite sudden after the Plaza Accord; and that over the last 20 plus years, the yen has remained at a rate essentially double that before the Plaza. These trends in the Japanese currency apply also in terms of the Nominal Effective Exchange Rate (NEER), although in terms of the Real Effective Exchange Rate (REER), the yen appreciation was more muted, with the REER today finally back at pre-Plaza levels (Figure 1). The objective of this paper is to assess the impact of this dramatic and sustained yen appreciation from 1985 until today on Japanese industries and firms.

We will examine how the high yen has lowered the "competitiveness" of Japanese industries, by raising the costs of Japanese industries relative to U.S. industries. We will compare—in terms of a common currency--the average costs of Japanese and U.S. industries. We will show that Japanese average costs at the industry levels have risen substantially between 1985-1995.[1] Since that time, the gap in average costs has narrowed, largely owing to more rapid wage increases in the U.S. We also show that in Japanese industries in which TFP growth has been robust, the gap in Japan-U.S. average costs has not widened very much. Finally, we focus on examining the determinants of Japanese TFP growth between 1984-2004, using Japanese firm level data. We find that larger firms and firms with more foreign capital have higher TFP growth rates.

How Japanese industries and firms responded to the rapid yen appreciation is not only of historical interest. Today, there is another Asian giant running high current account surpluses against the United States, with increasingly strident calls in the U.S. for the Asian giant to float and appreciate its currency. So far, China has firmly resisted calls for a sharp *reminbi* appreciation; and one of the reasons often given for this resistance is the purported damage the sharp yen appreciation since the late 1980s has done to Japanese industries and firms.

The emphasis of this paper on Japanese industries and firms may be puzzling. After all, as economists, are we not most concerned with the effect of the yen appreciation on Japanese consumers? A yen appreciation should lower the cost of importables; and of import competing goods, thus lowering the overall price index, resulting in higher consumer welfare. The reasons why we focus on the supply side, on firms and industries, and rather neglect the demand side, the consumers, in this paper is twofold. First, a careful, general equilibrium analysis of the "exchange rate" changes that are required to close global imbalances has already been done in Obstfeld and Rogoff (2005), Dekle, Eaton, and Kortum (2008) and elsewhere. Also, other papers in this

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[1] In related work, Jorgenson and Nomura (2007) calculate using detailed commodity level prices, the purchasing-power parity (PPP) exchange rates between Japan and the U.S., and found that for many of the

project, for example, by Philip Lane and Maurice Obstfeld have more macroeconomic, general equilibrium treatments of Japanese international macroeconomics. By focusing on Japanese industries and firms, we are filling an important, recent gap in the literature.[2]

The second reason is that as noted by Banerjee and Duflo (2005), it may be inappropriate to simply aggregate industries and firms in countries characterized by significant externalities and impediments to the mobility of labor. There is a view in development economics that emphasizes the exportables sector as an engine of growth and development (Rodrik, 2006). Suppose that productivity take-offs originate in the exportables sector; and spill over into other industries. Then, countries may prefer to maintain a depreciated exchange rate, to promote the exportables sector, and to enhance such spillovers. In such countries, an appreciation of the exchange rate that equally punishes (lowers the profits of) the exportables sector, but benefits (raises the profits of) of say the utilities sector will hurt the overall economy. With only macroeconomic data, we will not be able to analyze how an exchange rate appreciation may have specifically hurt some high externalities industries in the exportables sector.

II. The Simple Framework.

Let $C_{i,J}, C_{i,U}$ be the average cost functions in a common currency, say the dollar, for industry i in the tradeables sector in Japan and in the U.S., respectively. A rise in the yen relative to the dollar will have two effects on say, $C_{i,J}$. First, holding yen costs the same, dollar costs will rise one-for-one. Second, typically, yen costs will fall somewhat since some inputs are imported. However, since not all inputs are imported, a rise in

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42 industries examined, the actual yen-dollar exchange rate was much higher than the PPP exchange rates.
[2] McKinnon and Ohno (1997) have extensively analyzed the yen appreciation episodes of the late 1980s and early 1990s. They primarily examine aggregate and industry-level trends from a partial equilibrium

value of the yen will almost always raise $C_{i,J}$, as we show for several industries in the next Section. Applying a simple two-good (Japanese- goods, U.S.-goods) model of consumer choice (e.g. Bodnar, Dumas, and Marston (1998), Dekle (2005)), we get the following expression for the *price-cost markup* for Japanese goods in tradeables industry i:

$$\frac{P_{i,J}}{C_{i,J}} = \frac{1}{[\rho_i(1-\lambda_i)]},$$

where $P_{i,J}$ is the dollar price of Japanese goods, and ρ_i is a utility parameter measuring the substitutability between Japanese and U.S. goods. λ_i is the market share of Japanese goods, and is equal to: $\lambda_i = \dfrac{1}{1+\left(\dfrac{C_{i,J}}{C_{i,U}}\right)^{\rho_i}}$.

We can see from the above expressions that when the average cost of Japanese goods increases, the market share of Japanese goods declines. This is because as a Japanese firm's cost rise, the firm will have to raise dollar prices; and the rise in relative prices will cause consumers to shift their demand to U.S. goods. The degree to which this happens depends on the elasticity of substitution or ρ_i. The higher this elasticity, the more the rise in the cost of Japanese goods will shift demand to U.S. goods.

The price-cost margin will decrease when there is an increase in Japanese relative average costs. A fall in the market share induced by this increase in Japanese costs will raise the inverse price elasticity of demand ($\partial P / \partial X / P / X = \rho(1-\lambda)-1$). Thus, with a higher inverse price elasticity, for the same decrease in demand for Japanese goods,

perspective. The authors do not formally examine the impact of the yen appreciation on U.S. and Japanese cost functions, nor do they examine firm level data, as we do here.

prices of Japanese goods will rise by less. This will decrease the gap between Japanese prices and costs; and lower Japanese unit profits.

When there is a decrease in the price-cost margin, there is a decline in the amount of profits per unit of good sold (unit profits) that a Japanese firm earns. In addition, the rise in dollar prices will lower the quantity of Japanese goods sold. Thus, with both unit profits and the total number of units sold falling, Japanese profits (in dollars) will decline.

We will show below that the relative average costs of Japanese firms will tend to rise when the yen appreciates relative to the U.S. dollar. This will occur when there is no large offsetting decrease in the cost of inputs into Japanese production; or a rise in Japanese firm productivity (TFP). The next Section shows that at the industry level, the rapid yen appreciation since 1985 was generally not offset by input cost reductions or productivity increases.

III. The Changing Relative Average Costs of Japanese Industries versus U.S. Industries since 1985.

In this Section, we will analyze how the "competitiveness" or U.S.-Japan relative average costs) have changed over time. We measure changes in the competitiveness of Japanese industries by estimating the changes in their average cost of production in comparison with the changes in the average cost of production of U.S. industries. The change in average costs can be decomposed into the change in capital costs, the change in wages, the change in the cost of input materials, and finally, the change in total factor productivity.

We begin by explaining our methodology and basic assumptions. Suppose that there exists a well behaved constant returns to scale production function for a representative firm in industry *i* of country J of the following form:

$$Y_{i,J}(t) = F_{i,J}(L_{i,J}(t), K_{i,J}(t), X_{i,J}(t), T_{i,J}(t)) \tag{1}$$

where $Y_{iJ}(t)$ denotes the real gross output of this firm at time *t*, $L_{iJ}(t)$ is the labor input, $K_{iJ}(t)$ the capital service input, $X_{iJ}(t)$ the input of intermediate goods, and $T_{iJ}(t)$ the technology level.

The average cost of production of this firm, $C_{iJz}(t)$, is expressed by

$$C_{i,J}(t) = \frac{w_{i,J}(t)L_{i,J}(t) + r_{i,J}(t)K_{i,J}(t) + q_{i,J}(t)X_{i,J}(t)}{Y_{i,J}(t)} \tag{2}$$

where $w_{iJ}(t)$ denotes the nominal wage rate (measured in country J's currency) for workers in industry *i* of country J at time *t*, $r_{iJ}(t)$ represents the capital service price, and $q_{i,J}(t)$ the intermediate input price. We assume that each firm is a price taker in all factor markets. We also assume that factor prices and the technology level, $T_{iJ}(t)$, are continuous functions of time.

By differentiating equation (2) over time and using cost minimization conditions, we obtain

$$\hat{C}_{i,J}(t) = s_{L,i,J}(t)\hat{w}_{i,J}(t) + s_{K,i,J}(t)\hat{r}_{i,J}(t) + s_{X,i,J}(t)\hat{q}_{i,J}(t) - \hat{A}_{i,J}(t) \tag{3}$$

where the circumflex accents denote the growth rate of variables. $s_{L,\,i,J}(t)$, $s_{K,\,i,J}(t)$, and $s_{X,\,i,J}(t)$ denote the cost share of each production factor:

$$s_{L,i,J}(t) = \frac{w_{i,J}(t)L_{i,J}(t)}{w_{i,J}(t)L_{i,J}(t) + r_{i,J}(t)K_{i,J}(t) + q_{i,J}(t)X_{i,J}(t)}$$
$$s_{L,i,J}(t) = \frac{r_{i,J}(t)K_{i,J}(t)}{w_{i,J}(t)L_{i,J}(t) + r_{i,J}(t)K_{i,J}(t) + q_{i,J}(t)X_{i,J}(t)}$$
$$s_{L,i,J}(t) = \frac{q_{i,J}(t)X_{i,J}(t)}{w_{i,J}(t)L_{i,J}(t) + r_{i,J}(t)K_{i,J}(t) + q_{i,J}(t)X_{i,J}(t)}$$

$A_{i,J}(t)$ denotes the total factor productivity (TFP) level of industry i in country J at time t. The TFP growth rate can be defined by

$$\hat{A}_{i,J}(t) = \frac{\frac{\partial F_{i,J}}{\partial T_{i,J}} \frac{dT_{i,J}(t)}{dt}}{Y_{i,J}(t)}$$

Using growth accounting, we can estimate the TFP growth rate.

Equation (2) shows that we can explain the relative competitiveness (which we measure by the gap in the average cost of production) of the two countries in each industry by the gap in factor prices between the two countries and the gap between their TFP levels.

In order to apply equation (2) to discrete time-series data, we use a Tornqvist-type approximation of this equation:

$$\begin{aligned} \ln(C_{i,J}(t)) - \ln(C_{i,J}(t-1)) &= \frac{s_{L,i,J}(t) + s_{L,i,J}(t-1)}{2}(\ln(w_{i,J}(t)) - \ln(w_{i,J}(t-1))) \\ &+ \frac{s_{K,i,J}(t) + s_{K,i,J}(t-1)}{2}(\ln(r_{i,J}(t)) - \ln(r_{i,J}(t-1))) \qquad (4) \\ &+ \frac{s_{X,i,J}(t) + s_{X,i,J}(t-1)}{2}(\ln(q_{i,J}(t)) - \ln(q_{i,J}(t-1))) - (\ln(A_{i,J}(t)) - \ln(A_{i,J}(t-1))) \end{aligned}$$

We use year 1980 as the benchmark year and set $C_{i,J}(1980)=100$.

We can measure the inter-temporal changes in the competitiveness of industry *i* in country J in comparison with that of industry *i* in country U by the changes in the ratio of the average cost of production in the two countries measured in the same currency: $e(t)(C_{i,J}(t) / C_{i,U^*}(t))$, where $e(t)$ denotes the nominal exchange rate index between the currencies of the two countries (the value of country J's currency in terms of country U's currency). We use year 1980 as the benchmark year and set e(1980)=100.

Next, we explain our data. Data on the following factor inputs and on the TFP growth rate were obtained from the EU KLEMS Database (March 2007 version).

$w_{iJ}(t)L_{iJ}(t)$: nominal labor compensation in industry *i* in country J;

$w_{iJ}(t)$: labor compensation divided by the quality adjusted labor input index (1995=100) of industry *i* in country J;

$q_{iJ}(t)X_{iJ}(t)$: nominal intermediate input cost of industry *i* in country J;

$q_{iJ}(t)$: intermediate input cost divided by the real intermediate input index (1995=100) of industry *i* in country J; and

$\ln(A_{iJ}(t)-\ln(A_{iJ}(t-1))$: TFP growth rate of industry *i* in country J.

We estimated the service price of capital as follows:

$r_{i,J}(t)$=gross fixed capital formation price index (all assets, 1995=100) × (interest rate + depreciation rate – capital gains)

We obtained the gross fixed capital formation price indices from the EU KLEMS Database. We calculated the capital gain terms from these indices. For interest rates, we use the yield of newly-issued 10-year government bonds for Japan and the market yield on 10-year US Treasury securities for the US. Depreciation rates were obtained from the Japan Industrial Productivity (JIP) Database for Japan and from the BEA website for the

U.S. To measure capital service inputs, we used the real capital stock in 1995 prices from the EU KLEMS Database. For the yen-dollar exchange rates, we used the annual average interbank market exchange rate from Nikkei NEEDS.

If the appreciation of Japan's real exchange rate (Figure 1) had been accompanied by superior productivity growth in comparison with other countries, then the appreciation of the Yen until the mid-1990s would not have reduced the international competitiveness of Japan's manufacturing sector. However, in many manufacturing industries, the TFP growth achieved was not sufficient to cancel out the effects of the Yen appreciation. In particular, from the 1990s, Japan's TFP stagnated and Japan's manufacturing industries lost in competitiveness.

Figure 2 compares the TFP growth of manufacturing industries in Japan and in the U.S. In the period 1980-1990, (gross-output base) TFP growth rates in most manufacturing industries in Japan were higher than those in the U.S. However, during 1990-2004, TFP growth in almost all manufacturing industries became very low in Japan, with the exception of the electrical and optical equipment industries, and U.S. TFP growth in most manufacturing industries exceeded Japan's.

Figure 3, Panel A shows how average production costs have changed over time in Japan and in the U.S. in the electrical and optical equipment industry. Production costs will fall when there is a decline in wages, capital costs, materials costs, or a rise in TFP. In dollar terms, Japanese production costs will rise when the yen appreciates. Figure 3 shows that holding the *yen constant*, Japanese production costs in the electrical and optical equipment industry have trended along with U.S. production costs. However, in terms of dollars, Japanese production costs in this industry surged after the yen appreciation in 1985, reaching a peak at about 1995. Thereafter, Japanese production costs in terms of dollars started to decline, gradually approaching U.S. levels by 2005.

To see the role of wage rate and productivity changes on Japan-U.S. relative average production costs, Figure 3, Panel B shows that relative to Japanese wages, U.S. wages have surged, especially since 1995, contributing to the convergence of Japan-U.S. average costs. Japanese TFP growth rates have generally been lower than U.S. TFP growth rates, except for the period after 2002 in the electrical and optical equipment industry.

Figures 4, 5, 6, and 7 depict similar data for the rubber and plastics, the textiles, apparel, leather and footwear, the transport equipment, and chemicals and chemical products industries, respectively.[3] Generally, the patterns observed in these industries are similar to the pattern observed in the electrical and optical equipment industry. First, the yen appreciation sharply deteriorated the competitiveness of Japanese industries, starting in 1985. However, the rapid increase in U.S. wage rates has partially offset the drop in Japanese competitiveness. The decline in capital cost and intermediate input prices in Japan (unreported, to conserve space), also contributed to offsetting the effect of the yen appreciation.

Second, Japan's competitiveness relative to the U.S. reached bottom in 1995. This result is consistent with the fact that Japan's real effective exchange rate (REER) was most appreciated in 1995 (along with the yen-dollar rate and the nominal effective

[3]We created similar figures for other manufacturing industries (general machinery; basic and fabricated metals; other non-metallic minerals; coke, refined petroleum and nuclear fuel; food, beverages and tobacco; wood and of wood products; pulp, paper, printing and publishing; and manufacturing not elsewhere classified and recycling). However, to conserve space, we omit these figures.

exchange rate) (Figure 1). After that, the yen gradually depreciated in REER terms, and by 2006 the real effective exchange rate approached the level of the level of 1985.

Third, in industries where Japan's TFP growth was on a par with or higher than that of the U.S. (before 1990) such as transport equipment, chemicals and chemical products, general machinery, and pulp, paper, printing and publishing, the Japan-U.S. average cost gap in dollars did not become very large even in 1995, and becomes negligible by 2004. On the other hand, in industries where Japan's TFP growth was much smaller than that of the U.S., such as electrical and optical equipment, rubber and plastics, textiles, apparel, leather and footwear, basic metals and fabricated metal, and food, beverages and tobacco, the Japan-US gap in the average cost of production measured in dollars became very large in 1995, and even now remains sizable. Thus, it appears that in order to understand the trends in relative competitiveness across countries, it is important to understand differences in TFP growth rates across countries. In the next Section, we will examine the determinants of Japanese TFP, using Japanese firm level data.

IV. A Firm Level Analysis of Japanese Average Costs and Productivity.

In order to quantify and to determine the significance of the relationship between average costs, productivity, the real exchange rate, GDP, and other variables, here we run regressions with Japanese firm level data. The Japanese firm level data are a merged sample between the Development Bank of Japan Corporate Database, which includes firm level income and balance sheet variables; and a custom dataset constructed by Kyoji Fukao, which includes firm level factor shares and total factor productivity (Fukao, Inui, Kabe, and Liu, 2007). The merged dataset is of all the firms listed on the various Stock exchanges of Japan. The data are annual and run from 1985-2004.

Even within rather narrow industry categories such as motor vehicles, there are significant variations among firms in the pattern of total average costs and total factor productivity. Figures 8 and 9 depict the behavior of total average costs and TFP for Nissan and Toyota Motors. While Toyota's TFP increased sharply between 1987 and 2000, Nissan's was flat until about 1998, at which point it sharply accelerated until 2002. Of course, Toyota is known as a highly successful global firm throughout this period; while Nissan struggled until Carlos Gosn took over as CEO in the late 1990s.

Table 1 shows the relationship between log total average costs at the firm level, the log real exchange rate, and the log GDP level for various firm categories. From our sample, we drop agriculture, coal mining, metal and nonmetallic mining, oil and gas extraction, and public services. We classify firms into the nontraded and traded (manufacturing) categories; and in turn, classify the traded category into those firms producing differentiated and non-differentiated goods. (The differentiated goods category includes apparel, printing and publishing, non-electrical machinery, electrical machinery, motor vehicles, transportation equipment, and instruments.) Below we depict results from fixed effects panel data regressions. All standard errors are robust.

When there is an appreciation of the log real exchange rate, input costs will decline, since some inputs are imported. This decline in input costs will tend to lower log total average costs. From Table 1, we see that for all specifications, a rise in the log real exchange rate lowers log total average costs. For the motor vehicles industry, for example, a one percent appreciation of the real exchange rate lowers total average costs by about 50 percent. Total average costs are very strongly pro-cyclical.

Table 2 depicts the relationship between log total factor productivity at the firm level, the log real exchange rate, and the log GDP level. When there is an appreciation of the real exchange rate, for the tradeables industries at least, price-cost margins and profitability are squeezed. In order to lower costs, the firm may attempt to increase its total factor productivity. In addition, with a real exchange rate appreciation, the firm will be able to import higher quality imports, at a lower price. If imported input prices tend to underestimate quality, then TFP should rise.

However, we see that in all firm categories, an appreciation of the log real exchange rate is associated with a decline in log total factor productivity. Only in the motor vehicles industry do we see even an insignificant effect. Thus, there is no evidence that a company with productivity squeezed will tend to raise its productivity.

In Table 3, we examine what firm level characteristics are associated with improving total factor productivity. The firm level characteristics we examine are log total assets, the log ratio of net liquidity to sales, and the foreign-ownership share. In all specifications, a rise in log total assets raises TFP. That is, large firms tend to have higher productivity. The ratio of net liquidity to sales lowers TFP on average for the sample, and for firms producing non-tradeables. For firms producing tradeable goods; and for the motor vehicles industry, a rise in the net liquidity-sales ratio increases log TFP. Finally, for all firms, an increase in the foreign ownership share raises log TFP.

V. Conclusion.

We have shown that the substantial appreciation of the yen since 1985 has resulted in a significant rise in the ratio of Japanese average costs to U.S. average costs. Japanese industries that managed to continue to increase their TFP in the 1980s and

1990s have seen the smallest erosion in their competitiveness. Using firm level data, we show that compared to other firms, large firms and firms with foreign ownership have managed to increase their TFP.

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Figure 1: Exchange Rates

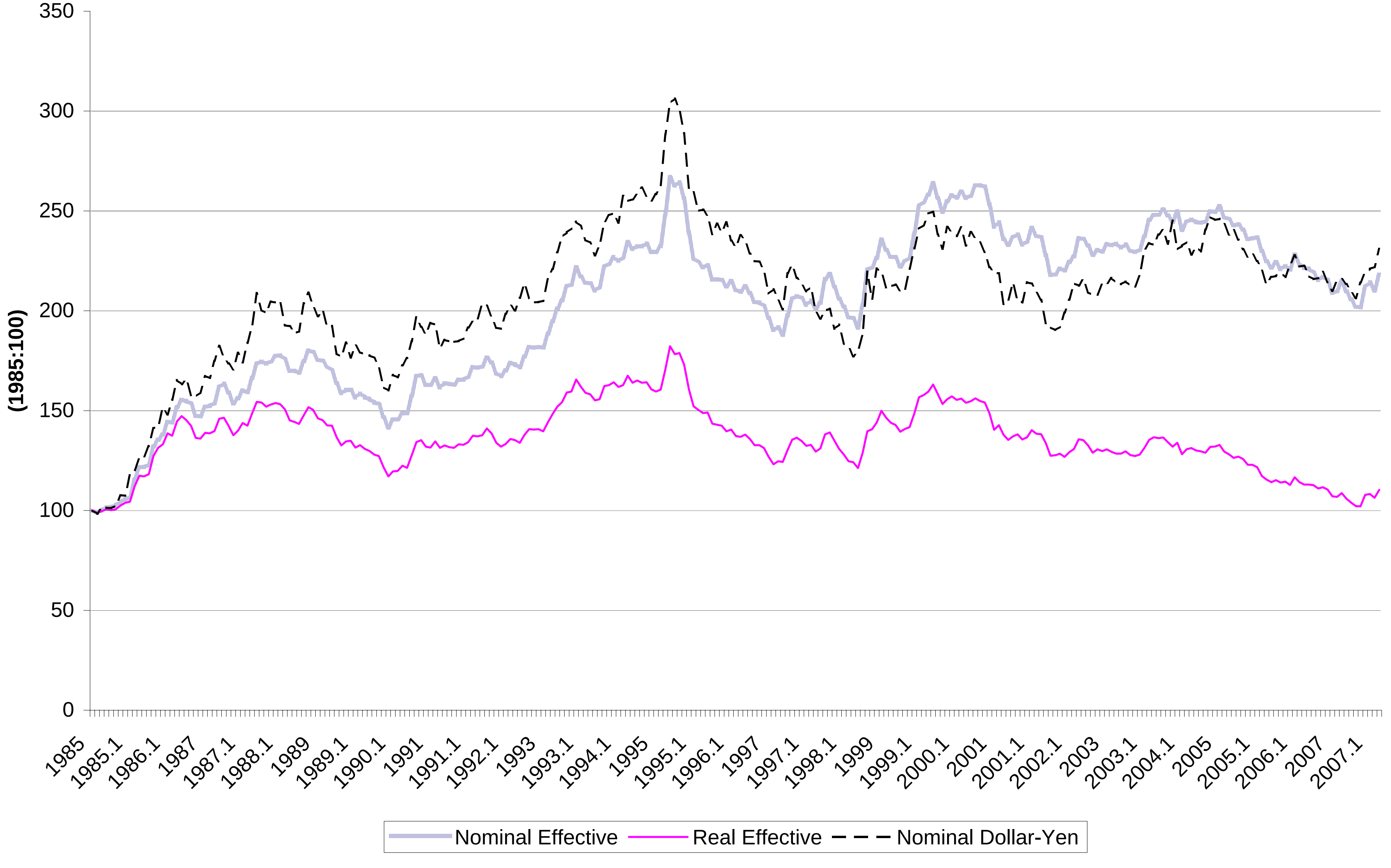
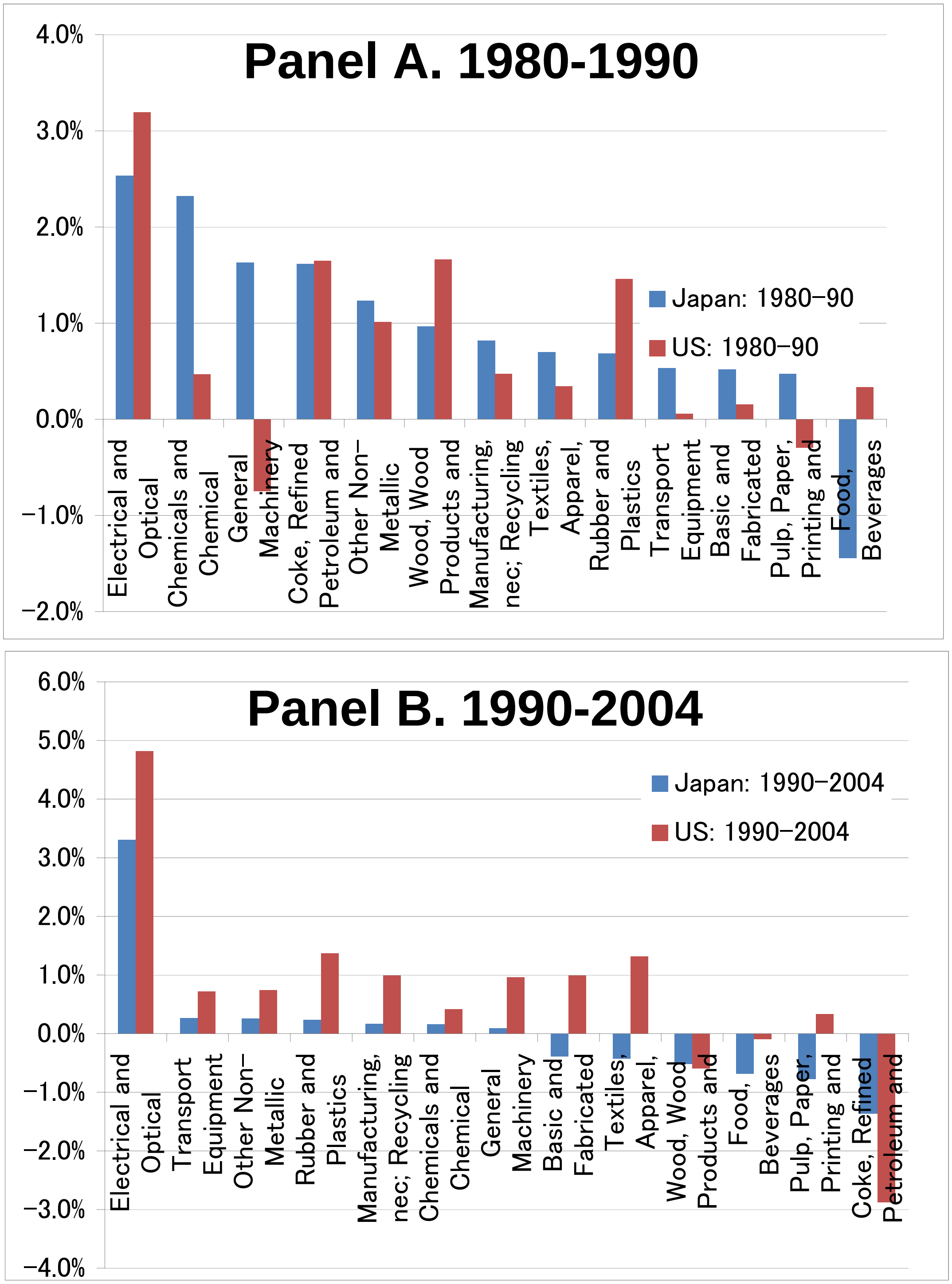
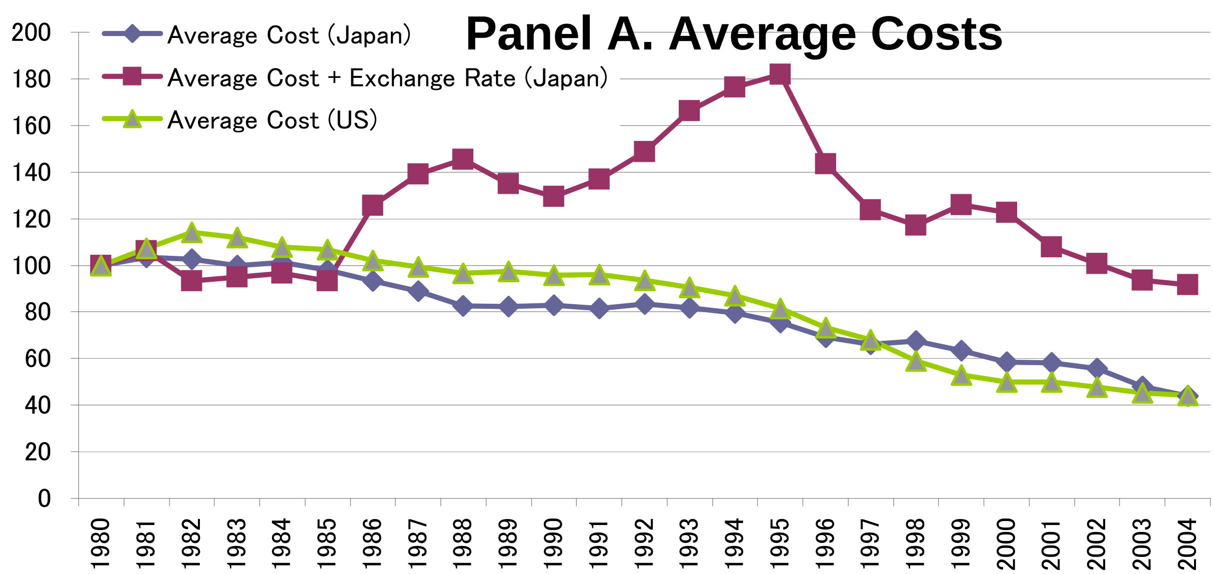


Figure 2 TFG Growth on a Gross Output Basis by Sector and by Period： Japan-US Comparison



Source： EU KLEMS Database, March 2007

Figure 3 Electrical and Optical Equipment



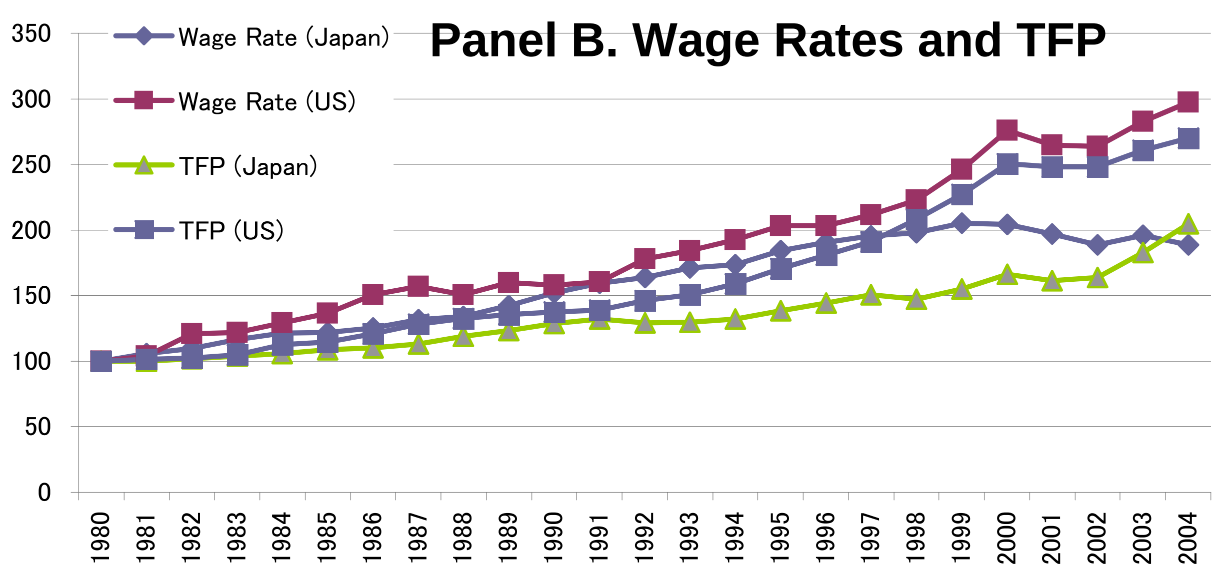
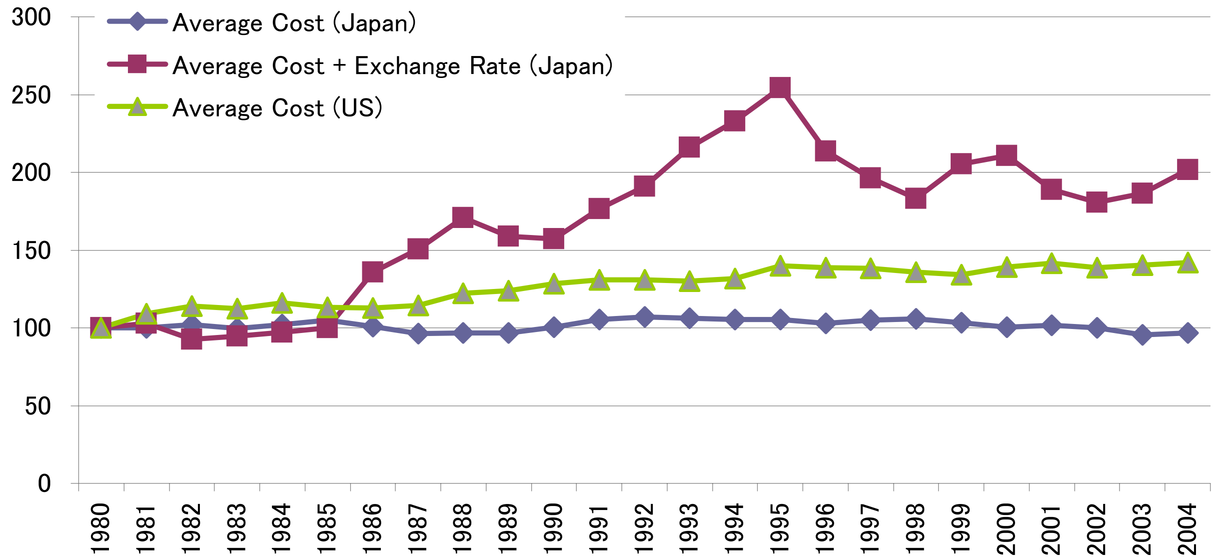


Figure 4 Rubber and Plastics



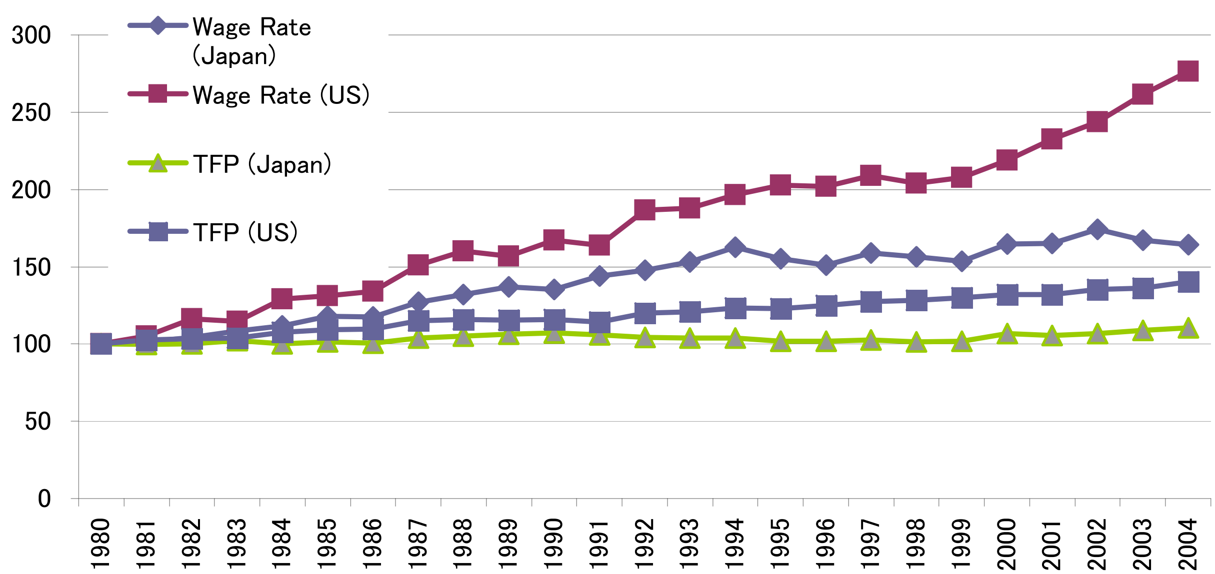
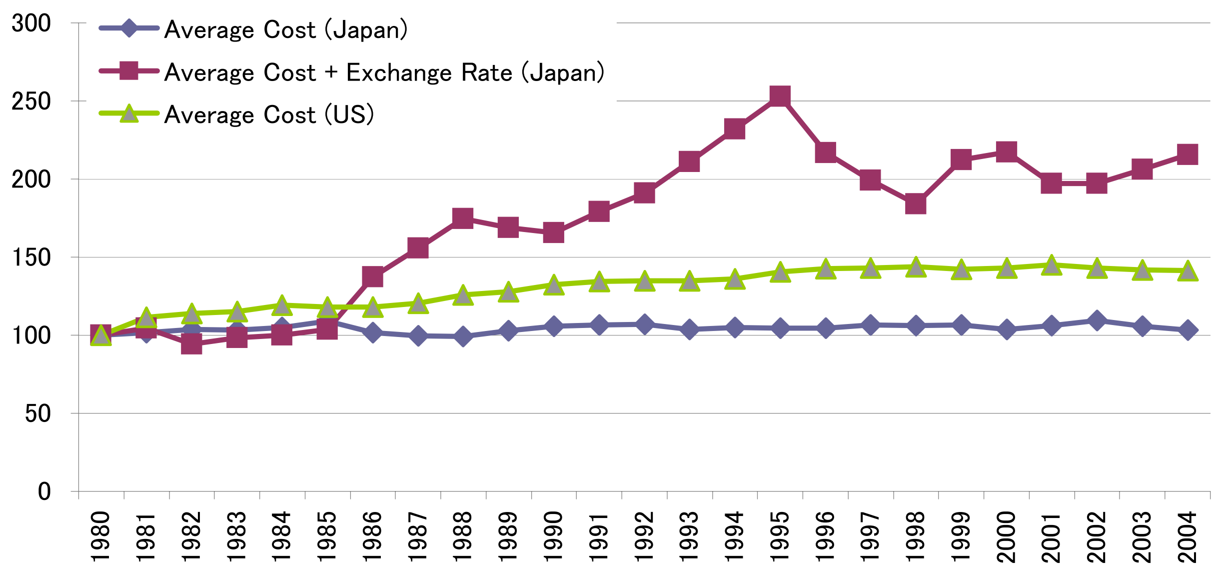


Figure 5 Textiles, Apparel, Leather and Footwear



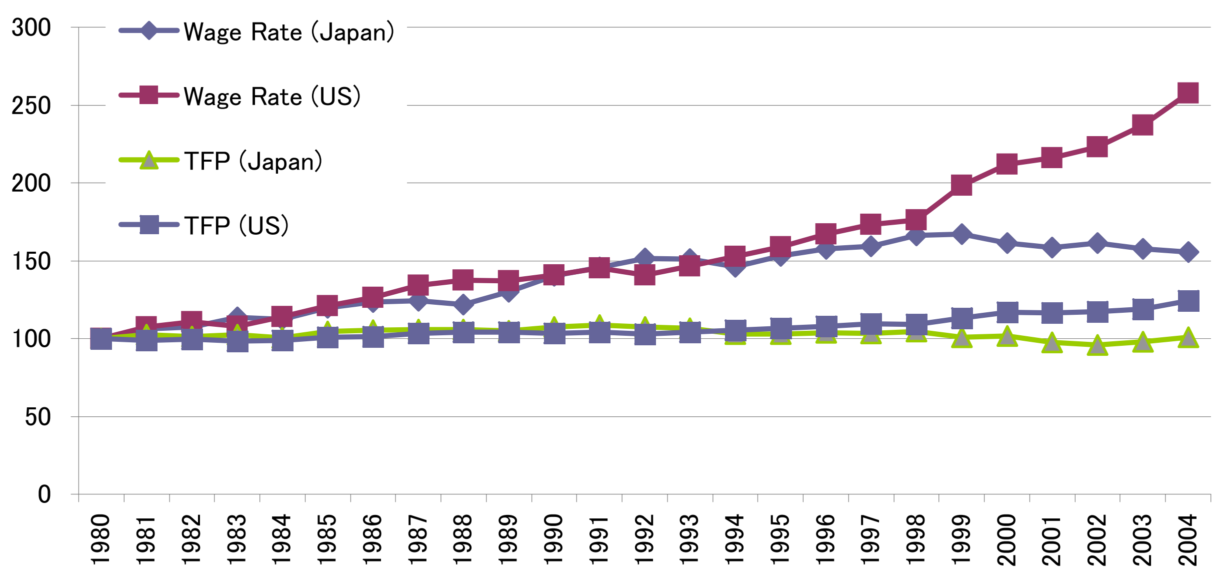
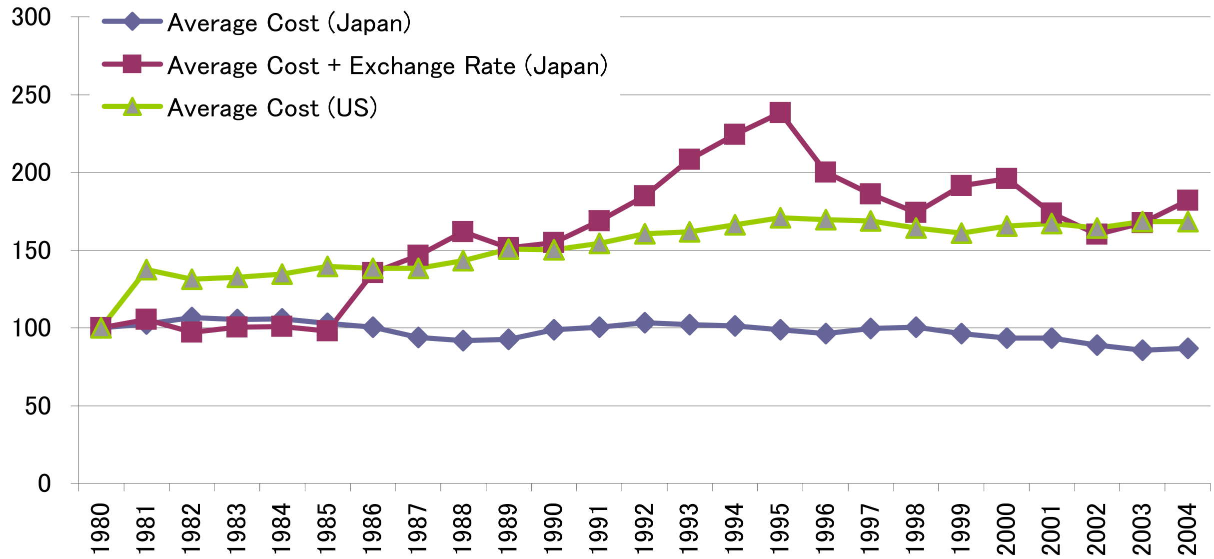


Figure 6 Transport Equipment



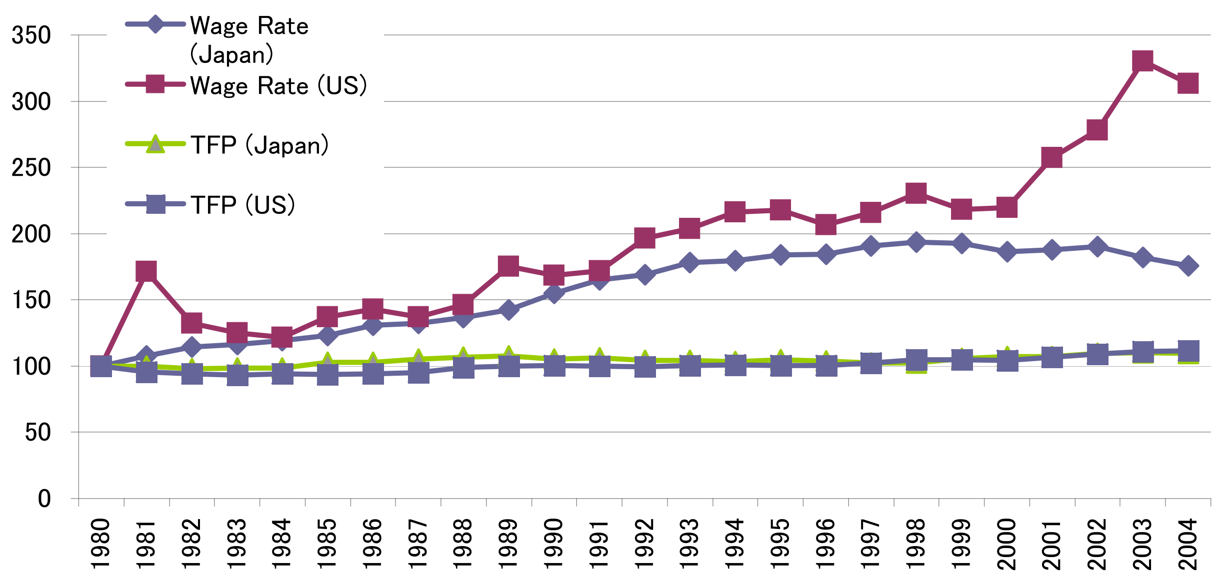
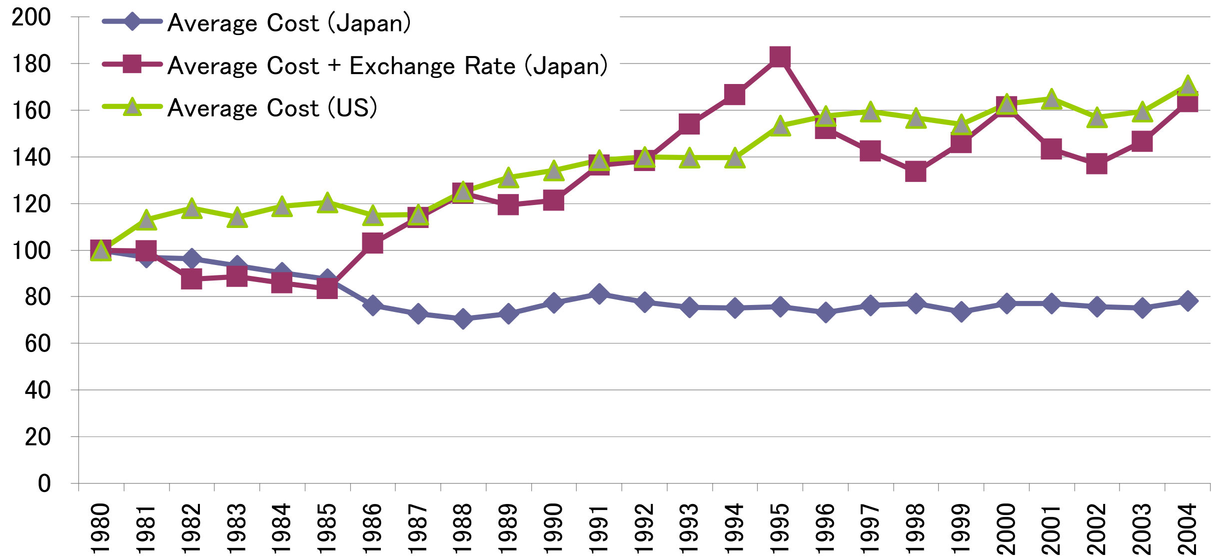


Figure 7 Chemicals and Chemical Products



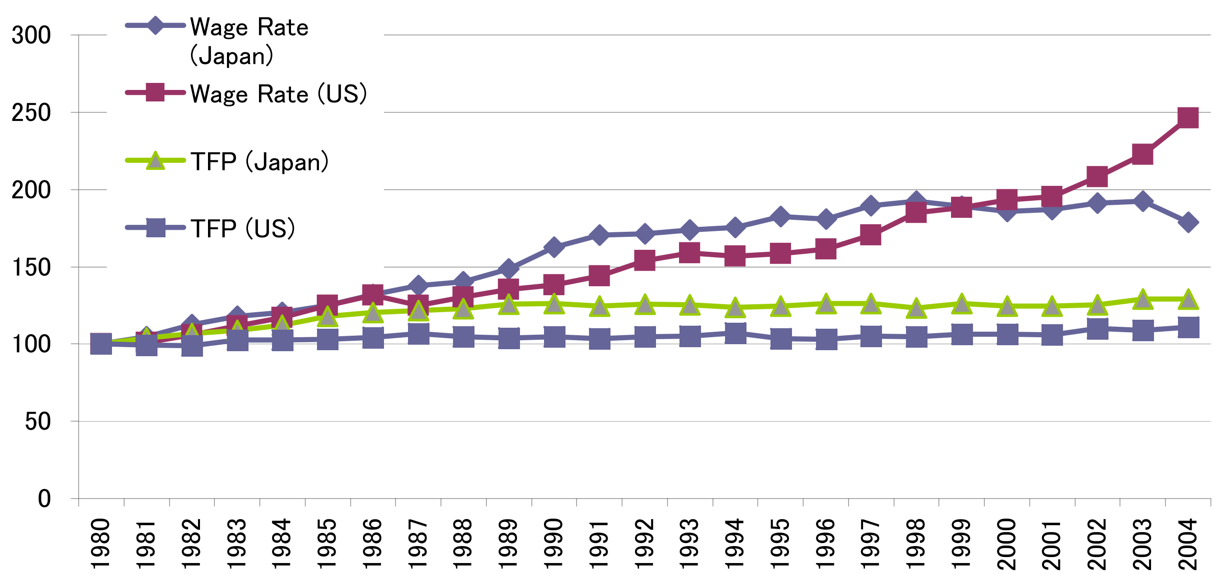


Figure 8

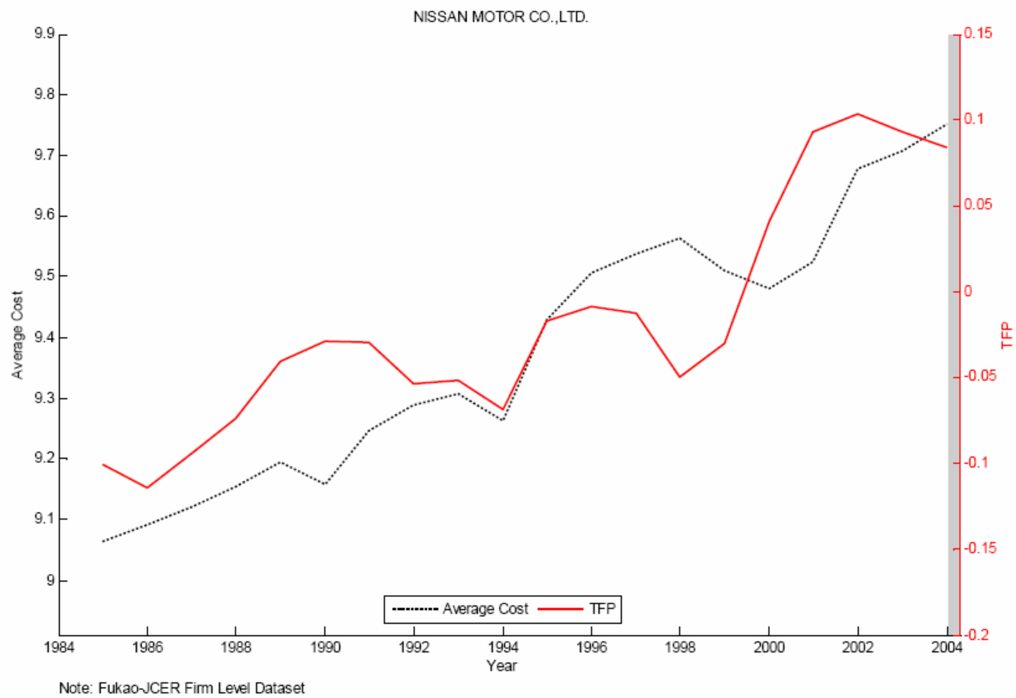
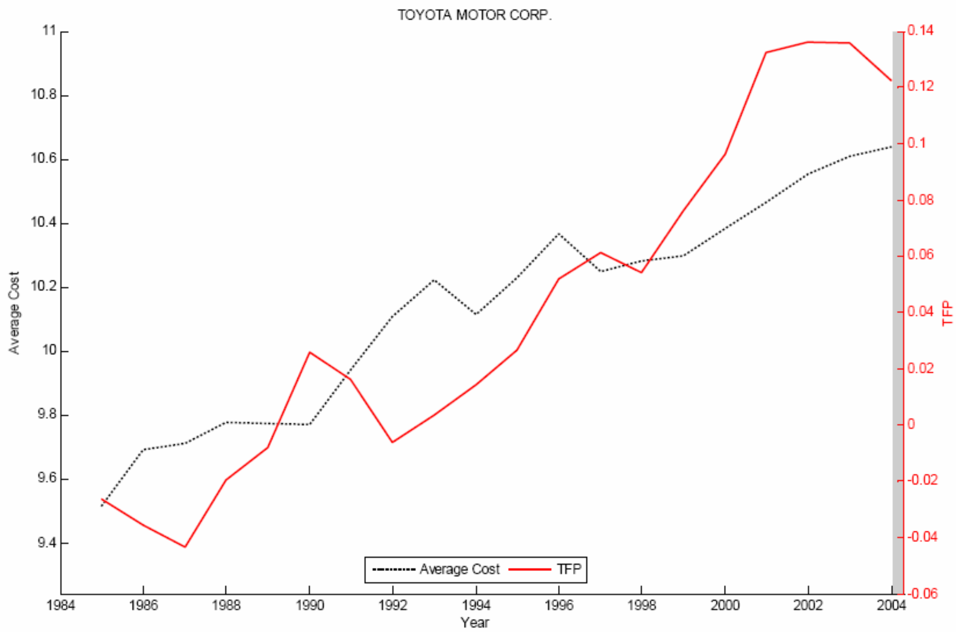

NISSAN MOTOR CO.,LTD.
Average Cost
TFP
Year
Average Cost
TFP
Note: Fukao-JCER Firm Level Dataset

Figure 9



Note: Fukao-JCER Firm Level Dataset

Table 1

Dependent Variable: "Average Total Costs"

	All	Non-tradeables	Tradeables	Tradeables Differentiated	Tradables Non-differentiated	Motor Vehicles
RExchRt	-0.27	-0.29	-0.23	-0.27	-0.18	-0.48
	(-13.77)	(-8.25)	(-10.23)	(-8.71)	(-5.67)	(-9.37)
Log GDP:	3.36	3.97	3.02	3.35	2.73	3.61
	(164.35)	(108.59)	(127.83)	(96.85)	(85.03)	(55.41)
R-squared:	0.561	0.5685	0.5608	0.6035	0.5381	0.7512
Firms:	1946	1393	995	672	721	99

Years: 1985-2004.

14-Feb

Table 2

Dependent Variable: "Total Factor Productivity"

	All	Non-tradeables	Tradeables	Tradeables Differentiated	Tradables Non-differentiated	Motor Vehicles
RExchRt	-0.11	-0.27	-0.089	-0.12	-0.061	-0.006
	(-24.59)	(-11.16)	(-17.67)	(-13.13)	(-13.29)	(-0.81)
Log GDP:	0.49	0.43	0.49	0.72	0.27	0.32
	(77.19)	(94.55)	(64.53)	(55.06)	(38.65)	(41.38)
R-squared:	0.1803	0.1342	0.2152	0.2199	0.1336	0.5323
Firms:	2388	994	1394	672	722	99

Years: 1985-2004.

14-Feb

Table 3

Dependent Variable: "Total Factor Productivity"

	All	Non-tradeables	Tradeables	Tradeables Differentiated	Tradables Non-differentiated	Motor Vehicles
RExchRt:	-0.0011	-0.0024	-0.000043	0.000029	-0.000092	0.00037
	(-5.14)	(-5.83)	(-1.77)	(0.68)	(-4.08)	(9.21)
Log GDP:	0.25	0.25	0.25	0.38	0.13	0.13
	(36.43)	(19.12)	(31.72)	(28.35)	(17.23)	(10.62)
TotAssets	1.50E-09	8.11E-10	2.91E-09	2.71E+09	4.79E-10	5.81E-10
	(5.53)	(2.09)	(6.71)	(4.73)	(0.68)	(1.95)
NetLiquid/	-16.54	-16.58	4149	-2627.95	9578.8	320021.5
Sales:	(5.44)	(-4.77)	(0.71)	(-0.21)	(1.86)	(2.31)
ForShare(%)	0.0012	0.0012	0.0011	0.0013	0.0013	0.00048
	(9.54)	(4.55)	(8.71)	(6.39)	(8.58)	(2.22)
R-squared:	0.1312	0.1336	0.1732	0.3049	0.1571	0.5021
Firms:	1908	736	1172	672	722	86

Years: 1985-2004. 14-Feb