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The Japan-U.S. Price Level Index for Industry Outputs

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The Japan-U.S. Price Level Index for Industry Outputs*

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Abstract

This paper provides new benchmark estimates of industry-level price differentials between Japan and the United States, based on the input-output framework expanded from the *2005 Japan-U.S. Input-Output Table* published in 2013 by the Ministry of Economy, Trade and Industry (METI). The purchasing power parities (PPPs) we construct cover not only the products for final demands, but also the products of outputs and for intermediate uses, using a classification of 174 products. We postulate a price model describing the relationships among producers' prices and purchasers' prices for domestically-produced and imported products, considering the differences in the trade structure, freight and insurance rates, duty tax rates, wholesale and retail trade margins, and transportation costs in each product between Japan and the United States. Using demand-side data for purchasers' price PPPs for final uses (e.g., the Eurostat-OECD PPPs) and for intermediate uses (e.g., the METI survey), producers' price PPPs for outputs are estimated based on our price model and the related parameters. Many sources of data on price differentials by agencies and ministries of the government of Japan are used in this paper.

Compared to our previous study in Nomura and Miyagawa (1999), which developed the 1990 benchmark estimates of industry-level price differentials between Japan and the United States, there are several improvements. One improvement is the expansion in the framework and the price model to cover imports from China, Germany, Korea, Malaysia, Taiwan, and Thailand. The second improvement is our revisions on PPPs for wholesale and retail trades. The revisions of PPPs for trade have a considerable impact on the estimates of PPP for gross domestic product (GDP) from the production side. In this paper, we examine Japan's margin rates and provide new estimates by products, based on establishment data from the *Census of Commerce* in 2002 and 2007 by METI. Our estimates suggest that the margin rates of retail in the official benchmark input-output table may be underestimated.

Our estimates enable us to illuminate the sources of price competitiveness through inter-industry transactions. Higher costs of products for intermediate use such as trade, electricity, and other energy in Japan have considerable and wider impacts on the price competitiveness in all industries. Japan's higher costs of trade (54% higher) and electricity (2.0 times higher) contribute to pushing the output prices in the manufacturing sector higher than the United States by 2.8% and 1.1%, respectively.

Keywords: Purchasing power parity, Competitiveness, Trade margins, International input-output table

JEL classification: E31, L81, R15

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1 Introduction

In international level comparisons, comparing the industry performance is a much harder task than comparing the economic performance at the aggregate level. It is not only because the industry-level comparisons are much more data-demanding, but also because the available data on price differentials are measured mainly on final demands. These data enable us to compile cross-country constant-price output volume indicators but only at the aggregate level, by estimating the price level index for GDP from the expenditure side. In contrast, the feasibility of comparing industry performance is particularly hindered by the lack of adequate data on the price differentials on domestic (gross) outputs and intermediate inputs across countries. This data gap has, for example, greatly limited productivity comparisons at industry level and in turn, offered little insight into the cross-country supply-side efficiency and possible policy implications.

The purpose of this paper is to partially fill this data gap by providing new benchmark estimates of industry-level price differentials between Japan and the U.S., based on the Isard-type input-output framework (Isard, 1951). The system of purchasing power parities (PPPs) we construct in this paper covers not only products for final uses, but also products of industry outputs and for intermediate uses, based on the classifications of 173 products for outputs and 174 products for intermediate uses.

We construct a framework of the production system using the *2005 Japan-US Input-Output Table* published in 2013 by METI (Ministry of Economy, Trade and Industry). Under this bilateral framework, we postulate a price model describing the relationships among producer's prices and purchaser's prices for domestically-produced and imported products, considering the differences in the trade structure, freight and insurance rates, duty tax rates, wholesale and retail trade margins, and transportation costs in each product between Japan and the U.S.[1] Using the demand-side data of purchaser's price PPPs for final uses (e.g. the Eurostat-OECD PPPs) and for intermediate uses (e.g. the METI's *Survey on Foreign and Domestic Price Differentials for Industrial Intermediate Input*[2]), the producer's price PPPs for outputs are estimated based on our price model and the related parameters.

This paper is an update of Nomura and Miyagawa (1999), which developed the 1990 Japan-US benchmark estimates of industry-level price differentials. As globalization has deepened since then, it has become more important to consider the differences in the import prices of the traded goods to Japan and the U.S. from other economies. We therefore expand the

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[1] The hybrid approach to determining the product PPPs between Japan and the U.S. was developed in Jorgenson, Kuroda, and Nishimizu (1987). Since the 1990s at Keio University, Tokyo, Masahiro Kuroda, Kazushige Shimpo, Koji Nomura, and Kozo Miyagawa have improved the framework and data. In the measurement of PPPs, there is a huge advantage in the bilateral comparisons between Japan and the U.S. due to the availability of the well-harmonized detailed bilateral input-output table (with some supplementary tables on international freight and insurance and tariffs). The first bilateral table between Japan and the U.S. for the year 1970 was developed in Japan at the IDE (Institute of Developing Economies) as a joint project with Keio Economic Observatory, Keio University in 1978. Then METI has been compiling the Japan-US tables since 1985 every five years. Another significant advantage is the availability of much richer data on price differentials among major industrialized countries, which have been investigated by the agencies and ministries of the Government of Japan since the late 1980s, as a response to an important policy focus on international price differentials after the Plaza Accord of 1985 resulted in the rapid appreciation of the Japanese yen.

[2] METI expanded the coverage of the survey and renamed it as *Survey on Foreign and Domestic Price Differentials for Industrial Goods and Services* in 2011.

framework of our bilateral input-output table (IOT) and develop a sub model to cover the imports by product from six exogenous economies, i.e., China, Germany, Korea, Malaysia, Taiwan, and Thailand, to Japan and the U.S., respectively. The second improvement is our revisions on PPPs for the wholesale and retail trades. The estimates of PPPs for trades, which are mainly determined by the Japan-US gaps in trade margin rates by product, has a considerable impact on the aggregated measures of PPP. In this paper, we reexamine the Japan's margin rates, based on establishment data of *Census of Commerce* in 2002 and 2007 by METI. We provide the new estimates of the margin rates for wholesales (for household, industries, and exports) and retail (for household) by products (for domestic outputs and imports). Our estimates suggest that the margin rates of retails in the official benchmark IOT in Japan may be considerably underestimated.[3]

Third, we revise the original Japan-US IOT by METI to obtain better harmonized estimates of the bilateral comparisons. In this revision work on the bilateral IOT, the most important task is to revise the treatment of Japan's consumption tax as separately from other indirect taxes. In the current Japanese System of National Accounts (JSNA) and Japan's Benchmark IOTs since the introduction of the consumption tax in 1989, the values for intermediate uses are recorded as the prices including not only the non-deductible consumption taxes, but also the deductible ones. And the consumption taxes (deductible and non-deductible) are not separately estimated from other indirect taxes by industries. Since the METI *2005 Japan-US IOT* follows this treatment, it makes it hard to compare Japan's prices with those in the U.S. In this paper, we newly estimate the deductible consumption taxes in each transaction and revised the Japan-US IOT by subtracting them.[4]

Fourth, compared to our previous work, we increase the volume of price data used from many sources of data on price differentials by various agencies and ministries of the Government of Japan and business sectors. The total number of price-differential data we use in this paper is 507. For each product we have 3 prices on different concepts (i.e. for industry or household use, at producer's or purchaser's prices, and including imports or not) on average and try to reconcile these prices based on the price model we develop. In addition, for the case that the appropriate data are not available or their accuracy cannot be checked, we developed the cost index approach, in which not only price differentials on the products for intermediate uses (estimated in this paper), but also the price differentials on labor and capital inputs as estimated in Jorgenson, Nomura, and Samuels (2015) are taken into consideration by industry (without TFP gap).

The remainder of this paper is organized as follows: Section 2 presents our methodological framework. In Section 3 we outline our data sources for our Japan-US bilateral IOT and many different sources of data on price differentials. Section 4 presents the framework and the estimates of trade margins. The estimated results of price level indices on industry outputs are

[3] The new development of the margin rates has enabled us to improve our price model to take into consideration the differences in margin rates of imports and domestic outputs. In addition, our price model has been improved to describe the margin rates in the domestic wholesales of exported goods.

[4] These noises were ignored in our previous work for the 1990 estimates in Nomura and Miyagawa (1999). Nomura, Miyagawa, and Okamoto (2014) presents the details of our adjustment processes on the original Japan-US IOT.

presented in Section 5. Section 6 concludes.

2 Framework

2.1 Producer's Prices

We start with a description of our framework of the production systems for Japan and the U.S. Figure 1 provides the Japan-US input-output table (IOT) we have developed in this paper. The original table is provided by the 2005 Japan-US input-output table published by METI in 2013.[5] We adjust some problems in this bilateral IOT and expand the framework to cover the imports from six exogenous economies; China (People's Republic of China), Germany, Korea, Malaysia, Taiwan (Republic of China), and Thailand. In the Isard-type (non-competitive import type IOT), all purchases in Japan and the U.S. from foreign countries are recorded separately from the purchases of domestic products. The areas surrounded by dotted squares in Figure 1 represent the imports to Japan or the U.S.

The prices of domestically-produced products are evaluated at the producer's prices (including the indirect taxes required for purchasers). The prices of imported products in Japan and the U.S., from the U.S. and Japan, respectively, are evaluated at the FOB (free on board) prices (producers' prices plus margin and transportation costs from producers to the custom). Thus the freight and insurance and tariff required for the Japan-US trade and the net indirect taxes required in imported countries (in Japan or the U.S.) are separately recorded from the FOB-price imports. The imports from exogenous economies are evaluated at the prices including CIF (cost, insurance, and freight), tariff, and the net indirect taxes required in imported countries (in Japan or the U.S.).

[5] The *2005 Japan-US IOT* estimated by METI is defined as the symmetric-IOT and estimated based on the Japan's 2005 Benchmark IOT. The estimates of the 2005 Symmetric IOT were extended by INFORUM at University of Maryland based on the 2002 Benchmark SUT by the U.S. BEA. In this paper, we separate crude oils and natural gas as distinct products. Thus the products are classified to 174 groups and the industries to 173 groups.

		Intermediate uses (N)		Household consumption (H)		Government consumption & Gross capital formation (Z)		Exports to exogenous countris (E)	Gross output (X)
		Japan (J)	the U.S. (U)	Japan (J)	the U.S. (U)	Japan (J)	the U.S. (U)		
Products in	Japan (J)	$\frac{p^{d,I}_{J,i} X_{JJ,ij}}{e_{J/U}}$	$\frac{p^{d,I}_{JU,i} X_{JU,ij}}{e_{J/U}}$	$\frac{e_{J/U} p^{d,H}_{J,i} X_{JJ,iH}}{e_{J/U}}$	$\frac{p^{d,H}_{JU,i} X_{JU,iH}}{e_{J/U}}$	$\frac{p^{d,I}_{J,i} X_{JJ,iZ}}{e_{J/U}}$	$\frac{p^{d,I}_{JU,i} X_{JU,iZ}}{e_{J/U}}$	$\frac{p^{d}_{JE,i} X_{JE,iE}}{e_{J/U}}$	$\frac{p^{d}_{J,i} X_{J,i}}{e_{J/U}}$
	the U.S. (U)	$p^{d,I}_{UJ,i} X_{UJ,ij}$	$p^{d,I}_{U,i} X_{UU,ij}$	$p^{d,H}_{UJ,i} X_{UJ,iH}$	$p^{d,H}_{U,i} X_{UU,iH}$	$p^{d,I}_{UJ,i} X_{UJ,iZ}$	$p^{d,I}_{U,i} X_{UU,iZ}$	$p^{d}_{UE,i} X_{UE,iE}$	$p^{d}_{U,i} X_{U,i}$
Freight and insurance for the Japan-US trade		$\tau^{f}_{UJ} p^{fob,I}_{UJ,i} X_{UJ,ij}$	$\frac{\tau^{f}_{JU} p^{fob,I}_{JU,i} X_{JU,ij}}{e_{J/U}}$	$\tau^{f}_{UJ} p^{fob,H}_{UJ,i} X_{UJ,iH}$	$\frac{\tau^{f}_{JU} p^{fob,H}_{JU,i} X_{JU,iH}}{e_{J/U}}$	$\tau^{f}_{UJ} p^{fob,I}_{UJ,i} X_{UJ,iG}$	$\frac{\tau^{f}_{JU} p^{fob,I}_{JU,i} X_{JU,iZ}}{e_{J/U}}$		
Tariff for the Japan-US trade		$\tau^{r}_{UJ} p^{fob,I}_{UJ,i} X_{UJ,ij}$	$\frac{\tau^{r}_{JU} p^{fob,I}_{JU,i} X_{JU,ij}}{e_{J/U}}$	$\tau^{r}_{UJ} p^{fob,H}_{UJ,i} X_{UJ,iH}$	$\frac{\tau^{r}_{JU} p^{fob,H}_{JU,i} X_{JU,iH}}{e_{J/U}}$	$\tau^{r}_{UJ} p^{fob,I}_{UJ,i} X_{UJ,iZ}$	$\frac{\tau^{r}_{JU} p^{fob,I}_{JU,i} X_{JU,iZ}}{e_{J/U}}$		
Net indirect taxes on imports of the Japan-US trade		$TX^{I}_{UJ,ij}$	$TX^{I}_{JU,ij}$	$TX^{H}_{UJ,iH}$	$TX^{H}_{JU,iH}$	$TX^{I}_{UJ,iZ}$	$TX^{I}_{JU,iZ}$		
Import from exogenous countries at the price of cif, tariff, and net indirect taxes (E)	China (C)	$\frac{p^{m,I}_{CJ,i} X_{CJ,ij}}{e_{J/U}}$	$p^{m,I}_{CU,i} X_{CU,ij}$	$\frac{p^{m,H}_{CJ,i} X_{CJ,iH}}{e_{J/U}}$	$p^{m,H}_{CU,i} X_{CU,iH}$	$\frac{p^{m,I}_{CJ,i} X_{CJ,iZ}}{e_{J/U}}$	$p^{m,I}_{CU,i} X_{CU,iZ}$		
	Germany (G)	$\frac{p^{m,I}_{GJ,i} X_{GJ,ij}}{e_{J/U}}$	$p^{m,I}_{GU,i} X_{GU,ij}$	$\frac{p^{m,H}_{GJ,i} X_{GJ,iH}}{e_{J/U}}$	$p^{m,H}_{GU,i} X_{GU,iH}$	$\frac{p^{m,I}_{GJ,i} X_{GJ,iZ}}{e_{J/U}}$	$p^{m,I}_{GU,i} X_{GU,iZ}$		
	Korea (K)	$\frac{p^{m,I}_{KJ,i} X_{KJ,ij}}{e_{J/U}}$	$p^{m,I}_{KU,i} X_{KU,ij}$	$\frac{p^{m,H}_{KJ,i} X_{KJ,iH}}{e_{J/U}}$	$p^{m,H}_{KU,i} X_{KU,iH}$	$\frac{p^{m,I}_{KJ,i} X_{KJ,iZ}}{e_{J/U}}$	$p^{m,I}_{KU,i} X_{KU,iZ}$		
	Malaysia (M)	$\frac{p^{m,I}_{MJ,i} X_{MJ,ij}}{e_{J/U}}$	$p^{m,I}_{MU,i} X_{MU,ij}$	$\frac{p^{m,H}_{MJ,i} X_{MJ,iH}}{e_{J/U}}$	$p^{m,H}_{MU,i} X_{MU,iH}$	$\frac{p^{m,I}_{MJ,i} X_{MJ,iZ}}{e_{J/U}}$	$p^{m,I}_{MU,i} X_{MU,iZ}$		
	Taiwan (W)	$\frac{p^{m,I}_{WJ,i} X_{WJ,ij}}{e_{J/U}}$	$p^{m,I}_{WU,i} X_{WU,ij}$	$\frac{p^{m,H}_{WJ,i} X_{WJ,iH}}{e_{J/U}}$	$p^{m,H}_{WU,i} X_{WU,iH}$	$\frac{p^{m,I}_{WJ,i} X_{WJ,iZ}}{e_{J/U}}$	$p^{m,I}_{WU,i} X_{WU,iZ}$		
	Thailand (T)	$\frac{p^{m,I}_{TJ,i} X_{TJ,ij}}{e_{J/U}}$	$p^{m,I}_{TU,i} X_{TU,ij}$	$\frac{p^{m,H}_{TJ,i} X_{TJ,iH}}{e_{J/U}}$	$p^{m,H}_{TU,i} X_{TU,iH}$	$\frac{p^{m,I}_{TJ,i} X_{TJ,iZ}}{e_{J/U}}$	$p^{m,I}_{TU,i} X_{TU,iZ}$		
	ROW (R)	$\frac{p^{m,I}_{RJ,i} X_{RJ,ij}}{e_{J/U}}$	$p^{m,I}_{RU,i} X_{RU,ij}$	$\frac{p^{m,H}_{RJ,i} X_{RJ,iH}}{e_{J/U}}$	$p^{m,H}_{RU,i} X_{RU,iH}$	$\frac{p^{m,I}_{RJ,i} X_{RJ,iZ}}{e_{J/U}}$	$p^{m,I}_{RU,i} X_{RU,iZ}$		
Value added		$\frac{VA_{J,j}}{e_{J/U}}$	$VA_{U,j}$						
Gross output		$\frac{p^{d}_{J,j} X_{J,j}}{e_{J/U}}$	$p^{d}_{U,j} X_{U,j}$						

Figure 1: Japan-US Input-Output Table (the Isard-Type)

To describe equations, we define six groups of demands, denoting:

N for intermediate uses,

H for household consumption (including consumption by NPISHs),

G for government consumption,

F for investment (GFCF and changes in inventories) by industries and government,

E for exports to exogenous economies, and

M for imports,

and the following three broad groups of the demands,

Z for domestic final demand excluding household consumption ($Z=\{G, F\}$),

I for domestic demand by industries and government (I={N, G, F})[6], and

D for domestic demand (D={I,H}={N, H, G, F}).

To construct the price model describing the production system in Figure 1, we define some notations of variables as follows,

$p^{d}_{k,i}$ Price of product *i* produced in country *k* at producer's prices in currency of country *k*,

$p^{d}_{kE,i}$ Price of product *i* produced in country *k*, purchased by exogenous economies at producer's prices (excluding net indirect taxes on products and consumption tax) in currency of country *k*,

$p^{d,l}_{k,i}$ Price of product *i* produced in country *k*, purchased by industries (*I*) or household (*H*) in country *k* at producers' prices in currency of country *k*, (If l = I, the product is purchased by industries for intermediate uses or investment, and the price includes net indirect taxes on products. If l = H, the product is purchased by household for final consumption, and the price includes net indirect taxes on products and consumption tax.),

$p^{d,l}_{kk',i}$ Price of product *i* produced in country *k*, purchased by industries (*I*) or household (*H*) in country *k'* at producers' prices in currency of country *k*, (If l = I, the product is purchased by industries. If l = H, the product is purchased by household. The both prices exclude net indirect taxes on products.),

$p^{m,l}_{kk',i}$ Price of product *i* imported from country *k*, purchased by industries (*I*) or household (*H*) in *k'*-country at the CIF prices plus tariff and net indirect taxes on imports in currency of country *k'*, (If l = I, the product is purchased by industries, and the price excludes consumption tax. If l = H, the product is purchased by household, and the price includes consumption tax.),

$p^{fob,l}_{kk',i}$ Price of product *i* imported from country *k*, purchased by industries (*I*) or household (*H*) in country *k'* at the FOB prices in currency of country *k*, (If l = I, the product is purchased by industries. If l = H, the product is purchased by household.)

$p^{c,l}_{k,i}$ Price of *i*-th composite product (domestic products plus imports), purchased by industries (*I*) or household (*H*) in country *k* at producers' prices in currency of country *k*, (If l = I, the product is purchased by industries, and the price includes net indirect taxes on products. If l = H, the product is purchased by household, and the price includes net indirect taxes on products and consumption tax.),

$X_{kk',ij}$ Volume of product *i* produced in country *k* and purchased by sector *j* in country *k'*,

$X_{k,i}$ Volume of product *i* produced in country *k*,

$\tau^{f}_{kk',i}$ Rate of freight and insurance of product *i* imported from country *k*, purchased in country *k'*,

$\tau^{r}_{kk',i}$ Rate of tariff of product *i* imported from country *k*, purchased in country *k'*,

$\tau^{l}_{k,i}$ Rate of net indirect taxes on products of product *i* in country *k* for industries (*I*) or

[6] Since the government consumption is defined at the actual base, the products for *I*={*N*, G, *F*} mainly refer the products consumed for industries' intermediate uses (*N*) and investment by industries and government (*F*). For simplicity, we use *I* to denote demand for industry uses.

household (H), (If l = I, the rate is for industries and excludes consumption tax.[7] If l = H, the rate is for households and includes consumption tax.),

$\tau^{d}_{k,i}$ The effective rate of indirect taxes for product i in country k,

$TX^{d}_{k,i}$ The amount of indirect taxes of i th domestic products in country k

$e_{k/k'}$ Exchange rate of currency of country k against the currency of country k', (e.g. Japan's exchange rate to the U.S. dollar is $e_{J/U}$)

$T^{e,l}_{k,i}$ Transportation service input for one unit of exported product i in country k, (If l = I, the service is input for industries. If l = H, the service is input for households.),

$W^{e,l}_{k,i}$ Trade service input for one unit of exported i-product in country k, (If l = I, the service is input for industries. If l = H, the service is input for households.),

$m^{T,e,l}_{k,i}$ Rate of transportation cost (T) of product i in country k for exported products, (If l = I, the rate is for industries. If l = H, the rate is for households.),

$m^{W,e,l}_{k,i}$ Rate of trade margin (W) of product i in country k for exported products, (If l = I, the rate is for industries. If l = H, the rate is for households.).

We begin with clarifying the treatment of indirect taxes in our model. In Japan's transactions of Figure 1, the consumption tax is included only in the prices of household consumptions. Thus the producer's prices of the domestically produced outputs, $p^{d,I}_{J,i}$ (for industry) and $p^{d,H}_{J,i}$ (for household) are distinguished in our model.[8] Corresponding to this identification, the rates of net indirect taxes on products for industries and households are also distinguished as $\tau^{I}_{J,i}$ and $\tau^{H}_{J,i}$, respectively. As for the prices of exports, since both of consumption tax and other indirect taxes on products are deductible, Japan's export prices to the U.S. ($p^{d,H}_{JU,i}$ and $p^{d,I}_{JU,i}$) are assumed as:

(1) $p^{d,l}_{JU,i} = p^{d,l}_{J,i}/(1+\tau^{l}_{J,i}) \qquad (k = J, U \text{ and } l = I, H).$

On the other hand, the Japanese producer's price $p^{d}_{J,i}$ is defined as a composition of the producer's prices for all types of demand. The total of the domestic indirect taxes (excluding indirect tax for imported products) of product i is described as:

(2) $TX^{d}_{J,i} = \left(\frac{\tau^{I}_{J,i}}{1+\tau^{I}_{J,i}}\right) p^{d,I}_{J,i} \sum_{j\in I} X_{JJ,ij} + \left(\frac{\tau^{H}_{J,i}}{1+\tau^{H}_{J,i}}\right) p^{d,H}_{J,i} X_{JJ,iH}.$

The first term on the right-hand side represents the amount of other indirect tax paid by industries (I) and the second term is the amount of the consumption tax and other indirect tax paid by households (H). Based on $TX^{d}_{J,i}$, the effective rate of indirect taxes for domestic product i in Japan is defined as:

(3) $\tau^{d}_{J,i} = TX^{d}_{J,i}/(p^{d}_{J,i} X_{J,i} - TX^{d}_{J,i}),$

[7] The consumption tax on the products purchased by the producers who produce consumption tax exempt products (e.g. medical care) are non-deductible. We describe that the consumption tax is excluded from $\tau^{I}_{k,i}$ in the description of our price model for simplicity, but some non-deductible consumption taxes in domestic final demand excluding household consumption (Z) are considered in our actual estimation.

[8] In addition to the differences in indirect taxes for industry and household uses, our price model permits the differences in the basic prices for industry and household uses, reflecting the observed price differentials in different demand types of the product which are classified to the same group. These may indicate that the types or qualities of the same product at the more detail level are different, but we treat them as if they were additive for simplicity of our price model.

where $p_{J,i}^{d}X_{J,i}$ is gross output in Japan. Using $\tau_{J,i}^{d}$, Japan's export price to the exogenous economies is assumed as:

(4) $\quad p_{JE,i}^{d} = p_{J,i}^{d}/(1+\tau_{J,i}^{d}).$

In the case of exports to exogenous economies, the difference in the uses in the imported countries (for industry or household) are not identified in our model, due to data constraints. Equations (1) to (4) are held for the U.S. similarly.

The output balance of the Japanese products at current prices based on the first-row matrix of the non-competitive import type IOT in Figure 1 is described as,

(5) $\quad p_{J,i}^{d}X_{J,i} = p_{J,i}^{d,I}\sum_{j\in I}X_{JJ,ij} + p_{JU,i}^{d,I}\sum_{j\in I}X_{JU,ij} + p_{J,i}^{d,H}X_{JJ,iH} + p_{JU,i}^{d,H}X_{JU,iH} + p_{JE,i}^{d}X_{JE,i}$

The first term on the right-hand side stands for industry uses (intermediate uses and investment) in Japan, the second term is the imports by the U.S. industries for the intermediate uses, the third term is the household uses in Japan, the fourth term is the imports by the U.S. households, and the final term is the exports to exogenous economies.

Corresponding to the Isard-type IOT in Figure 1, we define the Chenery-Moses-type IOT (the competitive import type IOT) for each of Japan and the U.S. (Chenery, 1953; Moses, 1955) Figure 2 represents this table for Japan (a similar table can be defined for the U.S.).

	Intermediate inputs (N)	Household consumption (C)	Government consumption & Gross capital formation (Z)	Exports (E)	(–)Imports (M)	Gross output (X)
Intermediate inputs	$p_{J,i}^{c,I}X_{J,ij}$	$p_{J,i}^{c,H}X_{J,iH}$	$p_{J,i}^{c,I}X_{JJ,iZ}$	$\sum_{j\in I}p_{JU,i}^{d,I}X_{JU,ij} + p_{JU,i}^{d,H}X_{JU,iH} + p_{JE,i}^{d}X_{JE,iE}$	$\sum_{k=U,E}(\sum_{j\in I}p_{kJ,i}^{m,I}X_{kJ,ij} + p_{kJ,i}^{m,H}X_{kJ,iH})$	$p_{J,i}^{d}X_{J,i}$
Value added	$VA_{J,j}$					
Gross output	$p_{J,j}^{d}X_{J,j}$					

Figure 2: Japanese Input-Output Table (the Chenery-Moses-Type)

Based on the Chenery-Moses-type input-output framework in Figure 2, the output balance including Japan's uses of imports at current prices is described as:

(6) $$p_{J,i}^{d}X_{J,i} = \sum_{j\in I}p_{J,i}^{c,I}X_{J,ij} + p_{J,i}^{c,H}X_{J,iH} + \left(\sum_{j\in I}p_{JU,i}^{d,I}X_{JU,ij} + p_{JU,i}^{d,H}X_{JU,iH} + p_{JE,i}^{d}X_{JE,i}\right) - \sum_{k=U,E}\left(\sum_{j\in I}p_{kJ,i}^{m,I}X_{kJ,ij} + p_{kJ,i}^{m,H}X_{kJ,iH}\right),$$

where $X_{J,ij}$ is the domestic demands of product *i* by sector *j* in Japan including both domestic products and imports, and $p_{J,i}^{c,I}$ stands for the corresponding prices of the composite products (of domestic- produced products plus imports). These demand prices are defined as:

(7) $\quad p_{J,i}^{c,l}X_{J,il} = p_{J,i}^{d,l}X_{JJ,il} + p_{UJ,i}^{m,l}X_{UJ,il} + p_{EJ,i}^{m,l}X_{EJ,il} \qquad (l = I, H).$

The outputs at constant prices are assumed to be additive among the product for different demands;

(8) $$X_{J,i} = \sum_{j\in D}X_{JJ,ij} + \sum_{j\in D}X_{JU,ij} + X_{JE,i} = \sum_{j\in D}X_{J,ij} + \sum_{j\in D}X_{JU,ij} + X_{JE,i} - \sum_{j\in D}X_{UJ,ij} - \sum_{j\in D}X_{EJ,ij}.$$

The former equation corresponds with the nominal balance of Equation (5) and the latter corresponds to Equation (6). For simplicity, we also assume the additivity among domestic inputs and imports:

(9) $X_{J,ij} = X_{JJ,ij} + X_{UJ,ij} + X_{EJ,ij} \qquad (j \in D).$

We define the demand share at constant prices:

(10) $w^{d,l}_{Jk,i} = \sum_{j \in l} X_{Jk,ij} / X_{J,i} \quad (k = J, U, l = I, H)$ and $w^{d}_{JE,i} = X_{JE,i} / X_{J,i}$,

where $w^{d,I}_{JJ,i} + w^{d,I}_{JU,i} + w^{d,H}_{JJ,i} + w^{d,H}_{JU,i} + w^{d}_{JE,i} = 1$. Based on Equations (5) to (10), Japan's output price of product *i* is described as:

(11) $p^{d}_{J,i} = p^{d,I}_{J,i} w^{d,I}_{JJ,i} + p^{d,I}_{JU,i} w^{d,I}_{JU,i} + p^{d,H}_{J,i} w^{d,H}_{JJ,i} + p^{d,H}_{JU,i} w^{d,H}_{JU,i} + p^{d}_{JE,i} w^{d}_{JE,i}.$

By substituting Equations (1) and (4) into Equation (11), we obtain:

(12) $p^{d}_{J,i} = \left\{ p^{d,I}_{J,i} \left(w^{d,I}_{JJ,i} + \frac{w^{d,I}_{JU,i}}{1+\tau^{l}_{J,i}} \right) + p^{d,H}_{J,i} \left(w^{d,H}_{JJ,i} + \frac{w^{d,H}_{JU,i}}{1+\tau^{l}_{J,i}} \right) \right\} \Big/ \left(1 - \frac{w^{d}_{JE,i}}{1+\tau^{d}_{J,i}} \right).$

Thus Japan's output price, $p^{d}_{J,i}$, is measured using $p^{d,I}_{J,i}$ and $p^{d,H}_{J,i}$, the demand shares, and the rates of indirect taxes.

On the other hand, in order to clarify the relationship between U.S. producer's price $p^{d,l}_{UJ,i}$ and Japan's import prices from the U.S., $p^{m,l}_{UJ,i}$, we describe the U.S. FOB price as:

(13) $p^{fob,l}_{UJ,i} = p^{d,l}_{UJ,i} + p^{d,l}_{UJ,T} T^{e}_{U,i} + p^{d,l}_{UJ,W} W^{e}_{U,i} \qquad (l = I, H),$

where $p^{d,l}_{UJ,T}$ and $p^{d,l}_{UJ,W}$ are the prices of U.S. transportation and trade sectors for the exports to Japan, respectively, and $T^{e,l}_{U,i}$ and $W^{e,l}_{U,i}$ are the volumes of transportation and trade services for one unit of exports of product *i* required in the U.S. We define the rate of transportation cost $m^{T,E,l}_{U,i}$ and the rate of trade margin $m^{W,e,l}_{U,i}$ for exported products as,

(14) $m^{T,e,l}_{U,i} = p^{d,l}_{UJ,T} T^{e}_{U,i} / p^{fob,l}_{UJ,i}$ and $m^{W,e,l}_{U,i} = p^{d,l}_{UJ,W} W^{e}_{U,i} / p^{fob,l}_{UJ,i} \qquad (l = I, H),$

respectively. From Equation (13) and (14), the FOB prices for households and industries are represented as:

(15) $p^{fob,l}_{UJ,i} = p^{d,l}_{UJ,i} \; / (1 - m^{T,e,l}_{U,i} - m^{W,e,l}_{U,i}) \qquad (l = I, H).$

The prices of imports for industry and household uses, $p^{m,I}_{UJ,i}$ and $p^{m,H}_{UJ,i}$, are calculated by adding the custom duty and indirect taxes on products to the CIF price as:

(16) $p^{m,l}_{UJ,i} = e_{J/U} (1 + \tau^{l}_{J,i})(1 + \tau^{r}_{UJ,i})(1 + \tau^{f}_{UJ,i}) p^{fob,l}_{UJ,i} = e_{J/U} \omega^{l}_{UJ,i} p^{d,l}_{UJ,i} \qquad (l = I, H),$

where $e_{J/U}$ is the exchange rate of the Japanese yen against the U.S. dollar, $\tau^{f}_{UJ,i}$ and $\tau^{r}_{UJ,i}$ are the rates of the international freight and insurance and the tariff for one unit of product *i* imported from the U.S. to Japan, respectively, and $\omega^{l}_{kk',i}$ are defined as $(1 + \tau^{l}_{k',i})(1 + \tau^{r}_{kk',i})(1 + \tau^{f}_{kk',i}) / (1 - m^{T,e,l}_{U,i} - m^{W,e,l}_{U,i})$ for $l = I, H$ for simplicity.[9]

Meanwhile, the demand share of the domestic product and the imported product is defined as:

(17) $w^{c,l}_{kJ,i} = \sum_{j \in l} X_{kJ,ij} / \sum_{j \in l} X_{J,ij} \qquad (k = J, U, E$ and $l = I, H),$

where $w^{c,l}_{JJ,i} + w^{c,l}_{UJ,i} + w^{c,l}_{EJ,i} = 1$ for $l = I, H$. By assigning Equations (16) and (17) to Equation (7), we obtain:

(18) $p^{c,l}_{J,i} = p^{d,l}_{J,i} w^{c,l}_{JJ,i} + e_{J/U} \omega^{l}_{UJ,i} p^{d,l}_{UJ,i} w^{c,l}_{UJ,i} + p^{m,l}_{EJ,i} w^{c,l}_{EJ,i} \qquad (l = I, H).$

[9] The data $\tau^{f}_{UJ,i}$ and $\tau^{r}_{UJ,i}$ are available from the 2005 Japan-US IOT by METI or its supplementary tables.

Similarly, the demand prices in the U.S. are shown as:

$$(19) \quad p_{U,i}^{c,l} = p_{U,i}^{d,l} w_{UU,i}^{c,l} + \omega_{JU,i}^{l} p_{JU,i}^{d,l} w_{JU,i}^{c,l} / e_{J/U} + p_{EU,i}^{m,l} w_{EU,i}^{c,l} \qquad (l = I, H).$$

Equations (18) and (19) describe the price relationship between the producer's prices of Japan and the U.S. through their bilateral trade.

Based on the definitions of our prices, we define several price level indices (PLI) between Japan and the U.S. as,

$$(20) \quad \mathbf{P}_{J/U,i}^{d} = \frac{p_{J,i}^{d}}{e_{J/U} p_{U,i}^{d}}, \mathbf{P}_{J/U,i}^{d,l} = \frac{p_{J,i}^{d,l}}{e_{J/U} p_{U,i}^{d,l}}, \mathbf{P}_{J/U,i}^{c,l} = \frac{p_{J,i}^{c,l}}{e_{J/U} p_{U,i}^{c,l}} \qquad (l = I, H),$$

where $\mathbf{P}_{J/U,i}^{d}$ is the PLI of output at producer's price of product i between Japan and the U.S.[10] The second equation describes the definition of the PLIs of output at producer's price for households and for industries, $\mathbf{P}_{J/U,i}^{d,H}$ and $\mathbf{P}_{J/U,i}^{d,I}$, respectively. The third equation describes the PLIs of demand prices at producer's price, $\mathbf{P}_{J/U,i}^{c,H}$ and $\mathbf{P}_{J/U,i}^{c,I}$, respectively. By substituting Equations (18) and (19), into (20), the Japan-US PLI of domestic demand prices for households and industries are obtained as follows:

$$(21) \quad \mathbf{P}_{J/U,i}^{c,l} = \frac{\mathbf{P}_{J/U,i}^{d,l} w_{JJ,i}^{c,l} + \omega_{UJ,i}^{l} w_{UJ,i}^{c,l} / (1+\tau_{U,i}^{l}) + \mathbf{P}_{EJ/U,i}^{m,l} w_{EJ,i}^{c,l}}{w_{UU,i}^{c,l} + \mathbf{P}_{J/U,i}^{d,l} \omega_{JU,i}^{l} w_{JU,i}^{c,l} / (1+\tau_{J,i}^{l}) + \mathbf{P}_{EU/U,i}^{m,l} w_{EU,i}^{c,l}} \qquad (l = I, H).$$

$\mathbf{P}_{Ek/U,i}^{m,l}$ is the PLI of the imports from exogenous economies to Japan or the U.S., relative to the domestic producer's prices in the U.S., which are defined as:

$$(22) \quad \mathbf{P}_{EJ/U,i}^{m,l} = \frac{p_{EJ,i}^{m,l}}{e_{J/U}\, p_{U,i}^{d,l}} \text{ and } \mathbf{P}_{EU/U,i}^{m,l} = \frac{p_{EU,i}^{m,l}}{p_{U,i}^{d,l}} \qquad (l = I, H).$$

The import price indices for Japan and the U.S., $p_{EJ/U,i}^{m,l}$ and $p_{EU/U,i}^{m,l}$ respectively, are determined by the sub model, as presented in Section 2.3. From Equation (21), we obtain:

$$(23) \quad \mathbf{P}_{J/U,i}^{d,l} = \frac{\omega_{UJ,i}^{l} w_{UJ,i}^{c,l} / (1+\tau_{U,i}^{l}) + \mathbf{P}_{EJ/U,i}^{m,l} w_{EJ,i}^{c,l} - \mathbf{P}_{J/U,i}^{c,l} \left(w_{UU,i}^{c,l} + \mathbf{P}_{EU/U,i}^{m,l} w_{EU,i}^{c,l} \right)}{\mathbf{P}_{J/U,i}^{c,l} \omega_{JU,i}^{l} w_{JU,i}^{c,l} / (1+\tau_{J,i}^{l}) - w_{JJ,i}^{c,l}} \qquad (l = I, H).$$

If the PLIs of the demand prices and the imports from exogenous economies are available, the PLI of output at producer's price are measured by this equation, for industry or household.

When the PLIs of $\mathbf{P}_{J/U,i}^{d,I}$ and $\mathbf{P}_{J/U,i}^{d,H}$ are measured, we can measure the PLI of domestic outputs, $\mathbf{P}_{J/U,i}^{d}$, based on Equation (12) as:

$$(24) \quad \mathbf{P}_{J/U,i}^{d} = \left\{ \mathbf{P}_{J/U,i}^{d,I} \left(\frac{p_{U,i}^{d,I} w_{JJ,i}^{d,I}}{p_{U,i}^{d}} + \frac{p_{U,i}^{d,I} w_{JU,i}^{d,I}}{(1+\tau_{J,i}^{I}) p_{U,i}^{d}} \right) + \mathbf{P}_{J/U,i}^{d,H} \left(\frac{p_{U,i}^{d,H} w_{JJ,i}^{d,H}}{p_{U,i}^{d}} + \frac{p_{U,i}^{d,H} w_{JU,i}^{d,H}}{\left(1+\tau_{J,i}^{H}\right) p_{U,i}^{d}} \right) \right\} \Big/ \left(1 - \frac{w_{JE,i}^{d}}{1+\tau_{J,i}^{d}} \right).$$

In this equation, $\mathbf{P}_{J/U,i}^{d}$ is defined including the indirect taxes. Since our framework is based on the METI's symmetric IOT, this product-PLI is identical to the industry-PLI ($\mathbf{P}_{J/U,i}^{d} = \mathbf{P}_{J/U,j}^{d}$). To enable us to compare the prices and volumes of outputs, the PLI of j-industry outputs at basic prices $\mathbf{P}_{J/U,j}^{d*}$ as:

$$(25) \quad \mathbf{P}_{J/U,i}^{d*} = \mathbf{P}_{J/U,i}^{d} \frac{1+\tau_{U,i}^{d}}{1+\tau_{J,i}^{d}}.$$

In our study, only the Japan-US differences in the indirect taxes on the consumption of liquor, tobacco, and gasoline are considered.

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[10] To distinguish the price level index from the prices, we use the bold as $\mathbf{P}_{UJ,i}^{d}$.

2.2 Purchaser's Prices

The section 2.1 describes the price model based on the producer's prices. However, the PPP data in main sources are measured at the purchaser's prices. In this section, we describe the relationship between the producer's prices and purchaser's prices. Some notations are defined additionally as follows:

$p_{k,i}^{pd,l}$ Price of product *i* produced in country *k*, purchased by industries (*I*) or household (*H*) in country *k* at purchasers' prices in currency of country *k*, (If *l* = *I*, the product is purchased by industries for intermediate uses or investment. If *l* = *H*, the product is purchased by household for final consumption.),

$p_{kk',i}^{pd,l}$ Price of product *i* produced in country *k*, purchased by industries (*I*) or household (*H*) in country *k'* at purchasers' prices in currency of country *k*, (If *l* = *I*, the product is purchased by industries. If *l* = *H*, the product is purchased by household.),

$p_{kk',i}^{pm,l}$ Price of product *i* imported from country *k*, purchased by industries (*I*) or household (*H*) in country *k'* at purchasers' prices in currency of country *k'*, (If *l* = *I*, the product is purchased by industries. If *l* = *H*, the product is purchased by household.),

$T_{k,i}^{l}$ Transportation service input for one unit of imported and domestic product *i* in country *k*, (If *l* = *I*, the service is input for industries. If *l* = *H*, the service is input for households.),

$W_{k,i}^{d,l}$ Trade service input for one unit of domestic product *i* in country *k*, (If *l* = *I*, the service is input for industries. If *l* = *H*, the service is input for households.),

$W_{k,i}^{m,l}$ Trade service input for one unit of imported product *i* in country *k*, (If *l* = *I*, the service is input for industries. If *l* = *H*, the service is input for households.),

$m_{k,i}^{T,l}$ Rate of transportation cost (*T*) of product *i* in country *k* for imported and domestic products, (If *l* = *I*, the rate is for industries. If *l* = *H*, the rate is for households.)

$m_{k,i}^{W,l}$ Rate of trade margin (*W*) of *i*-product in *k*-country for imported and domestic products, (If *l* = *I*, the rate is for industries. If *l* = *H*, the rate is for households.)

$m_{k,i}^{W,d,l}$ Rate of trade margin (*W*) of product *i* in country *k* for domestic products, (If *l* = *I*, the rate is for industries. If *l* = *H*, the rate is for households.)

$m_{k,i}^{W,m,l}$ Rate of trade margin (*W*) of product *i* in country *k* for imported products, (If *l* = *I*, the rate is for industries. If *l* = *H*, the rate is for households.)

The purchaser's price purchased by industries and households is defined as the sum of the producer-price value, the transportation cost, and the trade margin as:

$$(26) \quad p_{J,i}^{pd,l} = p_{J,i}^{d,l} + p_{J,T}^{d,l}T_{J,i}^{l} + p_{J,W}^{d,l}W_{J,i}^{d,l} \qquad (l = I, H),$$

where $p_{J,T}^{d,l}$ and $p_{J,W}^{d,l}$ are the output prices of the transportation and trade services in Japan and $T_{J,i}^{l}$ and $W_{J,i}^{d,l}$ are the transportation and the trade services required for one unit of product *i*. In our model, since the trade margin rate are distinguished for domestic products and imports, the superscript “d” is added for the trade margin. The rates of transportation cost and trade margin to the purchaser’s prices of domestic products are defined as:

(27) $m_{J,i}^{T,l} = p_{J,T}^{d,l} T_{J,i}^{l} / p_{J,i}^{pd,l}$ and $m_{J,i}^{W,d,l} = p_{J,W}^{d,l} W_{J,i}^{d,l} / p_{J,i}^{pd,l} \quad (l = I, H)$,

respectively, for each of industry or household uses. Based on Equations (26) and (27), the relationship between the producer’s prices and the purchaser’s prices is given by:

(28) $p_{J,i}^{d,l} = p_{J,i}^{pd,l}\left(1 - m_{J,i}^{T,l} - m_{J,i}^{W,d,l}\right) \quad (l = I, H)$.

Similar equations are developed for the U.S. products as well. The PLI of the purchaser’s prices of domestic products is described as:

(29) $\mathbf{P}_{J/U,i}^{pd,l} = \frac{p_{J,i}^{pd,l}}{e_{J/U}\, p_{U,i}^{pd,l}} = \mathbf{P}_{J/U,i}^{d,l} \frac{\left(1 - m_{U,i}^{T,l} - m_{U,i}^{W,d,l}\right)}{\left(1 - m_{J,i}^{T,l} - m_{J,i}^{W,d,l}\right)} \quad (l = I, H)$.

This equation gives the relationship between the producer-price PLI and the purchaser-price PLI of domestic products.

The PLI of demand prices, which are the prices of the composite product made up of both imports and its domestic counterpart, is represented as:

(30) $\mathbf{P}_{J/U,i}^{pc,l} = \frac{p_{J,i}^{pc,l}}{e_{J/U}\, p_{U,i}^{pc,l}} = \mathbf{P}_{J/U,i}^{c,l} \frac{\left(1 - m_{U,i}^{T,l} - m_{U,i}^{W,l}\right)}{\left(1 - m_{J,i}^{T,l} - m_{J,i}^{W,l}\right)} \quad (l = I, H)$.

The rate of transportation cost for the component of imports is the same as that for the domestic products. Thus the same rates of $m_{J,i}^{T,l}$ and $m_{U,i}^{T,l}$ are applied in Equations (29) and (30). On the other hand, the rate of domestic trade margin for imports $m_{k,i}^{W,m,l}$ is different from that for domestic products $m_{k,i}^{W,d,l}$ in our model. Thus Equation (30) is described using, $m_{J,i}^{W,l}$ and $m_{U,i}^{W,l}$, which are the rates of trade margin for composite products measured as:

(31)
$$m_{k,i}^{W,l} = m_{k,i}^{W,m,l} \sum_{j \in l} \left(p_{k'k,i}^{pm,l} X_{k'k,ij} + p_{Ek,i}^{pm,l} X_{Ek,ij}\right) / \sum_{j \in l} p_{k,i}^{pc,l} X_{k,ij}$$
$$+ m_{k,i}^{W,d,l} \cdot \sum_{j \in l} p_{kk,i}^{pd,l} X_{kk,ij} / \sum_{j \in l} p_{k,i}^{pc,l} X_{k,ij} \quad (kk' = JU \text{ or } UJ \text{ and } l = I, H).$$

Equation (31) indicates that the rate of trade margin for composite products $m_{k,i}^{W,l}$ is measured as a weighted average of $m_{k,i}^{W,m,l}$ and $m_{k,i}^{W,d,l}$, whose weights are the nominal value shares evaluated at the purchaser’s prices. This study estimates the rates of trade margins using establishment data from the Japanese Census of Commerce, as explained in section 4.

The PLIs, $\mathbf{P}_{J/U,i}^{pc,I}$ and $\mathbf{P}_{J/U,i}^{pc,H}$ in Equation (30), presents the Japan-US level comparison of demand prices evaluated by purchaser’s prices for industry and household uses, respectively. Using this PLI of the products for household uses, the Japan-US Purchasing Power Parity (PPP) for household consumption by product is shown as:

(32) $\mathbf{PPP}_{J/U,i}^{H} = e_{J/U} \mathbf{P}_{J/U,i}^{pc,H}$.

If the PPP data, $\mathbf{PPP}_{J/U,i}^{H}$, or the purchaser-price PLI, $\mathbf{P}_{J/U,i}^{pc,H}$, on household consumption between Japan and the U.S. are available, we can measure the producer-price PLI of demand prices, $\mathbf{P}_{J/U,i}^{c,H}$, from Equation (30), and then the PLI of domestic products, $\mathbf{P}_{J/U,i}^{d,H}$, can be measured from Equation (23).

Based on the price model we formulated above, we can illustrate the relationships among several PLIs and define four types of estimation processes from the observed PLIs to derive other PLIs using the price model in Figure 3. The PLI surrounded by each box means the observed PLI in each type of estimation process.

Type-1 indicates the case that the producer-price PLI of domestic outputs $\mathbf{P}^{d}_{J/U,i}$ is available based on surveys.[11] In this case, it is assumed that the difference between $\mathbf{P}^{d,I}_{J/U,i}$ (the arrow to the lower left in Figure 3) and $\mathbf{P}^{d,H}_{J/U,i}$ (the arrow to the higher left) is caused only by the difference in the treatment of consumption tax. Therefore, after $\mathbf{P}^{d*}_{J/U,i}$ is determined based on Equation (25), $\mathbf{P}^{d,I}_{J/U,i}$ and $\mathbf{P}^{d,H}_{J/U,i}$ are calculated as:

$$(33) \quad \mathbf{P}^{d,l}_{J/U,i} = \mathbf{P}^{d*}_{J/U,i} \frac{1+\tau^{l}_{J,i}}{1+\tau^{l}_{U,i}} \qquad (l = I, H).$$

Next, the producer-price PLI of composite products for intermediate use $\mathbf{P}^{c,I}_{J/U,i}$ and for household use $\mathbf{P}^{c,H}_{J/U,i}$ are derived based on Equation (21), considering the difference in import prices for Japan and the U.S. Finally, the purchaser-price PLI of the products for intermediate use $\mathbf{P}^{pc,I}_{J/U,i}$ and for household use $\mathbf{P}^{pc,H}_{J/U,i}$ are estimated using Equation (30), reflecting the difference in the trade margins and the transportation costs by product between Japan and the U.S.

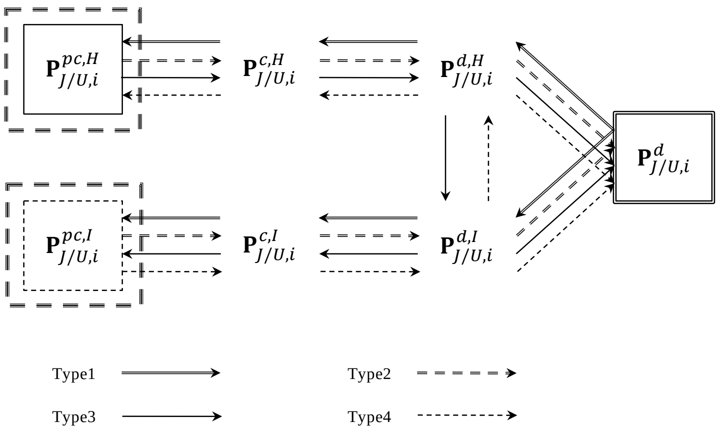

Figure 3: Estimation Process in Four Types of Price Scenarios

Type-2 is the case where data for the purchaser-price PLI of the products for industry use $\mathbf{P}^{pc,I}_{J/U,i}$ and household use $\mathbf{P}^{pc,H}_{J/U,i}$ are available. Based on this data, $\mathbf{P}^{c,I}_{J/U,i}$ and $\mathbf{P}^{c,H}_{J/U,i}$ (the arrow to the right in Figure 3) are calculated based on Equation (30). And then, $\mathbf{P}^{d,I}_{J/U,i}$ and $\mathbf{P}^{d,H}_{J/U,i}$ are estimated in accordance with Equation (23) and $\mathbf{P}^{d}_{J/U,i}$ is derived as the aggregates based on the Equation (24).

In Type-3 scenarios, only the purchaser-price PLI of the products for household use $\mathbf{P}^{pc,H}_{J/U,i}$ is available as observations (like the Eurostat-OECD PPPs). By considering the differences in trade margins and the transportation costs, $\mathbf{P}^{c,H}_{J/U,i}$ and $\mathbf{P}^{d,H}_{J/U,i}$ are estimated based on Equations (30) and (23), respectively. In this case, $\mathbf{P}^{d,I}_{J/U,i}$ is derived (the arrow pointing down in Figure 3) satisfying Equation (33) and $\mathbf{P}^{d}_{J/U,i}$ is determined using $\mathbf{P}^{d,I}_{J/U,i}$ and $\mathbf{P}^{d,H}_{J/U,i}$ based on Equation (24). Additionally, $\mathbf{P}^{c,I}_{J/U,i}$ and $\mathbf{P}^{pc,I}_{J/U,i}$ are estimated taking the difference in the import prices, the percentage of import, the trade margins, and the transportation costs between Japan and the U.S,

[11] The Type-1 scenarios include two approaches of the use of cost index and the reference PPP. The details of these approaches are explained in Section 3.2.

into the consideration. In Type 4 scenarios, $\mathbf{P}^{pc,I}_{J/U,i}$ is first observed instead of $\mathbf{P}^{pc,H}_{J/U,i}$ in Type-3 cases, but the processes to estimate other PLIs are similar.

2.3 Import Prices from Exogenous Economies

This paper expands the price model to incorporate the prices of the imports from exogenous economies (E) to Japan (J) and the U.S. (U). The estimates of these prices, $p^{m,l}_{EJ,i}$ and $p^{m,l}_{EU,i}$, respectively, are used to deduce the producer-price PLI of domestic products $\mathbf{P}^{d,l}_{J/U,i}$ in Equation (23). We define $p^{m,l}_{EJ,i}$ and $p^{m,l}_{EU,i}$ as the combined import prices from exogenous economies:

$$p^{m,l}_{Ek',i} = \sum_k p^{m,l}_{kk',i} v^{m,l}_{kk',i} = \sum_{k\neq R} e_{k'/k}\omega^l_{kk',i} p^{d,l}_{k,i} v^{m,l}_{kk',i} + p^{m,l}_{Rk',i} v^{m,l}_{Rk',i}, \quad (34)$$

$$(l = I, H,\ k = C, G, K, M, W, T, R, \text{and}\ \ k' = J\ or\ U),$$

where the $v^{m,l}_{kk',i}$ stands for the import shares at current prices from country k (the exogenous economies) to country k'(Japan and the U.S.). The sum of the import shares $\sum_k v^{m,l}_{kk',i}$ is one. $p^{m,l}_{Rk',i}$ is the average price of imported goods from the rest of the world (ROW). $\omega^l_{kk',i}$, which is defined in Equation (16), is the combined coefficient to transform the output prices in country k to the import prices in country k' from country k. Since it is difficult to obtain the output prices in country k ($p^{d,l}_{k,i}$) directly from statistical data, we construct the following sub model to determine $p^{d,l}_{k,i}$ in six exogenous economies (k) excluding the ROW.[12]

We describe the demand price (of the composite products) in country k as:

$$p^{c,l}_{k,i} = p^{d,l}_{k,i} v^{c,l}_{kk,i} + \sum_{k\neq k'} e_{k/k'}\omega^l_{k'k,i} p^{d,l}_{k',i} v^{c,l}_{k'k,i} + e_{k/J}\omega^l_{Jk,i} p^{d,l}_{J,i} v^{c,l}_{Jk,i}$$

$$+ e_{k/U}\omega^l_{Uk,i} p^{d,l}_{U,i} v^{cl}_{Uk,i} + p^{m,l}_{Rk,i} v^{c,l}_{Rk',i}, \quad (35)$$

$$(k = C, G, K, M, W, T,\ \ k' = C, G, K, M, W, T,\ \text{and}\ l = I, H).$$

where $v^{c,l}_{kk',i}$ is the demand share of the domestic product and the imported product at current prices from country k to country k'. The sum of the demand shares $\sum_k v^{c,l}_{kk',i}$ is one. In this equation, $p^{d,l}_{k,i}$ in the first and second terms of the right hand are the prices to be determined endogenously in the sub model. The third and fourth terms are the import prices from Japan and the U.S., respectively, whose output prices, $p^{d,l}_{Uk,i}$ and $p^{d,l}_{Jk,i}$, are pre-determined in the main model and are treated as exogenous variables in the sub model. And the final term is the exogenous import prices from the ROW.

If the U.S. demand price $p^{c,l}_{U,i}$ is pre-determined in our main model described in the previous sections and the demand-price PPPs are observed in the Eurostat-OECD PPPs, METI PPP survey, or other PPP surveys, the demand price in country k, $p^{c,l}_{k,i}$, are calculated. The Equation (35) is measured in each of six countries. If other variables in Equation (35) are given exogenously, the output prices of product i in six countries are determined by solving these equations.[13]

By substituting the estimated $p^{d,l}_{k,i}$ for six countries into Equation (34), import prices from exogenous economies to Japan and the U.S., $p^{m,l}_{EJ,i}$ and $p^{m,l}_{EU,i}$, are determined. Any revisions in

[12] In the sub model, indirect taxes are not considered for simplicity.

[13] In our study, exogenous variables related to China, Korea, Malaysia, Taiwan, Thailand are obtained from the Asian International IOT published by IDE (Institute of Developing Economies) and the variables related to Germany are obtained from WIOD (World Input-Output Database) funded by European Commission.

these prices change the estimates of $p_{Uk,i}^{d,l}$ and $p_{Jk,i}^{d,l}$ in the main model. Through several reiterations between the main model and the sub model, we obtain the final results of all types of PLIs between Japan and the U.S.

3 Data

3.1 Elementary Level Purchasing Power Parities

In our study, we use the price-differential data obtained from the Eurostat-OECD PPPs, the METI survey, and many sources published by agencies and ministries of the Government of Japan and business sectors. The total number of price data at the elementary level used in this study was 507. Since the number of product in our model is 174, multiple data for one product were used. The product level PLIs are calculated as the translog indices using the elementary level price data. If the weight for the elementary level is unavailable in aggregation, the product's PLI is calculated as a simple geometric average index.

Table 1: Concepts of Collected Data at the Elementary Level

	Purchaser's price									Producer's price			Total
	Intermediate uses $\mathbf{P}_{J/U,i}^{pc,N}$				Household consumption $\mathbf{P}_{J/U,i}^{pc,H}$				Investment $\mathbf{P}_{J/U,i}^{pc,F}$	$\mathbf{P}_{J/U,i}^{d}$			
CPC code	METI PPP survey	Other PPP surveys	Other surveys on unit prices	Total	Eurostat-OECD PPPs	Other PPP surveys	Other surveys on unit prices	Total	Eurostat-OECD PPPs	Other surveys on unit prices	Cost index or reference PPP	Total	
0 Agriculture, forestry and fishery					6			6		10	1	11	**17**
1 Ores and minerals; electricity, gas and water	10	3	2	15						5	1	6	**21**
2 Food, beverages and tobacco; textiles, apparel and leather	5		1	6	46	5		51			3	3	**60**
3 Other transportable goods, except metal products, machinery, equipment	67	6	9	82	11	13		24		3	4	7	**113**
4 Metal products, machinery and equipment	104		3	107	17	7	5	29	20		3	3	**159**
5 Constructions and construction services					1			1	3				**4**
6 Trade; accommodation, food and beverage serving; transport	23	5		28	10	1	1	12			4	4	**44**
7 Financial and related services; real estate; rental and leasing services	10			10	4	1	1	6		2	1	3	**19**
8 Business and production services	18			18	8	5		13	1		3	3	**35**
9 Community, social and personal services	12			12	20	1		21			2	2	**35**
Total	**249**	**14**	**15**	**278**	**123**	**33**	**7**	**163**	**24**	**20**	**22**	**42**	**507**

Table 1 represents the concepts of the collected data at the elementary level PPPs by broad group of product. Each row corresponds to a sector of Central Product Classification Ver.2. One of the most important data sources is the Eurostat-OECD PPPs, which is based on the ICP (International Comparison Programme) coordinated jointly by the World Bank, OECD and Eurostat. The latest survey is the 10th survey for 2011, but we mainly use the 8th survey for 2005 covering 45 countries. At the most detailed level, the 8th survey includes price data for 226 products which are called "basic headings". We use the detailed data provided by the OECD Statistics Directorate. The survey observes PPPs at purchaser's prices of composite products purchased by households or used as investment. As shown in Table 1, 123 price data for households and 24 price data for investment were used to correspond to $\mathbf{P}_{J/U,i}^{pc,H}$ and $\mathbf{P}_{J/U,i}^{pc,F}$, respectively.[14]

For intermediate products, the METI's *Survey on Disparities between Domestic and Foreign Prices of Industrial Intermediate Inputs* is the main data source. This survey has been conducted every year since 1993. The 2005 survey, collecting the price data of 193 goods and 56 services for intermediate uses, covered 6 countries namely, Japan, the U.S., China, Germany, Korea, and Taiwan. Data in this survey is measured in the purchaser's price PPPs. As seen in Table 1, 249 data are collected from this survey and used to estimate $\mathbf{P}_{J/U,i}^{pc,N}$, in our framework.[15]

Although these two surveys don't cover all the products, there are rich data on international price differentials based on the surveys implemented by a number of Japanese ministries. We use *Survey of PPPs on Consumer Goods and Services* (METI, 2002), *Survey of PPPs on Drugs and Medical Products* (Ministry of Health, Labour and Welfare, 2003), *Survey of Retail Prices of Food Products in Tokyo and Foreign Major 6 Cities* (Ministry of Agriculture, Forestry and Fisheries, 2006), and so on.[16] From these surveys, 14 price data for intermediate use and 33 price data for household use are used to estimate $\mathbf{P}_{J/U,i}^{pc,N}$ and $\mathbf{P}_{J/U,i}^{pc,H}$ respectively.[17]

In addition, other surveys on unit prices are used in this study. For example, the output prices of some agricultural products evaluated at the producer's price are directly observed from *Table on Value and Quantity* (*Butsuryo Hyo*) which was compiled as a supplementary table of the Japanese IOT and *Rice Outlook*, *Oil Crops Outlook,* or *Sugar and Sweeteners Outlook* published by the U.S. Department of Agriculture. The output prices for cattle, poultry and hog in Japan and the U.S. are directly obtained from the statistical data on livestock and its products published by the ALIC (Agriculture and Livestock Industries Corporation, Japan). The output prices of coal, crude oil, and natural gas are obtained from *Trends of the Japanese Mining Industry* published by METI and *Annual Energy Review* published by the U.S. Energy Information Administration. As the result, 20 price data are used to determine $\mathbf{P}_{J/U,i}^{d}$. Moreover, there are some other surveys on unit prices observing demand prices evaluated at purchaser's price are used and 15 price data for intermediate use and 7 data for household use are used as, $\mathbf{P}_{J/U,i}^{pc,N}$ and $\mathbf{P}_{J/U,i}^{pc,H}$, respectively.

The cost index approach is also adopted for some products, whose prices are difficult to directly observe. In the cost index approach, the producer-price PLIs of domestic products are estimated by the PLIs of all intermediate products we estimated in this paper and the estimates of the PLIs for labor and capital inputs estimated in Jorgenson, Nomura, and Samuels (2015), using the weights of the cost structures obtained from the Japan-US IOT. For some products whose data

[14] In Table 1, the purchaser's demand price for intermediate uses $\mathbf{P}_{J/U,i}^{pc,N}$ and for investments $\mathbf{P}_{J/U,i}^{pc,F}$ are distinguished. Both of them are treated as $\mathbf{P}_{J/U,i}^{pc,I}$ in the price framework explained in Section 2.

[15] The PPPs for 179 goods and 56 services were obtained from the 2005 survey, and the PPPs for 12 goods and 2 services are used from the surveys in other years. These PPPs in other years are converted to the 2005 PPPs using the Japanese PPI (CGPI for goods and CSPI for service by the Bank of Japan) and the U.S. PPI (by the BLS).

[16] In addition, *Survey of PPPs on Transportation and Related Services* (Ministry of Land, Infrastructure and Transport, 2005), *Survey of PPPs on Residential Buildings and Infrastructure* (MLIT, 2003), *Survey of PPPs on Wood Products* (Forest Agency, 1995), *Survey of PPP on Information Services* (Ministry for Internal Affairs and Communications, 2005), *Survey of PPP on Telecommunication Services* (Ministry for Internal Affairs and Communications, 2005), *Survey of PPPs on Major Consumer Goods and Services* (Cabinet Office, 2001), and *Survey of PPPs on Consumer Durables by Functional Attributes* (METI, 2002) are used in our study.

[17] These data are estimated for different years and different stages of demand. The differences in timing of the surveys were adjusted using the CPI and PPI (CGPI and CSPI by the Bank of Japan) in both countries. We have reconciled these data within our price model.

are not available, we apply the reference PPP approach, in which the PPPs of the similar products are applied. In this study, the cost index approach is applied for 10 elementary level products such as government service, education, and research (without giving consideration to TFP gaps between Japan and the U.S.), and the reference PPP approach is applied for 12 elementary level products.

3.2 Product Level Purchasing Power Parities and Price Model

As shown in Table 1, many of obtained price data are based on the purchaser's demand prices. Therefore, $\mathbf{P}_{J/U,i}^{d}$ is estimated in this study using $\mathbf{P}_{J/U,i}^{pc,I}$ and/or $\mathbf{P}_{J/U,i}^{pc,H}$ for many products, based on the types of estimation process defined in Figure 3. Table 2 presents the number of products corresponding to the types of estimation process we applied. Each row shows the Central Product Classification Ver.2, and the number in the column of "Total" equals the number of products classified in each group (the total is the number of all products, 174).

Table 2: Number of Products by Types of Estimation Scenarios

	Type 1	Type 2	Type 3	Type 4				
	Producer's price	Purchaser's price						
		Household &Industry use	Household use	Industry use	(Type 4.1) Intermediate uses&Investment	(Type 4.2) Intermediate uses	(Type 4.3) Investment	**Total**
CPC code	$\mathbf{P}_{J/U,i}^{d}$	$\mathbf{P}_{J/U,i}^{pc,H}$& $\mathbf{P}_{J/U,i}^{pc,I}$	$\mathbf{P}_{J/U,i}^{pc,H}$	$\mathbf{P}_{J/U,i}^{pc,I}$	$\mathbf{P}_{J/U,i}^{pc,N}$ & $\mathbf{P}_{J/U,i}^{pc,F}$	$\mathbf{P}_{J/U,i}^{pc,N}$	$\mathbf{P}_{J/U,i}^{pc,F}$	
0 Agriculture, forestry and fishery	8		4					**12**
1 Ores and minerals; electricity, gas and water	5	1		3		3		**9**
2 Food, beverages and tobacco; textiles, apparel and leather	1	3	20	1		1		**25**
3 Other transportable goods, except metal products, machinery, equipment	4	8	8	14		14		**34**
4 Metal products, machinery and equipment	1	6	10	28	5	16	7	**45**
5 Constructions and construction services			1	3			3	**4**
6 Trade; accommodation, food and beverage serving; transport	2	8	3	1		1		**14**
7 Financial and related services; real estate; rental and leasing services	1	3	2	1		1		**7**
8 Business and production services	3	4	3	1		1		**11**
9 Community, social and personal services	2	2	6	3		3		**13**
Total	**27**	**35**	**57**	**55**	**5**	**40**	**10**	**174**

According to Table 2, Type-1, which observes $\mathbf{P}_{J/U,i}^{d}$ firstly, was applied for 27 products, which were mainly classified in Agriculture and Mining sector. Since the estimation of $\mathbf{P}_{J/U,i}^{d}$ is the target of this study, Type-1 is the most preferable case. On the one hand, the PLIs for 35 products are estimated by Type-2 process, in which $\mathbf{P}_{J/U,i}^{pc,I}$ and $\mathbf{P}_{J/U,i}^{pc,H}$ are observed first. This type can be considered as the second best type. Type-3 determines $\mathbf{P}_{J/U,i}^{pc,H}$ first. 57 products, most of which are final consumption goods and services, are estimated by this method. This is the most frequent case among our four scenarios. Although Type-4, which first observes $\mathbf{P}_{J/U,i}^{pc,I}$, is similar to Type-3, this is divided into three sub-types depending on the kinds of the observed PLIs. In the first case, written as Type-4.1 in , the PLI of purchaser's demand price for industries $\mathbf{P}_{J/U,i}^{pc,I}$ is determined as using both the PLI of the products for intermediate use and investment, $\mathbf{P}_{J/U,i}^{pc,N}$ and

$\mathbf{P}_{J/U,i}^{pc,F}$, respectively. Type-4.1 is applied only to 5 products classified in Metal products, machinery, and equipment. Type-4.2 uses $\mathbf{P}_{J/U,i}^{pc,N}$ to determine $\mathbf{P}_{J/U,i}^{pc,I}$ and 40 products belong to this case. The PLIs of only 10 products are estimated by Type-4.3, which uses only $\mathbf{P}_{J/U,i}^{pc,F}$ to determine $\mathbf{P}_{J/U,i}^{pc,I}$.

4 Trade Margin

4.1 Issues

In this section, we examine the details on trade margins. Determining the trade margins are one of the most important topics in the PLI estimation due to its larger volume and potential impacts to the estimates of the producer-price PLIs for all kind of goods, except in the process of the type-1. We discuss some issues on the estimates of wholesale and retail margins in Japan.

In our previous study Nomura and Miyagawa (1999), the margin rates were obtained from the benchmark SUT/IOTs for Japan and the U.S.; i.e. the Japan's 1990 Benchmark IOT and the U.S. 1987 Benchmark SUT. As with that case, we firstly applied the margin rates obtained from the Japan's 2005 Benchmark IOT and the U.S. 2002 Benchmark SUT for our estimation of PLIs.

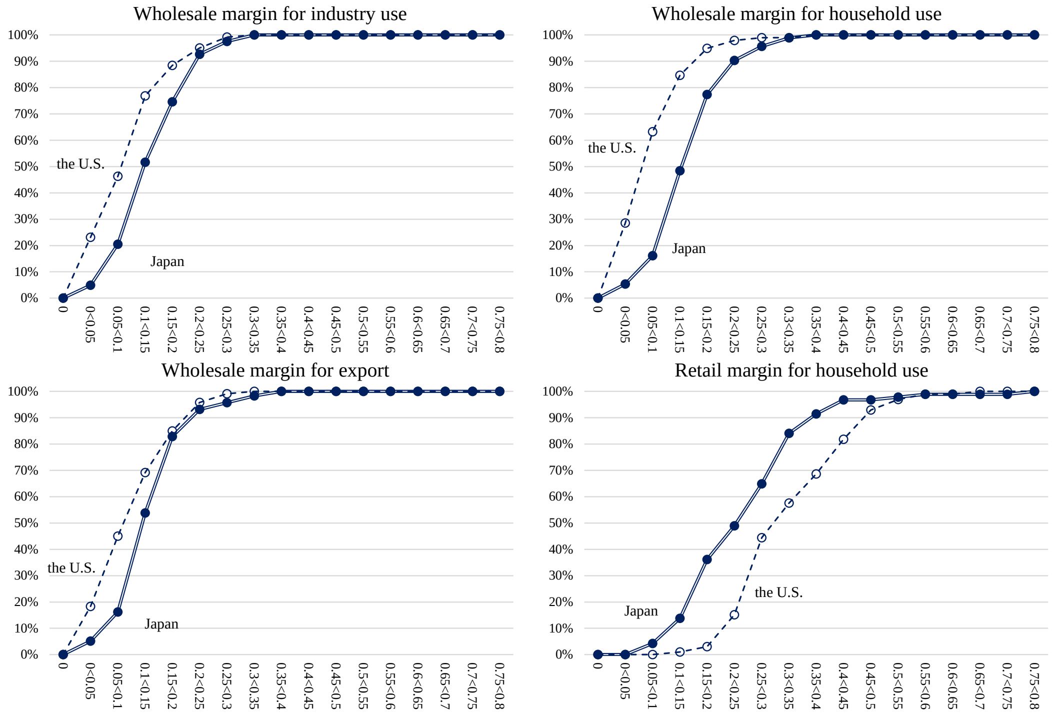

Figure 4: Japan-US Cumulative Histogram of Margin Rate (1: Japan IOT Case)

Figure 4 shows the cumulative histograms of margin rates (three wholesale margins for industry use, household use, and export and one retail margin) between Japan for 2005 and the U.S. for 2002. According to Figure 4, the U.S. wholesale margin rates are distributed more in lower rates compared to those in Japan, for all kinds of wholesale margins. In the retail margins, however, Japanese rates are distributed more in lower rates compared to the U.S. Our motivation is to check the accuracy of the lower rates of retail margins in Japan.

We start to examine the data source of the margin rates in the 2005 Japanese IOT. The *2002 Census of Commerce* (COC) by METI, is used as the major source to compile the wholesale and retail margins.[18] In the COC, although data of sales by product are collected from all establishments, data of purchases is collected only by corporation, which may consists of some establishments.[19] Due to this data constraint, the wholesale and retail margins by product in the Japanese IOT are estimated based on a simplified assumption that the margin rates for all products sold by one corporation are the same. Thus the margin rates by products are measured as the weighted average using the sales matrix of products by corporation. Moreover, the 2005 margin rate in the Japanese IOT is estimated by multiplying the change in the rate of margin from 2002 to 2005 obtained from the *Financial Statements Statistics of Corporations by Industry* (FSSCI) (see footnote 18). However, since the FSSCI collects the margin rates of only two sectors, wholesale and retail, these rates observed at the aggregate level are applied to extrapolate all kinds of the margin rates.[20] These can generate a large bias in the estimates of the margin rates by product in 2005.

Another problem is consideration of the quality difference of trade. For example, the quality of the wholesale service for imported products can differ from that of domestic products. The quality of electronic commerce may be different from that of the ordinary trade. The Japanese IOT assumes that the margin rates of imported and domestic products are identical and it doesn't consider the difference between the electronic and ordinary commerce. These differences in quality of trade are directly taken into consideration in our study.[21] To check the accuracy and to control these quality differences in measurement of margins, we estimate the margin rates by product using establishment-level data of the *2002 and 2007 COC*.

4.2 Estimation of Margin Rates

The estimated equations are formulated as:

$$(36) \quad m_j^h = \alpha^h + \beta^h \cdot EC_j^h + \sum_{k \in IND} \gamma_k^h \cdot D_{kj}^h \cdot IM_j^h + \sum_{k \in IND} \delta_k^h \cdot D_{kj}^h \cdot EX_j^h + \sum_{i \in PROD} \mu_i^h \cdot S_{ij}^h + \varepsilon_j^h,$$

$$(37) \quad m_j^r = \alpha^r + \beta^r \cdot EC_j^r + \sum_{k \in IND} \gamma_k^r \cdot D_{kj}^r \cdot IM_j^r + \sum_{i \in PROD} \mu_i^r \cdot S_{ij}^r + \varepsilon_j^r.$$

Equations (36) and (37) are the formulae for the wholesale and the retail establishments, respectively. And, m_j^x represents the margin rate of establishment j. If x=h, the establishment is

[18] Since this census was not conducted in 2005, the estimates for 2005 are estimated based on the 2002 estimates. The basic process of compilation is as follows: 1) The sales by sector are obtained from the *2002 COC*,;2) The sales of year 2005 are estimated by multiplying the sales of year 2002 by the change in sales from 2002 to 2005 obtained from the *Current Survey of Commerce*; 3) The margin rates of corporations by industry are calculated based on the *2002 COC* (the COC does not collect the values of purchase for the unincorporated); 4) The margin rate of year 2005 is estimated by multiplying the margin rate of year 2002 by the change in the rate of margin value from 2002 to 2005 obtained from the *Financial Statements Statistics of Corporations by Industry* (FSSCI) published by Ministry of Finance; 5) The provisional amount of margin by industry is estimated by multiplying the sales calculated in Step 2 by the rate of margin calculated in Step 4; and finally 6) By some adjustments, the final estimates of margins are determined.

[19] In the 2002 COC, 100 products are included in the wholesale and 91 products are included in the retail.

[20] In the 2002 COC, the wholesale consists of 78 industries and the retail consists of 72 industries.

[21] There are many other factors which generate the quality difference in trades: e.g., opening hours of shop, floor space, attitude of clerks, facilities of establishments, location of establishments, and so on. These factors are not controlled in our current estimation model and some are to be treated in our future research.

classified in the wholesale. If x=r, the establishment is classified in the retail. EC_j^x is the ratio of electronic commerce to total sales of establishment j. D_{kj}^x, is industry dummy variables. When the establishment j is classified in industry k, $D_{kj}^x = 1$, and when it isn't, $D_{kj}^x = 0$. IM_j^x and EX_j^x represent the ratios of import and export, respectively, to total sales. Since there are few exporting retailers, the term of EX_j^r is eliminated in Equation (37). S_{ij}^x is the ratio of sales of product i in the total sales of establishment j. Finally, ε_j^x is the error terms.

In Equations (36) and (37), α^x, β^x, γ_k^x, δ_k^x, and μ_i^x are the parameters to be estimated. β^x stands for the difference in margin rates between electronic commerce and ordinary trade. γ_k^x stands for the difference in margin rates between imported and domestic goods in industry k. Similarly, δ_k^x means the difference in margin rates between exported and domestic goods in industry k. The sum, $(\alpha^x + \mu_i^x)$, is the estimated margin rate of product i.[22] Since COC collects data of purchases only from each establishment, the margin rate of each product cannot be directly observed and thus the margin rates by product are estimated using equations presented. The weighted least squares, whose weights are defined as the square root of establishment's sales, are applied for estimation.[23]

Figure 5 compares our estimates and the margin rates in the official Japanese IOT. As a result of our estimation, the margin rates by product change considerably, compared to our previous study. Especially in case of the retail margin for households, our estimates of retail margin rates for many products were higher than those in the IOT. In contrast, in the case of wholesale margin for exports, our estimates are lower than those in the IOT for many products. As for individual products, the retail margin rates of foods, drinks, and agricultural products such as 29.Tea and coffee, 8.Poultry and egg production, 18.Meat and meat products, 19.Dairy products, 3.Fruits, 20.Seafood products, 21.Grain milling, and 30.Soft drinks were below 20 percent in the IOT. Our estimates, however, suggest they are underestimated. The estimated rates for these products were increased by 5 to 20 percentage points and these revisions seem reasonable. On the other hand, the wholesale margin rate for industry in 107.Motor vehicles exceeded 20 percent in the IOT. Based on our estimates, this wholesale margin rate is revised to 15 percent. The upward bias of five percentage point as the difference generates a sizeable overestimation of one trillion yen in purchaser's prices of motor vehicle.

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[22] Since $\sum_i S_{ij}^x = 1$ for all establishments, one product of S_{ij}^x is removed from the equations when the equations are estimated. Therefore, μ_i^x measures the difference of margin rate between the removed product and product i and α^x estimates the margin rate of the removed product.

[23] We estimated Equations (36) and (37) using the data of two surveys, the 2002 and 2007 COC. The margin rates by product in 2005 are the results provided by a simple linear interpolation of the estimates in 2002 and 2007.

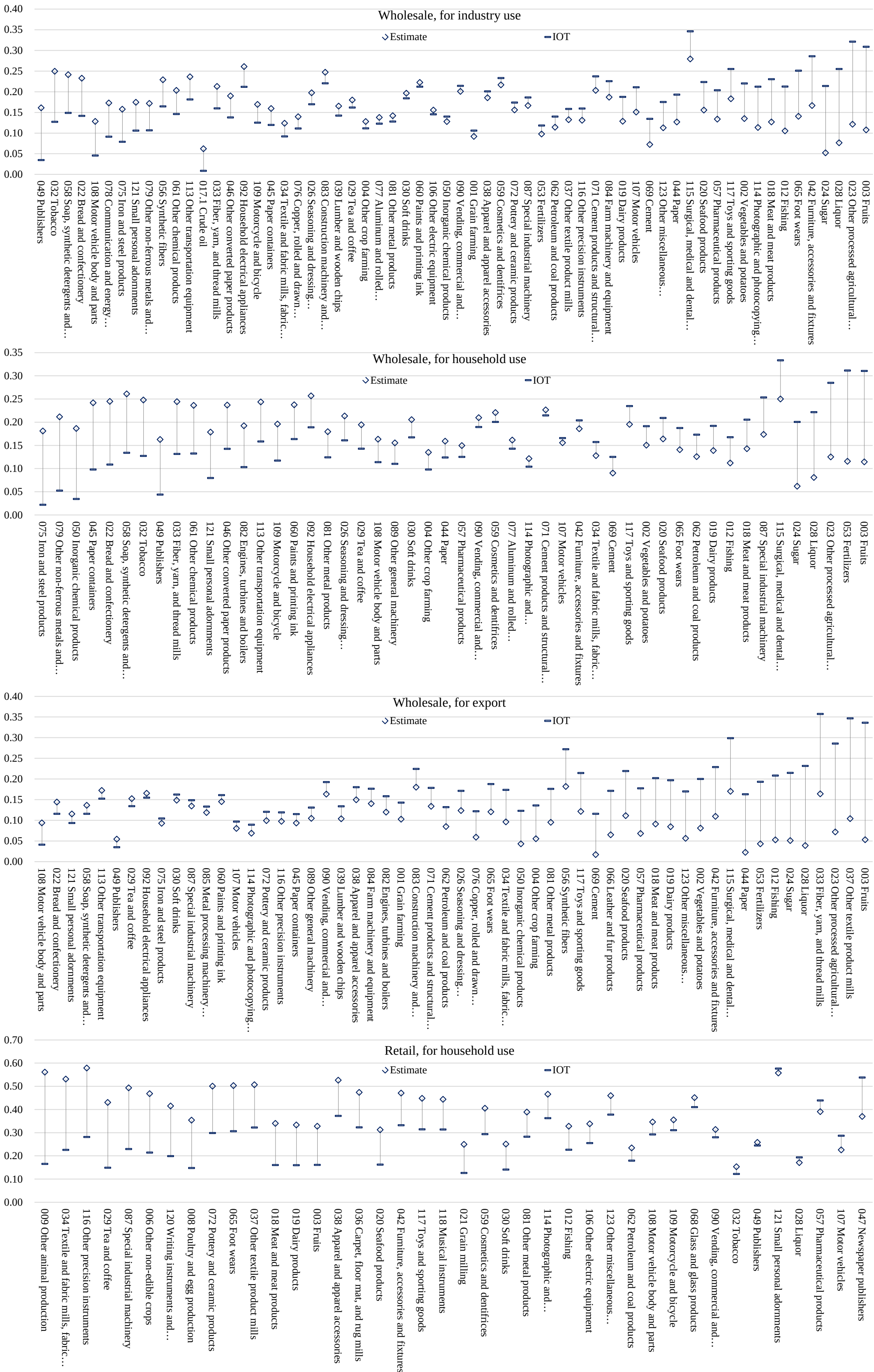

Figure 5: Estimated Margin Rates in Comparison with the Official Estimates

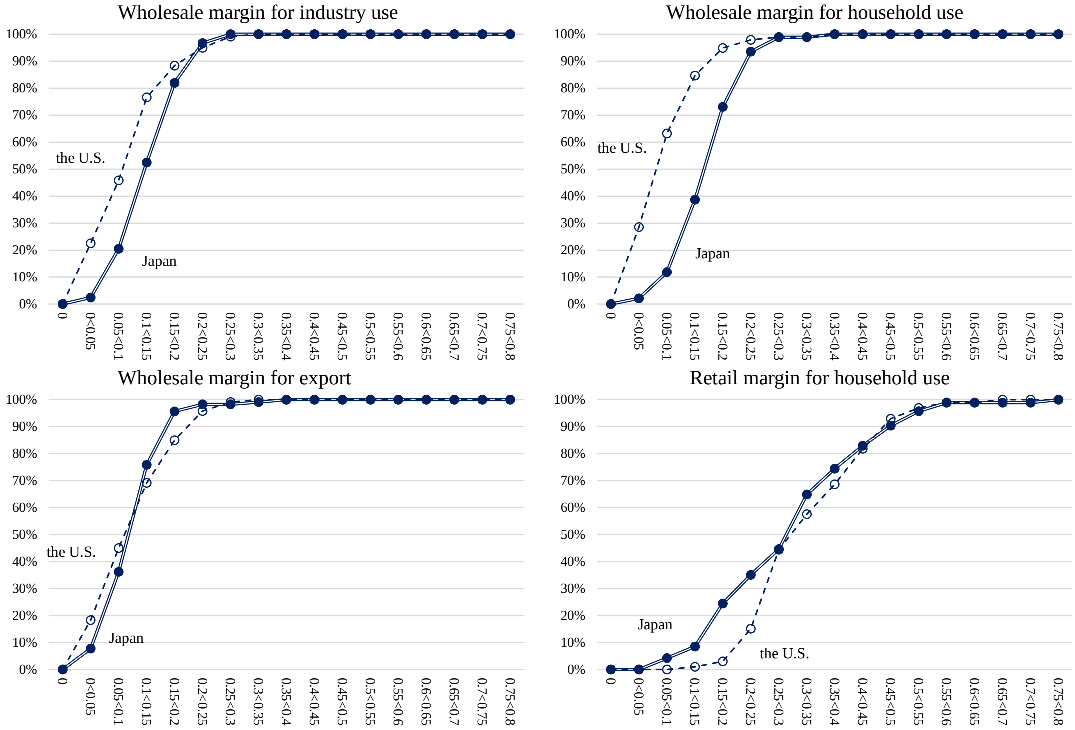

Figure 6: Japan-US Cumulative Histogram of Margin Rate (2:Our Revised Estimates)

Figure 6 shows the cumulative histogram of margin rates by product estimated using the COC. Compared to Figure 4, the histograms of the wholesale margin for export and the retail margin for household in Japan are approaching to those in the U.S. in Figure 6. On the other hand, the histograms in the wholesale margins for industry and household uses in Figure 6 are almost the same as Figure 4. We applied these results to calculate the PLIs.

As shown in Equations (36) and (37), the margin rates for imported and domestic products are distinguished for Japan in our estimation model. However, they are not separated in the U.S. SUT. In this study, the Japanese parameter, $\hat{\gamma}_i^x$, which are estimated above and represent the difference of margin rates between imported and domestic products, are assumptively applied for the U.S. case. Figure 7 compares the estimated margin rates between Japan and the U.S., for domestic products. Japan's margin rates are higher in two-thirds of the domestic products than those in the U.S.

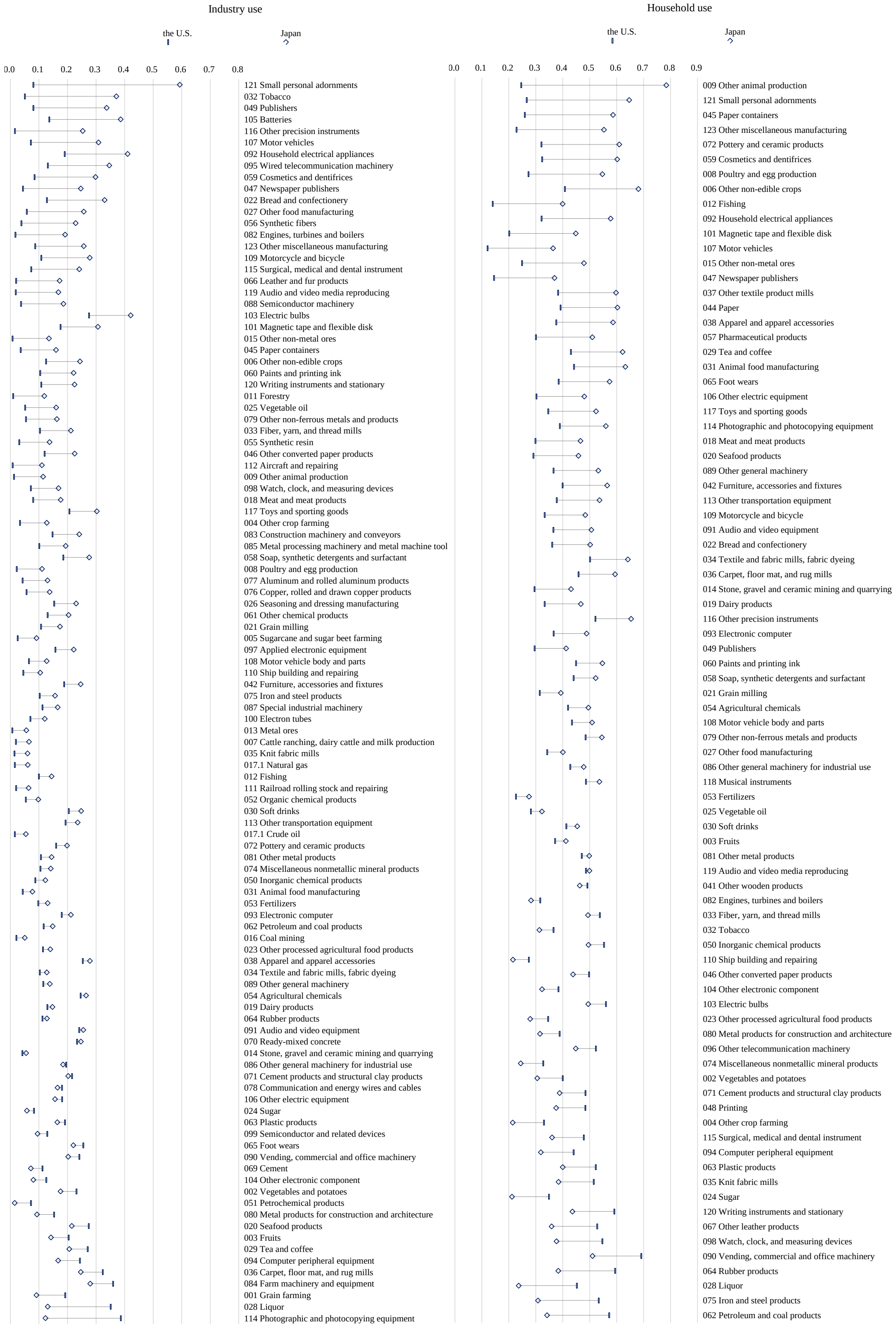

Figure 7: Japan-US Differentials in Margin Rates for Domestic Products

4.3 Price Level Indices for Wholesale and Retail Trades

The PLIs of wholesale and retail trades are measured based on some assumptions. The parameters $(\alpha^h + \mu_i^h)$ and $(\alpha^r + \mu_i^r)$ in Equations (36) and (37) mean the margin rates of ordinary trade of product *i* of domestically produced and consumed in Japan. We define the margin rates in Japan as:

(38) $m_{J,i}^{x,d,l*} = \hat{\alpha}^x + \hat{\mu}_i^x \quad (l = I, H, x = h, r),$

where $\hat{\alpha}^x$ and $\hat{\mu}_i^x$ are the parameters estimated in Equations (36) and (37). Although the similar kinds of estimated margin rates for the U.S. are required, the *U.S. Economic Census*, *Annual Retail Trade Survey*, or *Annual Wholesale Trade Survey* publishes the margin rates in which many types of transactions are included. Therefore, in this study, the estimated parameters for Japan are applied to estimate the adjusted margin rates in the U.S.

The relationship between the adjusted margin rate $m_{U,i}^{x,d,l*}$ and the actual margin rate $m_{U,i}^{x,d,l}$ for the U.S. domestic transactions is described as:

(39) $m_{U,i}^{x,d,l*} = m_{U,i}^{x,d,l} - \hat{\beta}^x \cdot EC_i^x \quad (l = I, H, x = h, r),$

where $\hat{\beta}^x$ is a parameter estimated in Equations (36) and (37) and EC_i^x shows the ratio of the electric commerce to total sales of product *i* in the U.S. Using $m_{J,i}^{x,d,l*}$ and $m_{U,i}^{x,d,l*}$, the PLIs of retail and wholesale trades are derived. The relative measure of the margin rates between Japan and the U.S. are described by definition as:

(40) $m_{J,i}^{x,d,l*}/m_{U,i}^{x,d,l*} = \left(p_{J,x}^{d,l,i} W_{J,i}^{x,d,l} / p_{J,i}^{pd,l}\right) / \left(p_{U,x}^{d,l,i} W_{U,i}^{x,d,l} / p_{U,i}^{pd,l}\right) \quad (l = I, H \text{ and } x = h, r).$

$W_{J,i}^{x,d,l}$ and $W_{U,i}^{x,d,l}$ are the volumes of trades required for one unit of product *i*, and $p_{J,x}^{d,l,i}$ and $p_{U,x}^{d,l,i}$ are the corresponding prices, in Japan and the U.S., respectively. We assume the volume of trade required for one unit of product *i*,

(41) $W_{k,i}^{x,d,l} = \sigma_i^x \left(p_{k,i}^{pd,l} / p_{k,i}^{d,l}\right)^{\theta_{k,i}^x} \quad \left(\sigma_i^x > 0,\ 0 \le \theta_{k,i}^x \le 1\right) \quad (k = J, U,\ l = I, H, \text{ and } x = h, r).$

Equation (41) indicates that the trade service is decomposed into two parts: first is the volume-term σ_i^x and the second is the quality-term. We assume the volume-term is the same for Japan and the U.S. by product. In the quality-term, θ_i^x is the parameter expressing how consumers evaluate the price difference between the purchaser's and producer's prices as the quality difference in trade by product. For example, wholesalers and retailers need to control the temperature and humidity of trading vegetables for keeping their freshness and to sell them under the clean condition. Thus the price difference between the purchase's price and producer's price, $\ln\left(p_{k,i}^{pd,l}/p_{k,i}^{d,l}\right)$, is larger than zero. If consumers fully evaluate this price difference as the quality difference in trade ($\theta_{k,i}^x$ is close to one), the difference, $p_{k,i}^{pd,l}/p_{k,i}^{d,l}$, should be counted as the difference in volume of trade, rather than the difference in price of trade. If consumers do not care freshness and cleanness so much ($\theta_{k,i}^x$ is close to zero), the difference, $p_{k,i}^{pd,l}/p_{k,i}^{d,l}$, should be counted as the difference in price of trade, rather than the difference in volume of trade. Thus the parameter $\theta_{k,i}^x$ is determined depending on the product and country.

By Equations (40) and (41), the PLIs of the wholesale and retail trades for product *i* can be formulated as,

(42) $\mathbf{P}_{J/U,x}^{d,l,i} = \left(\mathbf{P}_{J/U,i}^{pd,l}\right)^{1-\theta_{k,i}^{x}} \left(\mathbf{P}_{J/U,i}^{d,l}\right)^{\theta_{k,i}^{x}} \left(m_{J,i}^{x,d,l*} / m_{U,i}^{x,d,l*}\right) \quad (l = I, H, x = h, r)$,

where $\mathbf{P}_{J/U,i}^{pd,l}$ and $\mathbf{P}_{J/U,i}^{d,l}$ are the purchaser-price PLI and the producer-price PLI of domestic output of product *i*. In this study, as a first approximation, we assumed that $\theta_{k,i}^{x}$ is 0.5 for all products in both of Japan and the U.S. The PLIs on the right-hand side, $\mathbf{P}_{J/U,i}^{pd,l}$ and $\mathbf{P}_{J/U,i}^{d,l}$, are measured from our price model described in Section 2. The margin rates, $m_{J,i}^{x,d,l*}$ and $m_{U,i}^{x,d,l*}$, are calculated in Equations (38) and (39). As a result, the PLIs of the wholesale and retail trades for product *i* are estimated. Moreover, the PLI of retail trade $\mathbf{P}_{J/U,h}^{d}$ and wholesale trade $\mathbf{P}_{J/U,r}^{d}$ are aggregated by the weighted average of $\mathbf{P}_{J/U,h}^{d,l,i}$ and $\mathbf{P}_{J/U,r}^{d,l,i}$, respectively, whose weights are the current value of the respective margins of each product. Our estimates of $\mathbf{P}_{J/U,h}^{d}$ and $\mathbf{P}_{J/U,r}^{d}$ are 1.56 and 1.62, respectively.

5 Results

5.1 Price Level Indices by Product

Table 3 presents the estimated results of the representative measures of PLIs by the broad product groups based on the ISIC sections and divisions.[24] The first four columns present the price differentials in domestic outputs (the PLI excluding net indirect taxes, including taxes, for industry use, and for household use) and the next four columns show the PLIs for the composite of domestic and imported products (two PLIs at the producer's prices and two at the purchaser's prices). And the last two columns indicate the price differentials between Japan and the U.S. in their imports.[25] These PLI measures are consistently linked one another based on our price model, described in Section 2.

Our estimates show there are large differences among the PLI estimates based on the different concepts. For example, Japan's import prices of 29.Motor vehicles and trailers are higher than those in the U.S. (by 27.7 percent for industry use and by 10.4 percent for household use). However, the purchaser-price PLIs, which cover domestic products and imports, are almost equivalent (12.8 percent lower for industry use and 1.3 percent lower for household use in Japan than the US). When the impact of the differences in their margin rates from the purchaser-price PLIs is excluded, Japan's producer-price PLIs of the composite products are lower than the U.S. prices (by 21.1 percent for industry use and by 23.5 percent for household use). Especially, Japan's producer-price PLIs of the domestic products are considerably lower than those in the U.S. (by 24.3 percent for industry use and by 30.2 percent for household use). Furthermore, when we focus on the price differential in domestic product (excluding net indirect taxes), output price of Japan's motor vehicles and trailers is 25.9 percent lower than the U.S. counterpart. This result shows a strong price competitiveness of Japan's producers of motor vehicles and trailers.

[24] In some products of our 174 classification, the unpublished data at the most detailed level (basic headings) of the Eurostat-OECD PPPs are directly used as $\mathbf{P}_{UJ,i}^{pc,H}$. Since they are not in the public domain, we use 42 types of the broad product group for describing the demand-side PLIs.

[25] The differences in the quality of products imported by Japan and the U.S. may be somewhat reflected in the price differentials of imports from exogenous countries, although they should be counted in the volume differentials.

In contrast, although the PLI of imports of agriculture, forestry and fishing are about 30 percent higher in Japan, the PLI of domestic outputs are 2.2 times higher in Japan compared to the U.S. counterpart. This result shows Japanese producers are considerably inferior to the U.S. producers in price competitiveness of agricultural products. As such, in order to compare the price competitiveness by industry, these cases show that it is indispensable to estimate the differentials in output prices, which can considerably differ from the purchaser-price PLIs of composite products that are observed more easily.

Table 3: Estimated Results of Japan-US PLIs in 2005

	Domestic outputs				Composite products				Imports	
	$\mathbf{P}^{d*}_{J/U,i}$	$\mathbf{P}^{d}_{J/U,i}$	$\mathbf{P}^{d,I}_{J/U,i}$	$\mathbf{P}^{d,H}_{J/U,i}$	$\mathbf{P}^{c,I}_{J/U,i}$	$\mathbf{P}^{c,H}_{J/U,i}$	$\mathbf{P}^{pc,I,}_{J/U,i}$	$\mathbf{P}^{pc,H}_{J/U,i}$	$\mathbf{P}^{m,I}_{J/U,i}$	$\mathbf{P}^{m,H}_{J/U,i}$
A - Agriculture, forestry and fishing	2.189	2.254	2.594	1.504	2.192	1.505	2.201	1.786	1.259	1.299
B - Mining and quarrying	1.359	1.365	1.351	2.422	1.115	2.407	1.103	1.786	1.045	2.064
C - Manufacture	.949	.979	.972	1.262	.966	1.215	1.016	1.403	.950	1.033
10 - Food products	1.785	1.843	1.911	1.929	1.737	1.861	1.954	2.280	1.601	1.574
11 - Beverages	1.609	1.932	1.772	1.931	1.787	1.937	1.725	1.938	1.844	1.854
12 - Tobacco products	.266	.489	.467	.490	.515	.552	.763	.550	2.992	3.102
13 - Textiles	.708	.716	.714	.768	.694	.721	.691	1.129	.638	.646
14 - Wearing apparel	.948	.969	.948	.995	1.046	1.067	1.096	1.678	1.098	1.103
15 - Leather and related products	1.455	1.500	1.458	1.525	1.182	1.270	1.254	1.317	1.153	1.203
16 - Wood and wood products, except furniture	.859	.859	.850	1.195	.822	.860	.854	.885	.740	.825
17 - Paper and paper products	.945	.949	1.010	.566	1.032	.585	1.114	.727	1.185	.867
18 - Printing and reproduction of recorded media	.893	.897	.891	.961	.896	.965	.974	1.247	1.156	1.027
19 - Coke and refined petroleum products	1.124	1.478	1.149	2.553	1.158	2.547	1.163	1.581	1.206	2.384
20 - Chemicals and chemical products	1.027	1.030	1.109	.554	1.100	.593	1.167	.849	1.107	.835
21 - Pharmaceutical products	.791	.802	.898	.607	.940	.741	.916	.908	1.078	.799
22 - Rubber and plastics products	.773	.776	.749	1.269	.759	1.278	.755	1.074	.739	.692
23 - Other non-metallic mineral products	.902	.902	.907	1.189	.914	1.103	.942	1.256	.946	.997
24 - Basic metals	.801	.801	.810	.828	.840	.842	.886	.734	1.078	.906
25 - Fabricated metal products, except M&E	.914	.914	.897	1.058	.909	.939	.946	1.044	.609	.794
26 - Computer, electronic and optical products	.997	1.009	1.017	.871	1.033	.920	1.097	1.121	1.007	.744
27 - Electrical equipment	.946	.948	.968	1.159	.831	1.295	.810	1.327	.556	.815
28 - Machinery and equipment n.e.c.	1.060	1.064	1.146	1.259	1.092	1.133	1.121	1.212	.777	.610
29 - Motor vehicles and trailers	.741	.748	.757	.698	.789	.765	.872	.987	1.277	1.104
30 - Other transport equipment	1.021	1.029	1.107	.840	1.113	.837	1.137	1.124	1.101	.851
31 - Furniture	1.069	1.076	1.058	1.195	1.061	.995	1.054	1.474	1.064	1.023
32 - Other manufacturing	.714	.719	.760	.670	.783	.846	.927	1.289	.882	.905
33 - Repair and installation of machinery and equipment	1.026	1.034	1.045	1.235	1.054	1.219	1.095	1.205	1.037	1.028
D - Electricity, gas, steam and air conditioning supply	1.984	2.018	1.988	2.035	1.984	2.034	1.979	2.034	1.240	1.168
E - Water supply	1.191	1.211	1.260	1.065	1.266	1.065	1.268	1.113	.953	.901
F - Construction	1.052	1.054	1.067	.880	1.067	.880	1.067	.880	---	.754
G - Wholesale and retail trade	1.543	1.584	1.568	1.601	1.535	1.596	1.532	1.596	.796	.749
H - Transportation and storage	1.234	1.259	1.146	1.466	1.137	1.467	1.137	1.473	1.040	1.405
I - Accommodation and food service activities	1.205	1.240	1.183	1.329	1.177	1.286	1.177	1.290	.957	.989
J - Information and communication	1.051	1.063	1.040	1.135	1.039	1.136	1.066	1.197	1.045	1.150
K - Financial and insurance activities	1.142	1.140	1.029	1.348	1.025	1.348	1.029	1.348	.908	1.005
L - Real estate activities	1.730	1.745	1.738	1.745	1.738	1.745	1.738	1.745	---	---
M - Professional, scientific and technical activities	.843	.845	.827	.986	.821	.983	.819	.974	.752	.880
N - Administrative and support service activities	1.269	1.281	1.219	1.362	1.215	1.353	1.215	1.353	.855	.902
O - Public administration and defence	1.118	1.118	1.118	1.057	1.118	1.057	1.118	1.057	---	---
P - Education	1.287	1.287	1.287	1.287	1.209	1.287	1.207	1.287	.917	---
Q - Human health and social work activities	.626	.626	.627	.626	.627	.626	.628	.626	---	.548
R - Arts, entertainment and recreation	.973	1.010	.821	1.074	.819	1.071	.819	1.072	.790	.898
S - Other service activities	1.185	1.234	1.015	1.249	1.067	1.247	1.114	1.234	1.054	.921
Total	---	---	1.102	1.243	1.087	1.234	1.099	1.288	.981	1.051

Note: Industry classification is based on the ISIC Rev.4. The average exchange rate used for 2005 is 110.22 yen per dollar.

Figure 8 compares the differences in the purchaser-price PLIs for the composite of domestic and imported products between for industry and household uses, $\mathbf{P}^{pc,I}_{J/U,i}$ and $\mathbf{P}^{pc,H}_{J/U,i}$, respectively, by the product group. Although there is a positive correlation between them, the price differentials for household uses in most products (31 of 42 products) are larger than those for industry use; e.g., 13.Textiles, 14.Wearing apparel, 27.Electrical equipment, and 22.Rubber products. On the other hand, in some products like A-Agriculture, 17.Paper, 20.Chemicals, and F-Construction, the prices for industry use are higher than those for household use. If the differences in quality of the products for industry and household uses are negligible, it may indicate a possibility of inefficient transactions among industries, which may reduce the price competitiveness of industries to purchase them.

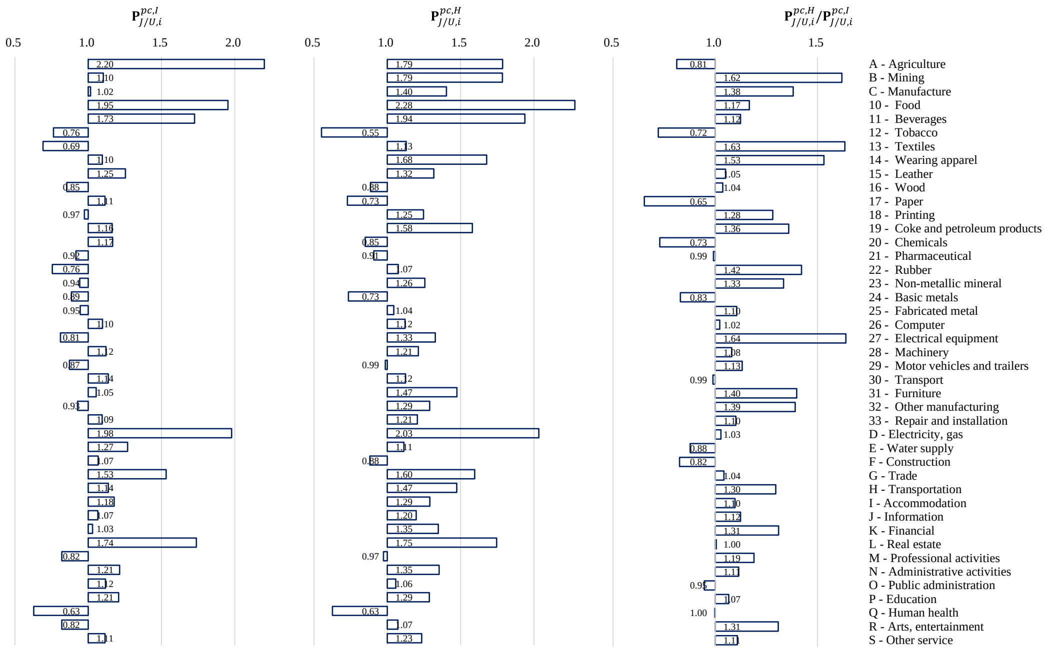

Figure 8: Purchaser-Price PLIs for Industry and Household Demands in 2005

The price competitiveness by industry is discussed in more detail in the next section. In this section we focus on the aggregate measures of PPP and PLI. Table 4 compares the aggregate PPPs between our estimates (using the translog index) and the Eurostat-OECD PPPs in 2005. Our estimate of PPP for GDP is slightly lower than the Eurostat-OECD PPP.[26] Table 4 also presents the alternative estimate of the PPP for GDP based on the trade margin rates in the 2005 Benchmark IOT in Japan, as a reference. This alternative case gives the estimate of 132.2 yen per dollar, which is slightly higher than the Eurostat-OECD PPP. Since the Eurostat-OECD PPP covers the final demands at purchaser's prices, it may include the impact of the indirect taxes on the domestic products for final uses. On the other hand, our model estimate is derived from aggregating the PPPs for industry-GDP at basic prices, excluding the impact of indirect taxes on products. Since Japan has higher rate of effective indirect taxes compared to the U.S. on average, it would be reasonable that our PPP for GDP at the production side is lower than the PPP for

[26] It is understandable that our estimate of the aggregate PPP for household consumption is almost identical to the Eurostat-OECD PPP, since we used their PPP data for many products at the elementary level.

GDP at the expenditure side in the Eurostat-OECD PPP. Thus we conclude that the alternative case overestimates the PPP for GDP at production side due to the lower estimates in retail margins in Japan's IOT.

There are some differences in the PPP for GFCF (gross fixed capital formation), of which the PPP for building and construction (B&C) is almost equivalent (115.5 yen and 119.0 yen), but for machinery and equipment (M&E) our estimate (126.1 yen) is considerably lower than the Eurostat-OECD PPP (164.0 yen). However, it may be hard to justify that the Eurostat-OECD PPP for M&E in GFCF is 15 percent higher than the PPP for household consumption, when considering our estimate of the price differential between industry and household by product, as shown in Figure 8.

Table 4: Aggregated PPPs in Comparison with Eurostat-OECD PPPs in 2005

	PPP				
	GDP	Household consumption	GFCF	B&C	M&E
Our estimates	127.10	141.93	121.13	115.49	126.09
(Alternative case)	132.21	142.53	122.44	115.48	128.56
Eurostat-OECD PPPs	129.55	142.94	136.00	119.00	164.00

Note: The average exchange rate used for 2005 is 110.22 yen per dollar. The alternative case is our estimates using the trade margin rates in the Japan's 2005 Benchmark IOT, not our revised estimates.

Figure 9 shows the extrapolated estimates of PPPs for GDP and household consumption up to 2014, using our benchmark PPP estimates in 2005 and the price indices from the national accounts in Japan (ESRI, Cabinet Office) and the U.S. (BEA) from 2005 to 2014, compared with the Eurostat-OECD estimates. The trends of both series are similar, but our estimate of the PPP for GDP is somewhat lower, reflecting the lower benchmark estimate. However, in the PPP estimate for household consumption, the order reversed and our estimate is slightly higher than the Eurostat-OECD PPP. In 2014, our estimates of PPPs for GDP and household consumption are 99.8 and 114.6 yen per dollar, respectively. The current exchange rate of 119.6 yen as of the end of February 2015 is already well above our PPP aggregates. Both producers and consumers in Japan could benefit the price advantages under the current exchange rate, which has been depreciated since December 2012 when Abenomics started.

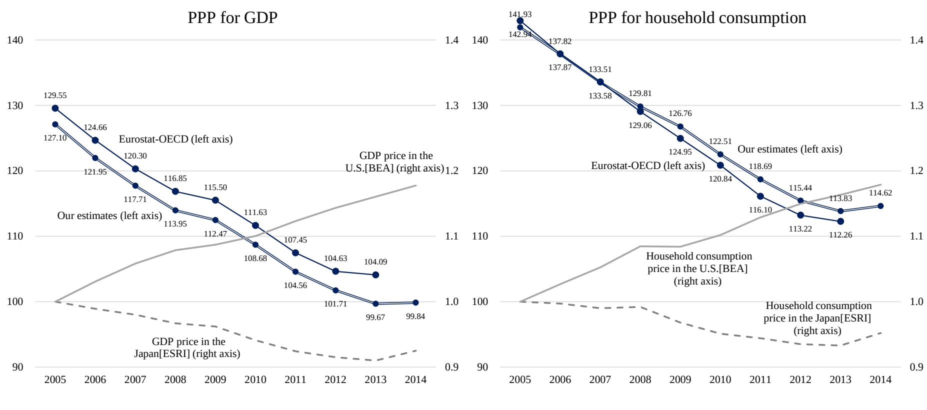

Figure 9: Extended Estimates of Aggregated PPPs until 2014

5.2 Industry Price Competitiveness

Figure 12 presents the industry PLI of domestic outputs based on 173 classifications (excluding the net indirect taxes), $\mathbf{P}_{J/U,j}^{d*}$, in 2005. There is a large diversity among the broader industry groups. Most estimates of PLIs classified in Agriculture, forestry and fishery, Mining, and Food and beverage are significantly over 1.0, with only two exceptions of 6.Other non-edible crops (0.62) and 17.Crude oil and natural gas (0.90).[27] Figure 10 illustrates the relationship between the Japan-US difference in the rate of tariff (the rate in Japan minus the rate in the U.S.) and the price gaps in domestic outputs (taking the log of PLI of outputs). The dots are plotted for the industries classified in Agriculture, forestry and fishery, Mining, and Food and beverage and the circles are used for others. Many of those industries in which the production prices in Japan are much higher than those in the U.S. are protected by the higher rates of tariff.

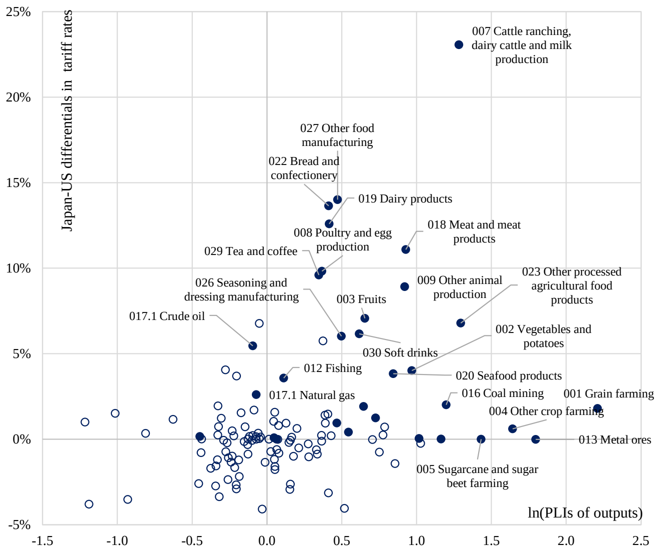

Figure 10: Price Competitiveness and Rate of Tariff and in 2005

The PLIs of outputs in 53 of 92 industries in manufacturing (except food and beverage) are below 1.0. Especially in the case of the large-scale industries whose production values in both Japan and the U.S. are over 100 billion dollars, Japan's output prices are lower in 75.Iron and steel products (0.72), 107.Motor vehicles (0.69), and 108.Motor vehicle body and parts (0.77), with a unique exception of 62.Petroleum and coal products (1.12). Figure 11 plots the export shares of domestic outputs and the price competitiveness in manufacturing. Some industries in Japan, such as 88. Semiconductor machinery, 107.Motor vehicles, and 105.Batteries, being superior in price competitiveness, succeed in increasing exports. On the other hand, 94.Computer peripheral equipment 110.Ship building and repairing, and 61.Other chemical products achieved an export promotion regardless of higher prices of their products.

[27] Japan's production of crude oil and natural gas is very small (only 0.36 percent of that in the U.S.) in 2005. Some of the products are regionally consumed at low prices.

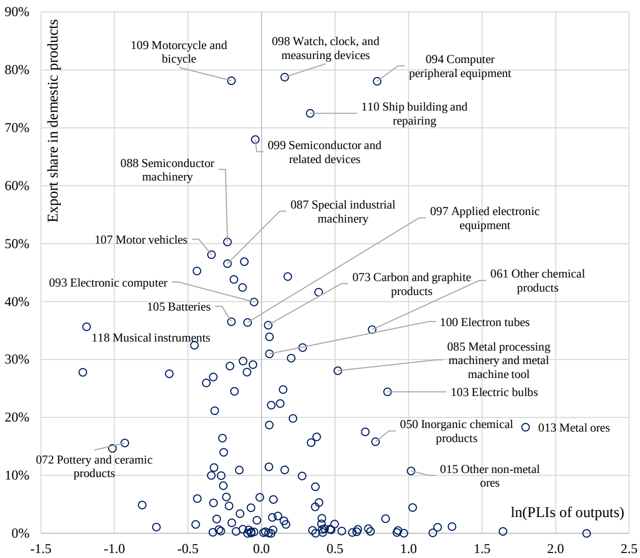

Figure 11: Price Competitiveness and Export Share in 2005

In services, Japanese industries are inferior in price competiveness in 36 of 50 industries in Figure 12, especially in 144.Warehousing and storage (3.34), 159.Motor vehicles rental and leasing (2.25), 128. Electricity (2.00), 129.Gas (1.89), 157.Internet service providers and related services (1.64), and 146.Postal service (1.44). However there are some service industries, in which Japan is much superior in price competitiveness compared to the U.S., like 152.Medical and health service (0.63) and 153.Veterinary service (0.65), mainly reflecting lower PLI for labor inputs in Japan relative to the U.S.[28]

Table 5 presents the Price Competitiveness Map of Japan in 2005, which describes the output price gaps (defined by the log of industry PLIs of outputs excluding net indirect taxes, $\mathbf{P}_{J/U,j}^{d*}$) and the contributions by the price gaps in the products for intermediate uses (defined by the nominal share of inputs times the log of purchaser-price PLIs of composite goods, $\mathbf{P}_{J/U,i}^{pc,I}$). The industries are arranged in rows and the products for intermediate uses in columns. The white bars indicate that the Japanese prices are higher than the corresponding U.S. prices and the gray bars indicate the opposite cases.

As aforementioned, Japan’s agriculture, food and beverage industries have inferior price competitiveness to their U.S. counterparts. An interesting property that Table 5 illuminates is that the intermediate inputs purchased by those industries tend to be also higher than those in the U.S. Although this is a property emerged from the aggregation process of the 174 products, this may reflect some inefficiencies down the supply chain, regardless of alternative opportunities to purchase the products with lower prices. In contrast, industries like 29.Motor vehicles and trailers, 24.Basic metals, and 13.Textile industries seem to sustain efficient transactions with their

[28] Another source is the TFP gap. Jorgenson, Nomura, and Samuels (2015) indicates that the Medical Care’s TFP levels were almost the same between Japan and the U.S. in the 1950s and the 1960s. Since the mid-1970s the TFP gap has widened substantially, mainly due to a steady decline in TFP in the U.S. industry and a stable TFP level in Japan. A gap of more than 50 percent has opened up since the end of 1990s.

counterparts to provide intermediate products. In 29.Motor vehicles and trailers industry, the lower costs of the products for intermediate uses improve its price competitiveness by 12.2 percent.

The 10.Food products industry is considerably inferior to the U.S. counterpart, with Japan's output price 55.8 percent higher. However, more than half of this inferior competitiveness is originated in the higher costs of agricultural products for intermediate uses (by 32.8 percent to increase the output prices). Decreasing tariffs on agricultural imports may considerably restore the price competitiveness of 10.Food products industry.

Although the products for intermediate uses by G-Wholesale and retail trade and D-Electricity are not the main sources of their inferior price competitiveness, higher costs of the products for intermediate uses of trade, electricity, and other energies in Japan have considerable and wider impacts on the price competitiveness in all industries. The higher costs of trade (54.3 percent higher) and electricity (2.0 times higher) in Japan contribute to pushing the output prices in C-Manufacturing sector higher than the U.S. by 2.8 percent and 1.1 percent, respectively. By these estimates, if the price competitiveness in these sectors could be improved to the U.S. level, it would foster price competitiveness in C-Manufacturing and I-Accommodation and food service activities by 3.9 percent and 6.2 percent, respectively.

6 Conclusion

We provided the new benchmark estimates of Japan-US industry-level price differentials for the year 2005, based on our price model describing the relationships among the different concepts of price level indices. The volume comparisons among countries are a challenging task, but it is an indispensable process for evaluating the price competitiveness and the efficiencies in country's production system relative to other countries. Compared to the U.S. as the reference country, our estimates illuminate the industry/product sources and the impacts of the weaknesses in Japan's industry competitiveness, highlighting potential areas for policy considerations.

The estimates of the Japan-US price level indices in this paper enable us to illuminate the sources of price competitiveness though the inter-industry transactions. Higher costs of the products for intermediate uses like trade, electricity, and other energies in Japan have considerable and wider impacts on the price competitiveness in all industries. The higher costs of trade (54.3 percent higher) and electricity (2.0 times higher) in Japan contribute to pushing the output prices in C-Manufacturing sector higher than the U.S. by 2.8 percent and 1.1 percent, respectively. The difference in qualities pf products, especially of retail trade, will be examined more in our further research.

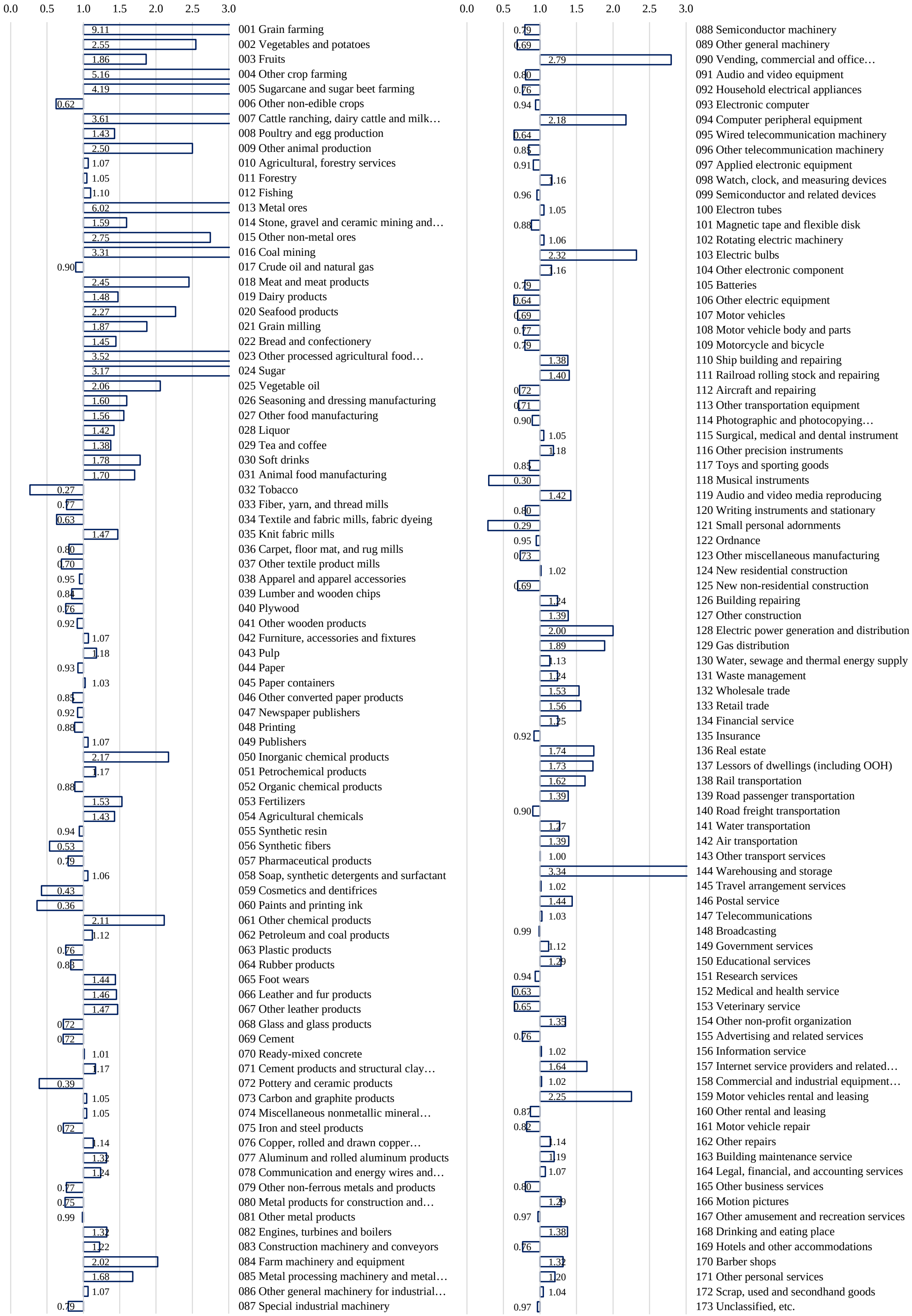

Figure 12: Industry PLI of Domestic Outputs in 2005

Table 5: Price Competitiveness Matrix of Japan in 2005

Industry \ Product	1 Agriculture	2 Chemicals and chemical products	3 Mineral and Metal products	4 Machinery, electronic, and transport equipment	5 Other manufacturing	6 Electricity	7 Other Energy	8 Wholesale and retail trade	9 Transportation and storage	10 Financial and insurance activities	11 Real estate activities	12 Industrial services	13 Other services	14 Others	Total sum	Output price gaps $\ln(\mathbf{P}^d_{J/U,j})$
A - Agriculture, forestry and fishing	.082	.014	.000	.001	.041	.006	.011	.025	.003	.001	.000	.002	.001	.001	.188	.868
B - Mining and quarrying	.000	.004	-.001	-.002	-.001	.025	.037	.023	.007	.011	.005	.024	.007	.004	.144	.468
C - Manufacture	.026	-.005	-.024	-.016	.003	.011	.005	.028	.004	.003	.002	-.003	.002	.003	.039	-.012
10 - Food products	.328	-.002	.000	.008	.068	.008	.004	.042	.005	.002	.001	-.003	.002	.002	.464	.558
11 - Beverages	.048	-.008	-.004	.001	.059	.008	.004	.037	.005	.003	.001	-.008	.002	.002	.148	.654
12 - Tobacco products	-.049	-.008	.001	.000	.000	.003	.002	.010	.003	.005	.000	-.021	.002	-.001	-.053	-.716
13 - Textiles	.000	-.038	.000	.000	-.078	.014	.006	.033	.004	.009	.002	-.001	.002	.002	-.044	-.344
14 - Wearing apparel	.000	-.023	.000	.000	-.076	.008	.002	.045	.004	.010	.003	-.004	.002	.002	-.028	-.031
15 - Leather and related products	.000	-.015	.000	.008	-.016	.008	.037	.053	.004	.003	.001	-.003	.003	.001	.083	.405
16 - Wood and wood products, except furniture	.004	.013	.000	.000	-.034	.011	.004	.035	.003	.004	.001	.003	.002	.001	.045	-.160
17 - Paper and paper products	.000	.000	.000	.000	-.003	.029	.003	.043	.004	.004	.002	-.004	.003	.002	.083	-.053
18 - Printing and reproduction of recorded media	.000	-.033	.000	.000	-.016	.006	.001	.031	.005	.004	.002	-.007	.005	.001	.000	-.113
19 - Coke and refined petroleum products	.000	.001	.000	.000	.000	.006	.019	.007	.025	.000	.000	.000	.001	.001	.060	.390
20 - Chemicals and chemical products	.001	.045	-.001	.001	.001	.021	.019	.022	.003	.003	.002	-.006	.003	.004	.118	.068
21 - Pharmaceutical products	.000	-.001	-.003	.000	.003	.006	.002	.022	.005	.003	.005	-.014	.004	.004	.036	-.220
22 - Rubber and plastics products	.000	-.053	-.002	-.002	-.001	.014	.001	.035	.004	.002	.002	-.002	.003	.002	.003	-.251
23 - Other non-metallic mineral products	.000	.004	-.020	-.001	-.002	.019	.011	.025	.007	.006	.002	.000	.003	.022	.076	-.142
24 - Basic metals	.000	.002	-.121	.000	.000	.019	.006	.023	.004	.002	.001	.000	.001	.003	-.060	-.255
25 - Fabricated metal products, except M&E	.000	-.005	-.060	.000	-.001	.010	.003	.028	.004	.004	.002	-.001	.003	.003	-.011	-.094
26 - Computer, electronic and optical products	.000	-.008	-.005	.020	-.002	.006	.002	.034	.003	.003	.002	-.004	.003	.002	.057	.014
27 - Electrical equipment	.000	-.005	-.018	.010	-.002	.014	.002	.025	.003	.003	.003	-.002	.003	.003	.038	-.048
28 - Machinery and equipment n.e.c.	.000	-.005	-.024	.023	-.001	.007	.002	.030	.003	.003	.002	-.002	.002	.002	.042	.065
29 - Motor vehicles and trailers	.000	-.010	-.015	-.130	-.001	.006	.002	.023	.001	.001	.001	-.004	.001	.001	-.122	-.281
30 - Other transport equipment	.000	-.013	-.016	-.045	-.001	.010	.003	.022	.002	.004	.001	-.002	.001	.003	-.028	.054
31 - Furniture	.000	-.015	-.020	-.004	-.027	.007	.002	.043	.002	.005	.003	-.005	.002	.002	-.006	.073
32 - Other manufacturing	.006	-.011	-.008	.000	-.018	.005	.004	.045	.003	.013	.001	-.003	.003	.002	.041	-.381
33 - Repair and installation of machinery and equipment	.000	-.007	-.011	.032	-.001	.010	.002	.045	.002	.003	.001	-.003	.002	.002	.078	.080
D - Electricity, gas, steam and air conditioning supply	.000	.001	.000	.000	-.001	.025	.018	.013	.008	.008	.006	.001	.002	.015	.097	.704
E - Water supply	.000	.001	.000	.000	-.001	.032	.010	.011	.003	.002	.002	-.004	.003	.017	.077	.191
F - Construction	-.001	-.007	-.024	-.009	-.004	.003	.007	.032	.001	.003	.002	-.009	.002	.005	.001	.069
G - Wholesale and retail trade	.000	-.001	.000	.001	-.001	.010	.007	.008	.006	.012	.016	-.001	.003	.003	.062	.457
H - Transportation and storage	.000	.000	.000	.002	-.001	.012	.017	.008	.009	.007	.011	-.005	.003	.005	.068	.205
I - Accommodation and food service activities	.017	.000	-.002	.014	.080	.012	.008	.050	.002	.004	.008	-.003	.004	.008	.202	.202
J - Information and communication	.000	.000	.000	.000	-.003	.005	.002	.008	.003	.003	.012	-.017	.009	.007	.028	.052
K - Financial and insurance activities	.000	-.001	.000	.000	-.002	.002	.001	.005	.006	.022	.008	-.012	.004	.004	.036	.132
L - Real estate activities	.000	.000	.000	.000	.000	.002	.001	.001	.000	.013	.003	.000	.000	.010	.030	.553
M - Professional, scientific and technical activities	.000	.000	.000	.000	-.003	.004	.003	.007	.003	.007	.003	-.007	.006	.002	.024	-.195
N - Administrative and support service activities	.000	.001	.000	.000	-.004	.001	.002	.010	.003	.010	.007	-.008	.003	.003	.028	.169
O - Public administration and defence	.000	.000	.000	.001	-.002	.007	.005	.008	.011	.001	.001	.000	.002	.010	.042	.111
P - Education	.002	.000	.000	.001	.002	.008	.004	.007	.003	.000	.001	-.001	.001	.005	.032	.252
Q - Human health and social work activities	.002	-.021	-.001	.001	.004	.007	.003	.025	.001	.003	.003	.000	.005	-.004	.029	-.469
R - Arts, entertainment and recreation	.002	-.002	.000	.005	-.003	.019	.006	.014	.002	.004	.008	-.007	.005	.010	.063	.010
S - Other service activities	-.001	-.002	-.002	.000	-.003	.008	.009	.014	.003	.006	.009	-.003	.007	.014	.059	.219

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