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DECOMPOSITION OF INCOME GAPS BETWEEN CHINA, JAPAN AND THE UNITED STATES FOR *CIRCA* 1935 BY A PRODUCTION PPP APPROACH

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ABSTRACT

Income gaps between countries can be decomposed into three effects, namely, a labour participation effect that is determined by demographic structure of population and working hours per person employed, an industry-specific productivity effect, and an industrial structure effect. Due to its "industry-of-origin" nature, the production-side purchasing power parity (PPP) approach is ideal to address the research problem because it enables not only the conversion of national income and labour productivity into a common *numéraire* but also the decomposition of income gaps between nations into the three major effects. In this study we first construct the production-side PPPs for major sectors (agriculture, manufacturing-mining, transportation-utilities, trade-finance services and government) in China and Japan with the US as the reference country for *circa* 1935. We then decompose the income gaps between these countries. Our preliminary decomposition results show that the income gap between Japan and the US and between China and the US is mainly (near or over 90%) attributed to much lower industry-specific productivity rather than differences in industrial structures. We have also found that higher labour participation rate in China and in Japan helped narrow down their income gaps with that of the US by about 15% and 30%, respectively.

Key Words: Production-side purchasing power parities (PPPs), comparative income level and labour productivity, decomposition of income gaps, economic development

***JEL* References**: L60, O47, P52

1. INTRODUCTION

Income gaps between nations and their dynamics have motivated a persistent intellectual inquiry and scholarly work about the causes and the determinants of wealth and poverty of nations since Adam Smith.[1] Attention has been particularly paid to large countries that have shaped the world economy at different times of the human history, for example, comparative studies for prewar or postwar periods on major industrialized countries by Maddison (1987), on UK, US and Germany by Broadberry (1998), on China by Maddison (1998), Wu (2001), and Maddison and Wu (2008), on Germany, Japan and US by van Ark and Pilat (1993), on Japan and Korea by Pilat (1994), and on major East Asian economies by Fukao, Ma and Yuan (2007) and Yuan, Fukao and Wu (2010).

Indisputably, countries have widely different institutions, traditions and policies, which have a powerful impact on the operation of atomistic market forces (Maddison, 2007). It would be superficial to believe that quantifiable "causes" or "explanations" can tell the whole story about why some countries are so rich and some so poor, and why some have caught up so quickly and some have fallen behind, but they are surely indispensable for a better understanding of deeper layers of causalities. This is especially true for understanding the driving forces behind the early industrialization in Japan and China in which their impressive postwar growth took root. However, there has been a lack of quantitative measures that could "explain" their income gaps with the world frontier.

Because of the well-known Balassa-Samuelson effect (Balassa, 1964; Samuelson, 1964) that market exchange rate-based international comparison underestimates (exaggerates) the real income of poor (rich) countries where non-tradables are cheaper (more expensive) than what suggested by market exchange rates, a direct measure of producer costs in national currencies for the same product or service between countries, or production-side purchasing power parity (PPP) approach, is more sensible and appropriate in the international comparison of income, output and productivity (Maddison and van Ark, 1988; van Ark, 1993). However, most income measures for prewar international comparisons are based on the expenditure PPP

[1] For literature in this field of the last half century see Denison (1967); Kuznets (1971); Maddison (1970, 1983 and 2001); Abramovitz (1989 and 1990); North (1990); Kravis, Heston and Summers (1975 and 1982); Summers and Heston (1988 and 1991); Landes (1998).

approach (Kravis, Heston and Summers, 1975 and 1982; Maddison, 1995), which only compares income levels measured by final goods and services, hence unable to address the issue as what are the important and quantifiable elements in a measured income gap between nations.

If taking a production point of view, one can reasonably argue that there are mainly three measurable effects behind an income gap between two countries in comparison, namely, a *labour participation effect* that is determined by age and gender structures of population and working hours per person employed, an industry-specific *labour productivity effect*, and an *industrial structure effect*, all can be coherently derived from a rigorous "national accounts" type of framework. Basically, the deeper layer factors such as institutions, traditions and policies will have impacts on factor costs through physical or moral barriers to factor mobility, market integration and improvement of efficiency, hence affecting labour participation, factor productivity, and the allocation of resources. Due to its "industry-of-origin" nature, the production-side PPP approach is ideal to address this research problem because it enables the construction of production PPPs for individual industries and thus an industry level output and productivity comparison between countries.

The focus of this study is to decompose income gaps between two major East Asian economies, China and Japan, and the United States for *circa* 1935, the most appropriate prewar period in terms of data availability and the influence of the war time policy. The choice of the time for this study is different from an earlier, pioneer work also using the production PPP approach by Pilat (1994) that focuses on 1939. Since by that time Japan already started a war with China and enacted a *National Mobilization Law* in 1938, it is inappropriate for an international comparison that aims to understand the fundamental forces of the economy over the long run.

The structure of the current study is organized as follows. Section 2 gives a brief literature review on PPP studies for major East Asian economies in the prewar period. Section 3 discusses main methodological issues in measuring production-side PPPs. Section 4 gives detailed accounts for data sources and handling. Sections 5 and 6 report and discuss, respectively, the estimates of sectoral production PPPs for China and Japan with the US as the base economy, and the comparative output and productivity in major sectors of these economies. Section 7 presents the methodology for the decomposition of income gaps between these countries into the effects of labour participation, labour productivity and industrial structure, and discusses the decomposition results. Finally, Section 8 concludes the study by highlighting unsolved problems with future research agendas.

2. A Brief Review of the Earlier Studies

There have been only a few income comparison studies on the prewar East Asian economies using the PPP framework except for some backward projections by Maddison (2001). Since the early 2000s, Fukao and his associates have begun to work on the construction of expenditure-side PPPs for Japan and its two prewar colonies, Korea and Taiwan, for 1935 (Yuan and Fukao, 2002; Fukao, Ma and Yuan, 2004 and 2006). Their studies led to a more comprehensive study for East Asia by including China in Fukao, Ma and Yuan (2007) in which expenditure PPPs are constructed for Japan/China, Japan/US and China/US for circa 1935.

However, the level of a country's real per capita GDP measured by expenditure PPPs is by nature merely a measure of a nation's welfare level relative to that of the benchmark country. It does not directly indicate the industrialization level of the country because it cannot provide industry-specific labour productivity and economic structure compared with those of the benchmark country. As such, the postwar rapid economic growth of the East Asian economies cannot be well understood without a proper measure of the prewar economic conditions in an internationally comparable framework. Therefore, there is a call for the use of the production PPP approach for the East Asian economies.

Yukizawa (1973) is perhaps the pioneer who follows Rostas (1948) using some physical quantity ratios to measure relative output and productivity between Japanese and US manufacturing industries for 1935-39. However, from the theoretical point of view the Rostasian approach is less reliable than the comparison of unit value or price ratios as well discussed in van Ark (1993). Another shortcoming of the Yukizawa's study is that, as a comment made by Pilat (1994, pp. 26-27), it is based on some census concept of value added and employment rather than on the basis of the standard national accounts concept of gross domestic product (GDP) and persons engaged or hours worked which is essential in inferring measured relative output and productivity to the economy as a whole.

A study by Pilat (1993) is the first one that follows the standard "industry-of-origin" approach to estimate Japan/US production-side PPPs for manufacturing industries in 1939. Manufacturing is the traditional focus of the production PPP-based comparative studies. Despite its importance in the earlier stages of development, the role of manufacturing cannot be fully understood without a good understanding of the conditions of the agricultural sector which provided the desired savings for the earlier development and the conditions of the service sector which served or facilitated the industrialization. Extended from his earlier studies on manufacturing, Pilat (1994) further constructs Japan/US production-side PPPs for the major sectors of the whole economy for 1939. However, the benchmark of Pilat's study is difficult to accept because by that time Japan already entered a war with China and enacted a *National Mobilization Law* in 1938. Thus, this benchmark is inappropriate for an international comparison that aims to understand the fundamental forces of the economy over the long run. For this purpose, and to match other prewar PPP studies, there is a need for production PPP-based income comparison for major East Asian economies for *circa* 1935.

In a earlier study (Fukao, Wu and Yuan, 2008), we made the first attempt using the production PPP approach to manufacturing output and labour productivity comparisons between China, Japan, Korea and the US for circa 1935. Compared with the manufacturing PPP estimates for Japan/US by Pilat (1993) using the same approach but focusing on 1939, our results suggest that the Japanese cost of manufacturing production relative to the US rose by 110 percent between 1935 and 1939 (see Fukao, Wu and Yuan, 2008, Table 4; Pilat, 1993, Table 2.5). Great differences are observed at industry level between the two studies. For example, the relative cost of chemical industry increased by 280 percent while the relative cost of steel industry rose by 64 percent over this period. These findings well justify the need for PPP estimates for all major sectors of the economy for the mid 1930s, the best (and latest) prewar time that can better reflect the normal trend of these economies.

3. METHODOLOGY

In principle, we follow the standard method of constructing the "industry-of-origin" PPPs developed by the International Comparison of Output and Production Program (ICOP) at the Groningen Growth and Development Centre (GGDC) led by Angus Maddison (see Maddison and van Ark, 1988) and its recent practices especially in prewar output and productivity comparisons including an UK/US comparison by de Jong and Woltjer (2007) and two UK/Germany comparisons by Broadberry and Burhop (2007) and by Fremdling, de Jong and Timmer (2007), all for 1935/36.

In this study we follow the standard ICOP "industry-of-origin" approach to compare producer prices between countries. The producer price is in principle unit value (UV) as it is derived from the value and quantity of a specific product or a specific service transaction. A unit value ratio (UVR) can be obtained by a direct comparison of the unit prices of the same product between two countries. With UVRs, production PPPs at sector level (i.e. one-digit industry) between two countries can be derived through weighting and aggregating from the basic level of industries (3 or 4-digit industry) to the level of industrial branches (2-digit industry), and then to the level of sectors.[2] Quantity weights at different levels of an industry are important for aggregating to an upper level of the industry.

More on UVRs in comparison with input-output table based double deflation approach…

Let us denote the benchmark or reference country as country *B* and set the price level of country *B* to 1 and denote any country that is in comparison with country *B* as country *Z*. We use Fischer geometric mean index for the international comparison of price levels. Following a similar approach used in Inklaa and Timmer (2008), we define the following PPPs for our analysis.[3]

Sectoral PPP for outputs

The output PPP for sector *I* in country *Z* that is to be compared with the benchmark country *B*, or $PPP_I^{Q(Z)}$, is defined by

(1) $$PPP_I^{Q(Z)} = \sqrt{\sum_{i \in I} v_{i,I}{}^{Q(B)} p_i{}^{Q(Z)} \frac{1}{\sum_{i \in I} v_{i,I}{}^{Q(Z)} \frac{1}{p_i{}^{Q(Z)}}}}$$

[2] In the "industry-of-origin" approach, a distinction is made between UVRs and PPPs. UVRs refer to product or service level price information and PPPs refer to price levels at more aggregated levels (industry, sector and the whole economy).

[3] For a simple, single deflation approach to the production-side PPP see Fukao, Wu and Yuan (2008).

where *I* denotes the set of output of sector *I* and $v_{i,I}^{Q(Z)}$ and $v_{i,I}^{Q(B)}$ denote the share of output *i* in total nominal output of sector *I* in country *Z* and *B*; $p_i^{Q(Z)}$ denotes the price level of output *i* in country *Z* in the base country currency, note that $p_i^{Q(Z)}$ is on a market price basis and includes indirect tax minus subsidies. We use the average market exchange rate in 1934-36 for the conversion of absolute price levels.[4]

Sectoral PPP for value added (double deflation)

Laspeyres price index (*PL*) for value added of sector *I* in country *Z*, $PL_I^{V(Z)}$, is defined by

(2) $$PL_I^{V(Z)} = \frac{\sum_{i\in I} v_{i,I}^{Q(B)}\left(p_i^{Q(Z)} - \sum_{s\in S} v_{s,i}^{M(B)} p_s^{Q(Z)}\right)}{1-\sum_{i\in I}\sum_{s\in S} v_{i,I}^{Q(B)} v_{s,i}^{M(B)}}$$

where $v_{s,i}^{M(B)}$ denotes the share of intermediate input *s* in total nominal output of *i* in the benchmark country *B* and $p_s^{Q(Z)}$ denotes price level of intermediate input *s* in country *Z* and $p_s^{Q(Z)}$ is on a market price basis and includes indirect tax minus subsidies. The upper case *S* denotes the set of all the commodities and services in the economy.

Paasche price index (*PP*) for value added of sector *I* of country *Z*, $PP_I^{V(Z)}$ is defined by

(3) $$PP_I^{V(B)} = \frac{1}{\left(\dfrac{\sum_{i\in I} v_{i,I}^{Q(Z)}\left(\dfrac{1}{p_i^{Q(Z)}} - \sum_{s\in S} v_{s,i}^{M(Z)} \dfrac{1}{p_s^{Q(Z)}}\right)}{1-\sum_{i\in I}\sum_{s\in S} v_{i,I}^{Q(Z)} v_{s,i}^{M(Z)}}\right)}$$

where $v_{s,i}^{M(Z)}$ denotes the share of intermediate input *s* in the nominal output of *i* in country *Z*.

Finally, PPP for the value added of sector *I* in country *Z*, $PPP_I^{V(Z)}$, is defined by

[4] We can also try "aggregation with integration" approach of Inklaar and Timmer (2008), in which sectoral output used in the same sector is excluded from the calculation of $v_{i,I}^{Q(Z)}$ and $v_{i,I}^{Q(B)}$.

(4) $$PPP_I^{V(Z)} = \sqrt{PL_I^{V(Z)} \cdot PP_I^{V(B)}}$$

Macro-level PPP for final outputs

When we measure macro-level PPP for outputs, we use the "aggregation with integration" approach as in Inklaar and Timmer (2008), in which output used in the same economy is excluded from the calculation of macro-level output. In order to simplify our analysis, we assume that effects of imports on PPP are negligible. Then, the macro-level PPP for *final* outputs of country *Z*, $PPP_S^{Q(Z)}$ is defined by

(5) $$PPP_S^{Q(Z)} = \sqrt{\sum_{i \in S} v_{i,S}^{F(B)} p_i^{Q(Z)} \frac{1}{\sum_{i \in S} v_{i,S}^{F(Z)} \frac{1}{p_i^{Q(Z)}}}}$$

where $v_{i,S}^{F(Z)}$ and $v_{i,S}^{F(B)}$ denote the share of final output *i* in the total final output of country *Z* and of *B*, respectively.

We can also define the macro-level PPP for value added, $PPP_S^{V(Z)}$ by the following modified version of equations (2), (3) and (4):

(2') $$PL_S^{V(Z)} = \frac{\sum_{i \in S} v_{i,S}^{Q(B)} \left(p_i^{Q(Z)} - \sum_{s \in S} v_{s,i}^{M(B)} p_s^{Q(Z)} \right)}{1 - \sum_{i \in S} \sum_{s \in S} v_{i,S}^{Q(B)} v_{s,i}^{M(B)}}$$

(3') $$PP_S^{V(B)} = \frac{1}{\left(\frac{\sum_{i \in S} v_{i,S}^{Q(Z)} \left(\frac{1}{p_i^{Q(Z)}} - \sum_{s \in S} v_{s,i}^{M(Z)} \frac{1}{p_s^{Q(Z)}} \right)}{1 - \sum_{i \in S} \sum_{s \in S} v_{i,S}^{Q(Z)} v_{s,i}^{M(Z)}} \right)}$$

(4') $$PPP_S^{V(Z)} = \sqrt{PL_S^{V(Z)} \cdot PP_S^{V(B)}}$$

Using the following relationships,

(6) $$v_{i,S}^{F(K)} = \frac{v_{i,S}^{Q(K)} - \sum_{s \in S} v_{s,S}^{Q(K)} v_{i,s}^{M(K)}}{1 - \sum_{i \in S} \sum_{s \in S} v_{i,S}^{Q(B)} v_{s,i}^{M(B)}}, \quad for \sum_{i \in S} v_{i,S}^{Q(K)} = 1, \quad K = Z, B$$

we can show that the macro-level PPP for final outputs, $PPP_S^{Q(Z)}$ is equal to the macro-level PPP for value added, $PPP_S^{V(Z)}$.

So far we have not explicitly taken into account the price gaps between domestically produced goods and services and imported goods and services. In Appendix 1, we will use a schematic input-output table to deal with this issue as well as the consistency problem between the production-side and expenditure-side PPPs.

4. DATA SOURCES AND PROBLEMS

In this section, we concentrate mainly on the data that are used in constructing PPPs, including sources, coverage and definition, industrial and sectoral classification, and their problems and how we deal with the problems. Sources and indicative notes are provided with tables. More details of sources, technical notes and handling are provided in Appendix 2. Matching tables for calculating product, industry and sector level PPPs in the case of China/Japan are given in Appendix 3.

International comparison of income and productivity requires micro (product and itemized service transaction) level data, which in our case do not exist or were not collected systematically. Among the East Asian economies, the most consistent and reliable long-term GDP series going back to the late-19th century are available only for Japan, thanks to the efforts of the Long-Term Economic Statistics (LTES) project under the leadership of Kazushi Ohkawa at the Institute of Economic Research (IER) of Hitotsubashi University, Japan, resulting in an extensive publication of 14 volumes for the Japanese economy (1974) in Japanese.[5] The IER group also extended this line of research to two former Japanese colonies, Taiwan and Korea, with the 1988 publication of a statistical volume compiled by Mizoguchi and Umemura. The volume provides annual estimates of GDP and its various components for these two economies during the period of Japanese occupation based on detailed economic statistics by the colonial administrations. (More details on Japanese micro data for estimating PPPs are in Appendix 2.)

There are two main sources for the Chinese data. The first one was China's first national income account constructed by Ou Pao-san during 1941-46, which resulted in

[5] This is accompanied by an abridged English version by Ohkawa and Shinohara in 1979.

a two-volume publication in Chinese in 1947 (Ou, 1947).[6] The work concentrated mainly on 1933, reflecting the detailed survey data for that year which were compiled by D.K. Lieu for the same period in 1937 (see NRC, 1937). Since Ou's work basically followed the western concepts of national income, its industrial classification is acceptable. The second source was the work jointly done by two US-based Chinese economists Liu Ta-chung and Yeh Kung-chia (1965)[7], which subsequently revised Ou's work. Liu-Yeh's revised estimates raised China's GDP for 1933 by 37 percent, that is, from Ou's 21.77 billion yuan to 29.88 billion yuan at 1933 prices (p.66). The differences between Liu-Yeh and Ou appear to be mainly in agriculture, factory manufacturing and handicrafts. They are basically empirical rather than conceptual differences. (More details on the Chinese micro data are given in Appendix 2.)

More to follow…

- The US data and problems.
- Input-output table used for double deflation … (Wassilly Leontief, 1966)
- …

5. ESTIMATED PRODUCTION-SIDE PPPS

The bilateral PPP results for China/US and Japan/US in Table 1 are obtained by unit value comparisons to derive UVRs, then by taking aggregation procedures through industries, branches to sectors to derive inter-country cross-weighted PPPs at different levels, and finally by calculating the Fisher average PPPs.

In the case of China/Japan comparison we have made 89 product comparisons for manufacturing industries, 30 in agriculture, 14 in mining, 15 in construction including two pieces of information on wage rates, 3 in public utilities, and 5 in finance and trade services.

In the case of Japan/US comparison we have made 99 comparisons in manufacturing, 26 in agriculture, 12 in mining, 15 in construction, 4 in public utilities and 7 in finance and trade services.

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6 See an English-language summary of the work published in the *Journal of Political Economy* (Ou, 1946).

7 Estimates in Yeh (1977) are basically the same as those in Liu and Yeh (1965). However, Yeh provides a time series for 1931-36， of which the data for 1935 are used in this study.

TABLE 1
SUMMARY OF ESTIMATED PPPS FOR GROSS OUTPUT BY SECTOR,
CHINA/US AND JAPAN/US, *CIRCA* 1935
(Single Deflation, Based on Unit Value Ratios)

	China/US		Japan/US	
	PPP Yuan/$ (Fisher)[1]	Relative Price level[2]	PPP Yen/$ (Fisher)[1]	Relative Price level[2]
Agriculture[3]	1.323	0.439	2.396	0.700
Construction[4]	0.909	0.302	2.687	0.786
Manufacturing & Mining	1.947	0.647	1.810	0.529
- Mining	2.834	0.941	3.657	1.069
- Manufacturing	1.910	0.634	1.744	0.510
Transportation & Public Utilities	0.981	0.326	2.118	0.619
Finance, Trade & Other Services	0.957	0.318	1.650	0.482
- Trade	0.909	0.302	2.687	0.786
- Finance, Insurance, Real Estate	1.275	0.424	1.881	0.550
- Other Services	0.392	0.130	0.879	0.257
Total Market Economy[5]	1.387	0.461	1.898	0.555

Source: Authors' estimation. See Appendix for details...
Notes:
1) Fisher PPP is a geometric mean of Laspeyres and Paasche PPPs (see Eq. 4 for industry PPPs) which are based on output unit values.
2) Measured as estimated PPP compared with market exchange rate. MER=3.01 for Chinese yuan/US$ and MER=3.42 for Japanese yen/US$ for 1935.
3) Including farming, forestry and fisheries.
4) Relative price level is estimated based on rental prices.
5) Excluding government services.

Our effort in the basic matching exercise represents a distinct progress from the first study on Japan/US by Pilat for 1939 using a similar production PPP approach in which only 20 matchings were made in agriculture, 6 in mining and 48 in manufacturing, but no details available for the matching for services (1994, pp. 22-24).

The results are very much in line with the Balassa-Samuelson hypothesis with relatively low prices (producer costs) found in non-tradables or services and relatively high prices in tradables in comparison with the prevailing exchange rates. (More details to be discussed …)

Next, to prepare for double-deflation PPPs we use the input-output table weights for intermediate inputs to adjust the PPP results reported in Table 1 to obtain PPPs for intermediate inputs by sector which are reported in Table 2. The results fall into a rather narrow range, basically aligned with output PPP estimates, suggesting a fairly rational producer behaviour in choosing the least-cost combination of inputs under the given constraints in the factor markets especially in China and Japan.

TABLE 2
SUMMARY OF ESTIMATED PPPS FOR INTERMEDIATE INPUTS BY SECTOR,
CHINA/US AND JAPAN/US, *CIRCA* 1935
(Based on Input-Output Table Weights)

	China/US		Japan/US	
	PPP Yuan/$ (Fisher)[1]	Relative Price level[2] (MER=3.01)	PPP Yen/$ (Fisher)[1]	Relative Price level[2] (MER=3.42)
Agriculture[3]	1.341	0.446	1.937	0.566
Construction[4]	1.765	0.586	1.836	0.537
Manufacturing & Mining	1.535	0.510	1.919	0.561
Transportation & Public Utilities	1.514	0.503	1.989	0.582
Finance, Trade & Other Services	1.374	0.456	1.909	0.558

Source: Authors' estimation. See Appendix for …… details.
Notes: 1-4 see Table 1.

The PPP results in Tables 1 and 2 help us produce the PPP estimates for value added using a double deflation approach that is similar to Fremdling, de Jong and Timmer (2007). The value added PPP estimates are reported in Table 3. In the case of Japan, our result is 1.84 yen per dollar for circa 1935 compared with 2.34 yen per dollar as estimated by Pilat for 1939. However, compared with the prevailing market exchange rates, the price level of the Japanese economy was 54 percent of the US level, which is very close to 60 percent based on Pilat's results (1994, Table 2.3). If the similarity is not a coincidence since we cannot rule out the effect of likely biases caused by data problems in either study, it may suggest that the relative industrial structure between Japan and the US remained largely unchanged, which means the relative effect of tradables and non-tradables on prices and exchange rates between the two countries also remained largely unchanged.

Relative price rises over the period 1935-39, as suggested by our PPP estimates for 1935 compared those by Pilat for 1939, mainly appeared in natural resource-based industries, that is, agriculture, mining and construction. They ranged from 50 percent (construction) to 150 percent (agriculture and mining). In the case of transportation, utilities and services, the two estimates suggest relative price declines over this period from 10 percent (transportation, utilities) to 20 percent (finance and other services), which may be difficult to accept. However, one has to bear in mind that by 1939 Japan already started a war with China and entered a war-time economy following a law for mobilizing national resources enacted in 1938. Since these industries include all state-controlled utilities and non-market services, the decline may not be a pure statistical artifact. On the other hand, as already mentioned Pilat worked on much less information than us because he only relied on the *Historical Statistics of Japan*

(Ref…), whereas we have made use of more other materials (Ref…). This means that his estimates rely on more aggregated price information than what available in the current study.

TABLE 3
SUMMARY OF ESTIMATED PPPS FOR VALUE ADDED BY SECTOR,
CHINA/US AND JAPAN/US, *CIRCA* 1935
(Double Deflation)

	China/US		Japan/US	
	PPP Yuan/$ (Fisher)[1]	Relative Price level[2] (MER=3.01)	PPP Yen/$ (Fisher)[1]	Relative Price level[2] (MER=3.42)
Agriculture[3]	1.070	0.355	2.075	0.607
Construction[4]	0.909	0.302	2.687	0.786
Manufacturing & Mining	4.065	1.351	1.752	0.512
Transportation & Public Utilities	0.876	0.291	2.257	0.660
Finance, Trade & Other Services	0.856	0.284	1.531	0.448
Market Economy Only (Production PPP)[5]	1.245	0.414	1.842	0.539

Source: Authors' estimation. See Appendix Table A…… details.
Notes: 1-4 see Table 1.
5) Excluding government services.
6) Including government services (Fukao, Ma and Yuan, 2007).

6. COMPARATIVE PRODUCTIVITY BY MAJOR SECTOR

As argued in Yuan, Fukao and Wu (2010), it makes a great sense to measure comparative labour productivity in hours worked rather than numbers employed. While we are reporting our preliminary results on the conversion from numbers employed to hours worked for all the three countries later in this section, after a long, painstaking process, we first report our basic data for a straightforward measure of labour productivity and its PPP-based comparative measure.

Tables 4 and 5 are our basic data used to calculate the simple, market exchange rate (MER) converted labour productivity for major sectors of the economy, reported in Table 6. Using the estimated PPPs in Tables 1 and 2, we can have PPP-based comparative labour productivity in Table 7.

TABLE 4
POPULATION AND EMPLOYMENT IN CHINA, JAPAN AND THE US BY SECTOR, *CIRCA* 1935
(Thousand Persons)

	Numbers (x000)			Sectoral Share* (%)		
	China	Japan	US	China	Japan	US
Population	528,000	69,254	127,250	100.0	100.0	100.0
Employment	227,326	30,969	42,388	43.1	44.7	33.3
Market Economy:	225,174	29,916	37,387	42.6	43.2	29.4
- Agriculture	193,300	14,403	8,651	*85.8*	*48.1*	*23.1*
- Construction	1,841	997	1,514	*0.8*	*3.3*	*4.0*
- Manufacturing & Mining	9,797	5,577	9,859	*4.4*	*18.6*	*26.4*
- Transportation & Public Utilities	4,565	1,317	2,908	*2.0*	*4.4*	*7.8*
- Finance, Trade & Other Services	15,671	7,622	14,455	*7.0*	*25.5*	*38.7*
General Government	2,152	1,053	5,001	0.4	1.5	3.9

Source: ……
Note: *Sectoral shares for market economy are calculated taking "market economy = 1".

TABLE 5
GDP MEASURED BY MARKET EXCHANGE RATES IN CHINA, JAPAN AND THE US *CIRCA* 1935
BY SECTOR

	GDP* (Millions of US$)			Sectoral Share (%)		
	China	Japan	US	China	Japan	US
Total GDP	9,246	4,391	59,600	100.0	100.0	100.0
Market Economy:	8,973	4,227	52,800	97.1	96.3	88.6
- Agriculture	6,233	836	6,700	67.4	19.0	11.2
- Construction	113	134	1,300	1.2	3.1	2.2
- Manufacturing & Mining	960	1,175	14,500	10.4	26.8	24.3
- Transportation & Public Utilities	585	444	7,500	6.3	10.1	12.6
- Finance, Trade & Other Services	1,083	1,638	22,800	11.7	37.3	38.3
General Government	272	164	6,800	2.9	3.7	11.4

Source: ……
Note: * The GDP figures are slightly different from those used in our previous study. The discrepancies are due to estimation and adjustment for "government". (Ref.)

TABLE 6
ABSOLUTE AND RELATIVE LABOUR PRODUCTIVITY MEASURED IN CHINA, JAPAN AND THE US, CIRCA 1935 BY SECTOR
(In MER$)

	China		Japan		US
	Labour productivity (in MER$)	Labour productivity (US=1)	Labour productivity (in MER$)	Labour productivity (US=1)	Labour productivity
Total Economy	41	0.029	142	0.101	1,406
Agriculture	32	0.042	58	0.075	774
Construction	61	0.071	134	0.156	859
Manufacturing & Mining	98	0.067	211	0.143	1,471
Transportation & Public Utilities	128	0.050	337	0.131	2,579
Finance, Trade & Other Services	69	0.044	215	0.136	1,577
Market Economy	40	0.028	141	0.100	1,412
General Government	127	0.093	156	0.115	1,360

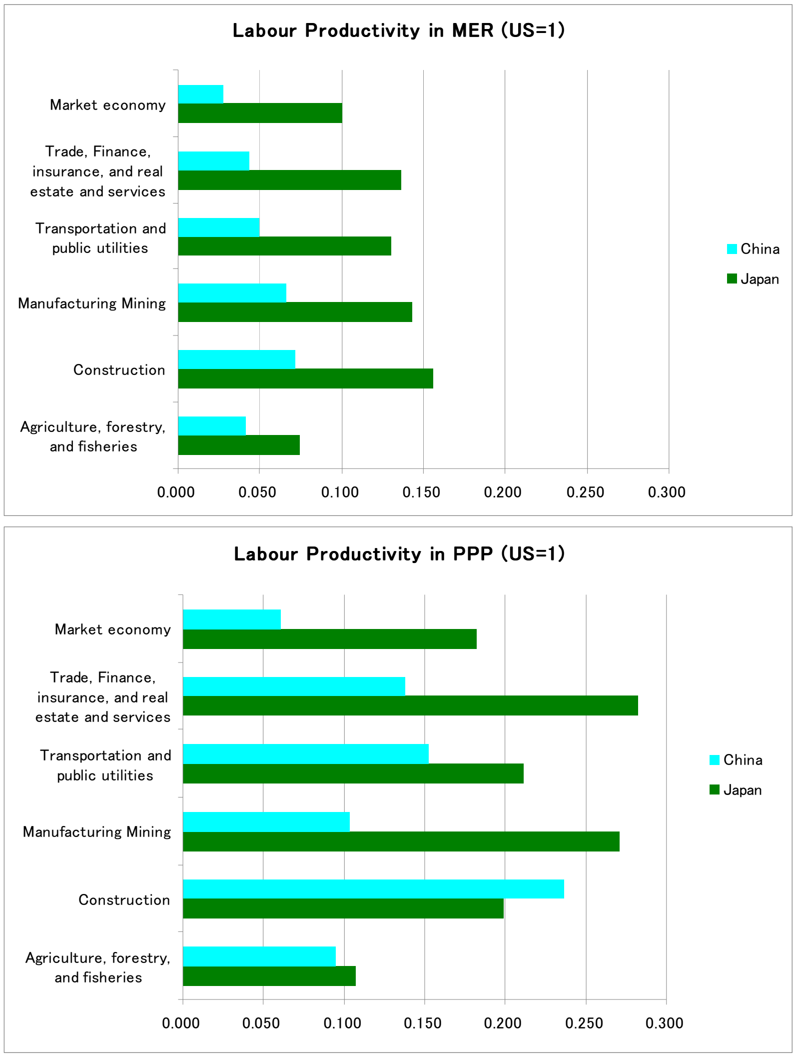
Source: ……
Note: ……

The comparison in labour productivity in MER and PPP is to show how the cross-industry labour productivity pattern has changed when the PPP-measured producer costs are taken into account to confirm that out results are consistent with the Balassa-Samuelson effect.

Figure 1 presents a productivity comparison between the results in MER and the results in single deflated PPP. As it shows, after converted to PPPs (single deflated), labour productivity of all sectors in China and Japan has narrowed down its gap with the US counterpart, the lower the factor cost in these countries compared with that of the US, the larger the extent to which the productivity gap has been reduced. In the case of Japan, this PPP effect is especially seen in finance-trade and manufacturing, all upward adjusted by nearly or over 100 percent from the level measured in MER; whereas in the case of China, this PPP effect is seen in construction, finance-trade and transportation in particular, all upward adjusted by more than two times. The least affected sector was construction and agriculture in Japan and manufacturing in China (more on this…).

This comparison also shows that taking into account the real producer costs, one can see that Chinese agricultural sector back to the mid 1930s was similarly productive as her Japanese counterpart and Chinese construction industry was even more productive than her Japanese counterpart.

FIGURE 1
COMPARISON OF LABOUR PRODUCTIVITY IN MER AND PPP MEASURES BY SECTOR, CHINA AND JAPAN VERSUS THE US



Source: Table 6 and 7.
Note: PPPs used in this chart are by single deflation approach.

There are two panels in Table 7, with one presenting labour productivity in PPP$ by the single deflation approach and the other one by the double deflation approach. In the case of labour productivity at macro-level, our result shows that Japan's labour productivity (adjusted by gross output PPP) is 23% of the US. Pilat gets 19% for 1929 and 27% for 1939 (1994, Table 2.6). So taking a mid point of this period, his result should be very close to 23%. In this sense, our results are quite consistent with Pilat's, even though there is huge gap in the case of construction sector, and some other strange results in Pilat's study. (More on this…)

TABLE 7
ABSOLUTE AND RELATIVE LABOUR PRODUCTIVITY MEASURED IN PPPS FOR CHINA, JAPAN AND THE US CIRCA 1935 BY SECTOR

	China		Japan		US
	Labour productivity (in PPP$)	Labour productivity (US=1)	Labour productivity (in PPP$)	Labour productivity (US=1)	Labour productivity
	(A) In PPP$ by Single Deflation				
Total Economy	144	0.102	321	0.228	1,406
Agriculture	73	0.095	83	0.107	774
Construction	203	0.237	171	0.199	859
Manufacturing & Mining	152	0.103	398	0.271	1,471
Transportation & Public Utilities	393	0.152	544	0.211	2,579
Finance, Trade & Other Services	217	0.138	446	0.282	1,577
Market Economy	86	0.061	257	0.182	1,412
General Government	1,360	1.000	1,360	1.000	1,360
	(B) In PPP$ by Double Deflation				
Total Economy	156	0.111	326	0.232	1,406
Agriculture	91	0.117	96	0.123	774
Construction	203	0.237	171	0.199	859
Manufacturing & Mining	73	0.049	411	0.280	1,471
Transportation & Public Utilities	440	0.171	511	0.198	2,579
Finance, Trade & Other Services	243	0.154	480	0.304	1,577
Market Economy	96	0.068	262	0.186	1,412
General Government	1,360	1.000	1360	1.000	1,360

Source: ……
Note: ……

In Yuan, Fukao and Wu (2010), we documented in details the sources and procedures in converting numbers employed to hours worked in manufacturing for these countries. In this study, we mainly concentrate on the sources and handling of the data used for the conversion. The Japanese data are from Japanese Empire Statistical Yearbook published by the Cabinet Bureau of Statistics (yyyy) and Materials of Japanese Labor Movement History, Vol. 10, published by its editorial committee (yyyy), numbers employed grouped by daily hours worked, available for mining, manufacturing, construction, utilities (gas, water and electricity), transportation and telecommunication-post service in systematic surveys. The US data are from Historical Statistics of the United States, millennial edition, Vol.2, "Work and Welfare" (Table Ba4576-4588), annual hours worked per person, available for mining, manufacturing, transportation-utilities, trade, finance-insurance-real estate, and (other) services. The Chinese data are from China Labor Annals published by Ministry of Industry (1932), data available as occasional or piecemeal surveys for mining, utilities, transportation, post service and personal services.

Our general principles in data handling and estimation are given as follows. Details of the nature of the data and data work are given in Appendix 2. Different from the case of Japan and the US in which reported data can be used straightway, the Chinese data are less systematic and largely unprocessed. Daily hours worked, occasionally together with annual leave or off-duty days, are reported for a specific industry at a location. The number of daily hours worked ranges from 8 to 12 hours in most cases. In the case without annual leave days, we assume that a person would work for 51 weeks if the number of his/her daily hours worked was 11 or less, and 50 weeks if it was more than 11.

For mining, the Chinese and US data refer mainly to coal mining industry, whereas the Japanese data cover coal, metal and non-metallic mining and oil extraction. For utilities, the Japanese and US data are more comprehensive than their Chinese counterpart which concentrates mainly on electricity. The case of transportation is similar in that the Japanese and US data are more comprehensive than the Chinese data which only cover two companies, one in bus service in Beijing and the other in railway service in Shandong. There are no data for construction in the case of China and the US. We assume the number of annual hours worked in construction in these countries is equal to that of utilities. For the number of annual hours worked in government services, we assume that it is equal to that of post office in the case of China and Japan. As for the US, we assume that it is equal to that of financial services. There are no data for trade industry in the case of China and Japan. Our estimation is based on the “relationship” between trade and transportation as in the case of the US. Annual hours worked of all other services are assumed to be equal to those of national average excluding government. Annual hours worked in agriculture in all cases are assumed to be equal to 75 percent of the national average, i.e. assuming a three-month idle season. The results are reported in Table 8.

TABLE 8
NUMBERS EMPLOYED, HOURS WORKED AND ANNUAL HOURS WORKED PER PERSON BY MAJOR SECTOR, CHINA, JAPAN AND THE US, CA 1935

	China			Japan			US		
	Numbers employed (thousands)	Hours worked (millions)	Annual hours per person	Numbers employed (thousands)	Hours worked (millions)	Annual hours per person	Numbers employed (thousands)	Hours worked (millions)	Annual hours per person
Total Economy	227,326	517,530	2,277	30,969	82,927	2,678	42,388	75,320	1,777
Agriculture	193,300	421,982	2,183	14,403	33,415	2,320	8,651	12,308	1,423
Construction	1,841	5,869	3,188	997	3,259	3,267	1,514	3,111	2,055
Manufacturing & mining	9,797	28,369	2,896	5,577	17,418	3,123	9,859	17,118	1,736
Transportation & utilities	4,565	13,538	2,966	1,317	4,145	3,147	2,908	6,354	2,185
Finance, trade & other services	15,671	42,504	2,712	7,622	21,948	2,880	14,455	26,952	1,865
Government	2,152	5,268	2,448	1,053	2,742	2,604	5,001	9,477	1,895

Sources: See text and appendix for details of the data used in the estimation.

TABLE 9

COMPARATIVE LABOR PRODUCTIVITY, PPP$ PER HOUR WORKED.

Table 9							
Total Economy	China Output/Hour	US=1	Output/Num US=1	Japan Output/Hour	US=1	Output/Num US=1	US
Agriculture	0.042	0.077	0.117	0.041	0.076	0.123	0.544
Manufacturing & Mining	0.025	0.030	0.049	0.132	0.155	0.280	0.847
Construction	0.064	0.152	0.237	0.052	0.125	0.199	0.418
Transportation & Public Utili	0.148	0.126	0.171	0.162	0.138	0.198	1.180
Finance, Trade & Other Ser	0.090	0.106	0.154	0.167	0.197	0.304	0.846
Market Economy	0.042	0.053	0.068	0.098	0.122	0.186	0.802
General Government	0.556	0.774		0.522	0.728		0.718

Sources: See text.

7. DECOMPOSITION OF INCOME GAPS

Decomposition of income gaps between countries

As we have argued, just like a meaningful international comparison in income, a meaningful examination of income gaps between countries requires PPP measures of income across the countries involved. Now, with the estimated PPP results for China, Japan and the US, we can not only measure but also decompose income gaps among these countries.

Let us begin with an income gap decomposition exercise. As given by the equation below, the logarithmic value of the ratio of per-capita GDP (y) of country Z over the benchmark country B can be decomposed into the following factor:

(7)
$$\ln\left(\frac{y^{(Z)}}{y^{(B)}}\right)=\ln\left(\frac{\frac{L^{(Z)}}{N^{(Z)}}}{\frac{L^{(B)}}{N^{(B)}}}\right)+\ln\left(\frac{\sum_{n=1}^{n}\theta_n^{(Z)}a_n^{(Z)}}{\sum_{n=1}^{n}\theta_n^{(B)}a_n^{(B)}}\right)$$

$$=\ln\left(\frac{\frac{L^{(Z)}}{N^{(Z)}}}{\frac{L^{(B)}}{N^{(B)}}}\right)+\ln\left(\frac{\sum_{n=1}^{n}\theta_n^{(Z)}a_n^{(Z)}}{\sum_{n=1}^{n}\theta_n^{(B)}a_n^{(Z)}}\right)+\ln\left(\frac{\sum_{n=1}^{n}\theta_n^{(B)}a_n^{(Z)}}{\sum_{n=1}^{n}\theta_n^{(B)}a_n^{(B)}}\right)$$

where N^Z and L^Z denote the population and the number of workers (hours standardized) in country Z, θ_n^Z denotes the share of workers in industry n of the entire workers employed in country Z, a_n^Z denotes the labor productivity of industry n in country Z. Variables with subscript B denote the corresponding values for the benchmark country B. Equation (7) implies that we can decompose the difference of per-capita income of the two countries into three effects, namely, labor participation effect,[8] industry-specific productivity effect and industrial structure effect. Country *Z* will become richer than country *B* if, *ceteris paribus*, it has a higher percentage of population working, it has a larger share of industries with a higher labor productivity, or for each industry it has a higher labor productivity.

The decomposition is applied to per capita GDP gaps measured in production PPPs as shown in Table 10. The table also reports per capita GDP gaps in other measures.

TABLE 10
PER CAPITA INCOME GAPS MEASURED BY MER AND PPPS BETWEEN CHINA, JAPAN AND THE US IN 1935

	Per Capita GDP			Per Capita GDP Gap (log)		
	China	Japan	US	US/ China	US/ Japan	Japan/ China
GDP in MER$:						
Total	18	64	514	3.350	2.080	1.269
Market Economy	17	61	415	3.195	1.917	1.278
GDP in Production PPP$:						
Total	39	116	514	2.575	1.491	1.084
Market Economy	37	110	415	2.420	1.328	1.093
GDP in Expenditure PPP$:						
Total	56	143	514	2.211	1.282	0.929
Market Economy	--	--	415	--	--	--

Source: ……
Note:

Our preliminary results are reported in Table 11 which may not be as expected by theory, that is, we do find large errors especially in the case of Japan/China decomposition.

TABLE 11
DECOMPOSITION OF PER CAPITA GDP GAPS IN PPPS BETWEEN CHINA, JAPAN AND THE US, CIRCA 1935

	US/China	US/Japan	Japan/China
Difference in Per Capita GDP (log)	2.420	1.328	1.093
1) Labour Participation Effect	-0.373	-0.385	0.013
	(-15.4)	*(-29.0)*	*(1.2)*
2) Economic Structure Effect	0.559	0.277	0.632
	(23.1)	*(20.8)*	*(57.9)*
3) Industry-Level Productivity Effect	2.113	1.472	0.291
	(87.3)	*(110.9)*	*(26.6)*
4) Estimation Error	0.121	-0.036	0.156
	(5.0)	*(-2.7)*	*(14.3)*

[8] Labor participation effect, L/N (L=r*A, r=labor participation rate); h (h=H/L, average working hours). Since A=working age population, there is also an age structure effect, holding gender effect constant (which can also be added in).

Source: ……
Note: Income gaps are in production PPPs and converted to logarithmic values. Figures in parentheses are contribution of individual effects in percentage.

It shows that in the case of the Japan-China comparison, the main cause of the per capita GDP gap is the difference in industrial structure (see Table 11). In both countries, labor productivity of agriculture (including forestry and fishery) is lowest among all the industries (Table 11). In the case of China, 86 percent of the workforce was working in agriculture and only 4 percent of the workforce was working in manufacturing and mining. Whereas in Japan, there was only 48 percent of the workforce was working in agriculture and 19 percent in manufacturing and mining. In fact, Japan's industrialization was partially accomplished though its specialization in manufacturing production which changed the world division of labor. In 1934-36, 88 percent of Japan's exports were manufactured goods and 59 percent of its imports were food stuffs and live animals (Table 3 of Fukao, Wu and Yuan 2008). However, in the case of China, 67 percent of its exports were primary products and exports and imports of food stuff and live animals were more or less balanced.

Japan's experience of accomplishing income increase through industrialization and accomplishing industrialization through international specialization has been well analyzed and there is no novelty around this. But when we compare producers' prices and purchasers' prices, which are reported in Fukao, Ma and Yuan (2006) by sector of China and Japan, we can find interesting differences.

Firstly, when we use production side PPPs, China's agricultural, fishery and forestry sector had relatively high productivity both in comparison with Japan's corresponding sector and in comparison with China's other sectors. When we compare labor productivity of two countries' agriculture, forestry and fishery sector using market exchange rate, then China's labor productivity level is 56% of Japan's level (Table 6). But most of this gap is caused by price difference of this sector's products between the two countries. As Table A1 shows, (producers') price level of this sector in China was 58% of Japan's corresponding price level in the case of Fisher average. In the case of grain, China's price level was 31% of Japan's level. Although welfare level of average farmers depends on not only labor productivity but also other factors, such as ownership structure of land and income distribution, it seems that welfare level of farmers in China were not very low in comparison with farmers in Japan. This relatively good performance of China's primary sector might have hindered industrialization in China by slowing down migration of workers to cities.

Secondly, when we compare demand side PPPs, which are based on average prices in major cities, China's food price level was 72% of Japan's food price level in the case of Fisher average. In the case of grain, China's price level was 68% of Japan's level. Gaps in purchasers' prices are much smaller than gaps in producers' prices. Probably we can point out several factors behind this China-Japan difference, such as difference of country size, low labor productivity of China's trade and other service sector (Table 7), low labor productivity of China's food processing industry (Table 8, Fukao, Wu and Yuan 2008), and Japan's active imports of food. Relatively smaller gaps between producers' prices and purchasers' prices in Japan must have contributed to make PPP adjusted real wage rates in Japanese cities much higher than corresponding values in Chinese cities. According to Figure 5 of Allen et al. (2005), welfare ratios in Kyoto-Tokyo, which is measured by nominal wages over food basket price level, was more than two times higher than welfare ratios in Canton and Beijing. This relatively high real wages in Japan's cities must have contributed labor migration to cities.

As we have seen in Table 11, the macro-level productivity gap between the US and Japan is mainly caused by the differences in productivity at sector level. Labor productivity gap is especially large in agriculture. But in all the sectors, Japan's productivity level was less than one third of the US level. What caused this huge productivity gap? In addition to technology gap, capital intensity must have played an important role. Since real wage level in Japan was much lower than that in the US, firms had incentives to choose more labor intensive technology in Japan.

More in this section…

8. Concluding Remarks

To be followed… Please see PPT at the conference.

Appendix 1: Consistency between the production and expenditure PPPs

Since we are dealing with the whole economy using the production PPP approach we face three methodological problems, all related to the consistency and coherence in a national account framework that systematically links production, income and expenditure.

1. All inputs and outputs, classified by product or service transaction, by industry and by sector, must be strictly coherent or integrated in an input-output framework for the whole economy of countries in comparison.
2. Under a closed economy assumption, the constructed PPPs for the final output of the whole economy must be the same as the PPPs for value added of the same economy, which ensures the consistency of the production-side PPPs with the expenditure-side PPPs.
3. However, when the coherence and integration is maintained, the difference between the production and the expenditure PPPs must reflect the terms of trade effect (Feenstra, Heston, Timmer and Deng, 2008), which should be consistent with the observed trade prices.

In Section 3, we did not explicitly take into account the price gaps between domestically produced goods and services and imported goods and services. We now use a schematic input-output table to deal with this issue and the consistency problem between the production-side and expenditure-side PPPs. Let us set up the following notations first: Q = gross output; V = value added; T = indirect tax minus subsidies; A = vectors in the use matrix, identified by the production of "goods (G)", "distribution services (D)" and "other services (S)" in subscripts; E = domestic expenditure; X = exports; M = imports; and P = (producers') prices. We assume a schematic input-output table in producers' prices for country Z, Table 0.a and structure of producers' prices in country Z (country B's price = 1), Table 0.b. To simplify our explanation, we assume that prices of goods and services do not depend on their use.

Table 0.a. Schematic Input-Output Table in Producers' Price for Country *Z*

		Goods	Distribution services	Other services	Domestic expenditure	Exports	Gross output
Domestic products	Goods	A_{GG} (Z)	A_{GD} (Z)	A_{GS} (Z)	E_G (Z)	X_G (Z)	Q_G (Z)
	Distribution services	A_{DG} (Z)	A_{DD} (Z)	A_{DS} (Z)	E_D (Z)	X_D (Z)	Q_D (Z)
	Other services	A_{SG} (Z)	A_{SD} (Z)	A_{SS} (Z)	E_S^D(Z)	X_S (Z)	Q_S (Z)
Imported products	Goods	A_{GG}^M(Z)	A_{GD}^M(Z)	A_{GS}^M(Z)	E_G^M(Z)		
	Distribution services	A_{DG}^M(Z)	A_{DD}^M(Z)	A_{DS}^M(Z)	E_G^M(Z)		
	Other services	A_{SG}^M(Z)	A_{SD}^M(Z)	A_{SS}^M(Z)	E_G^M(Z)		
	Value added	V_G(X)	V_D(Z)	V_S(Z)			
	Indirect tax minus subsidies	T_G(Z)	T_D(Z)	T_S(Z)			
	Gross output	Q_G (Z)	Q_D (Z)	Q_S(Z)			

Table 0.b. Structure of Producers' Prices in Country *Z* (Country *B*'s price = 1)

		Producers' Prices in Country *Z* (Country *B*'s price = 1)
Domestic products	Goods	P_G (Z)
	Distribution services	P_D (Z)
	Other services	P_S (Z)
Imported products	Goods	P_G^M (Z)
	Distribution services	P_D^M (Z)
	Other services	P_S^M (Z)

Note: To simplify our analysis we assume that prices of goods and services do not depend on their use.

In an input-output table framework, we can have the following two identities for total output by (broad) sector:

(A1) $$Q_i^{(Z)} = E_i^{(Z)} + X_i^{(Z)} + \sum_{j=G,D,S} A_{ij}^{(Z)}$$

(A2) $$Q_i^{(Z)} = V_i^{(Z)} + T_i^{(Z)} + \sum_{i=G,D,S} A_{ij}^{(Z)} + \sum_{i=G,D,S} A_{ij}^{M(Z)}$$

Nominal GDP and GDE of country *Z* are then expressed by

(A3) $$GDP^{(Z)} = \sum_{i=G,D,S}\left(Q_i^{(Z)} - \sum_{j=G,D,S}\left(A_{ij}^{(Z)} + A_{ij}^{M(Z)}\right)\right) = \sum_{i=G,D,S}\left(V_i^{(Z)} + T_i^{(Z)}\right)$$

and

(A4) $$GDE^{(Z)} = \sum_{i=G,D,S}\left(E_i^{(Z)} + X_i^{(Z)} - \sum_{j=G,D,S} A_{ij}^{M(Z)}\right)$$

From equations (A1) and (A2), we can have the identity $GDP^{(Z)} = GDE^{(Z)}$ for country *Z*.

Let us now introduce prices. Laspeyres price index for value added of sector *i* in country *Z*, $PL_i^{V(Z)}$ is defined by

(A5) $$PL_i^{V(Z)} = \frac{P_i^{(Z)} Q_i^{(B)} - \sum_{j=G,D,S}\left(P_j^{(Z)} A_{ij}^{(B)} + P_j^{M(Z)} A_{ij}^{M(B)}\right)}{Q_i^{(B)} - \sum_{j=G,D,S}\left(A_{ij}^{(B)} + A_{ij}^{M(B)}\right)}$$

where variables with (*B*) denote values for country *B*.

Paasche price index for value added of sector *i* in country *Z*, $PP_i^{V(Z)}$ is defined by

(A6) $$PP_i^{V(Z)} = \frac{1}{\dfrac{\dfrac{Q_i^{(Z)}}{P_i^{(Z)}} - \sum_{j=G,D,S}\left(\dfrac{A_{ij}^{(Z)}}{P_j^{(Z)}} + \dfrac{A_{ij}^{M(Z)}}{P_j^{M(Z)}}\right)}{Q_i^{(Z)} - \sum_{j=G,D,S}\left(A_{ij}^{(Z)} + A_{ij}^{M(Z)}\right)}}$$

Therefore, PPP for the value added of sector *i* in country *Z* is defined as a Fisher geometric mean:

(A7) $$PPP_i^{V(Z)} = \sqrt{PL_i^{V(Z)} \cdot PP_i^{V(Z)}}$$

Finally, we can define the PPP for GDP of country *Z* based on the Laspeyres and Paasche indices, that is,

(A8) $$PL^{GDP(Z)} = \frac{\sum_{i=G,D,S} P_i^{(Z)} Q_i^{(B)} - \sum_{i=G,D,S}\sum_{j=G,D,S}\left(P_j^{(Z)} A_{ij}^{(B)} + P_j^{M(Z)} A_{ij}^{M(B)}\right)}{\sum_{i=G,D,S} Q_i^{(B)} - \sum_{i=G,D,S}\sum_{j=G,D,S}\left(A_{ij}^{(B)} + A_{ij}^{M(B)}\right)}$$

and

(A9) $$PP^{GDP(Z)} = \frac{1}{\dfrac{\sum\limits_{i=G,D,S} \dfrac{Q_i^{(Z)}}{P_i^{(Z)}} - \sum\limits_{i=G,D,S} \sum\limits_{j=G,D,S} \left(\dfrac{A_{ij}^{(Z)}}{P_j^{(Z)}} + \dfrac{A_{ij}^{M(Z)}}{P_j^{M(Z)}} \right)}{\sum\limits_{i=G,D,S} Q_i^{(Z)} - \sum\limits_{i=G,D,S} \sum\limits_{j=G,D,S} \left(A_{ij}^{(Z)} + A_{ij}^{M(Z)} \right)}},$$

PPP for the GDP of country *Z* is then defined as a Fisher geometric mean of the two price indices:

(A10) $$PPP^{GDP(Z)} = \sqrt{PL^{GDP(Z)} \cdot PP^{GDP(Z)}}.$$

Similarly, the Laspeyres and Paasche price indices for the GDE of country *Z*, $PL^{GDE(Z)}$ and $PP^{GDE(Z)}$, can be defined as follows:

(A11) $$PL^{GDE(Z)} = \frac{\sum\limits_{i=G,D,S} \left(P_i^{(Z)} E_i^{(B)} + P_i^{(Z)} X_i^{(B)} - \sum\limits_{j=G,D,S} P_i^{M(Z)} A_{ij}^{M(B)} \right)}{\sum\limits_{i=G,D,S} \left(E_i^{(B)} + X_i^{(B)} - \sum\limits_{i=G,D,S} A_{ij}^{M(B)} \right)}$$

and

(A12) $$PP^{GDE(Z)} = \frac{1}{\dfrac{\sum\limits_{i=G,D,S} \left(\dfrac{E_i^{(Z)}}{P_i^{(Z)}} + \dfrac{X_i^{(Z)}}{P_i^{(Z)}} - \sum\limits_{j=G,D,S} \dfrac{A_{ij}^{M(Z)}}{P_i^{M(Z)}} \right)}{\sum\limits_{i=G,D,S} \left(E_i^{(Z)} + X_i^{(Z)} - \sum\limits_{j=G,D,S} A_{ij}^{M(Z)} \right)}}$$

Therefore, the PPP for the GDE of country Z can be obtained by a Fisher geometric mean:

(A13) $$PPP^{GDE(Z)} = \sqrt{PL^{GDE(Z)} \cdot PP^{GDE(Z)}}$$

In a nutshell, based on Equations (A1) and (A2) we can derive the identity $PPP^{GDP(Z)} = PPP^{GDE(Z)}$ and based an input-output framework, we can conceptually prove that an estimated production-side PPP must be equal to an estimated expenditure-side PPP, that is, $PPP^{GDP(Z)} = PPP^{GDE(Z)}$. This conceptual set up is important for checking up discrepancy in empirical results and identifying potential problems although it is highly data demanding.

APPENDIX 2: DATA SOURCES, PROBLEMS AND TREATMENT

(To be completed…)

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APPENDIX 3: DETAILS OF PPP ESTIMATION FOR THE CASE OF CHINA/JAPAN

TABLE A1: CHINESE PRICE LEVEL (JAPANESE LEVEL = 1), MANUFACTURING SECTOR

		Japanese weight			Chinese weight			Japanese		Chinese			Chinese/Japanese	Chinese price level		
		I	II	III	I	II	III	Units	Prices	Units	Prices	source		Japanese weight	Chinese weight	Fisher average
														exchang rate Yen/Yuan=0.88		
All industries														**1.547**	**1.001**	**1.244**
Food and kindred products		*0.108*			0.251									0.967	0.647	0.791
Liquor			*0.494*			0.234								0.615	0.666	0.640
	Liquor (Bai jiu)			*0.768*			0.500	*100L*	40.057	*dan*	9.445	*b*	0.536			
	Beer			*0.232*			0.500	*100L*	46.599	*dan*	18.000	*b*	0.878			
Flour and Starch			*0.217*			0.497								0.513	0.513	0.513
	Wheat flour			*1.000*			1.000	*kg*	0.152	*50kg*	1.710	*a*	0.513			
Cooking oil			*0.044*			0.134								0.862	0.763	0.811
	Rap oil			*0.475*			0.340	*kg*	0.367	*dan*	13.646	*b*	0.844			
	Sesame oil			*0.081*			0.330	*kg*	0.508	*dan*	13.327	*b*	0.596			
	Soybean oil			*0.444*			0.330	*kg*	0.356	*dan*	14.537	*a*	0.929			
Sugar			*0.173*			0.019								0.803	0.949	0.873
	Brown sugar			*0.130*			0.500	*kg*	0.230	*dan*	14.500	*a*	1.430			
	White sugar			*0.870*			0.500	*kg*	0.239	*dan*	7.453	*a*	0.710			
Salt			*0.037*			0.036								6.985	6.985	6.985
	Salt			*1.000*			1.000	*kg*	0.046	*dan*	14.070	*a*	6.985			
Tea			*0.020*			0.008								3.345	3.869	3.597
	Green tea			*0.943*			0.500	*kg*	0.524	*dan*	75.125	*b*	3.259			
	Black tea			*0.057*			0.500	*kg*	0.533	*dan*	111.708	*b*	4.760			
Other food			*0.015*			0.073								3.282	3.282	3.282
	Ice			*1.000*			1.000	*kg*	6.306	*tor*	18.211	*a*	3.282			
Textiles and their products		*0.310*			**0.474**									1.778	1.371	1.561
Silk			*0.160*			0.117								0.929	0.929	0.929
	Raw silk			*1.000*			1.000	*kg*	11.352	*dan*	463.963	*a*	0.929			
Yarn			*0.367*			0.502								1.003	1.137	1.068
	Cotton			*0.748*			0.340	*kg*	1.247	*jian*	162.100	*a*	0.814			
	Silk			*0.058*			0.330	*kg*	5.847	*dan*	323.951	*a*	1.259			
	Woolen			*0.194*			0.330	*kg*	2.437	*jian*	642.301	*a*	1.651			
Fabrics			*0.431*			0.268								2.761	2.840	2.800
	Cotton twill			*0.135*			0.295	*m*	0.132	*shichi*	0.087	*b*	2.250			
	Poplin			*0.125*			0.295	*m*	0.177	*shichi*	0.166	*b*	3.200			
	Calico			*0.269*			0.295	*tan(10m)*	0.526	*shichi*	0.062	*b*	4.018			
	Serge			*0.471*			0.114	*m*	1.617	*m*	2.948	*b*	2.072			
Knitgoods			*0.024*			0.082								1.612	1.612	1.612
	Cotton underwear			*1.000*			1.000	*dozen*	3.957	*dozen*	5.613	*b*	1.612			
Cotton			*0.018*			0.030								1.834	1.834	1.834
	Cotton wadding			*1.000*			1.000	*kg*	0.592	*dan*	47.782	*a*	1.834			
Wood products		*0.023*			0.003									0.964	0.964	0.964
Wood board			*1.000*	*1.000*		1.000	1.000	*3.3sq,m*	1.980	*3.3sq.m*	1.680	*d*	0.964	0.964	0.964	0.964

		Japanese weight			Chinese weight			Japanese		Chinese		source	Chinese/Japanese	Chinese price level		
		I	II	III	I	II	III	Units	Prices	Units	Prices			Japanese weight	Chinese weight	Fisher average
														exchang rate Yen/Yuan=0.88		
Paper and allied industries		***0.041***			0.045									1.368	1.205	1.284
Paper			***0.827***	***1.000***		0.542	1.000	*kg*	0.232	*kg*	0.294	***c***	1.443	1.443	1.443	1.443
Paperboard			***0.173***	***1.000***		0.458	1.000	*kg*	0.104	*kg*	0.093	***c***	1.008	1.008	1.008	1.008
Chemicals and allied products		***0.147***			0.070									2.010	0.859	1.314
Acid			***0.292***			0.015								2.956	2.900	2.928
	Sulfuric acid			***0.758***			0.740	*tons*	38.087	*tons*	92.247	***a***	2.752			
	Hydrochloric acid			***0.069***			0.250	*tons*	36.934	*50kg*	5.553	***b***	3.417			
	Nitric acid			***0.173***			0.009	*tons*	110.220	*tons*	355.420	***a***	3.664			
Soda			***0.082***			0.105								0.873	0.987	0.929
	Carbonated soda			***0.048***			0.334	*kg*	0.126	*tons*	99.562	***a***	0.900			
	Caustic soda			***0.829***			0.333	*kg*	149.906	*tons*	99.562	***a***	0.755			
	Bleaching powder			***0.123***			0.333	*tons*	67.397	*50kg*	4.928	***b***	1.662			
Other industrial chemicals			***0.066***			0.044								3.333	1.872	2.498
	Naphthalene			***0.266***			0.250	*kg*	0.085	*tons*	221.452	***b***	2.977			
	Alcohol			***0.208***			0.250	*kg*	0.756	*加仑*	1.114	***a***	8.844			
	Silicate			***0.355***			0.250	*kg*	0.070	*dan*	4.616	***a***	1.500			
	Alum			***0.170***			0.250	*kg*	77.818	*tons*	67.034	***b***	0.979			
Dye, Paint and Pigment			***0.082***			0.130								2.052	0.912	1.368
	Blue sulfide			***0.492***			0.334	*kg*	0.370	*jin*	0.421	***a***	2.587			
	Lacquer			***0.095***			0.333	*kg*	3.252	*pounds*	0.553	***a***	0.426			
	Paint			***0.413***			0.333	*kg*	0.540	*pounds*	0.385	***a***	1.788			
Oil			***0.087***			0.010								3.774	1.947	2.711
	Gasoline			***0.255***			0.200	*tons*	59.976	*kg*	0.323	***b***	6.120			
	Kerosene			***0.178***			0.200	*tons*	61.487	*kg*	0.218	***b***	4.029			
	Lubricants			***0.470***			0.200	*tons*	91.928	*kg*	0.211	***b***	2.608			
	Asphalt			***0.068***			0.200	*tons*	27.636	*tons*	89.982	***b***	3.700			
	Gelatin			***0.029***			0.200	*kg*	1.149	*dan*	33.644	***a***	0.665			
Vegetable oil and fat			***0.045***			0.016								1.040	1.170	1.103
	Cotton seed oil			***0.572***			0.334	*kg*	0.339	*dan*	10.671	***b***	0.715			
	Coconut oil			***0.419***			0.333	*kg*	0.274	*tons*	352.603	***b***	1.460			
	Tung oil			***0.009***			0.333	*kg*	0.427	*dan*	39.294	***b***	2.092			
Fertilizer			***0.191***			0.401								0.681	0.681	0.681
	Bean cake			***1.000***			1.000	*tons*	80.573	*dan*	2.415	***a***	0.681			
Soap			***0.030***			0.121								1.001	1.001	1.001
	Soap			***1.000***			1.000	*kg*	0.189	*box(30kg)*	5.000	***a***	1.001			
Pulp			***0.028***			0.007								2.789	2.789	2.789
	Pulp			***1.000***			1.000	*kg*	93.260	*tons*	228.914	***a***	2.789			
Tannery			***0.047***			0.081								0.777	0.844	0.810
	Cowhide			***0.800***			0.500	*pieces*	7.660	*pieces*	3.874	***a***	0.575			
	Acacia extract			***0.200***			0.500	*kg*	0.428	*gong-dan*	59.679	***a***	1.586			
Coke, coal			***0.052***			0.070								0.789	0.817	0.803
	Coke			***0.763***			0.500	*tons*	14.995	*tons*	10.040	***a***	0.761			
	Coal			***0.237***			0.500	*kg*	20.753	*tons*	16.090	***b***	0.881			

		Japanese weight			Chinese weight			Japanese		Chinese			Chinese/Japanese	Chinese price level		
		I	II	III	I	II	III	Units	Prices	Units	Prices	source		Japanese weight	Chinese weight	Fisher average
														exchang rate Yen/Yuan=0.88		
Stone, clay, and glass products		*0.026*			0.032									1.242	0.876	1.043
Glass			***0.284***			0.141								0.997	0.997	0.997
	Glass plate			***1.000***			1.000	*box*	7.567	*box*	6.640	***b***	0.997			
Brick and Tile			***0.131***			0.207								0.936	0.893	0.914
	Black brick			***0.127***			0.334	*numbers*	0.014	*numbers*	0.008	***a***	0.648			
	Common brick			***0.724***			0.333	*numbers*	0.071	*numbers*	0.046	***a***	0.742			
	Tile			***0.148***			0.333	*numbers*	0.043	*10000ge*	807.117	***b***	2.135			
Cement			***0.420***			0.430						***b***		0.610	0.610	0.610
	Cement			***1.000***			1.000	*barrel*	3.213	*tons*	38.192		0.610			
Lime			***0.025***			0.014								4.074	4.074	4.074
	Lime			***1.000***			1.000	*tons*	6.997	*dan*	1.254	***a***	4.074			
Enamelware			***0.140***			0.208								3.417	3.417	3.417
	Washbasin or Cup			***1.000***			1.000	*numbers*	0.082	*dozen*	2.957	***b***	3.417			
Metals and metal products		*0.174*			0.046									1.392	0.984	1.171
Metal smelting materials			***0.714***			0.113								1.501	1.414	1.457
	Pig iron			***0.079***			0.250	*tons*	35.956	*tons*	64.477	***b***	2.038			
	Steel Plate			***0.777***			0.250	*kg*	0.093	*tons*	124.458	***b***	1.524			
	Copper casting, rough			***0.090***			0.125	*tons*	738.087	*tons*	624.542	***b***	0.962			
	Tinplate			***0.014***			0.125	*kg*	0.303	*tons*	351.677	***b***	1.317			
	Lead			***0.012***			0.125	*kg*	0.253	*dan*	14.592	***a***	1.309			
	Aluminum			***0.027***			0.125		1.507	*tons*	1653.450	***b***	1.247			
Casting			***0.077***			0.095								1.334	1.334	1.334
	Cast-iron pipe			***1.000***			1.000	*kg*	0.089	*pounds*	0.047	***a***	1.334			
Other metal products			***0.209***			0.792								1.040	0.916	0.976
	Nail			***0.649***			0.250	*barrel*	7.097	*pounds*	0.059	***a***	0.937			
	Nib			***0.083***			0.250	*gorss*	4.200	*gross*	1.950	***b***	0.528			
	Umbrella bone			***0.060***			0.250	*dozen*	1.274	*dozen*	1.556	***a***	1.388			
	Zinc plate			***0.208***			0.250	*kg*	0.186	*tons*	239.417	***b***	1.462			
Machinery		*0.135*			0.049									1.216	1.490	1.346
Machinery			***0.721***			0.171								0.941	0.993	0.967
	Generators			***0.230***			0.300	*numbers*	997.064	*numbers*	514.771	***a***	0.587			
	Motor *			***0.754***			0.300	*numbers*	115.957	*numbers*	104.882	***b***	1.028			
	Fans			***0.016***			0.400	*numbers*	20.1114199	*numbers*	34.701	***a***	1.961			
Battery and Light bulb			***0.026***			0.266								2.111	1.259	1.630
	Accumulator			***0.050***			0.300	*numbers*	14.5719917	*numbers*	22.500	***b***	1.755			
	Battery			***0.278***			0.300	*numbers*	0.11980473	*dozen*	0.794	***a***	0.628			
	Light bulb			***0.672***			0.400	*numbers*	0.065	*numbers*	0.158	***a***	2.751			
			0.026			0.266								2.753	2.151	2.433
	Thermometer			***0.063***			0.300	*numbers*	0.575	*numbers*	2.000	***b***	3.950			
	AC voltage table			***0.380***			0.300	*numbers*	13.665	*numbers*	12.750	***b***	1.060			
	Clock			***0.557***			0.400	*numbers*	1.594	*numbers*	5.290	***a***	3.771			
Vehicle			***0.226***			0.296								1.811	1.811	1.811
	Bicycle			***1.000***			1.000	*numbers*	24.768	*numbers*	39.475	***a***	1.811			

	Japanese weight			Chinese weight			Japanese		Chinese			Chinese/Japanese	Chinese price level		
	I	II	III	I	II	III	Units	Prices	Units	Prices	source		Japanese weight	Chinese weight	Fisher average
													exchang rate Yen/Yuan=0.88		
Miscellaneous industries	***0.035***			0.031									2.221	1.165	1.608
Thermos bottle	***0.125***	***1.000***			**0.125**	1.000	*numbers*	0.331	*numbers*	0.628	***a***	2.160	2.160	2.160	2.160
Toothbrush	***0.125***	***1.000***			**0.125**	1.000	*dozen*	0.491	*numbers*	0.162	***a***	4.505	4.505	4.505	4.505
Handkerchief	***0.125***	***1.000***			**0.125**	1.000	*dozen*	0.476	*dozen*	0.202	***a***	0.482	0.482	0.482	0.482
Straw hat	***0.125***	***1.000***			**0.125**	1.000	*dozen*	3.634	*dozen*	16.926	***a***	5.293	5.293	5.293	5.293
Matches	***0.125***	***1.000***			**0.125**	1.000	*gross*	0.383	*box*	54.356	***a***	0.806	0.806	0.806	0.806
Pen	***0.125***	***1.000***			**0.125**	1.000	*dozen*	12.247	*dozen*	17.01	***b***	1.578	1.578	1.578	1.578
Pencil	***0.125***	***1.000***			**0.125**	1.000	*dozen*	0.071	*dozen*	0.145	***b***	2.322	2.322	2.322	2.322
Parasol	***0.125***	***1.000***			**0.125**	1.000	*numbers*	2.373	*donzen*	15.505	***a***	0.619	0.619	0.619	0.619
												89.000			

TABLE A2: CHINESE PRICE LEVEL (JAPANESE LEVEL = 1), AGRICULTURE, MINING, UTILITIES, SERVICES

	Chinese weight			Japanese weight			Chinese		Japanese				Chinese price level		
	I	II	III	I	II	III	Unit	Price Yuan	Unit	Price Yen	Source	Chinese/ Japanese	Japanese weight	Chinese weight	Fisher average
農林水産												ER Yen/Yu	0.63	0.50	0.56
耕作農業	***0.76***			***0.66***									**0.53**	**0.42**	**0.47**
穀物類		***0.64***			***0.63***								**0.30**	**0.33**	**0.31**
稲 糯稲を含む)			*0.60*			*0.84*	*tons*	40.7	*koku*	28.0		0.247			
小 麦			*0.20*			*0.07*	*tons*	60.0	*koku*	13.6		0.687			
トウモロコシ			*0.04*			*0.00*	*tons*	39.9	*koku*	9.8		0.606			
大 麦			*0.02*			*0.03*	*tons*	31.2	*koku*	7.8		0.492			
燕 麦			*0.00*			*0.01*	*tons*	29.2	*koku*	5.0		0.737			
裸 麦			*0.00*			*0.04*	*tons*	31.2	*koku*	11.7		0.421			
蕎 麦			*0.00*			*0.00*	*tons*	31.2	*koku*	9.7		0.412			
Other Grains			*0.14*			*0.01*	*tons*	51.8	*koku*	10.0		0.696			
イモ類		***0.05***			***0.08***								**1.21**	**0.92**	**1.06**
ジャガイモ			*0.20*			*0.29*	*tons*	48.8	*senkan*	94.7		2.196			
サツマイモ			*0.80*			*0.71*	*tons*	15.2	*senkan*	80.1		0.808			
豆類		***0.07***			***0.02***								**0.53**	**0.53**	**0.53**
大 豆			*0.30*			*0.50*	*tons*	55.8	*koku*	15.2		0.539			
落花生			*0.20*			*0.03*	*tons*	76.3	*100kin*	9.1		0.574			
エンドウ豆			*0.12*			*0.11*	*tons*	45.7	*koku*	18.6		0.377			
ソラ豆			*0.13*			*0.08*	*tons*	49.5	*koku*	12.5		0.569			
その他豆類			*0.24*			*0.28*	*tons*	68.5	*koku*	19.3		0.568			
蔬菜・果物		***0.12***			***0.09***								**1.61**	**1.60**	**1.61**
蔬 菜			*0.69*			*0.73*	*tons*	51.8	*100kan*	12.9		1.502			
果 物			*0.31*			*0.27*	*tons*	133.0	*100kan*	26.4		1.890			
園芸作物		***0.11***			***0.17***								**0.51**	**0.77**	**0.63**
胡 麻			*0.04*			*0.00*	*tons*	102.3	*koku*	24.9		0.462			
菜 種			*0.12*			*0.03*	*tons*	89.4	*koku*	15.3		1.098			
綿 花			*0.28*			*0.00*	*tons*	497.9	*100kan*	114.6		1.629			
麻			*0.04*			*0.01*	*tons*	300.0	*100kan*	167.4		0.672			
葉煙草			*0.30*			*0.09*	*tons*	339.0	*100kan*	234.4		0.542			
サトウキビ			*0.09*			*0.02*	*tons*	7.0	*senkin*	5.6		0.749			
毛 茶			*0.08*			*0.05*	*tons*	514.0	*100kan*	191.2		1.008			
繭			*0.06*			*0.79*	*tons*	500.0	*100kan*	427.5		0.439			
畜産	***0.21***			***0.17***									**0.58**	**0.57**	**0.58**
家畜平均			*0.97*			*0.89*	*head*	22.9	*head*	101.6		0.572			
鶏卵			*0.03*			*0.11*	*1000 (N*	14.0	*1000 (No.*	21.9		0.638			
林業	***0.02***			***0.10***									**0.96**	**0.96**	**0.96**
Wood board			*1.00*			*1.00*	*3.3sq.m*	2.0	*3.3sq.m*	1.7	FWY	0.964			
水産業	***0.01***			***0.07***									**1.22**	**0.71**	**0.93**
Fresh fish			0.80			0.50	kg	0.38	kg	0.71		0.609			
Salty fish			0.20			0.50	kg	1.85	kg	1.15		1.835			

	Chinese weight			Japanese weight			Chinese		Japanese			Chinese/ Japanese	Chinese price level		
	I	II	III	I	II	III	Unit	Price Yuan	Unit	Price Yen	Source		Japanese weight	Chinese weight	Fisher average
鉱業													0.85	0.92	0.88
金属鉱産	0.19			0.33									0.72	0.71	0.72
鉄鉱石			0.15			0.09	tons	2.8	tons	10.0		0.279			
マンガン			0.00			0.01	tons	9.9	tons	13.7		0.724			
金			0.26			0.40	g	2.7	g	3.1		0.864			
銀			0.01			0.13	g	0.0	g	0.1		0.541			
銅			0.02			0.37	tons	549.0	tons	741.5		0.740			
鉛鉱石			0.01			0.00	tons	97.5	tons	65.2		1.495			
亜鉛鉱石			0.00			0.00	tons	7.0	tons	2.1		3.368			
錫			0.47			0.00	tons	2327.0	tons	2074.3		1.122			
水銀			0.00			0.00	tons	3212.0	tons	5414.6		0.593			
アンチモン			0.07			0.00	tons	201.0	tons	235.3		0.854			
石油石炭	0.60			0.65									0.86	0.78	0.82
石炭			0.93			0.96	tons	5.3	tons	7.2		0.738			
石油			0.07			0.04	tons	125.3	tons	34.2		3.668			
非金属鉱	0.22			0.02									2.09	2.04	2.07
石膏			0.50			0.50	tons	17.0	tons	9.6		1.767			
硫黄			0.50			0.50	tons	150.0	tons	62.1		2.415			
建設業	Chinese				Japanese								0.93	0.82	0.87
材料	0.50			0.50									1.20	1.05	1.12
Wood products		0.06			0.23								0.96	0.96	0.96
Wood board			1.00			1.00	3.3sq.m	2.0	3.3sq.m	1.7	d	0.964			
Stone, clay, and glass products		0.62			0.26								1.24	0.88	1.04
Glass plate			0.14			0.28	box	7.6	box	6.6	b	0.997			
Black brick			0.07			0.02	numbe.	0.0	numbers	0.0	a	0.648			
Common brick			0.07			0.09	numbe.	0.1	numbers	0.0	a	0.742			
Tile			0.07			0.02	numbe.	0.0	10000ge	807.1	b	2.135			
Cement			0.43			0.42	barrel	3.2	tons	38.2		0.610			
Lime			0.01			0.02	tons	7.0	dan	1.3	a	4.074			
Washbasin or Cup			0.21			0.14	numbe.	0.1	dozen	3.0	b	3.417			
Metals and metal products		0.32			0.51								1.28	1.10	1.19
Pig iron			0.08			0.19	tons	36.0	tons	64.5	b	2.038			
Tinplate			0.04			0.03	kg	0.3	tons	351.7	b	1.317			
Aluminum			0.04			0.06	kg	1.5	tons	1653.5	b	1.247			
Cast-iron pipe			0.27			0.26	kg	0.1	pounds	0.0	a	1.334			
Nail			0.57			0.45	barrel	7.1	pounds	0.1	a	0.937			
Wage	0.50			0.50									0.65	0.65	0.65
Sawer's wage b)			0.50			0.50	daily	0.7	# daily	0.9		0.733			
Carpenter's wage b)			0.50			0.50	daily	0.6	# daily	1.0		0.577			

	Chinese weight			Japanese weight			Chinese		Japanese				Chinese price level		
	I	II	III	I	II	III	Unit	Price Yuan	Unit	Price Yen	Source	Chinese/ Japanese	Japanese weight	Chinese weight	Fisher average
交通 ·公益													0.48707	0.56898	0.52643
Public utilitis		***0.10***			***0.35***								**1.31**	**0.00**	**1.31**
Electricity a)			*1.00*			*1.00*	*1*kwh	0.2	*1*kwh	0.1		1.314			
Transportation and communications		***0.90***			***0.65***								**0.75**	**0.35**	**0.51**
Rickshaw pullers' wage *b)*			*0.50*			*0.50*	*daily*	0.5	*daily*	2.7		0.202			
Average railroad fares per passenge			*0.50*			*0.50*	*per pa:*	0.0	*per passe*	0.0		1.297			
												3.000			
商業サービス													0.615	0.5789746	0.5965598
金融・不動産	***0.29***			***0.25***									**0.38**	**0.38**	**0.38**
			1.00		1.00	*1.00*	*1 room*	1.7	*1 room (*	5.1		0.384			
商業サービス	***0.63***			***0.41***									**0.77**	**0.77**	**0.77**
All tradable goods of					1.00										
Services	***0.08***			***0.34***									**0.60**	**0.43**	**0.51**
Teachers' wage *b)*			*0.25*			*0.25*	*month.*	12.5	*monthly*	65.9		0.190			
Haircut *f)*			*0.25*			*0.25*	*once*	0.3	*once*	0.4		0.750			
Movie *h)*			*0.25*			*0.25*	*once*	0.2	*once*	0.3		0.667			
Newspapers *h)*			*0.25*			*0.25*	*1 set*	0.0	*1 set*	0.1		0.800			