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Regional Inequality and Industrial Structures in Pre-War Japan: An Analysis Based on New Prefectural GDP Estimates

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Abstract

Studies comparing regional income in Japan before and after World War II have frequently drawn a picture of radical change from an economy characterized by large regional disparities to one characterized by small regional disparities. This paper comes to a very different conclusion. Based on estimates of prefecture-level value added for five benchmark years from 1890 to 1940 (a detailed description of our estimation methodology is provided), we examine trends in the gap of economic development between prefectures during the pre-war period and find that this gap was much smaller than claimed in preceding studies and, in fact, not much greater than during the post-war period. Observing, moreover, a decline in inter-prefectural differences in terms of per-capita gross value added during the pre-war period, we conduct a factor analysis and find that a major reason for this decline was a decline in inter-prefectural differences in same-industry labor productivity. Thus, the picture of modern Japan's economic development presented here is very different from the one painted by preceding studies.

JEL classification codes: N15, O18, O47

Gross Prefectural Product and Industrial Structure in Pre-War Japan[*]

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1. Introduction

The first non-Western nation to achieve industrialization and sustained, and often rapid, economic growth, Japan occupies a unique place in the economic history of Asia. Much has been written about the country's early efforts at industrialization and even more about its post-war success. Yet, although the broad pattern of economic development during those early years, following the Meiji Restoration of 1868, is well documented at the national level – not least thanks to the efforts of those compiling the Long-Term Economic Statistics (LTES) of Japan at Hitotsubashi University – not much is known about the regional pattern of development, largely due to a lack of necessary data. This lack of data has resulted in pre-war Japan frequently being described as characterized by large regional disparities, which are often contrasted with small regional disparities during the post-war period.

Against this background, we, together with other researchers at Hitotsubashi University, have been making efforts to compile economic and other statistics for the 47 prefectures of Japan for the period from the early Meiji Period (1868-1912) to the outbreak of World War II. The present paper presents the first, interim results of our attempt to estimate prefectural output (gross prefectural

product, or "prefectural GDP" hereafter), populations, and employment, together with a detailed explanation of our estimation methodology and sources. In addition, we present a few simple analyses of inter-regional disparities using our estimation results. These analyses suggest that disparities among prefectures in terms of per-capita gross value added during the pre-war period were much smaller than claimed in preceding studies and, in fact, not much greater than during the post-war period, thus contradicting the results presented in preceding studies, which paint a picture of great regional inequality.

As is well known, in the national (or prefectural) accounts, gross domestic (or prefectural) product can be estimated from three sides, that is, the production, income, and expenditure side. In the estimation of historical national accounts (e.g., Mizoguchi, 2008), GDP is often estimated from the production and income side, gross domestic expenditure from the expenditure side, and the validity of the estimation is confirmed by comparing the two estimates. However, because sufficient statistics with regard to trade in goods and services between regions within one country are not available, retroactive long-term estimation of gross prefectural product using the expenditure approach is extremely difficult. Accordingly, we decided to estimate prefectural GDP wholly from the production and income sides.

A by-product of estimating prefectural GDP from the production side is that it becomes possible to estimate prefectures' industrial structure. Consequently, we estimate nominal and real gross value added, gross output, and intermediate input by prefecture with regard to 16 industries covering the whole economy. In addition, we estimate the number of occupied persons by eight slightly more aggregated industries plus the number of non-occupied persons. (However, for 1890, data are available only for the construction industry; transport, communication, and utilities; and the domestic trade and service sector).

Compared with other Asian countries, Japan from the Meiji Period onward is a treasure house of statistics and a large amount of prefectural data are available, such as the *Fuken Tokei Sho* [Prefectural Statistics] published annually by each prefecture as well as aggregate tables by prefecture of various statistical surveys, such as the *Kojo Tokei Hyo* [Factory Statistics]. The data we have been able to input and process so far represent only a fraction of the available material and there is still much room for improvement in our estimates. The estimation results presented here therefore should be regarded as an interim report on our long-term project of estimating prefectural GDPs. Yet, as far as we are aware, this is the first study on pre-war Japan to estimate GDP and industrial structure at the prefectural level that covers a period as long as the one considered here and that makes available details of the estimation methods and underlying data.[1] Thus, although it

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[1] The gross value added and number of employed persons by industry, prefecture, and year estimated in this paper will be published on the Hi-Stat Global COE website (http://gcoe.ier.hit-u.ac.jp/) in the near future.

represents a work in progress, we think that this study makes a significant contribution to research on economic development in Japan in particular and East Asia more generally.

As will be explained later, we have been able to construct data on prefectural GDPs and industrial structures from 1890 onward. In 1890, Japan was still a relatively poor country at an early, agrarian stage of economic development, providing a useful vantage point for the analysis of inter-regional differences in income and industrial structure.[2] For example, Japan's railroad network at this time was still in its infancy, with the Tokaido Line (1889) connecting Tokyo, Yokohama, Kyoto, Osaka and Kobe having been completed only a year earlier. Moreover, Japan's exports still resembled those of a typical developing country, consisting largely of primary products and raw silk.[3] According to estimates by Maddison (2003), Japan's per capita GDP in 1890 was 1,012 dollars (1990 international Geary-Khamis dollars), and thus below that of the United States seventy years earlier, which was 1,133 dollars in 1820.

The remainder of this paper is organized as follows. In the next section, we explain the basic strategy of our estimation. In the following sections we then explain the methodology and sources for the estimation of prefectural GDPs and industrial structures and report the main results thus obtained. Specifically, Section 3 deals with agriculture, forestry, and fishery, Section 4 deals with mining and manufacturing, and Section 5 deals with construction and tertiary industries (domestic trade and services; construction; and transport, communication, and utilities). Next, Section 6 reports the methodology and results for our estimation of prefectural populations and numbers of occupied persons, and Section 7 then examines trends in inter-regional income differences based on the prefectural GDP estimates. Section 8 takes a deeper look at the sources of inter-regional income differences during the pre-war period from the viewpoint of industrial structure and labor productivity. Finally, Section 9 provides a simple summary of the results obtained in this paper.

2. Basic estimation strategy

This section outlines our basic strategy for the estimation.

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[2] Vivid examples of inter-regional differences around this period can be found in the novel "Botchan" by Natsume Soseki, who arrived in his new post as English teacher at Matsuyama Junior High School in 1895. The novel caricatures the culture shock experienced by the main character (Botchan), who was born and raised in Tokyo, when living in a regional town.

[3] Primary goods accounted for 25 percent and raw silk thread for 45 percent of Japan's exports in 1892 (Yukizawa and Maeda, 1978).

2.1 Geographical division

At present, Japan is divided into 47 prefectures.[4] For the purpose of our analysis, we also applied this geographical division to the pre-war period. As a result of the abolition of feudal domains and the establishment of prefectures in 1871 (Meiji 4), 3 *fu* (metropolitan prefectures) and 306 *ken* (prefectures) were established in the country as a whole, which were subsequently merged into 3 *fu* and 35 *ken*.[5] However, as a result of popular movements to resurrect certain old prefectures, some were restored, and when eventually the prefectural system was officially proclaimed in 1890 (Meiji 23), Japan was organized into 3 *fu*, 43 *ken*, and 1 *do*, Hokkai-do, which at that time was under direct control of the central government. This means that for the period from 1890 onward, on which we concentrate, the administrative division of Japan remained almost unchanged; the only adjustments of prefectural territories we needed to make were for the three counties (*gun*) of Kita-Tama, Minami-Tama, and Nishi-Tama, control of which was transferred from Kanagawa prefecture to Tokyo-fu in 1893.

However, for manufacturing industry, we also conducted estimates for the year 1874. This means that we had to adjust our data to match the administrative divisions in 1874 to the 47 prefectures today. We did so by tracing changes in the prefectural "affiliation" of individual counties (*gun*) and adjusted prefectural data using information on the population of each *gun*, assuming that industrial production and industrial structure per capita were identical in all counties of a prefecture. We proceeded in a similar fashion with regard to the three counties of Tama-gun when these were transferred to Tokyo-fu in 1983 (see above).[6]

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[4] Strictly speaking, there are 47 administrative divisions, consisting of Tokyo-to, Hokkai-do, Osaka-fu, Kyoto-fu, and 43 other prefectures (*ken*).

[5] However, the Ryukyu Kingdom was formally annexed by Japan only in 1872 and renamed Ryukyu Domain, before becoming Okinawa Prefecture in 1879. On the other hand, Hokkaido did not become a prefecture on equal terms with other prefectures until 1947, but instead was first governed by the Development Commission (Kaitaku-shi) established by the Meiji government (1869-1882) and then, following a brief division into three prefectures, by the Hokkaido Agency (1886-1947).

[6] The inaccuracies resulting from these adjustments are likely to be minor. In its estimates of agricultural production in Korea from 1910-1970, Data Processing Section (Tokei Gakari) of the Institute of Economic Research of Hitotsubashi University (1980), for example, takes account of changes in the territory of several *do* (districts) in Korea using both the area of land under cultivation and the population for adjustments, and finds that the two estimates are quite close.

2.2 Industry classification

As mentioned earlier, a by-product of estimating prefectural GDP from the supply side is that it becomes possible to estimate prefectures' industrial structure. Specifically, we estimated gross value added at market prices for 16 industries that cover Japan's economy as a whole. The 16 industries are as follows:

Agriculture, forestry and fisheries (3): (i) agriculture; (ii) forestry; (iii) fisheries.
Mining and manufacturing (10): (iv) mining; (v) food products; (vi) textiles; (vii) lumber and wood products; (viii) printing and publishing; (ix) chemicals; (x) stone, clay and glass products; (xi) metal and metal products; (xii) machinery; (xiii) miscellaneous.
Construction and tertiary industries (3): (xiv) domestic trade and service industries; (xv) construction; (xvi) transport, communication, and utilities.

Moreover, we estimated the number of occupied (and non-occupied) persons by prefecture and type of occupation, distinguishing the following nine categories: (1) agriculture and forestry, (2) fisheries, (3) mining, (4) manufacturing and construction, (5) commerce, (6) transport and communication, (7) public administration (*komu*) and self-employed professionals, (8) domestic servants, etc., plus (9) non-occupied persons.[7] As an aside, the aggregate of (5) commerce, (7) public administration and self-employed professionals, and (8) domestic servants, etc., makes up the total occupied persons in (xiv) trade and services in the 16-industry-classification above.

2.3 Observation years

We estimated prefectural GDP by industry and for the total of all industries for the observation years of 1890, 1909, 1925, 1935, and 1940. All values are on a calendar year basis. In addition, we also estimated manufacturing industry output for 1874 and prepared annual estimates for agriculture for 1883-1940. We believe that in the relatively near future, it will be possible to complete the estimation of output in agriculture, forestry, and fisheries for 1874 as well as annual estimates for the period 1890-1940 of output in mining and manufacturing industry, construction, and tertiary industries.

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[7] However, for 1890, we were able to estimate the number of occupied persons only for the following of the 16 industries listed above: (xiv) trade and services; (xv) construction; and (xvi) transport, communication and utilities.

2.4 Control total and prefectural GDP

Broadly speaking, the approach we adopted for estimating prefectural GDPs is an eclectic mix of relying on and adapting existing estimates for all of Japan, and of conducting our own estimates using original sources providing prefecture-level data. Specifically, for mining and manufacturing industry, forestry and fisheries, and construction we used the estimated output values by industry for the Japanese economy as a whole from the Long-Term Economic Statistics (LTES) as control totals and essentially conducted our estimation from the viewpoint of how these totals can be allocated to the different prefectures. Total output values for mining and manufacturing are taken from Shinohara (1972), for forestry and fisheries from Umemura et al. (1966), and for construction from Ohkawa et al. (1974).[8] However, whereas the output data in the LTES often consist of net value added, which excludes fixed capital depreciation, we decided to estimate gross value added (i.e., including fixed capital depreciation) in conformity with GDP statistics. On the other hand, for agriculture, although we follow the methodology and sources of the LTES to some extent, we conducted our own estimates on the basis of original, prefecture-level statistical sources. Moreover, for tertiary industries, we conducted our estimates in such a way that the total value for Japan as a whole conformed with the values re-estimated by Settsu (2009). As a result, the total value for tertiary industries output for Japan overall also differs from Umemura et al. (1966), Ohkawa et al. (1974), Umemura et al. (1988), and others.

Finally, it is worth noting that the supply-side estimates of the LTES are based on the United Nations 1968 System of National Accounts (1968 SNA), and are conducted on the basis of GDP (or net domestic product) at market prices. Given that we follow the approach of LTES, this is consequently also the definition of gross domestic or prefectural product employed in this study.

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[8] Whether Okinawa is included in the output totals in the LTES is somewhat unclear. In personal communication with the authors, Toshiyuki Mizoguchi, a member of the LTES project, indicated that Okinawa, which at the time of the estimation was occupied by the United States, was excluded from the estimation. However, in Shinohara (1972), Umemura et al. (1966), and Ohkawa et al. (1974) we were not able to find any clear statement one way or the other. In this study, we therefore assumed that Okinawa was included in the LTES estimates; but even if Okinawa is not included in the LTES estimates, this is unlikely to have a great impact on our estimation results, since Okinawa's share in national output is small (in terms of gross value added in local prices, the share in our estimates ranges from 0.4 to 0.8 percent).

2.5 Adjustment for differences in regional price levels

Given that there is a tendency for the price level to be lower the poorer a country or region is, we need to take differences in the price level (purchasing power parity) into account or else there is a risk that output in poorer prefectures will be underestimated. Consequently, we estimated not only nominal gross output and gross value added by industry using local prices, but also employing average prices for all of Japan. This is equivalent to comparing the output of each prefecture using the Laspeyres index with Japan as a whole as the base region.

Specifically, GDP in regional prices for prefecture j in year t is calculated as

$$\sum_{i=1}^{I}\left(p_{i,j}(t)x_{i,j}(t) - \sum_{k=1}^{I} q_{k,j}(t)m_{k,i,j}(t) \right) \tag{1}$$

where $x_{i,j}(t)$ denotes the output of good i in prefecture j in year t, $p_{i,j}(t)$ stands for the price received by producers of good i in prefecture j, $m_{k,i,j}(t)$ is the quantity of good k used as intermediate input for the production of good i, and $q_{k,j}(t)$ represents the price paid by producers in prefecture j for good k (for simplicity, prices of the same intermediate good are assumed to be the same even if purchased by different industries).

Prefectural GDP expressed in national average prices is calculated as

$$\sum_{i=1}^{I}\left(p_{i}(t)x_{i,j}(t) - \sum_{k=1}^{I} q_{k}(t)m_{k,i,j}(t) \right) \tag{2}$$

where $p_i(t)$ and $q_k(t)$ show the national average price of product i and of intermediate good k, respectively. $p_i(t)$ and $q_k(t)$ are defined as follows:[9]

$$p_i(t) = \frac{\displaystyle\sum_{j=1}^{J} p_{i,j}(t)x_{i,j}(t)}{\displaystyle\sum_{j=1}^{J} x_{i,j}(t)}$$

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[9] Our data expressed in national average prices satisfy matrix consistency.

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$$q_k(t) = \frac{\sum_{j=1}^{J} q_{k,j}(t) m_{k,j}(t)}{\sum_{j=1}^{J} m_{k,j}(t)}$$

As can be easily confirmed, the total value of gross prefectural products expressed in local prices and the total value of gross prefectural products expressed in national average prices are the same by definition:

$$\sum_{j=1}^{J} \sum_{i=1}^{I} \left(p_{i,j}(t) x_{i,j}(t) - \sum_{k=1}^{I} q_{k,j}(t) m_{k,i,j}(t) \right) = \sum_{j=1}^{J} \sum_{i=1}^{I} \left(p_i(t) x_{i,j}(t) - \sum_{k=1}^{I} q_k(t) m_{k,i,j}(t) \right)$$

This identity is also holds true for the gross value added of some goods and services groups (e.g., the products of agriculture, forestry, and fisheries).

2.6 Regional and intertemporal comparisons

In order to examine patterns and developments in gross prefectural products, it would be very convenient if we could construct a table in which each column represents a particular year and each row a particular prefecture, with each cell showing the gross prefectural product for a particular year and prefecture, thus making possible a direct comparison both across prefectures and across years. The rows would then show developments in the output of specific prefectures, while the columns would make it possible to compare prefectures' output level in a particular year.

However, as explained in Fukao, Ma and Yuan (2007), constructing a table adjusted both interregionally and intertemporally unfortunately is theoretically impossible. The principle reason is the change in the terms of trade (relative prices).

The following example demonstrates why this is the case. Let us assume that prefecture A produces only one agricultural product and prefecture B produces only semiconductors. Let us further assume there are no intermediate inputs. Next, let us assume that in 1990, the per capita gross prefectural product of the two prefectures in terms of the national average price was the same. The population is assumed to be fixed. Let us also assume that whereas output volume in prefecture A remains fixed from 1990 to 2000, output volume in prefecture B doubles during this period. Moreover, national average prices for agricultural products remained fixed, but those for semiconductors halved during this period.

In terms of growth in gross prefectural product (the rows in the hypothetical table), this should

be entered as showing that whereas the real gross prefectural product of prefecture A remained unchanged, the real gross prefectural product of prefecture B doubled. However, in terms of the cross-prefectural comparison of output levels (the columns in the hypothetical table), the per capita gross prefectural product in the two prefectures measured in terms of national average prices should be entered as identical in both 1990 and 2000. This means that although the real gross output of prefecture B doubled, it did not become wealthier than prefecture A because the price of its product (semiconductors) fell.

Time-series estimates such as those of the Penn World Table and Angus Maddison (e.g., Madison 1995, 2003) place importance on information on economic growth (i.e., the rows in our example), where purchasing power parity is used only for a relatively recent single point in time to compare countries' relative income, while income levels for years are obtained through extrapolation using the growth rate of per capita real GDP. Using these kinds of tables for the comparison of income levels across countries (i.e., down the columns in our example) for years other than the benchmark year is therefore problematic.[10]

Because we are mainly interested in economic differences across prefectures, our estimates focus on making them comparable down the columns. That is to say, we devoted our main effort to constructing a table that allows us to examine for each year in which prefecture Japan's GDP as a whole was produced, expressed in regional prices and in national average prices, based on information for the appropriate year. Nevertheless, for reference, we also constructed tables providing estimates of the real gross prefectural product for each prefecture, but we were not able to sufficiently prepare price and real output data, and for industries other than agriculture estimated the following simple equation:

$$\sum_{n=1}^{16}\left(\frac{GVAR_n(t)}{GVAN_n(t)} \sum_{i \in I_n}\left(P_i(t)x_{i,j}(t) - \sum_{k=1}^{I}Q_k(t)m_{k,i,j}(t) \right) \right) \tag{3}$$

where n stands for the 16 industries and I_n represents the aggregate output of goods and services of industry n. $GVAR_n(t)$ is the real gross value added (in 1934-35 prices) in all areas of Japan in industry n in year t estimated in the LTES and $GVAN_n(t)$ is the nominal gross value added in all areas of Japan in industry n in year t estimated in the LTES. In other words, we used the estimate for all areas of Japan from the LTES as the implicit deflator for gross value added for each industry.

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[10] That being said, in addition to the real GDP series for the analysis of growth over time, the Penn World Table also includes real GDP per capita series adjusted for changes in the terms of trade, which allow cross-section analyses.

It should be noted that when estimating real output using equation (3) and using this to calculate economic growth rates, there is a risk that if a prefecture becomes better off as a result of favorable developments in the terms of trade, i.e., changes in relative prices across prefectures for the goods and services of a particular industry, this may give the false impression of that prefecture having registered economic growth.

3. Agriculture, forestry, and fisheries

The main aim of this section is to explain the methodology and sources used for the estimation of gross prefectural products in agriculture for the period 1883 to 1940. In addition to estimates in local prices, we also produced estimates in national average prices to adjust for interregional price differences, and estimates of real values expressed in 1935 prices to allow comparisons over time. Moreover, for forestry and fisheries, we allocated gross value added estimates for Japan as a whole taken from the LTES (Umemura et al., 1966) to prefectures based on the number of occupied persons. Details of this simple methodology are provided at the end of this section.

Our general strategy for the estimation of agricultural output by prefecture was to use, wherever possible, prefectural output volume and local prices. For that purpose, we rely on data by item and by prefecture reported in the *Noshomu Tokeihyo* [Statistical Yearbook of the Ministry of Agriculture and Commerce] and the *Nihon Teikoku Tokei Nenkan* [Statistical Yearbook of the Japanese Empire]. However, for a number of items, we used the price information reported in the LTES (Umemura et al., 1966), while for several other items of relatively little importance, we simply allocated the estimated output for Japan as a whole in the LTES (Umemura et al., 1966) to prefectures using prefectural acreage data or population estimates.

The following subsections describe our estimation procedure for agricultural output in detail. We begin by presenting in detail the method employed for constructing prefectural series of gross output value for rice and five other important staple crops (barley, naked barley, wheat, soybeans, and *azuki* beans). Second, we describe the estimation procedures for generating prefectural gross output series for six other staples crops (millet, barnyard millet, foxtail millet, buckwheat, sweet potatoes, white potatoes), and for five industrial crops (cotton, hemp, indigo, tobacco, and rapeseed) for which prefectural acreage and output data are available. Third, we construct prefectural series of tea output and cocoons production on the basis of prefectural series of tea and mulberry plantations acreage and LTES estimates (Umemura et al., 1966) of output volume for Japan as a whole. Fourth, we extrapolate prefectural output for other products from LTES series and prefectural population data. Fifth and finally, we estimate intermediate inputs and gross value added in local prices, national average prices, and in real terms expressed in 1935 prices.

3.1 Estimation of gross prefectural output of major staple food crops

For the six major staple crops (rice, barley, naked barley, wheat, soybeans, and *azuki* beans) we calculated annual series of gross output on the basis of prefectural output volumes and local unit prices. According to the LTES estimates, the total output value of these six items accounted for 72.7 percent of Japan's gross agricultural output in 1890, 60.7 percent in 1909, 56.8 percent in 1925, 60.5 percent in 1935, and 52.1 percent in 1940 (Table 1). Rice output series have been reconstructed very carefully by the authors of the LTES series on the basis of prefectural paddy field acreage and paddy output volumes, but the revision they introduced concerned exclusively the period prior to 1890. It is not surprising, therefore, to find that, for the period 1890-1940, the LTES figures for total acreage and output for Japan as a whole are identical to those reported in the *Noshomu Tokeihyo*. The discrepancy between the LTES and the *Noshomu Tokeihyo* for 1888 and 1889 is only 2 percent and 1 percent, respectively. In order to reach a complete coverage for the period starting in 1883, we extrapolated rice output for prefectures for which information was missing in 1883-1887: output volumes for Nara, Kagawa, and Okinawa prefectures were extrapolated assuming the same trend as for Osaka, Tokushima, and Kagoshima prefectures, respectively. The same procedure was used for other items for which information for these prefectures was also missing.

Table 1. Share of the six main staple crops in total Japanese gross agricultural output (in percent)

	1890	*1909*	*1925*	*1935*	*1940*
Rice	58.8	48.4	47	50.7	39.7
Barley, naked barley, and wheat	10.6	9.8	7.9	8.4	10.7
Soybeans, azuki beans	3.3	2.6	2.0	1.4	1.7
Total	72.7	60.8	56.9	60.5	52.1

Note: Authors' calculation based on LTES output volume and producers price series (Umemura et al., 1966).

LTES output volume series for barley, naked barley, wheat, soybeans, and *azuki* beans are identical to the figures reported in the *Noshomu Tokeihyo* for the years 1888, 1892 and the period from 1894 onward (data for 1889-1891 and 1893 are missing; data for *azuki* beans are not reported before 1892 and some minor differences are observed in 1888 and 1892 for soybeans). All missing data in existing series were interpolated (including data for 1885-87 and 1889-91 in the case of soybeans, and 1885-1893 in the case of *azuki* beans). However, for the period before 1885, the authors of the LTES (Umemura et al., 1966) thought that the output volumes reported in the *Noshomu Tokeihyo* were underestimated. They therefore extrapolated output volume backward. LTES estimates are

about 50 percent higher than the official data in the *Noshomu Tokeihyo* for *azuki* beans and about 15 percent higher for barley, naked barley, wheat, and soybeans.[11]

It should be noted that it is possible that available output series for rice, barley, naked barley and wheat, and other grains for the early Meiji period do not include seed used for production in the following year. For instance, at present, it is not possible to say with certainty whether the output data in the *Noshomu Tokeihyo* include seed, and whether the statistical treatment of seed differs by prefecture. However, even if, as a result of this, output of rice, the most important agricultural product, is underestimated, ignoring this is unlikely to give rise to large distortions, because the share accounted for by seed in total output is extremely small; the same can be said for pulses such as soybeans and *azuki* beans as well as some cereals such as foxtail millet and buckwheat. In the case of other grains, especially barley and wheat, the share of seed in total output is far greater than in the case of rice. However, with regard to these grains, a far more important reason for the underestimation of yield than the removal of seed from the output volume is the underreporting of output volumes. In any event, the underreporting of rice output is of some significance only before 1886. Considering that the main aim of this paper is to estimate prefectural output from 1890 onward, we decided to use the statistics on prefectural output volumes from the *Noshomu Tokeihyo* as they are.

The next task is to estimate local prices. We rely on annual averages of local wholesale prices reported in the *Nihon Teikoku Tokei Nenkan* and compare these series with LTES national averages of producer prices [Umemura et al. (1966)].[12] The description of the LTES estimation procedures

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[11] The reason why Umemura et al. (1966) thought that the output volumes reported in the *Noshomu Tokeihyo* before 1885 were underestimated is that the rise in yields implied by acreage and output volume data reported in the *Noshomu Tokeihyo* seems implausible; technical change did occur in paddy cultivation, but it is unlikely that this had a significant impact on other staple crops. However, the backward extrapolation procedure employed in the LTES also appears unsatisfactory, since it relies on output volume without taking acreage and therefore yields into account. Moreover, both the output data reported in the *Noshomu Tokeihyo* and the LTES output estimates are inconsistent with early Meiji consumption surveys (see Bassino, 2006). Re-estimating prefectural agricultural output for the period before 1890 requires careful consideration of trends in prefecture-level average yields and is beyond the scope of the present paper, but we are hoping to do so in the future.

[12] When looking at price data for agricultural products, it is necessary to consider differences in the processing stage of the product. The producer price for rice in Japan during the Meiji period generally is the price for polished rice (and not unhulled or unpolished rice), and the same can also be said for the price data in the LTES (Umemura et al., 1966). The regional price data in this paper are wholesale data and with regard to other grains and agricultural produce, too, the sources do not explicitly state whether prices are for processed goods, although, as with rice, this is likely to be the case.

indicates that producer prices series were based on data recorded for the benchmark years 1888, 1899-1901, and 1909-1911. We were able to collect local price data for rice, barley, and soybeans covering most Japanese prefectures for the period 1887-1899, and covering more than half of the prefectures for the period 1910-1918. A relatively high degree of coverage is also obtained for the same years for naked barley, soybeans and *azuki* beans.

Figures 1 and 2 provide a comparison of LTES producer prices and the unweighted average of wholesale prices for rice and barley for prefectures for which almost continuous price series are available. The most extensive regional wholesale price data set available for the entire period of 1875-1939 is based on information for 13 prefectures: Tokyo, Yokohama, Osaka, Kobe, Kyoto, Nagoya, Hiroshima, Kochi, Fukuoka, Kanazawa, Niigata, Sendai, and Otaru (labeled "Average-13" in the figures).

Figure 1. National average producer prices from the LTES (Umemura et al., 1966) relative to local wholesale prices: Rice

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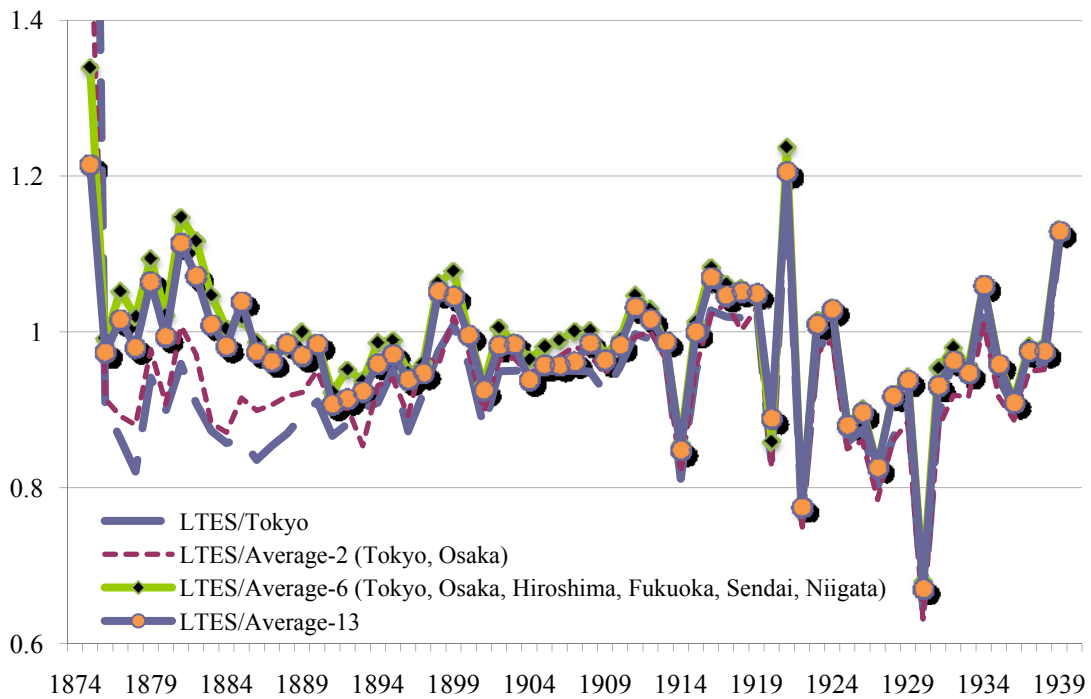
Figure 2. National average producer prices from the LTES (Umemura et al., 1966) relative to local wholesale prices: Barley
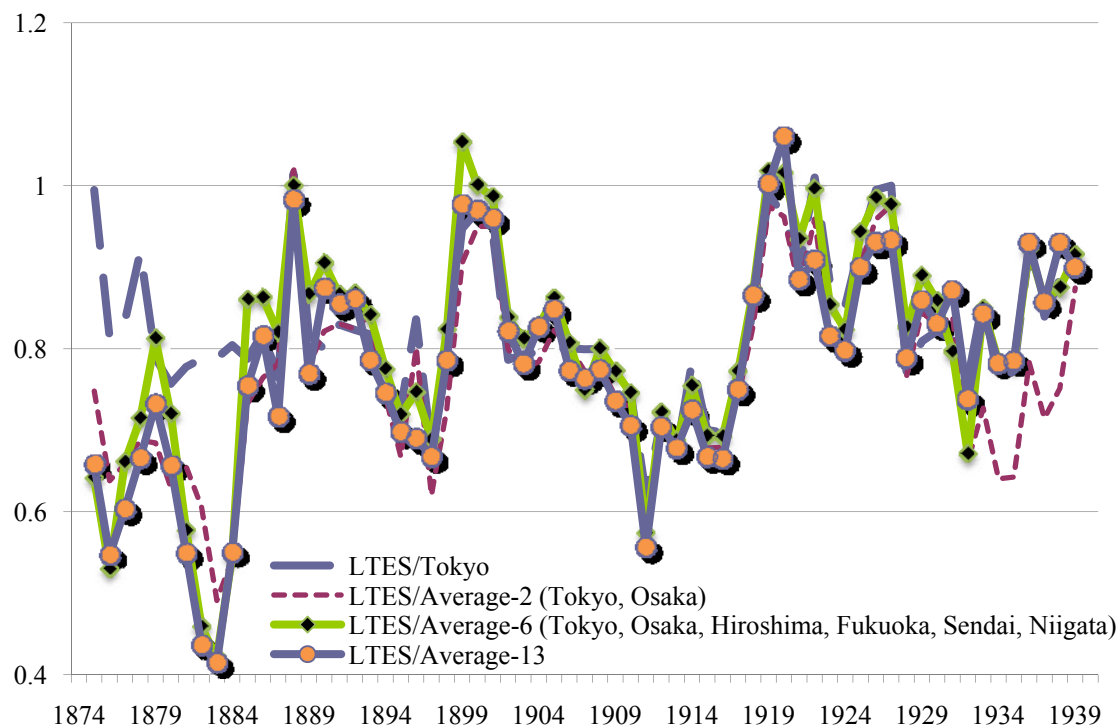
The two figures show that there are substantial deviations between the national average producer prices reported in the LTES (Umemura et al., 1966) and the average wholesale prices for the 13 regions ("Average-13"). At present, we have no explanation for these deviations. The movements in the averages for the different regional aggregations resemble each other quite closely, suggesting that the wholesale price data are indeed reliable. Similar results were obtained for wheat, naked barley, and soybeans (in the case of soybeans, we can rely on price data covering the entire period from 1875-1939 for only six markets: Tokyo, Osaka, Hiroshima, Kumamoto, Sendai, and Niigata).

Based on this examination of prices, we decided to estimate producer prices by prefecture on the basis of local wholesale prices, adjusting these and filling in missing data through extrapolation. For the adjustment, we assumed a wholesale margin equivalent to 10 percent of the wholesale price. When some oddities were observed, such as the relatively high price of soybeans in Tokyo during the 1920s or the high price of barley in Osaka in 1932-38, we decided to amend these figures assuming that the trend was the same as in Osaka and Tokyo, respectively. Missing price data for *azuki* beans were extrapolated on the basis of the relative price of *azuki* beans and soybeans for

available years (data covering the period 1887-1892 are available for all prefectures except Hokkaido and Okinawa). Data for 1940 that are missing in the *Nihon Teikoku Tokei Nenkan* were extrapolated assuming the same variation as in LTES price series.

3.2 Estimation of gross prefectural output of other staple crops and industrial crops

Prefectural acreage and output volume series are also available for six other staples (foxtail millet, barnyard millet, proso millet, buckwheat, sweet potatoes, and potatoes), and five industrial crops (cotton, hemp, indigo, tobacco, and rapeseed). According to LTES estimates (Umemura et al., 1966), these 11 crops accounted for 7.9 percent of agricultural gross output in 1890, 8.4 percent in 1909, 5.4 percent in 1925, 5.7 percent in 1935, and 7.8 percent in 1940 (see Table 2).

Table 2. Share of secondary staple crops, industrial crops, fruits, vegetables, sericulture products, and other animal products in Japan's gross agricultural output (in percent)

	1890	1909	1925	1935	1940
Foxtail millet	1.3	1.6	0.4	0.2	0.2
Barnyard millet	0.3	0.2	0.1	0.1	0.1
Proso millet	0.1	0.2	0.1	0.1	0.1
Buckwheat	0.1	0.1	0.0	0.0	0.0
Sweet potatoes	2.1	3.7	2.5	2.4	3.2
White potatoes	0.1	0.6	0.8	1.0	1.7
Cotton	1.2	0.0	0.0	0.0	0.0
Hemp	0.4	0.3	0.1	0.4	0.4
Tobacco	0.5	0.8	1.1	1.6	1.6
Indigo	0.8	0.2	0.1	0.0	0.0
Rapeseed	1.1	0.8	0.3	0.5	0.4
Sugarcane	0.5	0.8	0.2	0.3	0.2
Tea	0.9	1.0	0.8	0.7	1.1
Other industrial crops	1.5	1.8	1.7	1.9	2.0
Vegetables	4.7	7.2	6.4	7.0	8.5
Fruits	1.0	2.0	2.0	2.3	3.9
Green manure and forage crops	0.7	0.6	0.7	0.7	0.7
Straw goods	1.4	1.1	1.1	1.2	0.9
Cocoons	5.0	9.7	18.1	11.1	13.4
Other animal products	1.5	3.3	4.3	6.0	7.1

Source: See Table 1.

As in the case of barley, naked barley and wheat, the upward trend in yields suggests that output volumes reported in the *Nihon Teikoku Tokei Nenkan* were grossly understated before the 1910s,

particularly before 1890. For the same reason as for barley, naked barley and wheat, no attempt was made to reconstruct yields and therefore outputs at the prefectural level; missing output volume data for Nara, Kagawa, and Okinawa were extrapolated as already indicated above and other missing data interpolated. As it proved impossible to reconstruct local price series for these six staples and five industrial crops we relied on LTES estimates of national average of unit-price series. We constructed local prices by assuming the same magnitude of regional differential as for a composite index calculated on the basis of the price of a basket of rice and barley, with a weight of 1 *koku* for each of these items.

3.3 Estimation of gross prefectural output of silk and tea

Prefectural silk and tea outputs were estimated by relying on LTES output volume estimates. LTES series of cocoon output volume appear much more plausible than the figures recorded in official sources which imply that domestic demand was almost nil in early Meiji (that is, figures of output volume recorded are only slightly higher than export volume figures).

During the entire period studied, silkworm cocoons are second only to rice in terms of gross output value of a single item. According to the LTES estimates, sericulture products accounted for 5.9 percent of gross agricultural output in 1890, 11.1 percent in 1909, 19.1 percent in 1925, and 13.9 percent in 1940. Cocoons accounted for more than 80 to 90 percent of total sericulture products, with silkworm eggs making up the rest.

We allocated among prefectures LTES national output volume measured in terms of weight of cocoons on the basis of prefectural series of acreage under mulberry plantation. Output volume of mulberry leaves is unavailable but this is a minor inconvenience since we are only concerned with value added. Mulberry leaves were used as input in sericulture production, and so were silkworm eggs. Although silkworm eggs were traded nationally and internationally (exported in particular to Europe) it seems acceptable to consider that only a negligible share of prefectural output was not used as input in the same region (we do not have sufficient information on the regions of origin and destination of traded eggs for attempting an adjustment).

Tea output accounted for only around 1 percent of total agricultural output, with a very high degree of regional specialization, concentrating increasingly on Shizuoka prefecture as the main region of tea production in Japan. As in the case of silk, we use the LTES series of tea output volume and allocate a share to each prefecture on the basis of acreage under tea plantation for any given year. Regional unit-price series of cocoons and tea are extrapolated from LTES producer prices series in the same way as for the six staples and six industrial crops listed above.

3.4 Estimation of gross prefectural output of other items

For all other items, we allocated national gross output series among prefectures by assuming the same per capita output all across Japan. These other items include several staples of minor importance [grain sorghum (*morokoshi*), maize, oat, rye, peanuts, peas, broad beans, kidney beans, and cowpeas], and also vegetables, fruits, and edible animal products of animal husbandry (meat, poultry, and eggs). As most of these items were essentially traded locally, per capita output can be regarded as a proxy of per capita food supply. Considering the relatively high degree of homogeneity in consumer preferences across the Japanese archipelago, it seems reasonable to presume similar levels of per capita output among Japanese prefectures, although this of course does not apply to some items; for example, the climate of northeast Japan and Hokkaido is not suited for the cultivation of citrus trees, while pork was mostly consumed in Kyushu and Okinawa. Moreover, there is evidence of a relatively high degree of regional specialization in industrial crops such as konyaku roots, sesame, wax, and sugarcane Nevertheless, given that most of these products accounted for only a very small percentage of total output, it seems safe to assume that, for all staples of minor importance, vegetable, fruits, as well as animal product other than cocoons, and industrial crops other than those mentioned in Section 3.2, output volumes per capita were at similar levels in the different prefectures any given year.

However, we have to admit that with regard to sugarcane production, this poses a potential problem because the bulk of the output originated from Okinawa; our estimates will therefore tend to understate value added in agriculture for this prefecture. The collection of prefectural data regarding acreage under sugarcane cultivation that is currently in progress should help us to address this issue in future research.

It should be noted that the rapid rise between 1890 and 1925 in the share of fruits, vegetables, and edible animal products in Japanese agricultural gross output value implied by LTES series is quite implausible. As can be seen in Table 2, the shares of these items jumped considerably: from 4.7 to 7.2 percent in the case of fruits, from 1.0 to 2.0 percent in the case of vegetables, and from 1.5 to 3.3 percent in the case of edible animal products. These figures imply a rapid increase in per capita output (and therefore, implicitly, food supply, since these items were barely traded with the rest of the world). This picture is the consequence the backward extrapolation method used by the authors of the LTES estimates. We have to take into consideration that, for most items, LTES output volume series for vegetables, fruits, and edible animal products that cover the period prior to 1905 (or even prior to 1909 in some cases) are estimates. This is another issue we are hoping to address in future research.

3.5 Estimation of value added

Total gross output was then calculated. LTES estimates of input series were adjusted in order to avoid double counting; sericulture inputs (silkworm eggs), as well as green manure and forage crops were therefore excluded; we also regarded part of the feed of agricultural origin as a by-product of agricultural production and therefore excluded this from the input reported in LTES input estimates. Apart from seed, most remaining inputs are non-agricultural products; the total value of these inputs was around 13-14 percent of LTES output value period 1878-1940 (11.8 percent in 1890, 13.1 percent in 1909, 13.7 percent in 1925, and 13.8 percent in 1940).

Table 3. Nominal output and nominal gross value added in agriculture for Japan as a whole: Comparison of LTES values and our estimates (in million yen)

	1890	1909	1925	1935	1940
Gross output					
LTES (Umemura et al., 1966)	590	1,314	4,544	3,176	6,438
This study (regional prices)	532	1,268	4,597	3,058	5,676
This study (national average prices)	531	1,268	4,584	3,052	5,660
Gross value added					
LTES (Umemura et al., 1966)	469	1,055	3,711	2,542	5,228
This study (regional prices)	462	1,096	3,972	2,560	4,786
This study (national average prices)	462	1,096	3,960	2,554	4,770

Notes:

1. Gross value added from the LTES is gross output figures minus intermediate input figures published in the LTES.

2. The reason for the minor differences in the results using regional and national average prices is that we extrapolated the regional prices of grains (grains other than the six major staple crops) for which we did not have any regional price data, using the national average price trend from LTES and assuming that regional price differences for these grains were the same as regional price differences for rice and barley, naked barley, and wheat. Consequently, national average prices weighted by prefectural output using our regional price estimates are slightly different from the LTES series.

For each given year, we allocated inputs among prefectures assuming that inputs accounted for the same percentage of output in all prefectures. Owing to the lack of information on local prices for these different items, we assumed that regional differences were negligible. Table 3 summarizes the results at the national level, providing a comparison of the LTES series and our estimates of gross

output and value added. Using local prices or the national average of local prices does not affect the result for Japan as a whole very much. The differences between the LTES series and our estimates of gross output value are due, first, to the fact that we assumed a greater margin (10 percent) between producer and wholesale prices than Umemura et al. (1966); second, to the fact that our estimates of of movements in producer prices over time, which are mainly based on movements in wholesale prices, differ from those estimated by Umemura et al. (1966); and, third, to the fact that we did not include the output value of silkworm eggs both in gross output and in intermediate input, while Umemura et al. (1966) did. Regarding our estimates for 1940, the discrepancy may be also due to the fact that local prices were missing in the Nihon Teikoku Tokei Nenkan for that particular year and were therefore extrapolated from price data in 1939 assuming the same variation as in the LTES prices.

3.6 Estimation of real gross value added series

To construct prefectural real gross value added series for agriculture, rather than relying on the simple procedure shown in equation (3) using the implicit value added deflator from the LTES by intermediate industry classification, we employed a more rigorous procedure by multiplying the output volume of each item with 1935 prices. Moreover, we estimated not only real series in national average prices, but also in local prices. Let us point out here that in the case of agriculture, the real series, which are conceptually similar to the prefectural real gross value added series for other industries, are the real gross value added series expressed in national average prices. This is the series we used for agriculture when aggregating all sectors in order to obtain real gross prefectural product in national average prices.

Real prefectural gross value added series expressed in regional prices and national average prices were estimated using the following procedure. We started by estimating gross output and then calculating gross value added by subtracting intermediate input. Real gross output series expressed in 1935 regional prices and national average prices were obtained by multiplying the output volume of a particular product in each year by the 1935 local or national average price for that product. Prices for the six major staple food crops (rice, barley, naked barley, wheat, soybeans, and adzuki beans were obtained as described in Section 3.1. For prices of the other 13 agricultural products [in addition to tea and cocoons, the six other staple food crops (foxtail millet, barnyard millet, proso millet, buckwheat, sweet potatoes, and white potatoes) and five industrial crops (cotton, hemp, indigo, tobacco, and rapeseed)], we follow the LTES (Umemura et al., 1966) in our assumption regarding regional price differences, that is, we estimated these assuming that the regional price differences for these are the same as the average of the regional price differences for rice and barley

(see previous section). For other agricultural products [secondary staple crops (grain sorghum (*morokoshi*), maize, oat, rye, peanuts, peas, broad beans, and kidney beans), vegetables, fruit, and other animal products (meat, poultry, eggs)]], we multiplied the output in each year and prefecture by the national price for 1935 published in the LTES (Umemura et al., 1966). In other words, for these products, we assumed that regional price differences are negligible. Meanwhile, the real gross value added series in national average prices were estimated in the same way as the corresponding nominal series.

When calculating gross value added, we did so by subtracting the farm value of inputs from total output. However, in order to avoid subtracting farm inputs twice, we subtracted from input series input goods produced in agriculture (seed, green manure, etc.; see Section 3.5 above on the adjustment of input series). Real input series are then estimated using the same procedure as that used for the nominal input series. That is, input series are estimated assuming that regional price differences for inputs are negligible and that the ratio of inputs to output is the same across prefectures.

Moreover, since the LTES (Umemura et al., 1966), provide unit price series for intermediate inputs of services (those summarily reported under "Other") and these series expressed in 1934-36 prices are relatively stable, we decided that there would be no problem in using the real intermediate input series of services for all of Japan (in 1934-36 prices) from the LTES for the estimation of real gross value added series in 1935 prices in this study. However, as a result of this procedure, small discrepancies arise in our estimation between the nominal gross value added for 1935 (valuing inputs in 1935 prices) and 1935 real gross value added (with intermediate inputs of services valued in 1934-36 prices).

3.7 Estimation of gross prefectural output of forestry and fisheries

With regard to forestry and fisheries, we employed an extremely simple procedure to obtain prefectural gross value added in this interim estimation. Specifically, we allocated the LTES estimates for Japan as a whole based on the gainfully occupied population in each prefecture in forestry and fisheries (see Section 6). That is, we assumed that, in each year, labor productivity (measured in nominal values) was identical across prefectures. In other words, our estimates here ignore the fact that labor productivity may differ as a result of regional differences in the technology level, resources, the capital-labor ratio, etc., and they also ignore regional differences in output and input prices.

We are currently working on output and price data by item and prefecture for forestry and

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fisheries to conduct similar estimates of regional gross value added as in the case of agriculture. We are hoping to publish the results in the near future.

4. Mining and manufacturing

This section explains our procedure for estimating prefectural GDP and industrial structure in the mining and manufacturing sectors. In addition, we present a simple analysis of trends in the distribution of industrial production during the period we focus on. Specifically, this section is divided into the following subsections, focusing primarily on manufacturing. Section 4.1 provides a description of our data sources. This is followed by a discussion of issues related to the coverage of these data sources (Section 4.2) and adjustments we make to compensate for the fact that sources before 1939 do not include small-scale establishments with fewer than five employees (Section 4.3). Sections 4.4 and 4.5 then describe our estimation procedure, respectively focusing on the estimation of value add and the conversion of prefectural output series in local prices to series in national average prices. Next, Section 4.6 uses the obtained estimates to examine trends in the distribution of manufacturing activity in Japan over time. Finally, Section 4.7 provides a description of our estimation of prefectural output in mining.

4.1 Basic data sources

The key data sources for manufacturing are the *Fuken Bussan Hyo* [Tables of Prefectural Products] published by the Ministry of Popular Affairs in the early years of the Meiji period; the *Kojo Chosa* [Factory Survey] covering factories with five or more employees, conducted annually from 1883, and published as part of the *Noshomu Tokeisho* [Agricultural and Commercial Statistics] by the Ministry of Agriculture and Commerce; and finally the "Kojo Tokei Chosa [Factory Statistics Survey]", begun in 1909 and reported in the *Kojo Tokei Hyo* [Factory Statistics]. In addition, prefectural data are available in the *Fuken Tokei Sho* [Prefectural Statistics] published since the early Meiji period. The following is an overview of the characteristics of each of these sources.

(a) *Fuken Bussan Hyo* [Tables of Prefectural Products]: 1874

The *Fuken Bussan Hyo*, brought into existence through a Department of State edict dated October 18th, 1870, can be considered to signal the birth of official modern industrial statistic in Japan. The

Fuken Bussan Hyo are based on a survey of the output of 29 product categories, such as agricultural products, marine products, lumber and wood products, and mining products for each prefecture and their aggregates. However, from 1876 onward, the survey covers only agricultural products and was published by the Agricultural Extension Department of the Ministry of Internal Affairs as the *Zenkoku Nosan Hyo* [Table of National Agricultural Products]. In this study, we rely on the data from the *1874 Fuken Bussan Hyo* to estimate values for our first benchmark year (1874). Specifically, we used the compilation of these data provided Hitotsubashi Daigaku Keizai Kenkyujo Kokumin Shotoku Suikei Kenkyukai Shiryo (1959-1964).

(b) *Noshomu Tokei* [Agricultural and Commercial Statistics]: 1883-1924

With the establishment of the Ministry of Agriculture and Commerce in April 1881, the compilation of output surveys was transferred from the Ministry of Internal Affairs to the Ministry of Agriculture and Commerce. Moreover, in 1883, the "Noshomu Tsushin Kisoku [Regulations for Reports of the Ministry of Agriculture and Commerce]" were enacted and statistics on the manufacturing sector were added to the *Noshomu Tokei*. In addition, while the *Fuken Bussan Hyo* and the *Zenkoku Nosan Hyo* had only concentrated on output, the *Noshomu Tokei* for agriculture also surveyed land under cultivation and reported separately arable land area for own-farming and tenant farming, while for manufacturing it provides data on the number of factories, production equipment, number of factory workers, and wages. However, these new statistics on manufacturing activities concentrate mainly on textiles and spinning, and no longer report output for all industrial products, which is why we did not use the *Noshomu Tokei* in our estimations for the manufacturing sector. The *Noshomu Tokei* were discontinued after 1924, although the statistics on industrial products in the *Noshomu Tokei* were continued in the *Shokosho Tokei Hyo* [Statistics of the Ministry of Commerce and Industry] based on the "Shokosho tokei hokoku kisoku" ["Regulation for Statistical Reports of the Ministry of Commerce and Industry"] in 1925.

(c)   *Kojo Tokei Hyo* [Factory Statistics]: 1909-1938

The factory surveys conducted on basis of the above-mentioned "Regulations for Reports of the Ministry of Agriculture and Commerce" of 1883 were revised several times, but in 1909, a new ministerial ordinance ("Kojo tokei hokoku kisosku [Regulations on reports for factory statistics]") was enacted to provide for the collation of a new set of statistics separate from the surveys conducted for the *Noshomu Tokei,* namely the *Kojo Tokei Hyo* [Factory Statistics], which were to

focus on factories with five or more workers. Moreover, the methodology of data collection, which until then consisted of the filling in of information by interviewers, was changed to the present self-reporting principle, where the factory owner is obliged to report the information. To begin with, the *Kojo Tokei Hyo* were collected based on a survey conducted every five years, but from 1919 onward, they were collected annually.

(d) *Kogyo Chosa* [Survey of Manufactures] and *Kogyo Tokei* [Census of Manufactures]: 1939−present

From 1939, the statistics, under the name *Kojo Chosa* [Factory Surveys] started to cover all factories and cottages irrespective of the number of employees. In 1947, the *Kojo Chosa* became the *Kogyo Chosa* [Survey of Manufactures] as the "Designated Statistics Number 10" under the Statistics Law, covering all manufacturing industries as defined in the Japan Standard Industry Classification. The *Kogyo Chosa* became the *Kogyo Census* in 1950 and then the *Kogyo Tokei Chosa* [Census of Manufactures], which continues until today. From 1939 until the present, the results of these surveys have been published as the *Kogyo Tokei Hyo* [Census of Manufactures], and from 1947 onward, it is relatively easy to compile and aggregate statistics from the *Kogyo Tokei Hyo*. Therefore, our discussion below concentrates on the period from the early Meiji era until 1940.

(e) *Fuken Tokei Sho* [Prefectural Statistics]

The *Fuken Tokei Sho* were published annually by each prefecture from around 1873 onward and provide various statistics for each prefecture as a whole. They started as simple one-page printed statistical tables called "X-ken Ichiran Hyo" ["Statistical Overview of Prefecture X"] or "Y-kenchi Ichiran Hyo" ["Statistical Overview, Prefectural Government Y"] and summarily came to be labeled *Fuken Tokei Sho* based on the "statistics form" introduced by the Ministry of Internal Affairs in 1883. They were renamed again and became the present-day *X-ken Tokei Nenkan* [Statistical Yearbook of Prefecture X]. In addition, various other regional statistics were compiled in the Meiji period, such as the *Shifuhanken Gai Hyo* [Summary Tables of the (Hokkai-do Development) Commission, Metropolitan Prefectures, Feudal Domains, and Prefectures] by the Statistics Bureau as well as the *Chishi Satsuyo* [Topographical Summary], the *Gunson Ido Ichiran* [List of Differences Among Districts and Villages], and the *Chiho Yoran* [Summary of Districts] by the Ministry of Internal Affairs. The *Fuken Tokei Sho* cover the period between the *Fuken Bussan Hyo* of 1874 and the *Kojo Tokei Hyo* of 1909 and are very important statistics, but have the following weaknesses:

1. Inputting the information from each volume of the *Fuken Tokei Sho* is extremely laborious.

2. Until 1883, the coverage of the statistical surveys for each prefecture as well as definitions vary, and it is difficult to make them consistent.

3. Extensive reorganization of prefectures took place between 1883 and 1890, making it necessary to make substantial adjustments for territorial changes.

For these reasons, we decided for the time being to rely on the aggregate results by prefecture for 1890 prepared by Umemura, Takamatsu and Ito (1983). We leave the examination of statistical sources related to the *Fuken Tokei Sho* and their use in the economic analysis of regional developments for future research.[13]

4.2 The coverage ratio of each of the statistical sources, and control totals

One of the shortcomings of the factory surveys mentioned above is that their coverage is incomplete. That is, the surveys concentrate on modern factories and ignore small-scale manufacturing production such as traditional handicraft industry. To take account of this issue, Shinohara (1972) estimated manufacturing industry gross output for all of Japan by painstakingly aggregating and comparing[14] data from a range of different statistical sources, including the ones mentioned above, and, moreover, comparing demand- and supply-side statistics (based on the commodity flow approach). Figure 3 provides a comparison of the manufacturing output in each of the statistical sources and the estimates by Shinohara (1972).

To estimate prefectural gross value added, we used the Shinohara's (1972) estimates as the control total for manufacturing industry gross output for Japan as a whole. Then, using prefectural

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[13] Another related task is the examination of data in the *Kangyo Nenpo* [Industry Promotion Yearbook], which Matsuda (1978) argues provides more fundamental survey results than the *Fuken Tokei Sho*. Again, this is a task we hope to tackle in the future.

[14] Shinohara (1972) applied the following three-step procedure to estimate total output: (1) For output by sector for the years 1919-1940, he used the values recorded in the *Kojo Tokei Hyo* as the basis and added to these the estimated output of factories with less than five workers, as well as processing fees and repair charges, and output of government-run factories. (2) Using the *Noshomu Tokei Hyo*, he constructed output series for major items going back to the early Meiji period, and using the trend in these time series, extrapolated the series obtained in step (1) back to the early Meiji period. And (3), he adjusted the long-term series obtained in the previous step with data from the *1874 Fuken Bussan Hyo*.

data from the various sources (*Fuken Bussan Hyo* for 1874, *Fuken Tokei Sho* for 1890, and *Kojo Tokei Hyo* for 1909), we allocated the control total to prefectures and, using information on gross value added ratios, estimated the gross value added for each prefecture.

Figure 3. Manufacturing industry output in each of the statistical sources and estimates by Shinohara (1972) (in million yen)
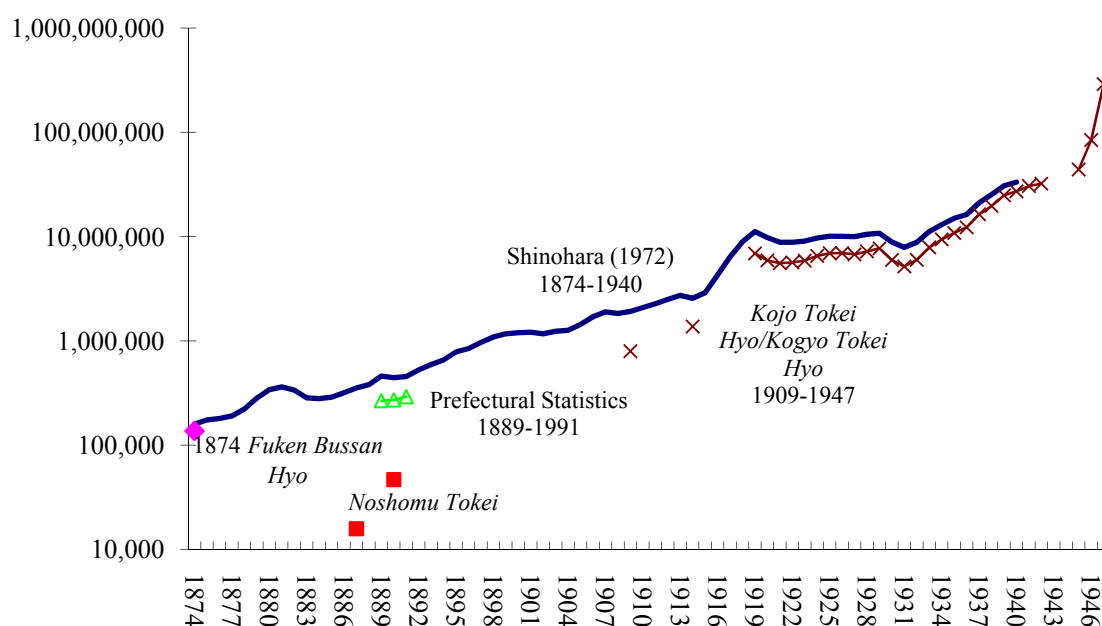
Note: The vertical axis shows logarithmic values. The values from the *Kojo Tokei Hyo* are for factories with five or more workers. (From 1939 onward, survey results for factories with fewer than five workers are available, but not shown in the figure).

4.3 Adjustments to take account of small-scale establishments and estimation of gross output by prefecture and industry (in local prices)

Concluding that the *1874 Fuken Bussan Hyo* can be considered to be an exhaustive census, Shinohara (1972) assumed the aggregate output values found therein to be the total output in Japan. We followed this assumption and estimated the gross output for each of the 47 prefectures after making necessary adjustments for the redrawing of prefectural boundaries in the intervening years, applying the procedure described in Section 2 based on population data at the *gun* (county) level in

1874.

With regard to the data for 1890 in the *Fuken Tokei Sho* and for 1909, 1925, and 1935 in the *Kojo Tokei Hyo*, we regarded the discrepancies between the national aggregate of prefectural outputs in each of the industries and the national output estimates for each industry by Shinohara (1972) to be accounted for by the output of small-scale establishment with fewer than five employees. Then, using the 1939 *Census of Manufactures*, which for the first time includes small-scale establishments with fewer than five employees, we calculated the output share of small-scale establishments in total prefectural output by industry, and using these ratios, proportionally allocated the above-mentioned discrepancies. Finally, for 1940, we used the data from the *Census of Manufactures* for that year without this adjustment, since small-scale enterprises are included.

In order to check the validity of this approach, we examined the distribution of small-scale enterprises by prefecture and by industry in the three years of 1939, 1941, and 1942, and found this to be stable. In addition, for a longer-term perspective, we calculated the difference between the total number of workers in the manufacturing sector of each prefecture, which we estimate in Section 6, and the number of workers in factories with five or more people for the years 1909 and 1925. We then calculated the correlation coefficients between these differences and the regional distribution of workers in factories with fewer than five people in the 1939 *Census of Manufactures*. The correlation coefficients for 1909 and 1925 are 0.93 and 0.96, respectively. This suggests that in the period we focus on there were no major changes in the regional distribution of employment in small-scale establishments. The output share of establishments with fewer than five workers in total output by prefecture and industry calculated from the 1939 *Census of Manufactures* and Shinohara (1972) is shown in Figure 4.[15]

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[15] It should be noted that prefectural accounts tend to understate manufacturing activity in metropolitan areas such as Tokyo and Osaka, even today. Consider the case of large firms whose head offices, without any production facilities, are usually located in such metropolitan areas. Such head offices systematically control and manage the firm as a whole, and strictly speaking, such activities, too, should be regarded as part of manufacturing production. If the head office is located in, say, prefecture A, while the production facility, is located in prefecture B, then head office services are "exported" from prefecture A to prefecture B. However, even in today's *Prefectural Accounts*, this kind of head office services production is not adequately considered. For example, looking at prefectural input-output tables, which provide the source data for the *Prefectural Accounts*, such head office activities are treated asymmetrically: While the Tokyo Metropolitan Area has been reporting head office activity separately since the *Showa 60-nen Tokyo-to Sangyo Renkan Hyo* [*1985 Tokyo Metropolitan Area Input-Output Tables*] published by the Statistics Department of the General Affairs Bureau of the Tokyo Metropolitan Government, including exports and imports of head office services to other regions, input-output tables of other prefectures do not report exports and imports of head office services. Due to obvious data constraints, this study does not take such head office services

Figure 4. Share in total output accounted for by small-scale establishments by prefecture and by industry: 1939
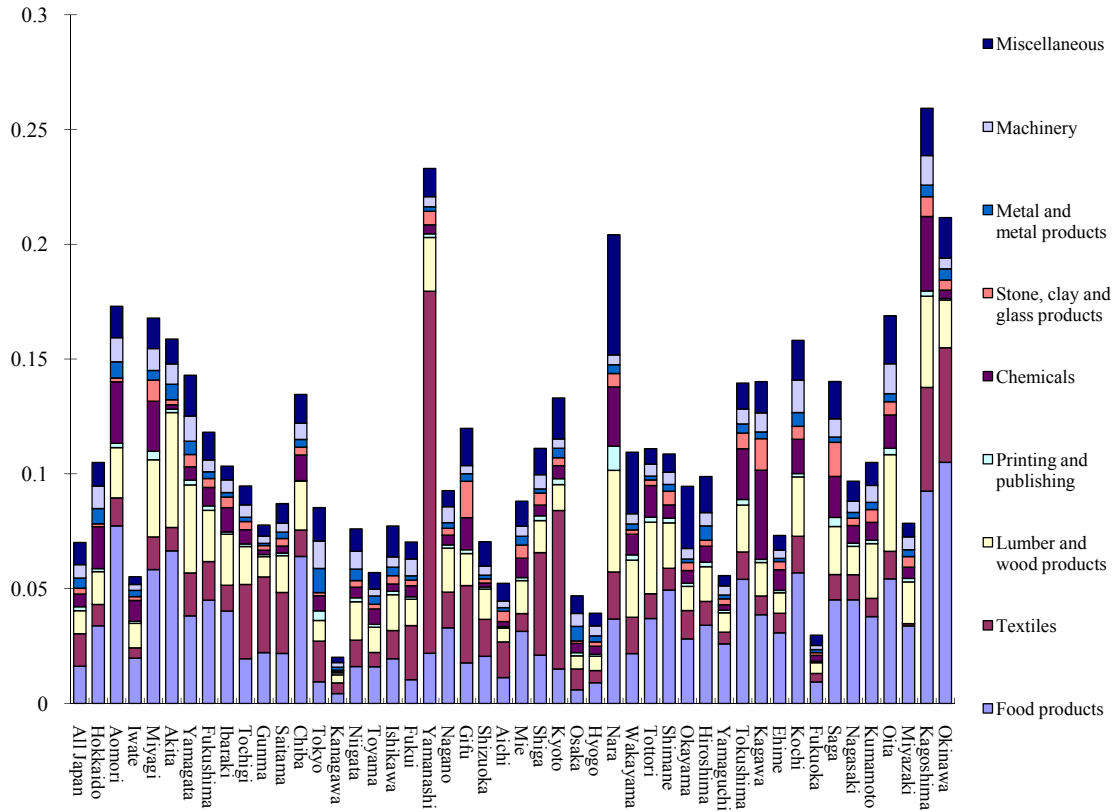

4.4 Estimation of value added

Next, we explain our estimation of value added. Unfortunately, ratios of value added by prefecture and industry can be calculated from official statistics only from 1948 onward, while ratios of value added for small-scale establishments with fewer than five employees can be calculated only from 1960 onward. On the other hand, ratios of value added by industry for Japan as a whole can be obtained from 1929 onward. As shown in Figure 5, value added ratios declined substantially during the disorder following World War II, but became relatively stable from the 1960s onward. Moreover, looking at value added ratios for individual industries in the 1930s and 1950s, the differences for many of them do not appear that great. Other notable developments regarding the post-war period that can be gleaned from the figure include the following: (1) Value added ratios differ considerably

into account.

across industries, but a trend of convergence can be observed over the long term. (2) The value added ratio in the machinery industry declined rapidly in the post war period. And (3), although the value added ratio of the textiles industry was among the lowest during the pre-war period, it has been rising during the post-war period and is now among the highest.

Figure 5. Value added ratio by industry for Japan as a whole in manufacturing industry
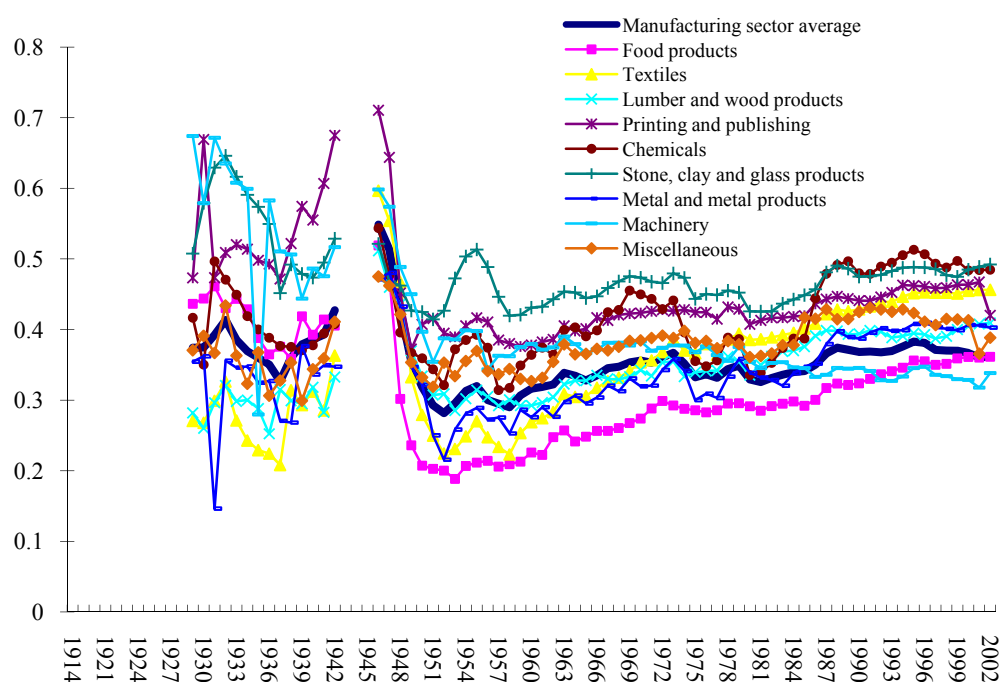
Source: For 1929-1938, *Kojo Tokei Hyo*, for 1939-2002, *Kogyo Tokei Hyo* [Census of Manufactures].

In addition to the lack of data for the calculation of prefectural value added ratios for the pre-war period, information on gross value added in manufacturing is entirely lacking for the period before 1929. We therefore estimated gross value added ratios by prefecture or region for the pre-war period using the gross value added ratio for Japan's manufacturing industry overall for 1929 (the earliest year for which data are available) and 1935, and the gross value added ratio by prefecture and by region for establishments with more than five employees reported in the 1950 *Kogyo Tokei Hyo* [Census of Manufactures].[16]

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[16] The LTES estimated time series of the value added ratio of Japan's manufacturing sector overall for the period before 1929 using the following equation [Ohkawa, Takamatsu and Yamamoto (1974)]:

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Specifically, we calculated the value added ratio $V_{i,j}(t)$ in industry i in prefecture j in year t using the following equation:

$$V_{i,j}(t) = V(t) \times V_{i,j}(50) / V(50)$$

where $V(t)$ is the average gross value added ratio in manufacturing industry in Japan overall in a year close to t reported in either the *Kojo Tokei Hyo* or the *Kogyo Tokei Hyo* [Census of Manufactures]. $V(50)$ is the average gross value added ratio for manufacturing industry overall for Japan as a whole in 1950 and $V_{i,j}(50)$ shows the value added ratio in industry j in prefecture i in 1950. For $V(t)$ for 1874, 1909, and 1925 we used the value for 1929, and for 1940 we used the value for 1935.

4.5 Conversion of prefectural output series into national average prices

The next step we took was to convert prefectural output series to national average prices. We did so by calculating the prefectural unit prices for all items for which both output values and quantities are available in the *Kojo Tokei Hyo* for 1914, 1925, and 1935, and then computing the ratio of the prefectural price to the national average price for each item. Observations for which the ratio exceeded 2 or fell below 0.5 – reflecting, for example, differences in quality - were treated as outliers and discarded. Having done so, we then obtained the weighted relative average prices for each industry and prefecture using prefectural output as weights.

The further back we go, the smaller is the number of items for which we can match output values and quantities. For prefectures and industries for which we could not obtain a sufficient number of items, we substituted missing values with data from the closest year for which data are available. This means that for relative prices for the benchmark years of 1890 and 1909, we used the corresponding relative prices for 1914, and for 1940 those for 1935.

Using the comparison of relative prices of gross output by prefecture and industry, we converted the gross value added in local prices into gross value added in national average prices. It should be noted that in doing so, we did not change the value added ratios to take account of interregional differences of intermediate goods prices.

$$\frac{Y(t)}{T(t)} = \frac{P(t)X(t) - Q(t)M(t)}{P(t)X(t)} = 1 - \frac{Q(t)}{P(t)} \times \frac{M(t)}{X(t)}$$

were T stands for gross output, Y is net value added, P is the manufactured goods price index, Q is the intermediate goods price index, X is the index of output volume, and M is the intermediate goods input volume index. However, assuming that the intermediate input ratio in production remains fixed over time, they used the value for 1930 and substituted the ratio of the intermediate goods price index and the manufactured goods price index, Q/P , into the above equation, and calculated the net value added ratio for each year.
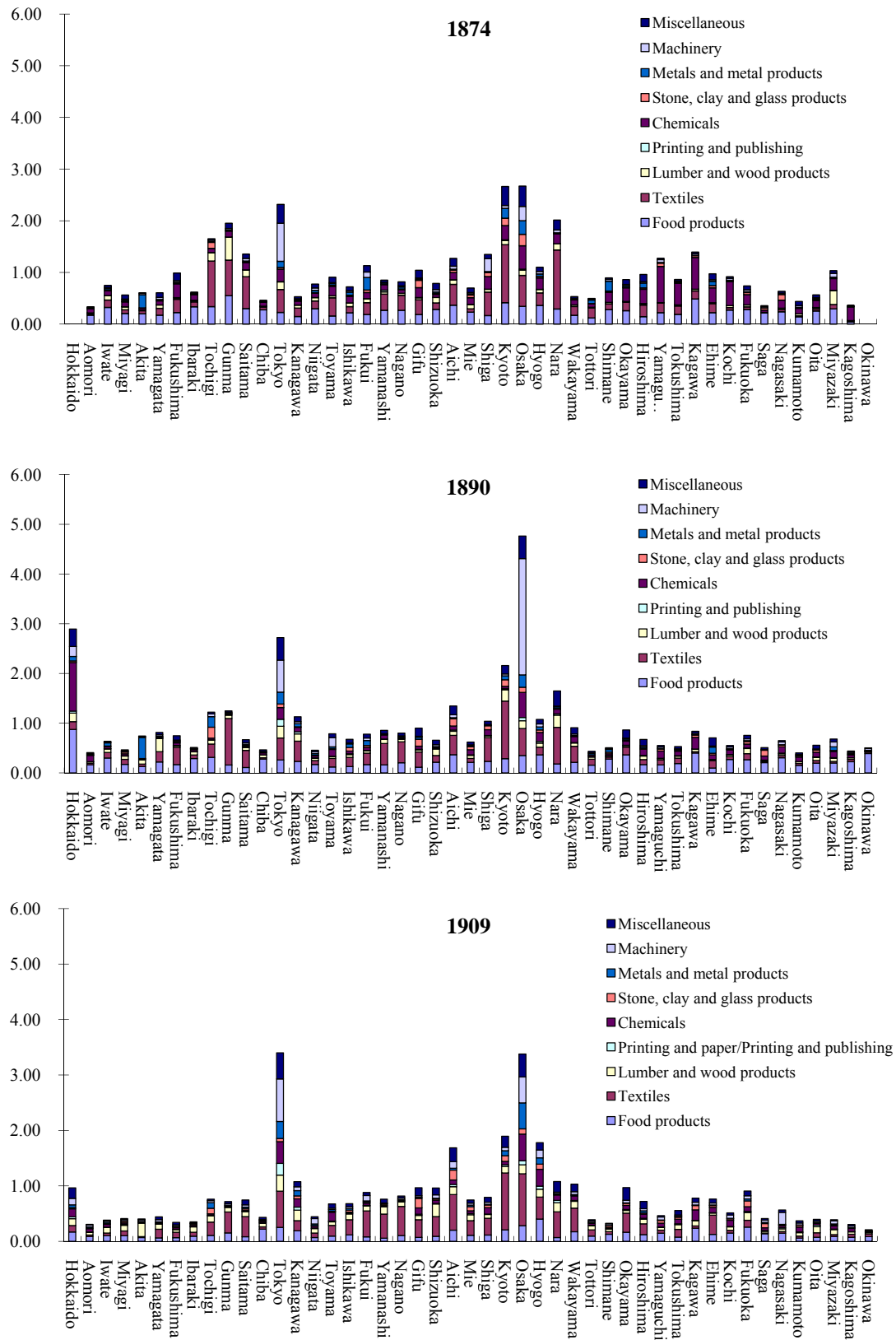
The national total gross value added for each of the 10 manufacturing subsectors in national average prices thus obtained should, as mentioned in Section 2, in principle be identical to the national total of gross value added in local prices of each subsector. In subsectors where the two are not identical, we multiplied the prefectural gross value added of this subsector in national average prices by the ratio of the national total gross value added of this subsector expressed in local prices over national total gross value added of this subsector expressed in national average prices.
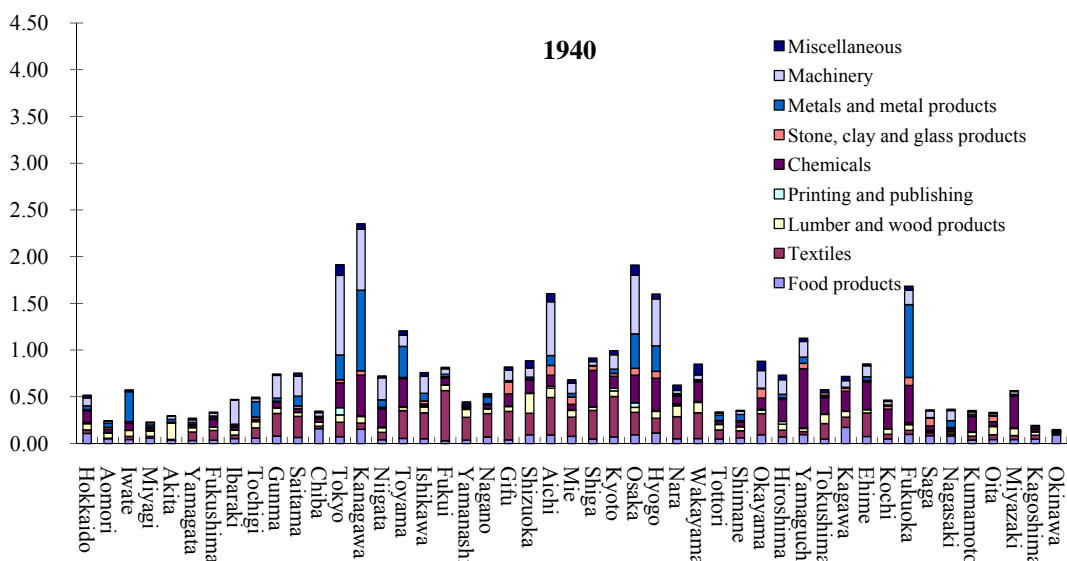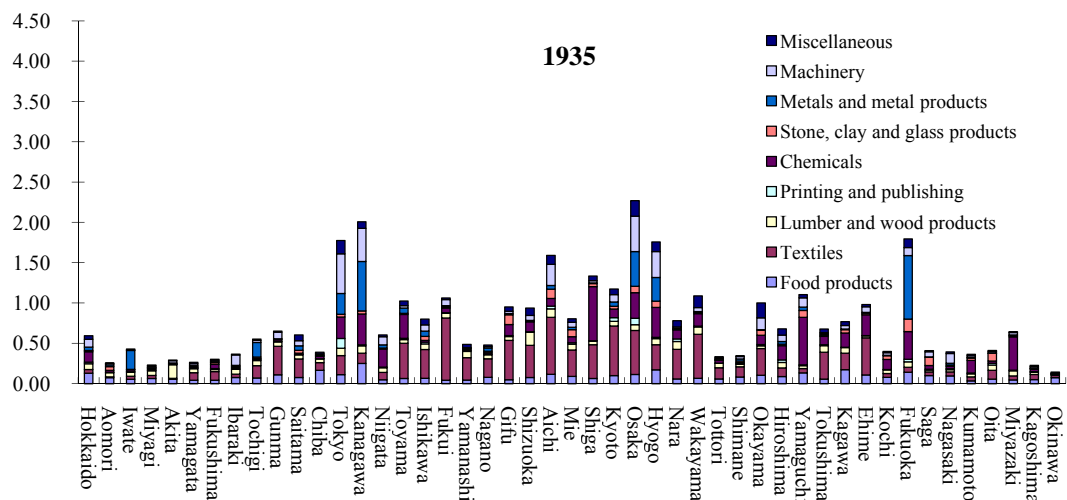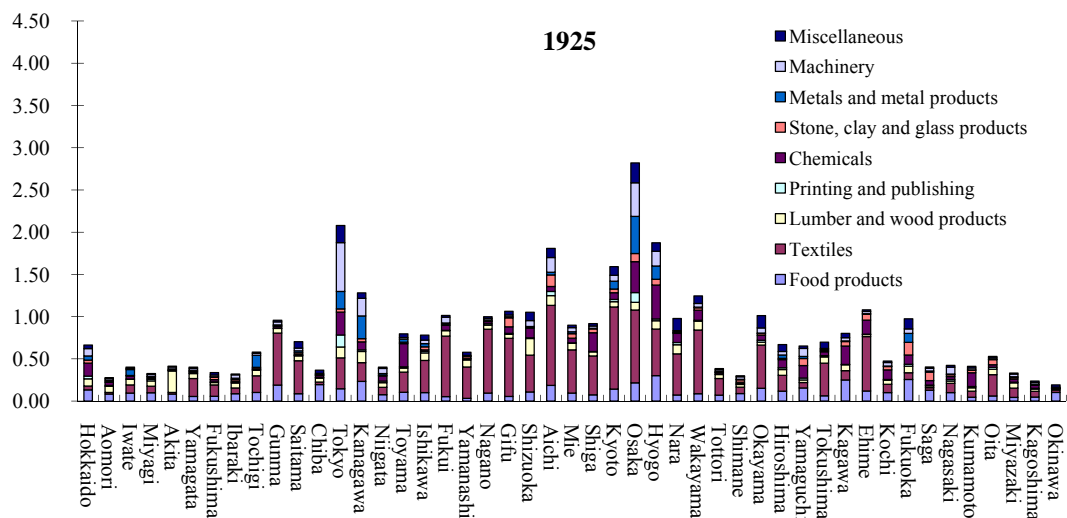
4.6 Trends in the distribution of manufacturing output

As in other countries, manufacturing industry was the growth engine of modern Japan's economic development. Ignoring the World War II period, the share of manufacturing industry in net domestic product continuously increased until the 1960s, rising from 4 percent in 1872 to 16 percent in 1925 and reaching 22 percent in 1960 (Kuznets, 1966). However, industrialization does not proceed evenly, and having described the procedures we employed to estimate prefectural manufacturing output, let us now examine how the regional distribution of manufacturing activity in Japan evolved over time. This has direct import on the level of per capita GDP of individual prefectures in Japan, since, as Fukao and Saito (2006) have shown, the value added per worker in the secondary and tertiary sectors even in 1874 already was about twice as high at that in the primary sector, even when by-employments in the latter are considered, and this ratio rose further to about 2.5 in the 1930s. What is more, because the tradability of construction and tertiary industry output tends to be low, regional specialization in high value added activities in these sectors is less likely to arise. On the other hand, agricultural and manufacturing products are highly tradable, allowing regional specialization. Thus, if a particular prefecture imports agricultural products and exports manufacturing products, the share of agriculture in prefectural output will decline and that of manufacturing increase. Given the higher value added in manufacturing than in agriculture, such specialization in manufacturing therefore will raise prefectural per capita GDP.

Given these considerations, let us take a look at developments in prefectural "manufacturing intensity," defined as prefectural per capita manufacturing output (gross value added in national average prices) over time for our benchmark years. The manufacturing intensity for each of the prefectures, normalized by dividing prefectural per capita manufacturing output by per capita manufacturing output for Japan as a whole, is shown in Figure 6. Note that data for Okinawa and Hokkaido for 1874 are not available, because these had not been established as prefectures (see footnote 5).

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Figure 6. Per capita manufacturing output by prefecture (in national average prices)

1925

Miscellaneous
Machinery
Metals and metal products
Stone, clay and glass products
Chemicals
Printing and publishing
Lumber and wood products
Textiles
Food products

1935

Miscellaneous
Machinery
Metals and metal products
Stone, clay and glass products
Chemicals
Printing and publishing
Lumber and wood products
Textiles
Food products

1940

Miscellaneous
Machinery
Metals and metal products
Stone, clay and glass products
Chemicals
Printing and publishing
Lumber and wood products
Textiles
Food products

33

Starting with 1874, it can be seen the core centers of handicraft industry during the Edo period, such as Kyoto, Osaka, and Nara, as well as Tokyo, played a leading role in manufacturing activity in Japan. Moreover, Gunma, Tochigi, and Saitama also had prospering manufacturing industries, concentrating on food processing and textiles. Per capita manufacturing output in Kyoto, the most industrialized prefecture at the time, was 8.0 times the level of that in Aomori, which was the least industrialized, 7.5 times that of Saga, and 7.3 times that of Kagoshima.

In 1890, Osaka, the center for machinery production such as arms and ships, occupied the clear top position. Other prefectures with active manufacturing sectors include Hokkaido, which produced food and chemical products, Kyoto, which saw an expansion of its textile industry, and Tokyo. Osaka's per capita manufacturing output was 11.7 times that of Aomori and 11.8 times that of Kumamoto.

By 1909, Tokyo had become a major manufacturing center alongside Osaka. Tokyo's per capita manufacturing output was 16.3 times that of Okinawa and 11.2 times that of Aomori, indicating that the gap between the top and the bottom prefectures in terms of per capita manufacturing had grown even further.

Next, the figure for 1925 shows a growing agglomeration of manufacturing industry around the main manufacturing centers of Osaka and Tokyo, with neighboring prefectures such as Hyogo and Kanagawa, showing substantial increases and Aichi emerging as another manufacturing center. In addition, industrialization, concentrating on textiles, had started spreading to the northern inland Kanto region (the region northwest of Tokyo), the Tokai region south-west of Tokyo on the Pacific coast, and Hokuriku, the region north-west of Tokyo on the Japan Sea side of Japan.

Finally, by 1935 and 1940, as the importance of the textile industry was beginning to wane and the heavy and chemical industries gained a prominent role, the concentration of industry shifted again, with Kanagawa and Fukuoka playing prominent roles.

The preceding overview suggested that the gap between leading and lagging prefectures in terms of industrialization widened until 1909. However, looking at the coefficient of variation of prefectural per capita manufacturing industry gross value added (at regional prices) actually shows that while this did increase until the middle of the Meiji period (1890), it subsequently shrank until 1909, before increasing again, as illustrated in Figure 7. The coefficient of variation peaked at 0.71 in 1940 against the background of military preparations focusing on heavy industries for the war with China and World War II (1937-1945). However, following the war, regional differences rapidly diminished until the beginning of the 1970s.

Figure 7. Coefficient of variation of per capita manufacturing gross value added (at local prices)
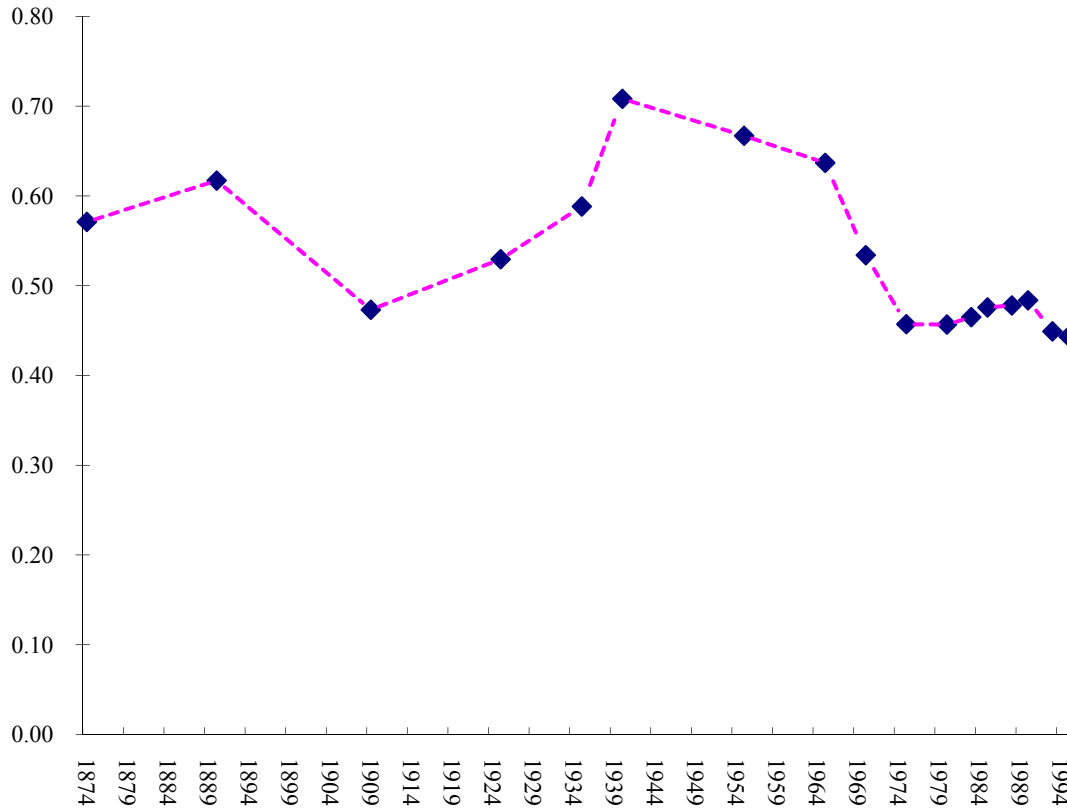
Finally, let us examine the pattern of industrialization in terms of Krugman's (1991) index of regional specialization. The index of regional specialization is defined as

$$S = \frac{2}{n(n-1)} \sum_{j=1}^{n} \sum_{k=1}^{n-1} SI_{j,k}$$

where

$$SI_{j,k} = \sum_{i=1}^{m} \left| \frac{Q_{i,j}}{Q_j} - \frac{Q_{i,k}}{Q_k} \right|$$

and Q_{ij} is the gross value added (either in local prices or national average prices) in prefecture j's

industry i and Q_j is the gross value added (either in regional prices or national average prices) for all manufacturing industries in prefecture j. Moreover, n is the number of prefectures and m is the number of industries. If S is 0, this means that the industry composition of the manufacturing sector in prefectures j and k is completely identical. On the other hand, if S is 2, this indicates specialization where the industry composition in the two prefectures is completely different.

As Figure 8 shows, regional specialization advanced from 1909 to 1940, but after the war, industries became more evenly distributed. The increase in specialization after 1909 may, as in the case of the United States (see Kim, 1995), be related to the development of the railroad system. Japan's railroad network, as shown in Figure 9, rapidly expanded during the period from 1910 to 1930 (for details, see Minami, 1965).

Figure 8. Index of regional specialization (based on gross value added in local prices and in national average prices)
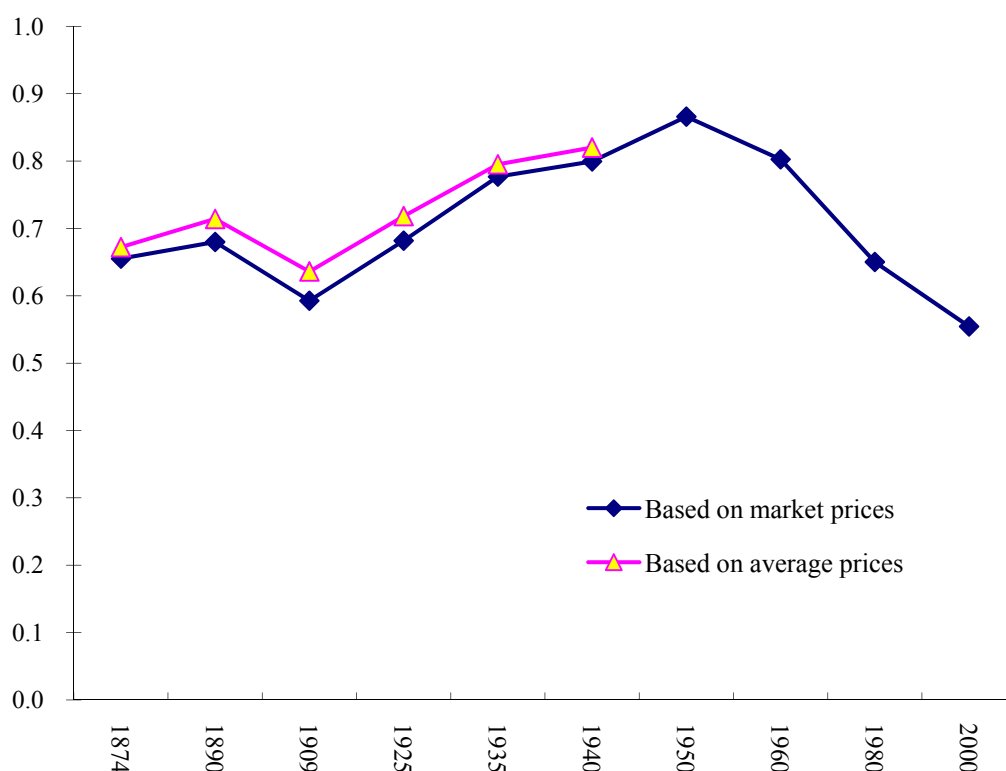
Figure 9. Expansion of Japan's rail network

Kilometers
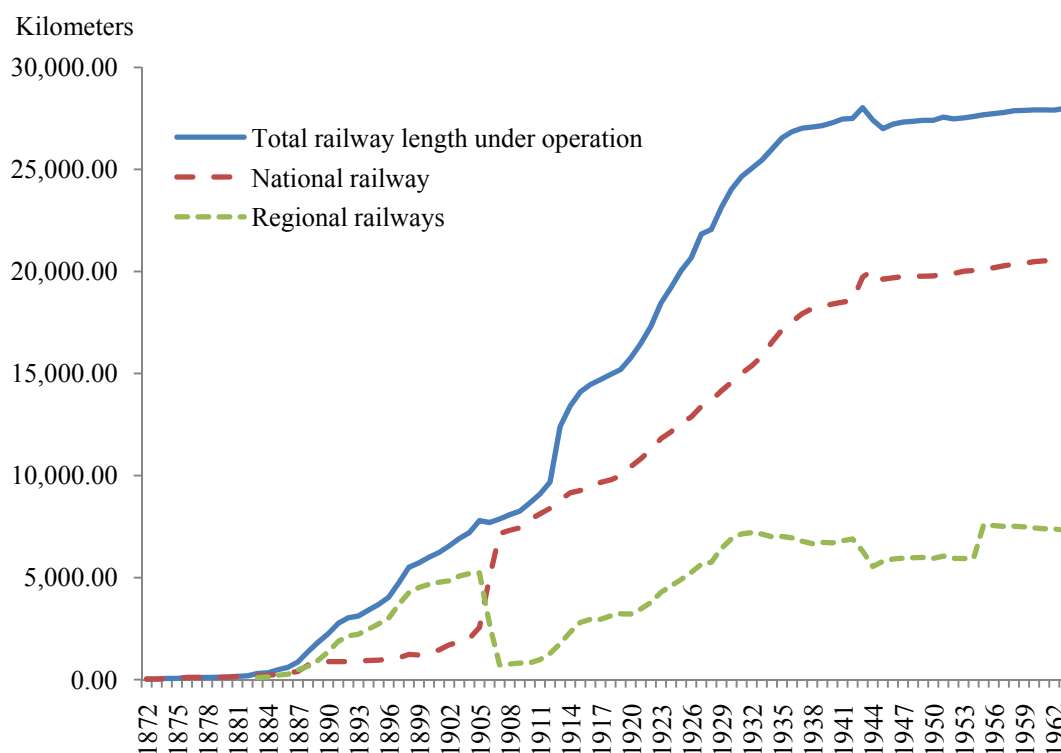
Source: Minami (1965).

4.7 Estimation of mining output

Output by prefecture for the mining industry is taken from the *Honpo Kogyo no Susei* [Trends in Japan's Mining Industry] for each year (published from 1906 onward) compiled by the Bureau of Mining, Ministry of Agriculture and Commerce, and *Honpo Kogyo no Susei 50 Nenshi* [A 50 Year History of Trends in Japan's Mining Industry] published by the Research and Statistics Department, Minister's Secretariat, Ministry of International Trade and Industry (1963-64). However, because for 1890, output by type of product is reported only in terms of quantity, we calculated the national average price for each product, using the output value and quantity data for each product estimated by Shinohara (1972). We then multiplied this with the output quantity of each product in each prefecture and calculated the nominal output for each prefecture in national average prices for 1890.[17]

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[17] The output of iron and steel as well as nonferrous metals of smelting plants attached to mining activities is

Next, to convent prefectural output series into national average prices, we proceeded in the same manner as for manufacturing industry. That is, we calculated the prefectural unit prices for all items for which both output values and quantities are available and then obtained the weighted average of the ratio of prefectural prices to national average prices using output as weights. However, for 1890 (due to the lack of data), in order to convert output series in national average prices into output in local prices, we used the values for 1909 (and similarly, for 1890 and 1909, for items for which data also were not available, the values for 1925 or 1935).

Moreover, we again readjusted the output values for each prefecture so that the national total of prefectural mining output obtained in this manner equals the estimates of total nominal output calculated by Shinohara (1972).

For the calculation of value added, we calculated the gross value added ratios for metal, coal, oil, and all the other types of mining products, respectively, using data on gross output values and intermediate input values in the 1935 *Honpo Kogyo no Susei*. We then calculated nominal gross value added by prefecture by multiplying these gross value added ratios by the nominal output by prefecture for each benchmark year.

5. Construction and tertiary industry

In this section, we explain the estimation of gross value added in the construction and tertiary industry. In the LTES (Ohkawa et al., 1974), tertiary industry is classified into three sectors, namely commerce-services B; transport, communication, and utilities (gas, electricity, water); and public administration, professionals, and domestic servants, etc.[18] In the intermediate industry classification in this study (consisting of 16 categories), we merge "commerce-services B" and "public administration, professionals, and domestic servants, etc." and refer to this sector as "commerce and services" and the remaining tertiary industries as "transport, communication, and utilities."

In contrast with the agriculture and mining and manufacturing sectors covered so far, obtaining data by prefecture on the tertiary sector is extremely difficult. In fact, the situation is not much better with regard to aggregate data at the national level. As a result, the approach taken in the LTES (Ohkawa et al., 1974) was to estimate output from the income side rather than the production side as for the other sectors. Although this approach gives rise to some concern, we had little choice but to

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separated from mining and included in the metal industry in the manufacturing sector.

[18] The sector labels here follow the LTES (Ohkawa et al. 1974). For a definition of commerce-services B, see Section 5.1 below.

follow this approach in our estimates for this sector.[19]

To begin with, let us present an outline of our estimation method. Simplifying considerably, the estimation from the income side can be represented by the following equation:

Income = gainfully occupied population × per capita income.

The income referred to here is a mix of incomes consisting of wage incomes and operating surpluses. Because the income calculated on the basis of this equation is net value added at factor cost, if we adjust this for indirect taxes minus subsidies as well as fixed capital depreciation, we obtain gross value added at market prices. The estimation procedures we actually employed can be broadly divided into two types, depending on whether it was possible to obtain per capita income data by prefecture or not. For industries for which per capita income data by prefecture were available, it is possible to calculate prefectural gross income by multiplying prefectural per capita income with the number of occupied persons by prefecture and industry. (The estimation of the gainfully-occupied population by prefecture and industry will be explained in Section 6.) On the other hand, for industries for which such data are not available, we took the LTES estimates of national total income in a particular industry and allocated this to the different prefectures based on prefectures' share in the national total of gainfully occupied persons in that industry; finally, combining this with information on inter-prefectural differences in per capita income in other industries, we calculated prefectural income in the industries in question.

In practice, the only industry for which we were able to obtain information on per capita income by prefecture is commerce-services B (specifically, on corporations and unincorporated proprietors who paid taxes). Thus, for prefectural income differences in other industries, we relied on information for commerce-services B. The exception is the construction industry, for which we used prefectural differences in the per capita gross value added in manufacturing industry.

As described in the preceding sections, for agriculture, forestry and fisheries as well as mining and manufacturing, we took price differences between regions with regard to nominal output into account and calculated two types of series, one in local prices, and one in national average prices. However, because we were unable to obtain data on regional price differences for service industries, we only calculated prefectural income in local prices. Moreover, we also use these values for

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[19] However, we hope that in the future we may be able to conduct estimates from the production side as there is an abundance of data at least on certain industries in the tertiary sector, such as transport and communication, finance, and public administration. Estimating gross value added from the production and the income side and being able to compare the two would be of great significance, but because this requires an enormous amount of work, we were not able to do so in this study.

analyzing prefectural differences in the macro economy as a whole. In other words, for the construction and tertiary industries, we examine prefectural differences in gross value added ignoring prefectural differences with regard to goods and services produced or intermediate input.

Finally, a few remarks about the estimates for 1890 are in order. As will be explained in the following section, to estimate the gainfully occupied population by prefecture and industry, we mainly had to rely on our estimates for 1906 to 1940, since earlier data are extremely scarce. For some industries, data on the gainfully occupied population at the national level are available, and we allocate these to each of the prefectures using information for 1906. For industries where no such data are available, we used the share of the gainfully occupied population in the relevant industry in the prefectural population in 1906 and multiplied this by the prefectural population in 1890. Because information for 1890 on per capita income is also difficult to come by, we generally obtained income estimates for 1890 relying on indirect methods such as using data for 1897. Accordingly, the reliability of these estimates is also rather weak. The following subsections explain our estimation procedure for each of the sectors.

5.1 Commerce-services B

Commerce-services B in the definition of the LTES (Ohkawa et al., 1974: 130) consist of a mixture of service categories such as merchandising business, intermediary brokerage business, finance and insurance, leasing, hospitality, eating and drinking places, entertainment, etc. The estimation in this study follows the estimation procedure of Ohkawa et al. (1974), but uses the revised estimates of the national total of gross income obtained by Settsu (2009) as control totals. The estimation procedure can be summarized as follows. As already mentioned, because total income in this sector is calculated as the gainfully occupied population multiplied by per capita income, except for 1890 we took the data on the gainfully occupied population in the commerce sector from Section 6, which deals with the estimation of the gainfully occupied population by industry, and, following the LTES (Ohkawa et al., 1974), divided this into the following five categories: (1) corporations, (2) single proprietorships (business tax payers), (3) single proprietorship (business tax exempts), (4) family employees, and (5) employees; moreover, we separately estimated the number of those from other industries engaged in by-employments in the commerce sector.

In previous work, two different methodologies of subdividing commerce services can be found – that employed by Ohkawa et al. (1974) and Takamatsu (1975), and that employed by Umemura et al. (1988). Here, we followed the latter, except that we also distinguish between taxpaying and tax-exempt proprietorships. However, because we detected some problems in the prefectural figures for the sum of these proprietorships (taxpaying and tax-exempt) for 1888 in the *Noji Chosa Hyo*

[Agricultural Survey] published by the Department of Agriculture and Commerce that Umemura et al. (1988) used, we did not conduct estimates for the period before 1906.[20] In addition, rather than using the share of proprietorships in the number of gainfully occupied persons published in the 1920 *Population Census*, as Umemura et al. (1988) did, we calculated this share using the figures obtained after the reclassification of industries (see Section 6). Finally, the number of employees [category (5) above] from 1906 to 1913 was calculated as the residual [i.e., the total number of gainfully occupied persons in commerce-services B minus the number of gainfully occupied persons in categories (1) to (4)] and in some cases we obtain slightly negative values. In these cases, we estimate the number of employees using the share of employees in the gainfully-occupied population for the year nearest and adjusted the total by subtracting the excess part from the number of family employees. For 1890, figures for the number of employees were obtained by dividing the total for Japan for that year taken from Umemura et al. (1988) and allocating this using prefectures' share in the gainfully occupied population in 1906.

An important factor we cannot ignore in national income estimates based on the income approach is income from by-employments. By-employment is of course considered in the estimation in the LTES, but in this study, we employed a different procedure for the estimation of the number of those engaged in by-employment based on Settsu (2009).[21] Because the details of the procedure are described in that study, we will not repeat them here, but put simply, the estimation procedure consists of regressing the share of those whose principal occupation is in classifications other than commerce and transport and communication that are engaged in commerce or transport and communication on the share of those occupied in agriculture among all occupied persons as well as the population density, and then inserting the actual values of the explanatory variables into the estimated equation to obtain estimates of the number of those engaged in by-employment for each prefecture.

Next, for the per capita income for taxpaying single proprietorships for 1925 and 1935, we used the net income per entrepreneur from the business income tables (individuals) in the *Shuzeikyoku Tokei Nenpo Sho* [Statistical Yearbook of the Tax Bureau] published by Tax Bureau of the Ministry of Finance, which is the same source as that used by Ohkawa et al. (1974) to calculate income in the

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[20] Specifically, we found 12 prefectures for which the number of proprietorships in 1888 seemed to be unreasonably large. This means that if the numbers are indeed excessive, the estimates of the number of gainfully occupied persons in commerce-services B in 1885 in Umemura et al. (1988) on the basis of these records will also be too large.

[21] However, it should be noted that both in the LTES and in this study, by-employment in public administration or as a professional or domestic servant is not considered in the estimation using the income approach.

benchmark years in the LTES.[22] Because net income by prefecture is available only up to 1936, for 1940 we used the values for 1936. Moreover, since business income tax was imposed only from 1927 onward, similar data for earlier years are unavailable. Accordingly, for 1925 we used figures for 1927 on the net income subject to business income tax, for 1909 we used the sales proceeds of wholesale and retail trade, and for 1890, we used the sales proceeds of wholesale and retail trade for 1897.[23]

For income of corporations, for 1925, 1935, and 1940 we took the per firm profit calculated by deducting the losses of loss-making firms from the profits of profit-making firms in the *Kaisha Tokei Hyo* [Tables of Statistics of Corporations] and for 1890 and 1909 the per firm income of type I income tax reported in the *Shuzeikyoku Tokei Nenpo Sho*. There are many problems with using type I income tax for our analysis, since it applied not only to commerce and services but to all corporations, including those in other industries; however, these are the only data available that we could use.

For the other categories, that is, tax-exempt single proprietorships, employees, and those engaged in by-employment, we calculated an index of income differences using the per capita income by prefecture for taxpaying single proprietorships mentioned above and converted the national per capita income for each of the categories re-estimated by Settsu (2009) into prefectural values. Because this procedure applies the income differentials of high income categories to low income ones, this may be problematic. A potential way to improve on this in the future would be to use a methodology that, for example, takes wage differentials into account.

Using these estimates of the number of gainfully occupied persons and the per capita income by category, we then calculated prefectural income for each benchmark year and adjust the obtained values so that they are consistent with the national totals reported in Settsu (2009). In addition, we allocated to each of the prefectures interest income received from other industries and imputed rent using the share of prefectures' commerce-services B income in income for Japan as a whole.

5.2 Public administration, professionals, and domestic servants, etc.

In the LTES (Ohkawa et al., 1974), income for the public administration, professionals, and

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[22] The business categories we used for the estimation are the same as the ones used in Ohkawa et al. (1974).

[23] An alternative method for 1925 would be to use the sales proceeds of wholesale and retail trade, as for 1909 and 1890. However, looking at the sales proceeds in 1925, the differences between prefectures seem too large and we therefore decided not to employ this methodology here. Another reason for employing the figures for 1927 is that these data cover not only wholesale and retail trade but also other subsectors of commerce-services B.

domestic servants, etc., categories are all estimated separately, but in this study we decided to estimate them together. There are two reasons for this. First, in the estimation of the number of gainfully occupied persons, it is not possible to distinguish between public administration and professionals. And second, the figures on the number of gainfully occupied persons as domestic servants, etc., in Ohkawa et al. (1974) differ greatly from those in Umemura et al. (1988). What is more, as previously mentioned, data on the gainfully occupied population by prefecture are unavailable for 1890. For this reason, we calculated income by prefecture in 1890 by allocating national total income in this sector in 1890 estimated by Settsu (2009) to each of the prefectures using the prefectural composition of the gainfully occupied population in these categories in 1906.

Information on prefectural differences in per capita income in these categories is also unavailable. We therefore employ the index on prefectural income differences obtained from the per capita income of taxpaying single proprietorships in commerce-services B to convert prefectural incomes calculated from the national average income into values that take income differences into account. As for commerce-services B, prefectural incomes are then adjusted so that the national total obtained by multiplying the number of gainfully occupied persons by per capita income is consistent with the values obtained by Settsu (2009).

Moreover, these categories and commerce-services B were aggregated as "trade and services."[24] The reason is that we cannot divide the adjustment item (indirect taxes minus subsidies) and fixed capital depreciation (with all values taken from Ohkawa et al., 1974), which are necessary for the calculation of gross value added at market prices, into each of these categories. We then allocated the adjustment item and fixed capital depreciation to the different prefectures using prefectures' share in the national total of "trade and services" net income. This implies that the share of indirect taxes minus subsidies and fixed capital depreciation in net income is assumed to be identical in all prefectures.

5.3 Transport, communication, and utilities; construction

For transport, communication, and utilities, as well as construction, we generally used the same estimation procedure as for public administration, professionals, and domestic servants, etc. However, data on the number of gainfully occupied persons by prefecture for the utilities and construction industries are unavailable. (In the estimation of time series of the gainfully employed population by sector in Section 6 below, these industries are included in manufacturing). Therefore, we needed to conduct separate estimates of the gainfully occupied population in these industries for

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[24] This corresponds to what Ohkawa et al. (1974) label "commerce-services A."

the benchmark years for our income estimation here. For 1925, we used the averages of the 1920 and 1930 *Population Censuses* (after reclassifying industry categories; the same applies below), and for 1935, the average values of the 1930 and 1940 *Population Censuses.* For 1909, we calculated the shares of both sectors in the manufacturing sector using data from the 1920 *Population Census* and then computed the number of gainfully occupied persons in each of the two sectors by multiplying the shares with the 1909 data for manufacturing employment in each prefecture. For 1890, we proceeded as follows. First, because manufacturing employment data by prefecture are unavailable, we calculated the number of gainfully occupied persons by prefecture in the utilities and construction sectors in 1906 using the same method as for 1909. Second, we then calculated the gainfully occupied population in the two sectors in each of the prefectures in 1890 by multiplying the share of the gainfully occupied population in the two sectors in the total prefectural population in 1906 by the prefectural population in 1890. In doing so, we adjusted the prefectural figures for the gainfully occupied population in these two sectors in 1906 so that the national total was consistent with that in the LTES (Umemura et al., 1988).

Finally, per capita income was estimated using the same procedure as that employed as for public administration, professionals, and domestic servants, etc., except that for utilities and construction, we calculated the index of regional income differences using the prefectural per capita income in the   manufacturing sector and not that in commerce-services B.

5.4 Patterns in prefectural tertiary industry share and per capita GDP

Let us now take the estimates that we obtained and look at prefectural patterns in the relationship between tertiary industry and prefectural per capita GDP. Figure 10, for each benchmark year, depicts the gross value added share of tertiary industry (the total of trade and services plus transport, communication, and utilities) in gross prefectural income on the vertical axis and prefectural per capita GDP on the horizontal axis. As can be seen, from 1890 to 1935, prefectures with a high per capita GDP tended to have a higher tertiary industry share in prefectural GDP. This result is consistent with Petty's Law with regard to economic development and changes in industrial structure.

Moreover, looking at the pattern over time, the slope of the fitted curve drawn in each of the panels clearly becomes flatter. As will be discussed in Section 7, inter-prefectural inequality as indicated by the coefficient of variation of per capita GDP declined during this period, so that the flattening of the slope of the fitted curve in this figure suggests that there is a close relationship between the growth in the tertiary industry share in each prefecture (i.e., structural change) and the decline in inter-prefectural inequality. Section 8 discusses this issue in greater detail.

The figure also shows that for 1940, the fitted curve is almost flat and the pattern looks quite different from those for the other years. This is likely to a considerable extent the result of the shift to a war economy, such as the expansion of manufacturing related to military demand in Kanagawa prefecture.

Figure 10. Tertiary industry value added shares in prefectural GDP and prefectural per capita GDP
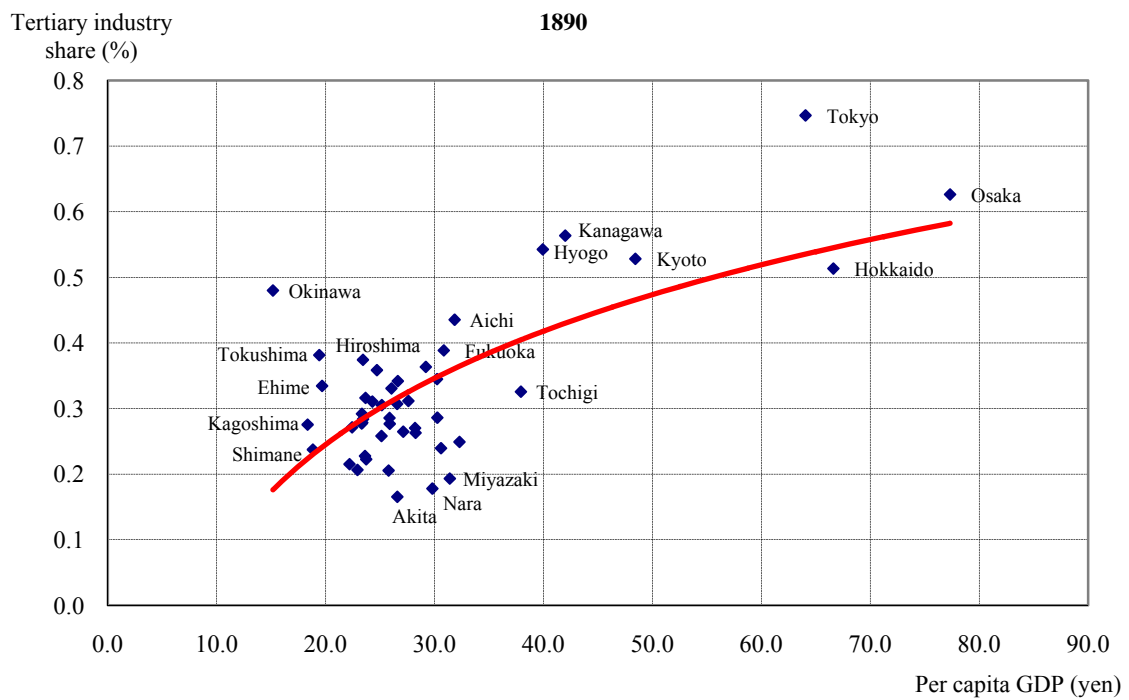
1909
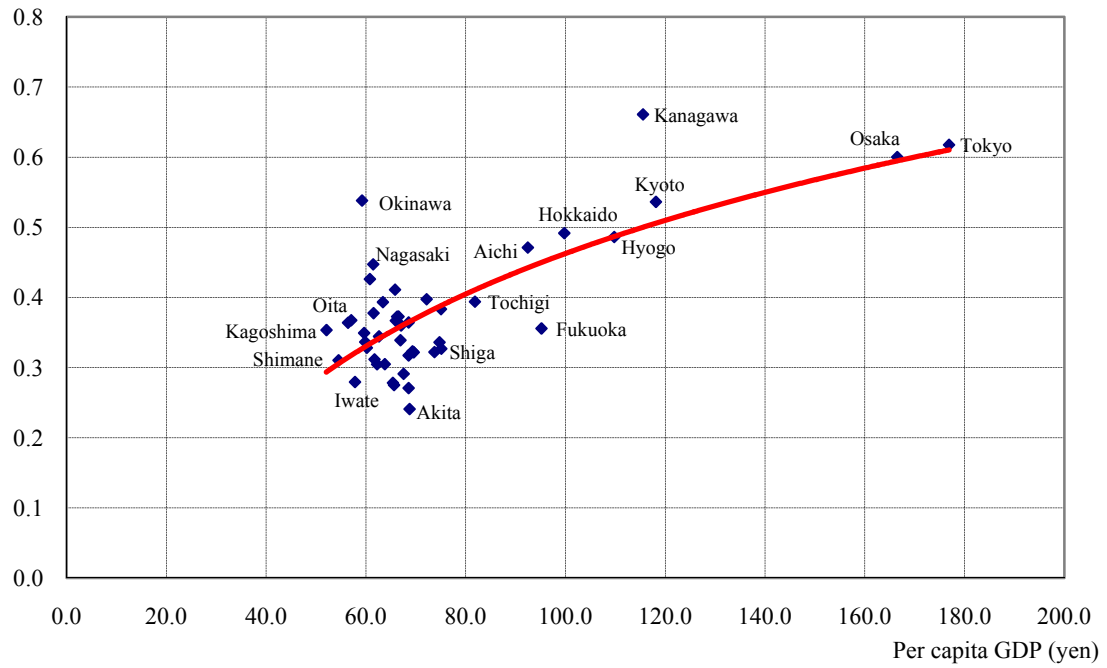
Tertiary industry
share (%)

1925

Tertiary industry
share (%)

Tertiary industry share (%)

1935

Per capita GDP (yen)

Tertiary industry share (%)

1940

Per capita GDP (yen)

6. Prefectural populations and gainfully occupied population by prefecture and industry
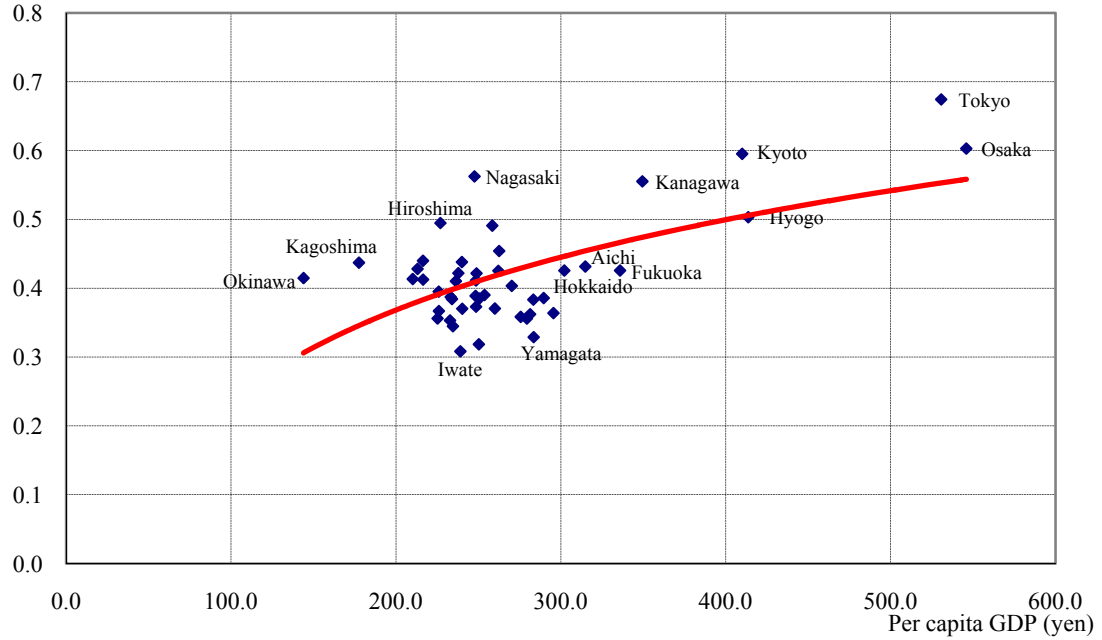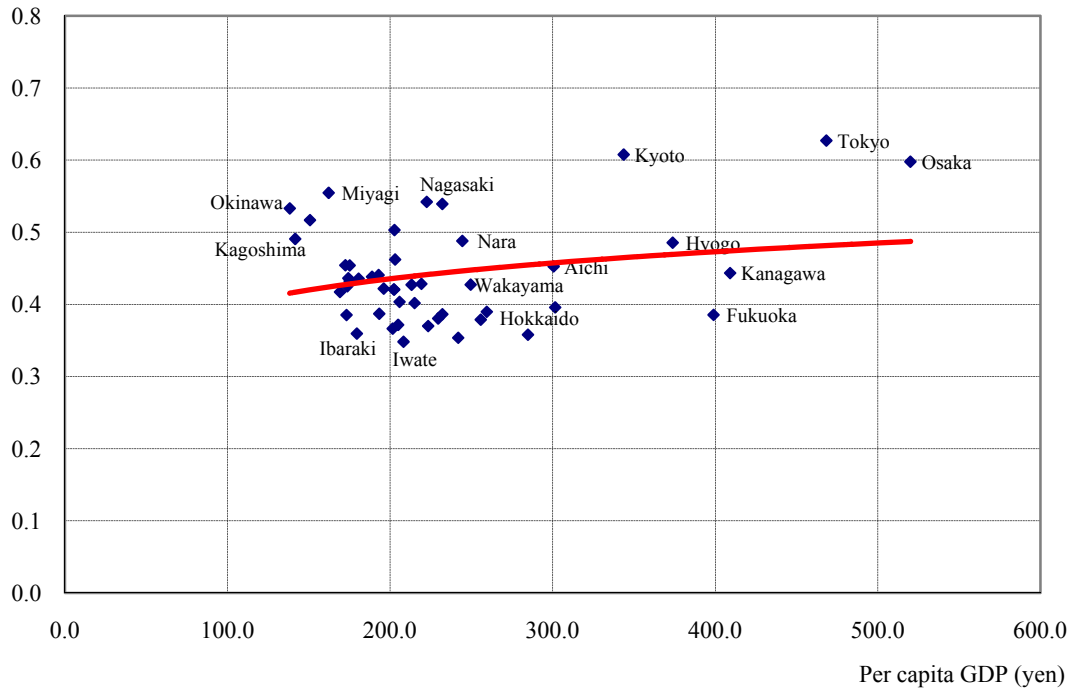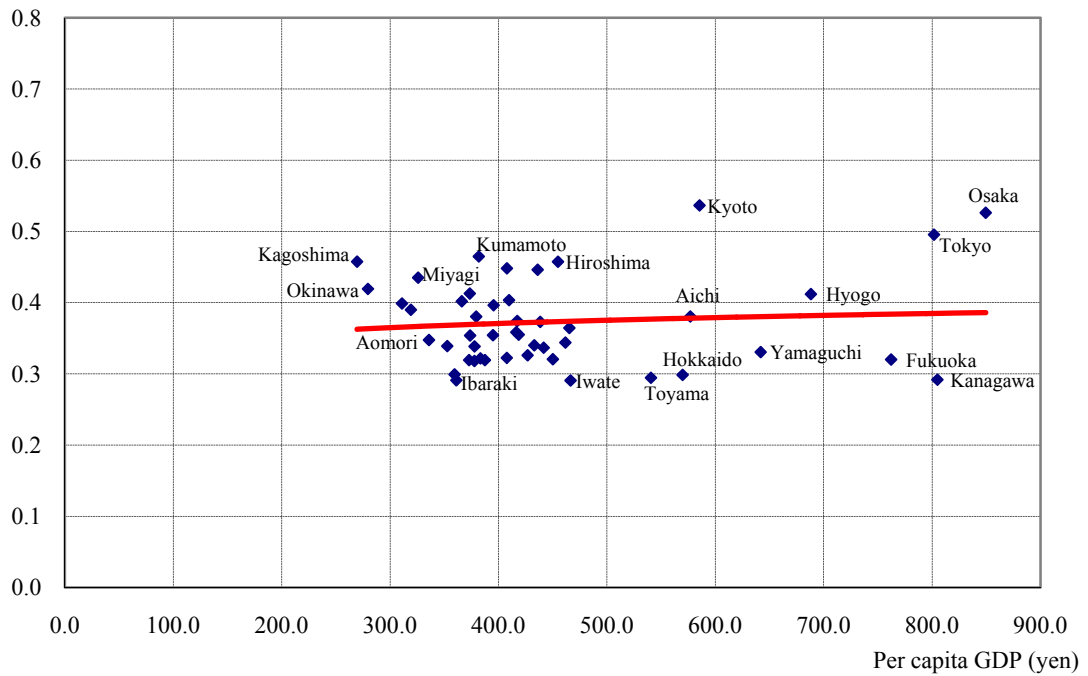
In this section, we explain our procedures for estimating prefectural populations (Section 6.1) and the gainfully occupied population by prefecture and industry (Section 6.2).

6.1 Prefectural populations

While economic studies rely on a variety of data, among the most basic and essential must be counted population data. This is certainly the case in our attempt here to estimate prefectural income for pre-war Japan, for which data on prefectural populations at the time are indispensible. Yet, in practice, obtaining such data is not a simple matter. Of course, from 1920 onward, when Japan first started to implement its *Population Census*, highly reliable population statistics by prefecture are available and in this study we use the *Population Census* figures as they are, with only minor adjustments, such as changing them to year-end figures. The challenge is obtaining prefectural population statistics for the period before that.

As is well known, until the implementation of the first *Population Census* in 1920, the population was recorded on the basis of family registers. However, since these family registers relied on self-reporting, delays and omissions mean that it was difficult to capture the population accurately. Nevertheless, as shown by Takase (1991) and Saito (2002), around 1890, when death certificates became necessary, reports on deaths appear to have been accurate to some extent. This means that the greatest remaining problem in estimating prefectural populations is to adequately capture domestic population movements.

Domestic population movements before 1920 were recorded through the "temporary residence (*kiryu*)" system. *Kiryu* means that someone resides somewhere other than the place of principal register (*honseki*) for more than 90 days. The temporary resident was obliged to submit an "incoming temporary residence notification" at the place of temporary residence and an "outgoing temporary residence notification" at the place of principal register, and the temporary resident was then recorded in the temporary residence register through this notification.[25] Moreover, the temporary residence notification system required the submission of a departure notification upon leaving a place of temporary residence, of a return notification to the place of principal register upon returning to the place of principal register, and of a change of temporary residence notification to the place of principal register when moving to a third area. Based on these notifications, temporary

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[25] For details on the temporary residence system, see Saito (1973) and Ito (1983). A brief explanation of temporary residence statistics is provided in the appendix of Saito (1998).

residence registers were kept. Consequently, if we add the population of incoming temporary residents in the temporary residence registers to the principal registered population (*honseki jinko*) and subtract the population of outgoing temporary residents, this makes it possible to obtain the de facto population of each prefecture. In fact, for years before the 1920 *Population Census*, the officially reported "de facto" population for each year was calculated using this method.

In other words, the "de facto" population of each prefecture was calculated as follows:

Current resident population =

Principal registered population + Incoming temporary population –

Outgoing temporary population

If notifications of incoming and outgoing temporary residents accurately reflect actual population movements, and as long as there are no large problems with regard to figures on the principal registered population, then the statistics on the "de facto" population should also be more or less accurate. However, in practices, incoming temporary residents often did not submit an outgoing temporary residence notification at their principal residence or a departure notification at their temporary residence, so that the incoming temporary resident population in the temporary residence registers increases cumulatively and the national total of incoming temporary residents exceeds that of outgoing temporary residents (in theory, the two should be equal). That is, there is a tendency for the reported "de facto" population of each prefecture to exceed the actual population.[26]

Complicating things further, periodic adjustments were made to the temporary residence records (*kiryu seiri*). These adjustments, which are known to have been implemented in cities in many regions of Japan during the first half of the Taisho period (Taisho period: 1912-1926), took the form of field surveys conducted in order to correct for discrepancies with regard to incoming and outgoing temporary residents. Incoming temporary residence notifications of non-existent incoming temporary residents were removed from the records, as were outgoing temporary residents that did not submit an outgoing temporary residence notification, with the aim of arriving at figures that are close to the actual population. For our purposes, these adjustments of temporary residence records

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[26] The government authorities at the time also recognized this excess in the incoming temporary residents population, and when publishing statistics for the "de facto" population by prefecture, calculated two time series: an "A type" (*koshu*) population series in which the figures from the registers are used as they are; and a "B type" (*otsushu*) population series in which the surplus in the number of incoming temporary residents was proportionally subtracted using the following ratio: (incoming temporary residents + outgoing temporary residents in a particular prefecture)/ (incoming temporary residents + outgoing temporary residents for all of Japan). The term "reported 'de facto' population" in this study in all cases refers to the "A type" population series.

pose a problem: while the resident population figures should be close to the true population at times when such adjustments were made, these adjustments give rise to large discontinuities in the population time series.

How to overcome these two problems regarding the recorded "de facto" population – that is, that it systematically overstate the actual population in most years, and the discontinuities introduced by the occasional adjustments – presents a major challenged. Against this background, the procedure we employed is as follows. First, for the period from 1920 onward, we used the prefectural population data published by the Statistics Bureau of the Ministry of Internal Affairs and Communications converted to year-end population data. Second, we divided the period prior to 1920 into two subperiods, 1898 to 1919 and 1890 to 1897. For the period from 1898 to 1919, we distinguish between prefectures comprising the six largest cities (i.e., the prefectures of Tokyo, Osaka, Kyoto, Aichi, Kanagawa, and Hyogo) and other prefectures, and then estimate the population as follows:

A.   Prefectures other than those comprising the six major cities

(i)   Using the reported de facto prefectural populations from the *Nihon Teikoku Jinko (Seitai) Tokei* [Population Statistics of Imperial Japan],[27] published by the Cabinet Bureau of Statistics every five years from 1898 onward, as benchmarks, we calculated the growth rates between these benchmark years using the fixed percentage method and took the five-year moving average of the growth rate.

(ii)   When there are discontinuities in the population series as a result of the adjustment of temporary residence records, we connected the population growth rates before and after the discontinuity using the recorded population for each year from the *Fuken Tokei Sho*.[28]

(iii)   We then calculated prefectural populations for 1918, extrapolating backward using the annualized growth rates from 1920 to 1925. Using the population figures for 1918 thus obtained, we employed the population growth rate obtained in the previous step and estimate prefectural populations back to 1898.

(iv)   Next, aggregating the prefectural population figures for each year and comparing the result

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[27] In 1898, *Nihon Teikoku Jinko Tokei,* thereafter *Nihon Teikoku Jinko Seitai Tokei.*

[28] Although the *Nihon Teikoku Jinko Seitai Tokei* provide population data only at five-year intervals from 1898 to 1918, while annual data are available from the *Fuken Tokei Sho*, we use the data from the former as benchmarks because the *Nihon Teikoku Jinko Seitai Tokei* were compiled by the national government and and research suggests that they are more reliable than the *Fuken Tokei Sho* compiled by prefectural governments. For details, see Ito (1983: 55-58).

with the national population for each year reported in the LTES (Umemura et al., 1988), we allocated the residual based on prefectures' share in the national population. (However, the prefectures comprising the six biggest cities described below were excluded from this procedure.)[29] Finally, we smoothed the figures we obtained using five-year moving averages.

B. Prefectures comprising the six major cities

For prefectures comprising the six major cities the basic estimation procedure is similar to that for the other prefectures, but it differs in that we replace the population data for these cities from the *Nihon Teikoku Jinko Seitai Tokei* with the estimated city populations from Ito (1983). [Moreover, as mentioned, we excluded these prefectures when allocating the residual in step (iv) above, that is, we subtracted the population of the six prefectures from our estimate of the national population and the national population reported in the LTES (Umemura et al., 1988)].

Summing up the procedure for the period from 1898 to 1919, the basic strategy of our estimation is not to rely on the reported "de facto" population figures, as explained above, they overstate the actual population, but instead to regard the implied growth rates as more reliable, take the earliest available prefectural population statistics, those from the 1920 *Population Census*, and then extrapolate population figures backward using the implied growth rates.

Next, let us explain how we estimate prefectural populations before 1898. Because the historical sources for population data before and after 1898 differ and as a result the treatment of incoming and outgoing temporary residents also differs, the population data cannot be directly linked. Thus, given the lack of a more appropriate methodology at present, we obtained prefectural population estimates for 1890 by extrapolating backward from 1898 using the growth rates of the reported "de facto" population in the *Nihon Teikoku Minseki Kokohyo* [Table of Households and Population of Imperial Japan] by the Ministry of Internal Affairs.[30] Similar to our estimation for the period after 1898, we calculated the moving geometric averages of the growth rate series and adjusted the prefectural population estimates so that the national total was consistent with the LTES (Umemura et al., 1988). However, because we once more took the moving averages following this

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[29] Population estimates in the LTES (Umemura et al., 1988) for 1871 to 1920 are for the population of Japanese in Japan proper and do not include foreigners, while those for 1920 onward cover the entire population. To obtain series for the entire population for the period before 1920, we simply multiplied the series by the ratio of the entire population to the Japanese population in 1920.

[30] In practice, we took the data for the "A type" resident population from the *Meiji 17-nen Yori Do-40-nen ni Itaru Dofuken Genju Jinko* [Prefectural Resident Populations from 1884 to 1907], which is a compilation of the prefectural population data from each of the volumes of the *Nihon Teikoku Minseki Kokohyo*.

adjustment, our estimates differ slightly from those in the LTES.

6.2 The gainfully occupied population by prefecture and industry

To estimate the gainfully-occupied population by prefecture and industry, we employed the same methodology that Umemura et al. (1988) used for their estimates at the national level in the LTES. However, because it is virtually impossible to estimate at the prefectural level the gainfully occupied population by age group, as Umemura et al. (1988) did at the national level, we cannot estimate prefectural unemployment based on this information. We therefore decided to estimate the number of unemployed using the mortality tables by industry from the *Nihon Teikoku Shiin Tokei* [Statistics on the Causes of Death in Imperial Japan] published by the Statistics Bureau, Ministry of Internal Affairs. For this reason, the national totals for each industry obtained by aggregating prefectural figures differ somewhat from those in the LTES (Umemura et al., 1988).[31]

Because the procedure for estimating the gainfully occupied population is described in Umemura et al. (1988), we refer the interested reader there for a detailed explanation. Here, we only briefly explain the differences between the estimation in this study and that in Umemura et al. (1988).

The approach employed by Mataji Umemura can be summarized as follows. Using the employed population by industry from the 1920, 1930, and 1940 *Population Censuses* as benchmarks, he interpolated or extrapolated for earlier or later years using the number of deaths by industry, data on which are available for 1906 to 1936 in the *Nihon Teikoku Shiin Tokei.* That is, the estimation is based on the extremely strong assumption that there are no differences in mortality rates between industries. Moreover, the estimates of the gainfully occupied population are on the basis of persons' principal occupation and do not include by-employments.

In principle, we estimate the gainfully occupied population by prefecture using the same methodology. However, in some cases, although figures for Japan as a whole can be estimated, it is not possible to obtain prefectural estimates using the same sources and procedures as Umemura et al. (1988). For example, just like Umemura et al. (1988), in order to have consistent industry classifications over time, we reaggregated data at the detailed industry level. However, the *Population Census* for 1940, one of the benchmark years, does not provide a breakdown by detailed industry classification of the number of gainfully occupied persons at the prefectural level. (On the other hand, such a breakdown is available in the 1920 and 1930 *Population Censuses.*) We therefore used the *Showa 15-nen Kokusei Chosa Tokei Genpyo* [Original Statistics Tables for the 1940

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[31] Especially in the figures for before 1920, there are larger discrepancies.

Population Census], which provide a detailed industry breakdown, to reaggregate the data.[32]

Moreover, the industry classification in the *Nihon Teikoku Shiin Tokei*, from which we obtain figures on the number of deaths by industry, is not as detailed at the prefectural level as it is at the national level. For that reason, we were forced to confine ourselves in this study to the following broad categories: (1) agriculture and forestry, (2) fisheries, (3) mining, (4) manufacturing and construction, (5) commerce, (6) transport and communication, (7) public administration and professionals, and (8) other (which corresponds to "domestic servants, etc.," in the preceding section). A ninth category is those not gainfully occupied.[33] It should be noted that there are some small inconsistencies between this 8-industry classification and the 16-industry classification used in the estimation of gross value added above. Specifically, while in the 16-industry classification the salt industry is included in the manufacturing sector, it falls under fisheries in the 8-industry classification here. Similarly, in the 16-industry classification the utilities sector (gas, electricity, water) is included in transport and communication, but in the 8-industry classification, it falls under manufacturing and construction. In the calculation of productivity by industry in Section 8, we do not adjust for these inconsistencies. A final note is that the gainfully occupied population in trade and services in the 16-industry classification correspond to the total of the gainfully occupied population in commerce, public administration, professionals, and others in the 8-industry classification.

7. Trends in regional inequality

Having explained how we arrived at our estimates of prefectural GDPs, let us now examine how they compare to preceding estimates and what they imply in terms of trends in regional inequality. Figures 11 and 12 below show the trend in the coefficient of variation (i.e., the standard deviation divided by the mean) of per capita prefectural GDPs and their industry composition, where for period from 1955 onward we used the data from the *Kenmin Keizai Keisan Nenpo* [*Annual Report on Prefectural Accounts*] (various years) published by the Economic and Social Research Institute, Cabinet Office (formerly, Economic Planning Agency, EPA). It should be noted that these post-war *Prefectural Accounts* are, in the terminology we use here, only expressed in local prices.

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[32] The Research Centre for Information and Statistics of Social Science attached to the Institute of Economic Research at Hitotsubashi University holds a microfilm copy of this. Details on the *Showa 15-nen Kokusei Chosa Tokei Genpyo* can be found in Documentation Centre for the Japanese Economy, Institute of Economic Research, Hitotsubashi University, ed., (19--) (publication year unknown).

[33] The sum total of these categories equals the total population for each prefecture.

The statistics of the *Prefectural Accounts* for 1955-1969 are based on the 1953 SNA, while those for 1970-1989 are based on the 1968 SNA, and those for 1990-2005 are based on the 1993 SNA. Values from 1965 onward are on a fiscal year basis, while those before that are on a calendar year basis.

Figure 11, furthermore, shows the coefficients of variation calculated using (1) Matsumoto's (2004) estimates of per capita prefectural income (in 1934-36 average prices) for 1905, 1920, and 1935; (2) per capita prefectural income based on the prefectural income estimates for 1930, 1935, and 1940 of the Kokumin Keizai Kenkyu Kyokai [Society for the Study of the National Economy] (1956);[34] and (3) the per capita gross prefectural product based on the Kokumin Keizai Kenkyu Kyokai's (1956) estimates of gross prefectural product. Moreover, the figure also shows the coefficient of variation calculated from figures for 1950 by the Nihon Kaihatsu Ginko nai Chiiki Keizai Kenkyu Kai [Study Group on the Regional Economy, Japan Development Bank] (1969).[35] It should be noted that the estimates in all these studies are expressed in local prices.[36] As shown in Figure 11, the coefficient of variation for per capita gross prefectural product in national average prices, which takes regional price difference into consideration, is not very different from the coefficient of variation for per capita gross prefectural product at local prices. A possible reason is that we were able to calculate gross value added at national average prices only for agriculture, mining and manufacturing.

Finally, Figure 11 also shows the Gini coefficient calculated using our per capita prefectural GDP estimates in local prices for the pre-war period and the per capita prefectural GDP from the *Prefectural Accounts* for the post-war period and assuming that within a particular prefecture per capita GDP is evenly distributed.

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[34] Reprinted in Keizai Kikakucho Chokan Kanbo Chiiki Mondai Kenkyu Shitsu [Investigative Office on Regional Issues, Research and Statistics Department, Director General's Secretariat, Economic Planning Agency] (1964) and Toyo Keizai Shinposha (1991).

[35] The EPA estimated per capita nominal prefectural income for 1950 for most prefectures. Nihon Kaihatsu Ginko nai Chiiki Keizai Kenkyu Kai filled in estimates for prefectures with missing data.

[36] Matsumoto's (2004) figures include Okinawa, but those of the Kokumin Keizai Kenkyukai and the Nihon Kaihatsu Ginko nai Chiiki Keizai Kenkyu Kai do not. Moreover, the *Prefectural Accounts* include Okinawa only from 1973 onward, and for 1973-74, figures on a U.S. dollar basis were converted to yen basis using a rate of 305 yen/dollar.

Figure 11. Coefficient of variation of per capita prefectural GDP (or income) and Gini coefficient: 1890-2005
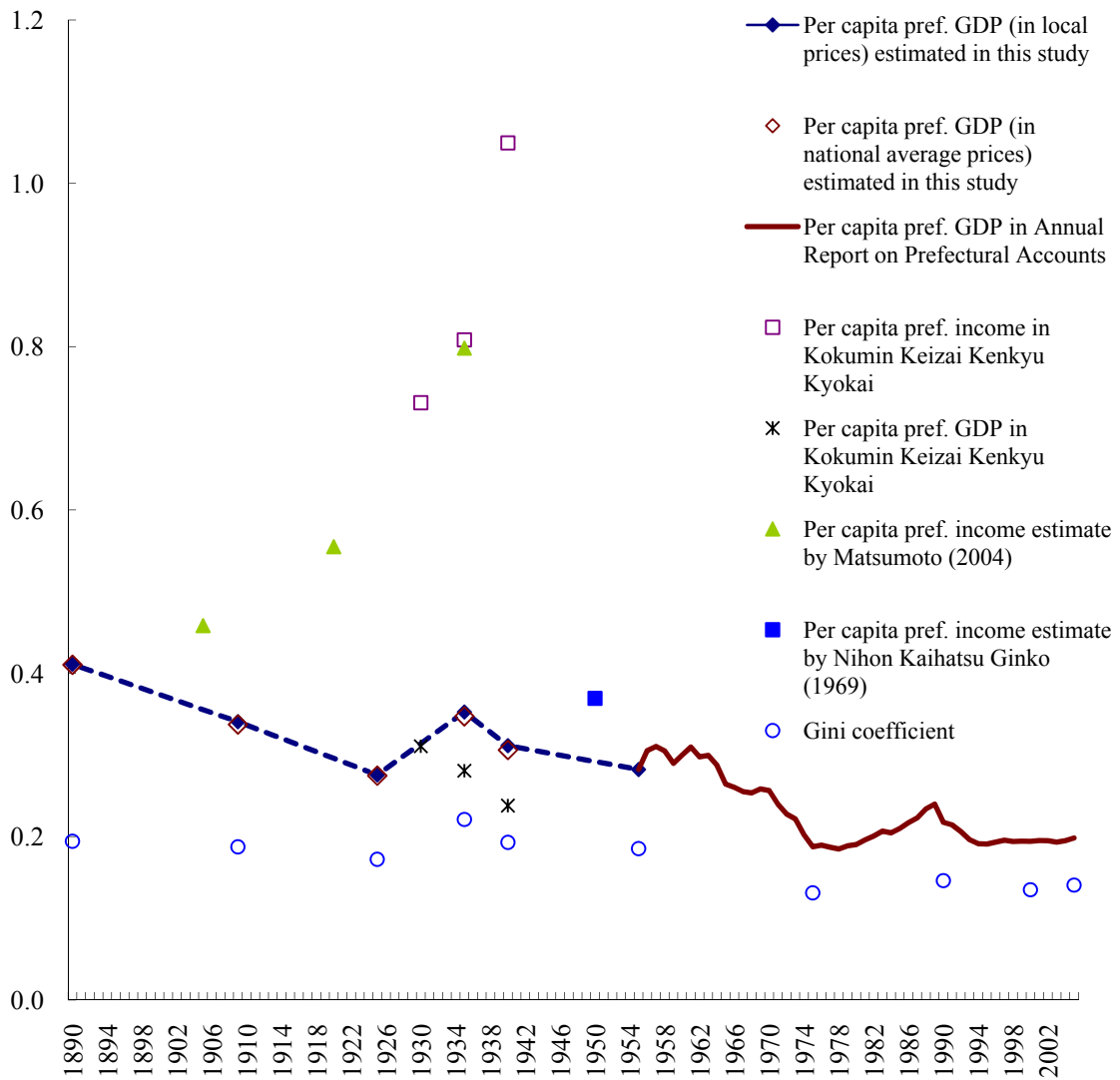
Note: The Gini coefficient was calculated based on the cumulative population share using the per capita prefectural GDP estimates of this study (in local prices) and the per capita prefectural GDPs from the *Annual Report on Prefectural Accounts*.

The estimation by the Kokumin Keizai Kenkyu Kyokai was conducted as part of the "Showa 30-nendo Tohoku Chiho Sogo Kaihatsu Chosa [Fiscal Year 1955 Investigation on the General Development of the Tohoku Region]" and in addition to 1930, 1935, and 1940 also estimates prefectural income for each year from 1948 to 1952 from the production, distribution, and

expenditure sides. However, at present, detailed explanations of the estimation methodology can only be found for the estimates for the post-war period, but not for the pre-war period.[37]

If we conjecture from the estimation procedures employed for the post-war period and other national income estimates for the same period, the Kokumin Keizai Kenkyu Kyokai likely adopted the following approach for the pre-war period. Using prefectural production, distribution (income), and expenditure statistics, the basic idea was to allocate national income estimated from the three sides to the different prefectures in order to estimate prefectural income from the production, distribution (income), and expenditure sides. The national income figures that are allocated to the different prefectures are probably those from Keizai Shingi-cho, Kokumin Shotoku-ka [National Accounts Division, Economic Council Agency] (1954) or revised values thereof.[38] However, a major problem of these estimates is that although income from the production, distribution, and expenditure side should essentially be identical, no attempts have been made to compare the estimates from the three sides and check for discrepancies. Yet, looking at per capita income in Tokyo prefecture, for example, no matter which year we take, income from the production side is only about half of that from the distribution side, so the discrepancies between the two are extremely large.

The estimates of prefectural income from the production side by the Kokumin Keizai Kenkyu Kyokai for the pre-war period probably employed the same approach as that taken in this paper, that is, estimates for the primary sector and manufacturing industry likely are based on production statistics, while those for construction and tertiary industry are based on income side information (with estimated per capita value added multiplied by the gainfully occupied population), with prefectural GDP in each of these expressed in market prices. On the other hand, the estimates from the distribution side likely are estimates of prefectural income estimated from tax statistics for individuals and corporations, so that, unlike in the case of gross prefectural product, the estimation is based not on where something was produced, but where those receiving the income resided. The

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[37] In what detail the methodology and results of the prefectural income estimates in the "Showa 30-nendo Tohoku Chiho Sogo Kaihatsu Chosa [Fiscal Year 1955 Investigation on the General Development of the Tohoku Region]" were published is not entirely clear, but some explanations have been published in Kokumin Keizai Kenkyu Kyokai (1955a, b; 1956) (available in the depository of the Research Centre for Information and Statistics of Social Science, Institute of Economic Research, Hitotsubashi University). Two of these volumes, Kokumin Keizai Kenkyu Kyokai (1955a) and (1956), which describe the estimation methodology of post-war prefectural income, have been reprinted in Kokumin Keizai Kenkyu Kyokai (1998).

[38] For example, looking at the estimates of income from the production-side by industry (for Japan as a whole) by the Kokumin Keizai Kenkyu Kyokai, these are consistent – with the exception of those for secondary industry – with those by the Economic Council Agency.

estimates from the distribution side are on a factor cost basis, that is, they do not include indirect tax minus subsidies, and on a net basis, that is, they do not include capital depreciation.[39] Finally, in the case of the expenditure-side estimates, the basis for estimation is not final demand for the output of each prefecture but the final demand in each prefecture (domestic absorption in the terminology of international economics), which does not include net exports of goods and services abroad and to other regions.

However, to compare gross prefectural product and prefectural income, it is necessary to estimate the net income (net receipts of factor income from outside the prefecture) for each prefecture not only by allocating indirect taxes minus subsidies for Japan as a whole and estimating capital depreciation, but also by adjusting for differences between where something is produced and where those receiving the income reside. Similarly, to compare gross prefectural demand and gross prefectural product, it is necessary to estimate net exports of goods and services. However, the Kokumin Keizai Kenkyu Kyokai does not attempt to compare the results of the estimates from the three sides, for which the estimation of prefectural income balances and net exports is essential but extremely difficult.

Of the three estimates by the Kokumin Keizai Kenkyu Kyokai, which it conducted separately and the mutual consistency of which it did not examine, we believe the estimates from the production side to be the most reliable. Looking at the estimation procedures for the post-war period, the estimates from the expenditure side rely on extremely bold estimations such as of consumption propensities by prefecture. Moreover, because net exports are not included, the underlying definition is very different from that commonly employed for gross prefectural expenditure. As for the estimates from the income side, it appears that the Kokumin Keizai Kenkyu Kyokai respectively used corporate income tax (Type I income tax) statistics and personal income tax (Type III income tax) statistics from the *Shuzei-kyoku Tokei Nenpo* [Annual Report of the Tax Bureau] (various years) in order to allocate Japan's total corporate income and total personal income across prefectures.[40]

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[39] For the distribution-side estimate, the Kokumin Keizai Kenkyu Kyokai calculated two series as control totals: domestic gross income at market prices ("regional gross distribution" in their terminology) and domestic net income at factor prices ("regional distribution income" in their terminology). Of these, the national income series reprinted in Keizai Kikakucho Chokan Kanbo Chiiki Mondai Kenkyu Shitsu (1964) and Toyo Keizai Shinposha (1991) (that is, the series depicted in Figure 11) is the latter series.

[40] The cross-sectional correlation between prefectural corporate income estimates by the Kokumin Keizai Kenkyu Kyokai and the prefectural corporate income tax revenue reported in the *Shuzei-kyoku Tokei Nenpo* is very close to one for 1930, 1935 and 1940. Similarly, the cross-sectional correlation between the prefectural personal income estimates by the Kokumin Keizai Kenkyu Kyokai and the prefectural personal income tax revenue reported in the *Shuzei-kyoku Tokei Nenpo* is very close to one for the three years.

However, estimates from the income side based on tax statistics, and especially income tax statistics including corporate taxes, are littered with various problems. Because corporate taxes are paid at the firm level, tax revenues decisively depend on the location of company headquarters. Probably for this reason, the corporate income of prefectures in which many corporate headquarters are located, such as Tokyo and Osaka, is abnormally high in the estimates of the Kokumin Keizai Kenkyu Kyokai. However, essentially, economic activity should be captured not at the firm level but the establishment level.[41, 42] The direct use of personal income tax statistics is also problematic. Personal income tax (Type III income tax) payers accounted for less than 10 percent of the total population at that time (Yazawa, 2004). Consequently, there is a risk that personal income is overestimated for prefectures with a high concentration of tax payers. The fact that the coefficient of variation in the prefectural income estimates of the Kokumin Keizai Kenkyu Kyokai is extremely high is likely caused by the problems associated with the use of this type of tax statistics.

The estimation results of the Kokumin Keizai Kenkyu Kyokai were subsequently cited by Keizai Kikakucho Chokan Kanbo Chiiki Mondai Kenkyu Shitsu (1964) and Toyo Keizai Shinposha (1991). However, Toyo Keizai Shinposha (1991) for some reason only reproduced the estimates of per capita prefectural income from the distribution (income) side, and analyses in subsequent studies (e.g., Barro and Sala-i-Martin, 1992; Matsumoto, 2004; METI, 2007) are also entirely based on the estimates of per capita prefectural income by the Kokumin Keizai Kenkyu Kyokai.

Going back now to the results shown in Figure 11, the large differences between the coefficients of variation for per capita gross prefectural product based on our estimates and that of the Kokumin Keizai Kenkyu Kyokai (1956) as well as the coefficients of variation for per capita gross prefectural income based on Matsumoto (2004) and Kokumin Keizai Kenkyu Kyokai (1956) are likely caused not only by the differences in estimation procedures just explained, but also by the differences in underlying definitions. That is, whereas the estimates of gross prefectural product measure production activity at market prices within each prefecture, the estimates of prefectural income at factor cost do not include indirect taxes minus subsidies and, moreover, include income receipts such as investment earnings from other prefectures and abroad (corresponding to a surplus in the balance of income in international balance of payments statistics). This means that interprefectural inequality will appear larger in terms of prefectural income than in terms of gross prefectural product if wealthy individuals, who tend to be concentrated in prefectures with a high per

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[41] Aware of this issue, Crafts (2005) in his estimation of regional income in Victorian Britain, for example, adjusts regional data of business and professional profits in accordance with the proportion of receipts accruing to "individuals and firms" as opposed to "companies and local authorities" (however, such data are available only for 1949-50).

[42] Japan's present gross prefectural product statistics are based on this approach (see Nagafuji, 2002).

capita gross prefectural product such as Tokyo and Osaka receive large amounts of land rent and investment income from other prefectures. On the other hand, if residents of poor prefectures receive employment income while working away from home, the inequality in prefectural income levels will appear smaller in terms of prefectural income than gross prefectural product. Whether the kind of large factor income transfers between prefecture implied by the discrepancy between the output and income estimates of the Kokumin Keizai Kenkyu Kyokai did in practice occur is a matter that still needs to be researched. Looking at the post-war period, for which both prefectural income and gross prefectural product statistics available, the coefficient of variation for prefectural income in the 2005 *Prefectural Accounts*, for example, is 0.17, which is smaller than that for gross prefectural product, which is 0.20. These issues regarding the differences between prefectural income and gross prefectural product are a topic we would like to leave for future studies.

The prefectural estimates from the production side by the Kokumin Keizai Kenkyu Kyokai (gross prefectural product) can be considered to be generally comparable to our estimates. If we actually compare them, the coefficients of variation based on the Kokumin Keizai Kenkyu Kyokai's estimates are generally smaller than those based on our estimates. Moreover, looking at the ratio of the per capita income of the richest to that of the poorest prefecture for each year, we also find that this is generally smaller: For 1935, the ratio (for Osaka, the richest prefecture, and Kagoshima, the poorest) is 2.7 in the Kokumin Keizai Kenkyu Kyokai estimates, compared with a ratio of 3.8 (for Osaka and Okinawa) in our estimates. Similarly, for 1940, the ratios are 2.4 (for Kanagawa and Kagoshima) in the Kokumin Keizai Kenkyu Kyokai estimates and 3.2 (for Osaka and Kagoshima) in our estimates.[43] Another difference can be seen with regard to the trend in the coefficient of variation over time. Whereas in the case of the Kokumin Keizai Kenkyu Kyokai estimates, it consistently declines from 1930 to 1940, based on our estimates it rises from 1925 to 1935 and then falls in 1940. However, overall, if we calculate the correlation coefficient between their and our gross prefectural output estimates (excluding Okinawa) for 1935 and 1940, the values at 0.96 and 0.94 are quite high, and it can be said that the estimates are relatively close.

That being said, there are two major problems with regard to the national income estimates used as control totals in the estimates of the Kokumin Keizai Kenkyu Kyokai. As mentioned earlier, it appears that the Kokumin Keizai Kenkyu Kyokai used the national income data from Keizai Shingi-cho (1954). However, according to Ohkawa et al. (1974), the income estimates by industry in Keizai Shingi-cho (1954) underestimate values for the manufacturing and construction industries. Moreover, although Ohkawa et al. (1974) do not explicitly say so, looking at one of their tables (Ohkawa et al., 1974: 156), the agricultural output estimated by the Kokumin Keizai Kenkyu Kyokai

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[43] Even if we leave out Okinawa from our estimation results, the ratio for Osaka and Kagoshima in 1935 is still 3.7 and the coefficient of variation for each year remains essentially unchanged.

for 1940 is too large.[44]

Another problem related to this is that if we broadly divide the Kokumin Keizai Kenkyu Kyokai estimates into the primary, secondary and tertiary sector, it appears that the increase in primary sector income in rural prefectures greatly contributed to the decrease in interprefectural inequality from 1930 to 1940. However, comparing the share of primary sector income in the per capita income for the total of all industries for Japan as a whole, we find that this is 16.4 percent for 1935 and 17.5 percent for 1940, but in the estimates of the Kokumin Keizai Kenkyu Kyokai, it is 19.8 and 24.1 percent, respectively.[45] Although a more detailed examination of the reasons for the decline in inequality is necessary, this comparison suggests that the Kokumin Keizai Kenkyu Kyokai estimates exaggerate the expansion in agricultural output during this period and it can be conjectured that this is one cause for the large decline in the coefficient of variation.

Next, let us examine the estimates by Matsumoto (2004). According to the preface, the estimate for 1905 is based on the output of all products for all prefectures from the *Fuken Tokei Sho* (see the preface of Matsumoto, 2004), and although the details of the estimation procedure with regard to the construction and the tertiary sector are unclear, it seems that Matsumoto partly used more detailed prefectural statistics than ours. Overall, though, it can be conjectured that the estimation was conducted using a relatively similar approach to ours. For example, the correlation between Matsumoto's per capita prefectural income estimates for 1905 and our per capita gross prefectural product estimates at local prices for 1909 is quite high with a correlation coefficient of 0.94 and, as can be seen in Figure 11, the coefficient of variation is also not that different.

On the other hand, for 1935, because he used the prefectural value added ratios from Keizai Kikakucho Chokan Kanbo Chiiki Mondai Kenkyu Shitsu (1964), the correlation coefficient between Matsumoto's estimates excluding Okinawa and the Kokumin Keizai Kenkyu Kyokai estimates, at 0.99994, is close to 1.[46] Moreover, the ratios of the prefectural estimates of the two are 1.09 at the most and 1.04 at the least, so that it can be said that the two are very similar estimates. Therefore, Matsumoto's estimates for 1935, and the high coefficient of variation they imply, cannot really be said to be independent estimates of those of the Kokumin Keizai Kenkyu Kyokai.

As shown in Figure 11, our estimation results suggest that regional inequality in Japan in local prices steadily declined in the long-run. The highest coefficient of variation is 0.41 for 1890, and the per capita prefectural GDP of Osaka, the richest prefecture at the time was 5.1 times that of Okinawa,

[44] However, it should be noted that agricultural output values in the annual estimates in Ohkawa et al. (1974) are at market prices, while the Kokumin Keizai Kenkyu Kyokai estimates are at factor cost.

[45] Production income by industry was calculated by dividing net domestic income at factor cost.

[46] A description of the value added ratio by prefecture for 1935 in Matsumoto's estimation is provided in Matsumoto (2004: 92, fn. 7).

the poorest, and 3.4 times that of Iwate prefecture, the poorest prefecture in northern Japan (Figure 12). The coefficient of variation declined over time to 0.28 in 1925, indicating growing equality. This value is virtually the same as that for 1964-65, and the disparity in terms of the ratio of per capita gross prefectural product of the most prosperous prefecture and the poorest prefecture declined, to 3.8 for Osaka and Okinawa and 2.7 for Osaka and Aomori, in northern Japan, the poorest prefecture on Japan's four main islands.
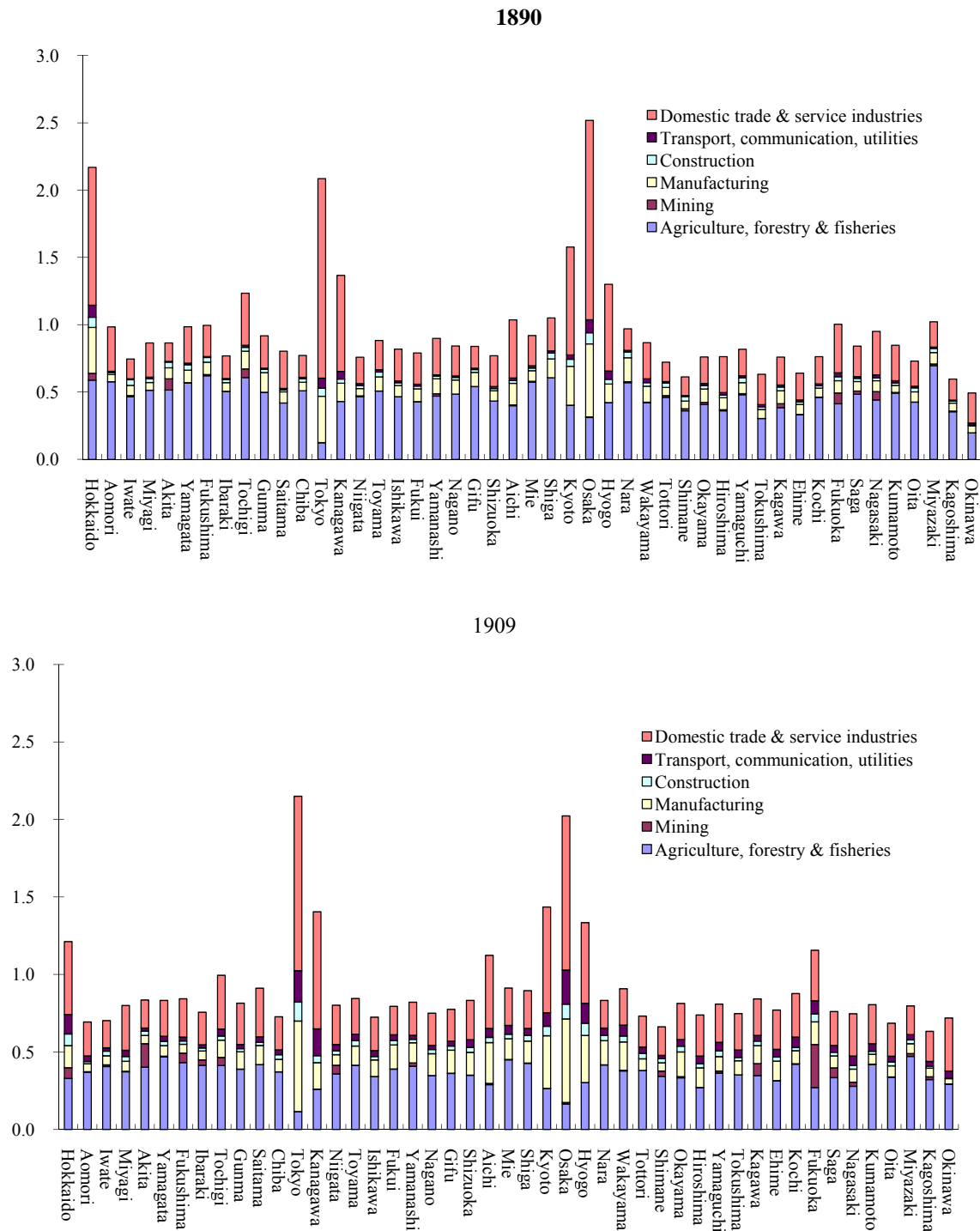
These results showing a steady decline in the coefficient of variation, apart from the period from 1925 to 1935, when the relative price of agricultural products fell and the heavy and chemical industries developed,[47] differ greatly from those obtained by Matsumoto (2004), which suggest that the coefficient of variation during the pre-war period increased over time from 1905 onward. In this context, it is useful to refer to a study by Barro and Sala-i-Martin (1992), who used developments in the standard deviation of the log of state per capita personal income to examine trends in interregional income inequality in the United States from 1880 to 1988. They showed that, in the long-run, interregional inequality declined, but that an increase in equality could be seen during the Great Depression (see Figure 14). They argue that the increase in inequality was caused by the fact that the decline in the relative price of agricultural products during this time worsened the terms of trade of agricultural states that were already poor to begin with. It is possible that the temporary increase in inequality in Japan from 1925 to 1935 suggested by our results was caused by the decline in the price of agricultural products during this period. Nevertheless, the coefficient of variation for 1940 based on our estimates is only 0.31, which is much lower than that based on the Kokumin Keizai Kenkyu Kyokai (1956) estimates, which reached 1.07.

Finally, looking at our results for the Gini coefficient, these show that this also declined, from 0.19 in 1890 to 0.14 in 2005, indicating again that in the long-run, inequality followed a downward trend. However, in contrast with the results for the coefficient of variation, the the Gini coefficient suggests that regional inequality in 1935 was quite large, with a Gini coefficient of 0.22 for that year.
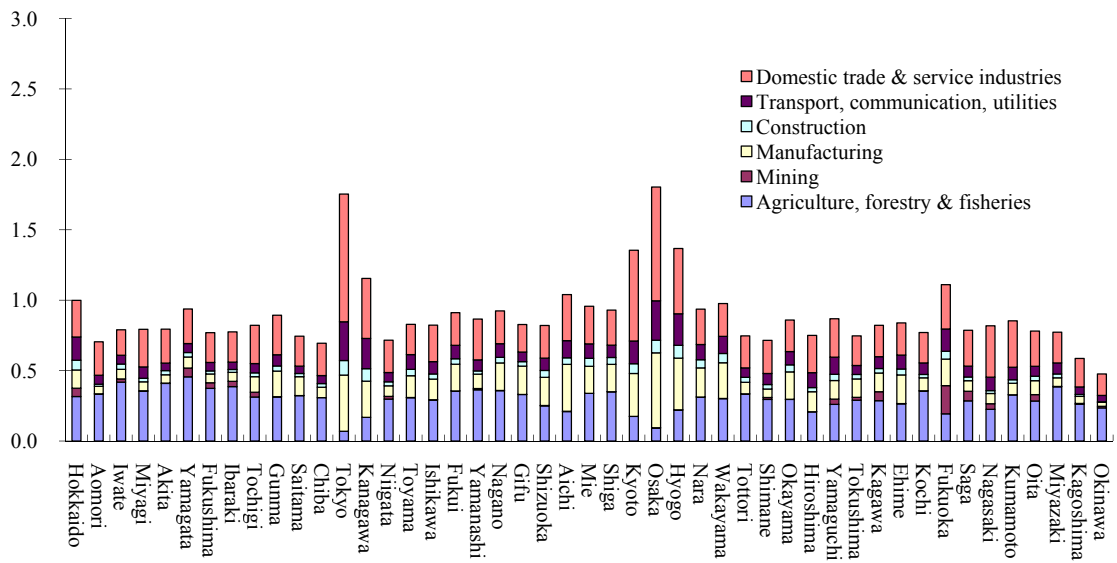
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[47] On the deterioration in the agricultural terms of trade due to the decline in agricultural prices during the Great Depression, see Odaka (1989: 146-151).

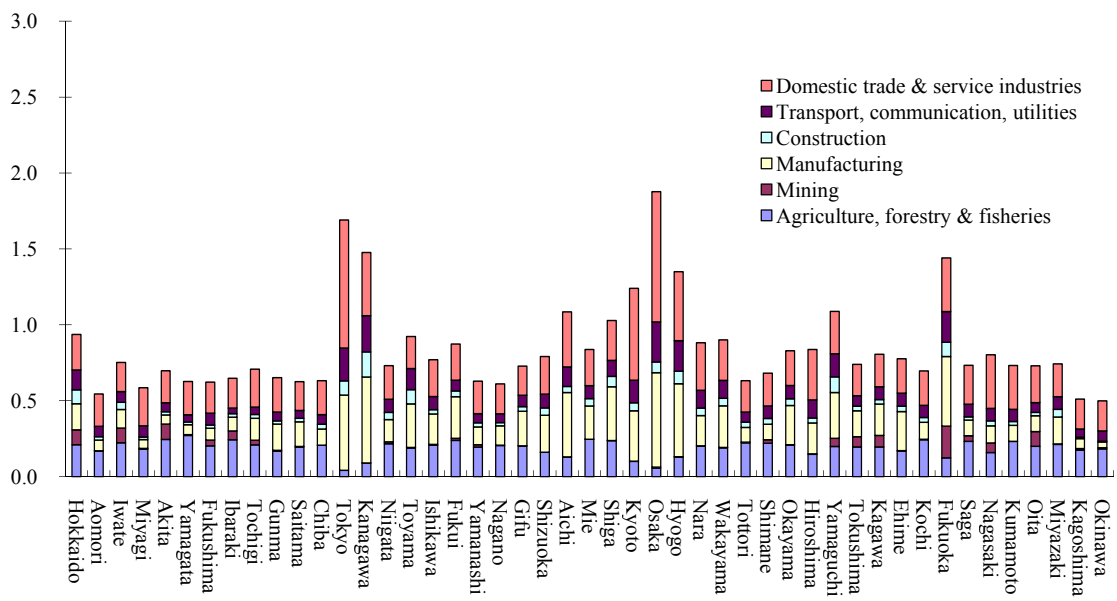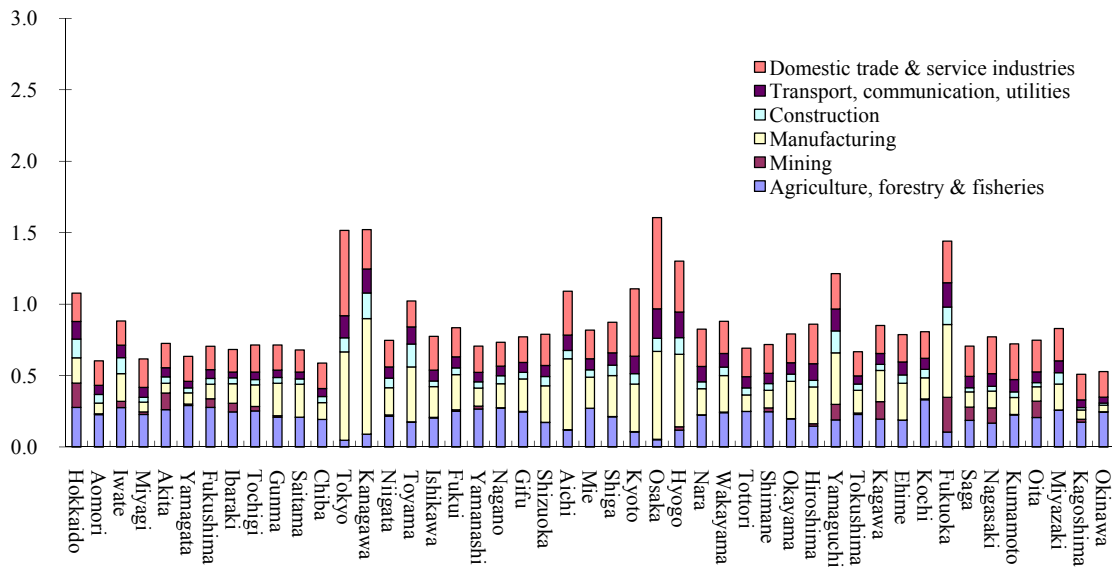**Figure 12. Per capita prefectural GDP and industry structure** (at local prices; national average=1)

1890

1909

1925

1935

1940

3.0

2.5

2.0

1.5

1.0

0.5

0.0

■ Domestic trade & service industries
■ Transport, communication, utilities
□ Construction
□ Manufacturing
■ Mining
■ Agriculture, forestry & fisheries

Hokkaido Aomori Iwate Miyagi Akita Yamagata Fukushima Ibaraki Tochigi Gunma Saitama Chiba Tokyo Kanagawa Niigata Toyama Ishikawa Fukui Yamanashi Nagano Gifu Shizuoka Aichi Mie Shiga Kyoto Osaka Hyogo Nara Wakayama Tottori Shimane Okayama Hiroshima Yamaguchi Tokushima Kagawa Ehime Kochi Fukuoka Saga Nagasaki Kumamoto Oita Miyazaki Kagoshima Okinawa

In our analysis so far, we have looked at trends in interregional inequality using the coefficient of variation of the per capita prefectural GDP, the Gini coefficient (calculated based on the assumption that within a particular prefecture per capita GDP is evenly distributed), and the ratio of per capita prefectural GDP of the wealthiest to the poorest prefecture. We would now like to examine whether similar changes in interregional inequality can also be observed when using other indicators. In order to do so, we examine the trend in the ratio of the average per capita prefectural GDP of the top 10 percent (20 percent) of prefectures in term of cumulative population relative to the average per capita prefectural GDP of the bottom 10 percent (20 percent) of prefectures (Figure 13). Again, the result shows that in the long-term, inequality has tended to decrease, but that there was a temporary increase in inequality between 1925 and 1935. A key aim of Figure 11 was to allow a comparison with the post-war era and we therefore used estimates in local prices. However, even when we use the estimates in national average prices, the results for the pre-war period essentially remain unchanged.

As we saw above, the long-term trend in Japan has been for interregional economic inequality to decline. We also saw that Japan experienced a temporary increase in inequality between 1925 and 1935, when the relative price of agricultural products fell and the heavy and chemical industries developed rapidly. But are these trends peculiar to Japan? Or can similar developments also be observed for other countries? In order to examine this issue, let us compare the relationship between economic development and regional inequality, as measured by the coefficient of variation, in Japan with the experience of the United States and China.

This we do in Figure 14, which on the horizontal axis shows national real per capita GDP (in

1990 international Geary-Khamis dollars) based on Maddison's (2003) estimates and, on the vertical axis, the coefficient of variation for gross regional product (or income). The coefficient of variation for Japan is based on our estimates and Cabinet Office data. For China, the figure shows the coefficient of variation for gross provincial product for 1952-2001 and for provincial income for 1993-2001. Finally, for the United States, the figure shows the coefficient of variation for state personal income for 1880-2001.

Figure 13. Ratio of average per capita prefectural GDP of the top and bottom 10 percent (20 percent) of prefectures in term of cumulative population: 1890-2005
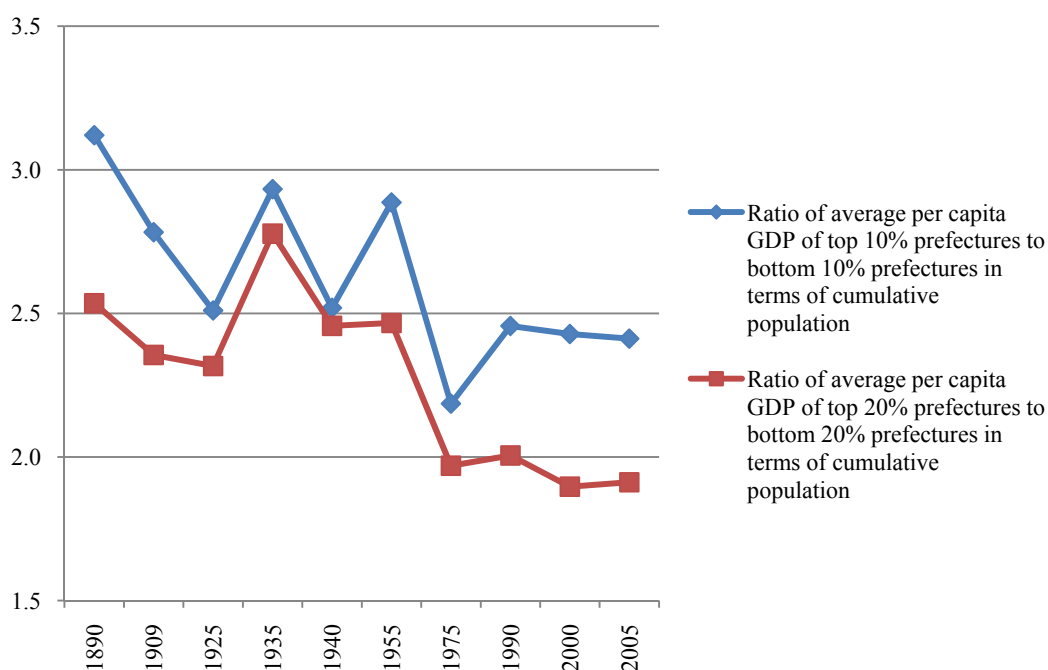
Note: The figures for 1955 do not include Okinawa.

It should be noted that, when comparing the results for the three countries, the degree of regional inequality, and hence the coefficient of variation, is affected by the way these countries are divided into administrative units as well as the size of their territory. With that caveat in mind, we can glean the following observations from Figure 14. First, the relationship between economic development and regional inequality in Japan appears to be relatively similar to that in the United States. Although there are differences in that regional economic inequality remained larger in the United States until a higher level of GDP, regional inequality as measured by the coefficient of variation declined in the long-run in both countries. Moreover, in both countries regional inequality increased during the period of the Great Depression from the end of the 1920s through the 1930s.

Further, both countries experienced an increase in regional inequality for a while from the latter half of the 1970s during the move to a service economy. (In both countries, the coefficient of variation – for both gross prefectural product and prefectural income for Japan and state personal income for the United States – registered its lowest value in 1978.)

Figure 14. Economic development and regional income inequality in Japan, China, and the United States

Per capita real GDP (in 1990 international Geary-Khamis dollars)
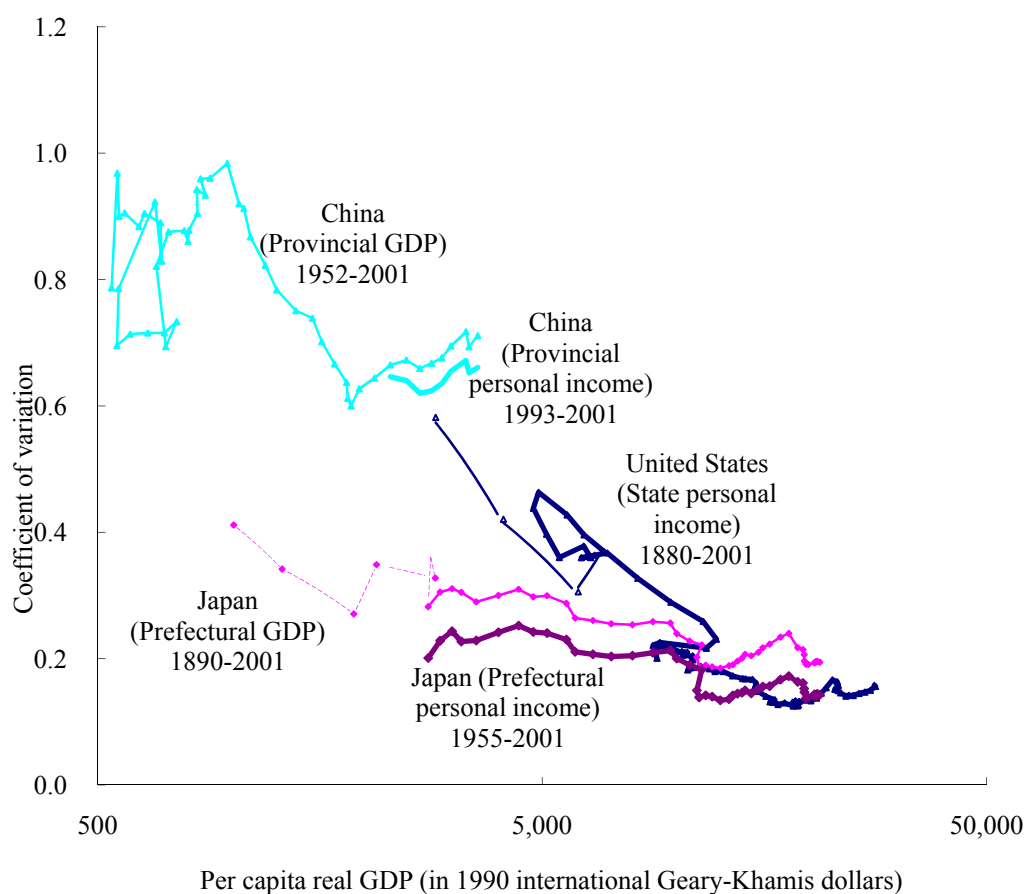
Sources: For China, data before 1993 are from Department of Comprehensive Statistics, National Bureau of Statistics of China (1999), while figures from 1993 onward are from Department of National Accounts, National Bureau of Statistics of China (2007). For the United States, figures before 1929 are from Hope and Thomas (1964), while figures from 1929 onward are from the website of the U.S. Department of Commerce, Bureau of Economic Analysis (http://www.bea.gov/regional/index.htm). National per capita real GDP (in 1990 Geary-Khamis international dollars) data are from Maddison (2003).

Note: "Provincial income" for China is calculated by excluding net production taxes and capital depreciation from "gross provincial product."

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Second, in the case of China, with the exception of the period of the Cultural Revolution from 1967 to 1978, when the coefficient of variation for per capita gross provincial product rose rapidly from 0.69 to 0.98, the long-term trend is generally also one of declining inequality. However, since 1990, when the coefficient of variation (for per capita gross provincial product) recorded a post-war low of 0.60, the trend has reversed and regional inequality has increased again.

Third and finally, Figure 14 shows that regional inequality in China, in terms of the coefficient of variation, is considerably greater than that experienced in the United States or Japan in the past. Reasons for this large regional inequality in China include the fact that for a long time, there were restrictions on rural-urban migration and that although such restrictions have been relaxed in recent years, factors remain, especially with regard to the education of the young, that impede rural-urban migration.

8. Industrial structure, labor productivity, and regional inequality

Next, let us try to examine the causes of regional inequality and of changes therein in pre-war Japan from the viewpoint of industrial structure and differences in labor productivity.

Denoting the average of the wealthiest group of prefectures (the top 20 percent or top 10 percent in terms of cumulative population) by subscript T and the average for Japan as a whole by subscript J, we can decompose the logarithm of the ratio of the per capita prefectural GDP of the wealthiest group of prefectures, y_T, to the average per capita prefectural GDP for Japan as a whole as follows:

$$
\ln\left(\frac{y_T}{y_J}\right) = \ln\left(\frac{\frac{L_T}{N_T}}{\frac{L_J}{N_J}}\right) + \ln\left(\frac{\sum_{n=1}^{N}\theta_{n,T}a_{n,T}}{\sum_{n=1}^{N}\theta_{n,J}a_{n,J}}\right)
$$

$$
= \ln\left(\frac{\frac{L_T}{N_T}}{\frac{L_J}{N_J}}\right) + \ln\left(1 + \frac{\sum_{n=1}^{N}\frac{1}{2}(a_{n,T}+a_{n,J})(\theta_{n,T}-\theta_{n,J})}{\sum_{n=1}^{N}\theta_{n,J}a_{n,J}} + \frac{\sum_{n=1}^{N}\frac{1}{2}(\theta_{n,J}+\theta_{n,T})(a_{n,T}-a_{n,J})}{\sum_{n=1}^{N}\theta_{n,J}a_{n,J}}\right)
$$

$$
= \ln\left(\frac{\frac{L_T}{N_T}}{\frac{L_J}{N_J}}\right) + \ln\left(1 + \frac{\sum_{n=1}^{N}\frac{1}{2}(a_{n,T}+a_{n,J})(\theta_{n,T}-\theta_{n,J})}{\sum_{n=1}^{N}\theta_{n,J}a_{n,J}}\right) + \ln\left(1 + \frac{\sum_{n=1}^{N}\frac{1}{2}(\theta_{n,J}+\theta_{n,T})(a_{n,T}-a_{n,J})}{\sum_{n=1}^{N}\theta_{n,J}a_{n,J}}\right)
$$

$$
+ \varepsilon_{T,J}
$$

In the above equation, N_T and L_T stand for the population and the gainfully occupied population of prefecture group T, $\theta_{n,T}$ is the share of those occupied in industry n in the total gainfully occupied population in prefecture group T, and $a_{n,T}$ represents labor productivity in industry n in prefecture group T (where labor productivity is gross valued added in national average prices divided by the gainfully occupied population). All variables with subscript J represent the average for Japan as a whole. Denoting the average of the poorest group of prefectures (the bottom 20 percent or top 10 percent in terms of cumulative population) by subscript B, we can also decompose the logarithm of y_B/y_J using the same equation above.

Consequently, we can decompose the logarithm of the ratio of the average per capita prefectural GDP of the wealthiest prefectures and of the poorest prefectures, y_T/y_B, as follows:

(1) Differences in the ratio of the gainfully occupied population

$$\ln\left(\frac{\dfrac{L_T}{N_T}}{\dfrac{L_B}{N_B}}\right)$$

(2) Differences in labor productivity caused by differences in industrial structure

$$\ln\left(1+\frac{\displaystyle\sum_{n=1}^{N}\frac{1}{2}\left(a_{n,T}+a_{n,J}\right)\left(\theta_{n,T}-\theta_{n,J}\right)}{\displaystyle\sum_{n=1}^{N}\theta_{n,J}a_{n,J}}\right)-\ln\left(1+\frac{\displaystyle\sum_{n=1}^{N}\frac{1}{2}\left(a_{n,B}+a_{n,J}\right)\left(\theta_{n,B}-\theta_{n,J}\right)}{\displaystyle\sum_{n=1}^{N}\theta_{n,J}a_{n,J}}\right)$$

(3) Difference caused by intra-industry difference in labor productivity

$$\ln\left(1+\frac{\displaystyle\sum_{n=1}^{N}\frac{1}{2}\left(\theta_{n,J}+\theta_{n,T}\right)\left(a_{n,T}-a_{n,J}\right)}{\displaystyle\sum_{n=1}^{N}\theta_{n,J}a_{n,J}}\right)-\ln\left(1+\frac{\displaystyle\sum_{n=1}^{N}\frac{1}{2}\left(\theta_{n,J}+\theta_{n,B}\right)\left(a_{n,B}-a_{n,J}\right)}{\displaystyle\sum_{n=1}^{N}\theta_{n,J}a_{n,J}}\right)$$

(4) Residual

$$\varepsilon_{T,J}-\varepsilon_{B,J}$$

Because we were able to estimate the gainfully occupied population by industry only from 1909 onward, we conduct our factor decomposition of regional inequality for 1909, 1925, 1935, and 1940.

We distinguish the following four industries: agriculture, forestry, and fisheries; mining, manufacturing, and construction; trade and services; and transport and communication.

Table 4 provides summary statistics for the share of the gainfully occupied population in the total population and labor productivity by industry for the top and bottom 20 percent of prefectures as well as the national average, on which the factor decomposition is based. The table shows the following. First, for Japan as a whole, if we compare labor productivity across industries, we find that whereas differences in labor productivity between agriculture, forestry, and fisheries on the one hand and mining, manufacturing, and construction as well as transport and communication on the other tended to increase, those between agriculture, forestry, and fisheries on the one hand and trade and services on the other shrank considerable. This reflects the fact that whereas in mining, manufacturing, and construction as well as transport and communication, labor productivity increased through capital accumulation and technological improvements, labor productivity stagnated in trade and services.

Table 4. Share of gainfully occupied population in total population and industry differences in labor productivity

	1909			1925			1935			1940		
	Top 20% average	Bottom 20% average	Japan average	Top 20% average	Bottom 20% average	Japan average	Top 20% average	Bottom 20% average	Japan average	Top 20% average	Bottom 20% average	Japan average
Share of occupied persons in population (%)	43.22	48.92	47.60	42.74	47.52	45.37	43.69	47.86	45.48	44.13	47.49	45.94
Agriculture, forestry, and fisheries	1.25	0.87	1.00	1.29	0.84	1.00	1.44	0.84	1.00	1.95	0.86	1.00
Mining and manufacturing (including construction)	2.00	0.90	1.37	1.59	0.74	1.22	2.09	0.87	1.60	1.76	1.19	1.64
Domestic trade and service industries	2.82	1.47	1.99	1.89	1.23	1.49	1.62	1.03	1.30	1.43	0.88	1.12
Transport and communication	3.33	1.61	2.29	3.82	2.33	2.98	4.35	2.53	3.44	3.24	1.97	2.62

Notes:

1. Labor productivity is calculated as gross value added/number of gainfully occupied persons.
2. The figures show relative productivity levels setting the average productivity in agriculture for all Japan to 1.
3. "Top 20% average" and "Bottom 20% average" refer to the averages of the top 20 percent and bottom 20 percent of prefectures in terms of cumulative population.
4. The salt industry falls into "Agriculture, forestry, and fisheries" for the calculation of the share of occupied persons in the population, but into "Manufacturing" for the calculation of gross value added. Moreover, public administration falls into "Manufacturing and construction" for the calculation of the share of occupied persons in the population, but into "Transport and communication" calculation of the share of occupied persons in the population.

Next, comparing differences in labor productivity within each industry between the wealthiest

and poorest prefectures, we find that in all industries labor productivity in the wealthy prefectures is almost twice as high as in the poor prefectures. Moreover, looking at the change in the difference over time shows that the difference increases in agriculture, forestry, and fisheries, while in the other industries it generally decreases. For example, in mining, manufacturing, and construction, the regional difference diminishes from a factor of 2.2 (=2.00/0.90) in 1909 to a factor of 1.5 (=1.76/1.19) in 1940.

Finally, comparing the shares of the gainfully occupied population, these tend to be higher in poorer prefectures than in wealthier ones. Known as the "first Douglas-Arisawa law" (Douglas, 1934; Arisawa, 1956), this reflects that the lower the income level of household heads, the higher is the ratio of employment among wives and other family members, and that especially in the early phase of economic development, those employed in agriculture often are engaged in by-employments in handicraft industry and trade and services (see, e.g., Settsu, 2009). According to Table 4, this kind of interregional difference in the share of the gainfully occupied population gradually decreases.

Let us now turn to the factors contributing to the interprefectural differences in per capita GDP. Table 5 presents the results of our decomposition of the logarithm of the ratio of average per capita prefectural GDP of wealthy prefectures to that of poorer prefectures, y_T/y_B, into the factors (1) to (4) listed above. The results show that interprefectural differences in the share of the gainfully occupied population, which tends to be higher in poorer regions, had the effect of decreasing differences in per capita prefectural GDP in all periods. On the other hand, interprefectural differences in industry structure and differences in labor productivity within the same industry both were important sources in bringing about the observed differences in per capita prefectural GDP. For example, looking at the top and bottom 20 percent prefectures in 1925, per capita prefectural GDP differed by a factor of 2.7 (=exp(0.975)). 64 percent of this difference was brought about by differences in labor productivity within the same industry and 54 percent was caused by differences in industry structure, while differences in the share of the gainfully occupied population had the effect of shrinking the difference in per capita prefectural GDP by 14 percent.

Next, looking at changes in the contribution of the three factors over time, we find that the impact of regional differences in industry structure on per capita prefectural GDP differences generally remained unchanged over time. Moreover, the offsetting effect of interprefectural differences in the share of the gainfully occupied population weakened over time with the decrease in such differences. Consequently, the greatest contribution to the decrease in interprefectural differences in per capita GDP was made by the decrease in differences in labor productivity within the same industry. For example, comparing the top and bottom 20 percent prefectures, labor productivity within the same industry differed by a factor of 1.9 (=exp(0.624)) in 1909, but by 1940, this had shrunk to a factor 1.6 (=exp(0.461)).

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Table 5. Factor decomposition of differences in per capita prefectural GDP

	1909	1925	1935	1940
	Comparison of top and bottom 10% of prefectures in terms of cumulative population			
Differences in average per capita prefectural GDP (logarithm)	1.032	0.975	1.103	0.999
	(100)	(100)	(100)	(100)
(1) Contribution of differences in the share of the gainfully occupied population	-0.165	-0.119	-0.108	-0.071
	(-15.96)	(-12.16)	(-9.78)	(-7.14)
(2) Contribution of differences in labor productivity due to differences in industrial structure	0.596	0.526	0.570	0.563
	(57.73)	(53.92)	(51.71)	(56.36)
(3) Contribution of differences in labor productivity within the same industry	0.722	0.624	0.653	0.495
	(69.99)	(63.98)	(59.24)	(49.58)
(4) Residual	-0.121	-0.056	-0.013	0.012
	(-11.74)	(-5.74)	(-1.17)	(1.196)
	Comparison of top and bottom 20% of prefectures in terms of cumulative population			
Differences in average per capita prefectural GDP (logarithm)	0.838	0.805	1.013	0.886
	(100)	(100)	(100)	(100)
(1) Contribution of differences in the share of the gainfully occupied population	-0.143	-0.114	-0.128	-0.095
	(-17.11)	(-14.14)	(-12.65)	(-10.77)
(2) Contribution of differences in labor productivity due to differences in industrial structure	0.424	0.436	0.561	0.519
	(50.64)	(54.22)	(55.37)	(58.55)
(3) Contribution of differences in labor productivity within the same industry	0.624	0.513	0.585	0.461
	(74.53)	(63.79)	(57.74)	(52.10)
(4) Residual	-0.067	-0.031	-0.005	0.001
	(-8.06)	(-3.86)	(-0.45)	(0.12)

Notes:
1. Figures in parentheses show the contribution of each factor to differences in per capita prefectural GDP in percent.
2. Based on estimates in average national prices.

From a theoretical point of view, the "catch up" in labor productivity in the lagging prefectures that these figures suggest must be the result of capital deepening, the accumulation of human capital, and/or increases in total factor productivity (TFP) as a result of improvements in production efficiency and technology. Unfortunately, because we were unable to estimate capital input and education levels by prefecture and industry in this study, we cannot conduct a detailed analysis of this issue. However, it seems likely that increases in the capital-labor ratio and technological catch-up in the poorer prefectures made a substantial contribution to the reduction of labor productivity differentials. In this context, an import point when considering regional differences in the capital-labor ratio and changes in such differences, all else being equal, is that the migration of labor from poorer to wealthier regions tends to lead to a decrease in interregional differences in capital-labor ratios and, as a results of this, a decrease in differences in labor productivity.

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Unfortunately, it is difficult to obtain data on regional labor migration for the pre-war period; however, using our prefectural data, we can examine the relationship between the rate of population growth and per capita GDP. This we do in Figure 15, which shows the coefficient of correlation between per capita prefectural GDP at the beginning of the period and the annual rate of prefectural population growth during the period. We find that the correlation coefficient in the pre-war period is extremely high, matching that for era of high-speed growth after the war. Although it is difficult to distinguish between the natural and the social increase in prefectural populations, Figure 15 suggests that in the pre-war period, just like during the high-speed growth era, labor migration may have greatly contributed to the decrease in regional inequality in per capita GDP. [48, 49]

Figure 15. Coefficient of correlation between per capita prefectural GDP at the beginning of the period and the annual rate of prefectural population growth during the period

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[48] Hayashi and Prescott (2008) argue that there was relatively little labor migration between industries in pre-war Japan. However, the active migration between regions that our results suggest seems to contradict to their argument.

[49] On the other hand, as Barro and Sala-i-Martin (1992) have pointed out, it is also possible that the outmigration of labor from poorer regions may increase regional inequality, if it is mainly workers with a higher educational attainment that migrate to wealthier regions. However, examining the reasons for the decrease in post-war regional economic inequality in Japan using data on labor migration by educational attainment, prefectural capital accumulation, public investment, and government income transfers, Fukao and Yue (2000) found that even when taking educational attainment into account, labor migration greatly contributed to the decrease in inequality.

Next, let us consider what we can say from Tables 4 and 5 about the increase in economic inequality between 1925 and 1935. First, according to Table 5, the main reason for the increase in inequality during this period is that the impact of regional differences in industry structure on differences in prefectural per capita GDP increased. Because we measure gross value added per worker on the basis of (national average) current market prices, part of this reflects the impoverishment of agricultural prefectures through the decline in the relative prices of agricultural products during this period. Second, the contribution of regional differences in within-industry labor productivity to economic inequality also increased. The increase in regional differences in labor productivity during this period was particularly pronounced in agriculture, forestry, and fisheries and mining, manufacturing, and construction (Table 4). Possible reasons for this include changes in intra-industry relative prices within agriculture and within manufacturing as well as the growing regional specialization within the manufacturing sector seen in Figure 8. A final observation is that the increase in regional economic inequality from 1975–1990 (Figure 11) coincided with the only period (ignoring the upheaval during World War II) when the population increase in wealthy regions fell below that in poor regions (Figure 15), which may have contributed to the increase in regional inequality. However, no such shift in the pattern of regional population growth can be observed when regional inequality increased during 1925–1935.

9. Conclusion

We would like to conclude this paper by highlighting some of the key findings that our estimation of prefectural GDPs and industrial structures has produced. The point that we would like to emphasize the most is that prefectural inequality in pre-war Japan seen from the production side was much smaller than claimed in preceding studies measuring prefectural inequality from the income side – and in fact not that different from the post-war period – and that, moreover, we also did not find as remarkable an increase in inequality over time as claimed in previous studies. Certainly, inequality increased during the period from 1925 to 1935, which saw the development of the heavy and chemical industries, growing specialization in wealthy prefectures in industries in which labor productivity was high, and a decline in relative prices of agricultural products vis-à-vis other goods and services (i.e., a deterioration in the terms of trade of agricultural prefectures). However, even during this period, inequality was not as great as had been believed so far. Moreover, for the period from 1890 to 1925, a large reduction in regional inequality matching that during the period of high-speed growth from 1955 to 1975 can be observed.

These findings appear to contradict studies such as those by Minami (1996, 2007) and Moriguchi and Saez (2008), which paint an image of radical change from great inequality during the

pre-war to period to low inequality during the post-war period. However, because these studies examine income inequality and, moreover, do not measure prefectural differences, the results cannot be directly compared. What is more, their findings and ours are, of course, not necessarily mutually exclusive. Rather, what the different findings seem to suggest is that economic development during the pre-war period reduced inequality across prefectures, but the income distribution within prefectures was highly unequal when compared with the post-war period, and that inequality increased especially in the large cities during the interwar period (see Minami, 2007, on the latter point).[50]

The next issue we addressed was to examine the factors that gave rise to the observed trends in prefectural inequality. To do so, we compared two groups of prefectures – wealthy prefectures and poor prefectures – and decomposed differences in average per capita gross prefectural product for the two groups into (1) differences in the share of the gainfully occupied population, (2) differences in labor productivity due to differences in industry structure, and (3) differences in labor productivity within the same industry. The analysis indicated that the decrease in prefectural inequality during the pre-war period mainly owes to the fact that differences in labor productivity within the same industry decreased. Further, given this finding as well as the strong correlation between the rate of population growth and per capita prefectural GDP, we suggested that prefectural inequality may have decreased through a decrease in differences in capital-labor ratios brought about by labor migration.

Finally, we considered possible reasons for the increase in prefectural inequality during the period from 1925 to 1935, which contrasts with the long-term trend of decreasing prefectural inequality throughout the rest of the period we examined. The decomposition of differences in prefectural GDP showed that the increase in prefectural inequality during this period was brought about mainly by the increase in differences in labor productivity due to differences in industry structure and, to a lesser extent, by an increase in differences in labor productivity within the same industry. We suggested that these results most likely reflect the impoverishment of agricultural prefectures through the deterioration in the terms of trade of agricultural products during this period and the growing regional specialization in manufacturing industry.

Of course, these findings are provisional and have to be verified through more detailed studies in the future. Moreover, as has been repeatedly stated, there still remains much room for

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[50] Another study of considerable interest in this context is that by Yazawa (2004). Measuring pre-war prefectural income inequality by calculating the Gini coefficient from tax data, he finds that prefectural inequality, which was high from 1880 to 1900, declined from 1900 onward and then subsequently rose again slightly (Yazawa, 2004: 193). Although his study is limited to high-income earners (due to the use of tax data), this trend in prefectural inequality is very similar to our result.

improvement of the estimates themselves. These are tasks that we hope to tackle next in order to obtain more robust estimates and gain a clearer picture of the regional pattern of development of Japan's economy during the pre-war period.

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