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# STRUCTURAL TRANSFORMATION AND INCOME INEQUALITY, REVISITED

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**Abstract**

This study analyzes the mechanism of structural transformation, defined as the reallocation of economic activity from high-productivity tradable sectors (agriculture and manufacturing) to low-productivity service sectors, and its implications for changes in the overall distribution of income within an economy. The focus is on the observed fact of development that the service sector's employment share tends to increase at a faster rate than does the sector's value-added share. An empirical analysis indicates that the different rates of changes in employment and value-added shares account for a stagnant increase in per capita income in the service sector, resulting in interpersonal income inequality as economic development progresses and the service sector's share increases. Next, we present a simple static model to analyze the difference between employment and value-added shares and determine that the change in the relative capital intensity of the tradable sector versus that of the service sector is a key factor in causing the difference.

***Keywords*****:** Structural transformation; income distribution; value-added and employment shares of services; capital intensity

***JEL Classification*****:** C23; D31; O14; O15; O41

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## 1. Introduction

The structural transformation of a country wherein the focus of economic activity shifts from high-productivity tradable sectors (agriculture and manufacturing) to low-productive service sectors is a global phenomenon. This study examines the relationship between this structural transformation and income distribution.

This study focuses on the most important observed fact of structural transformation, which is that the service sector's employment share tends to increase at a higher rate than does the sector's value-added share. We focus on the differing structural transformation patterns because the different rates of changes in employment and value-added shares indicate a stagnant increase in per capita income in the service sector. This stagnant increase may result in interpersonal income inequality as economic development progresses and the service sector's share increases. Although the literature empirically explored the relationship between structural transformation and income distribution, little attention has been paid to the relationship between the distinctly differing structural transformation patterns between added value and employment and income inequality. In fact, previous studies on structural transformation have little explored these differing structural transformation patterns.

The implications of structural transformation for income distribution were first explored by the seminal work of Kuznets (1955). Subsequently, a number of studies have been published on the Kuznets curve of the inverted U-shaped relationship between inequality and structural transformation.

A well-established empirical fact is that a positive relationship exists between the share of services in both added value and employment and GDP per capita. On the basis of the observation, previous studies revealed that an increase in structural transformations in the service sector (deindustrialization) has important implications for income distribution. For example, Mollick (2012) used a long-run span of data from the United States (1919–2002) and revealed that as the employment share in goods-producing activities declines, income inequality increases. Kollmeyer (2018) also focused on the effect of deindustrialization and the offshoring of routine manufacturing jobs on income distribution in the United States. The author emphasized the fact that those factors create larger distributional effects within the context of institutional changes, including declines in trade unions.

Dastidar (2012) reviewed the vast literature and comprehensively analyzed the structural change–inequality relationship using data on 78 developed and developing countries. The study incorporated past levels of inequality and income per capita as explanatory variables to control for differences in countries' development levels in various economic and political institutions other than the rate of structural changes. The study found that substantial differences exist between developed and developing country experiences.

Developing countries' experiences differ from the classic pattern of structural transformation; agriculture's value-added share has declined and has been accompanied by the growing importance of the service sector rather than the industrial sector. In developing countries experiencing service-led economic growth at the expense of agriculture, inequality is likely to increase during the process, and this increase in inequality is sharper for countries with historically greater inequality. In contrast, in

developed countries, the service sector's share is increasing along with a shrinking share of industry, which is likely to reduce inequality. In recent years, however, the income inequality tends to rise also in many developed countries.

Our empirical methodology is a simple cross-country regression with a measure of income inequality as the dependent variable and the difference between the service sector's employment and value-added shares as explanatory variables without dummy variables for developed and developing countries. The different structural transformation patterns can explain the changes in income inequality equally for developed and developing countries, as discussed in the next section. In this newly discovered structural change–inequality relationship, we can clarify the mechanism that makes the Kuznets inverted U-shaped relationship apply differently to developing and developed countries. Figure 1 illustrates the relationship between the ratio of the service sector's employment share to value-added share (vertical axis) and per capita income (horizontal axis). As Figure 1 indicates, this relationship is approximated by a polynomial function; the ratio of employment share to value-added share (which is closely linked to income inequality) increases rapidly and then starts to decrease during the initial economic development phase. However, the ratio increases again in the developed phase. As such, the Kuznets inverted U-shaped relationship between income inequality and structural transformation can be applied only to developing countries.

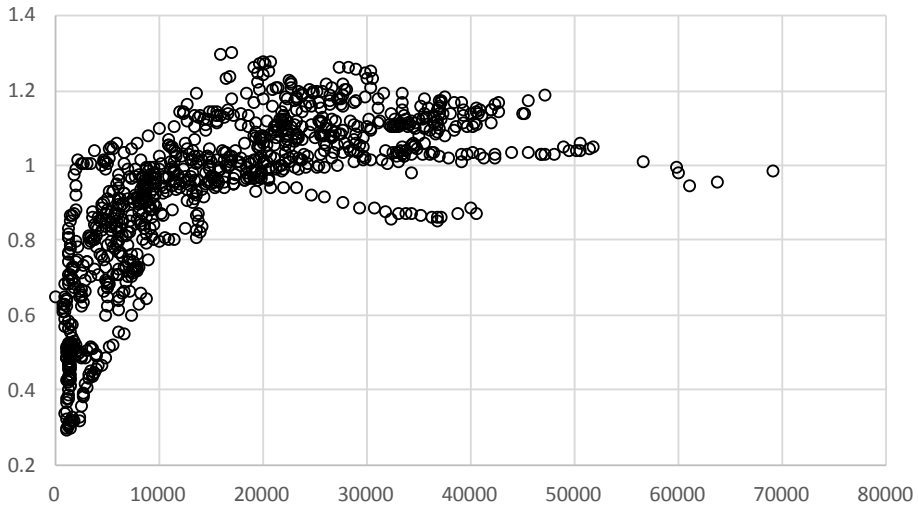



**Figure 1.** Ratio of the service sector's employment share to value-added share and per capita income
Notes: The horizontal axis indicates GDP per capita (value of expenditure-side real GDP at chained PPPs (in millions of 2011 US$) deflated by population (in millions)). The vertical axis indicates the ratio of the service sector's employment share to value-added share. Data source: Penn World Table version 9.0 and the GGDC 10-Sector Database

Next, we present a simple static model to analyze the factors behind the difference between value-added and employment shares and find that the relative capital intensity (the degree of capital deepening) between the tradable and service sectors is key to the difference. In the initial economic development phase, the relative capital intensity of tradable sectors to the service sector increases for industrialization. This increase works to shift labor from tradable sectors to the service sector, thus making the service sector's

employment share larger than its value-added share. In the next developed phase, the relative capital intensity of tradable sectors to the service sector levels off. Thus, the ratio of the service sector's employment share to value-added share stops increasing. However, amid the ongoing economic globalization, the ratio has started to increase again (the relative capital intensity between the tradable and service sectors increases) in developed countries. In developed countries, many tasks for which labor is substitutable by capital are automated given a steep decline in the relative price of investment goods. Thus, the degree of capital deepening increases in developed countries, implying that tasks with low elasticity of substitution between capital and labor are likely to be offshored to developing countries (Dao and Others, 2017).

Blum (2008) exhibited a research interest similar to that of this paper with respect to the causal relationship between income inequality and physical capital, which accumulates at different rates in different sectors. The author found that changes in the economy's sectoral composition, coupled with capital accumulation at different rates in different sectors, was the most important force behind the widening of the wage gap between 1970 and 1996 in the United States.

The contributions of this paper are summarized as follows. First, we find a new measure (the difference between services' employment and value-added shares) as a factor that affects income inequality. Hereafter, we call this measure the relative structural transformation measure. The estimated results from a fixed-effects panel data model indicate that this new measure has strong explanatory power for income inequality. Second, the relative capital intensity between tradable and service sectors is revealed to be a deterministic factor that affects the new measure and thus income inequality.

This paper proceeds as follows. The next section contains the empirical facts of the differing structural transformation patterns and their relationships to income inequality. Sections 3 and 4 provide the model analysis that detects the factors behind the differences between the service sector's employment and value-added shares. Section 5 concludes.

## 2. Empirical Facts

### 2.1. Differing structural transformation patterns

Figure 2 indicates the relationship between the services' share of nominal added value (GDP) (vertical axis and percentage) and GDP per capita (horizontal axis and logarithmic value) from 1950 to 2013 for 41 countries, including 15 high-income countries and 26 developing countries.[1] The dispersed share of services in developing countries with lower income can be observed in Figure 1. For developed countries—on

[1] In this section, the service sector includes all industries other than agriculture, mining, manufacturing, utilities, and construction. Forty-one countries are divided into four groups: Africa (Botswana, Ethiopia, Ghana, Kenya, Malawi, Mauritius, Nigeria, Senegal, South Africa, Tanzania, Zambia, Egypt, and Morocco), East Asia + India (China, India, Indonesia, Malaysia, the Philippines, and Thailand), Latin America (Argentina, Bolivia, Brazil, Colombia, Costa Rica, Venezuela, and Mexico), and high-income countries (the United States, Germany, Denmark, Spain, France, the United Kingdom, Italy, the Netherlands, Sweden, Japan, South Korea, Chile, Taiwan, Hong Kong, and Singapore). The source of the data is the 10-Sector Database (the Groningen Growth and Development Centre). “High income” is based on the World Bank's definition.

the far right in this figure—the overall share of the service sector appears to move upward

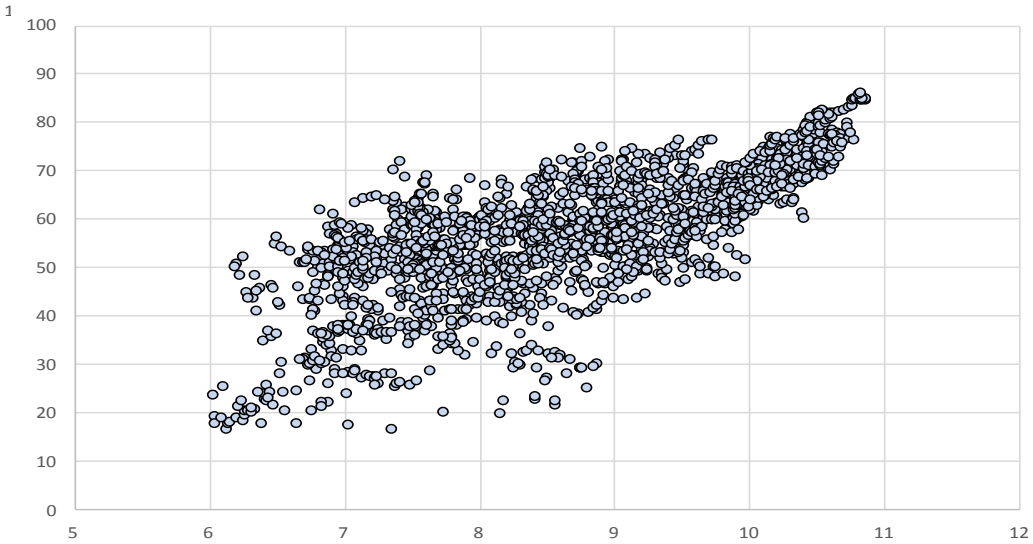



**Figure 2.** Services share of nominal added value and GDP per capita
Notes: The horizontal axis indicates the logarithmic GDP per capita (value of expenditure-side real GDP at chained PPPs (in millions of 2011 US$) deflated by population (in millions)). The vertical axis indicates the services share of nominal added value (%). The data source is the same as for Figure 1.

Figure 3 illustrates the change in the service sector's share of employment for all of the countries sampled in Figure 2. Compared with Figure 2, which illustrates the service sector's GDP share, Figure 3 shows that the sector's share of employment appears to grow at a mostly consistent and more rapid rate in accordance with income.

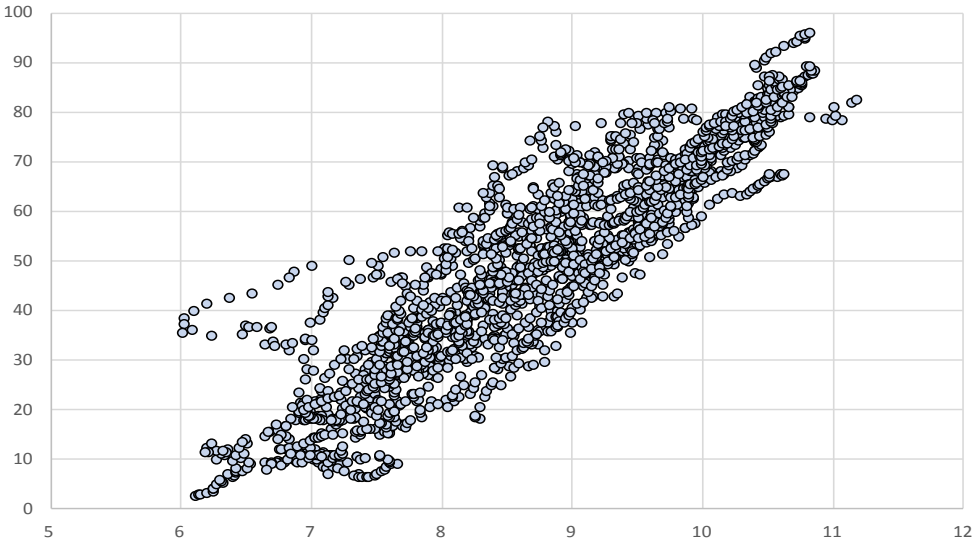



**Figure 3.** Services share of employment and GDP per capita
Notes: The horizontal axis indicates the logarithmic GDP per capita (value of expenditure-side real GDP at chained PPPs (in millions of 2011 US$) deflated by population (in millions)). The vertical axis indicates the services' share of employment (%). The data source is the same as that for Figure 1.

Next, we estimate the relationship between income and changes in the share of services for these countries by using panel data from these countries. Table 1 indicates the estimation results. Rows (1) to (4) indicate estimations for the value-added share, and rows (5) to (8) provide the employment share. Rows (1), (3), (5), and (7) are estimations from pooled OLS, and rows (2), (4), (6), and (8) are those from panel estimations with fixed effects for the sample countries. All estimations include an explanatory variable, GDP per capita (logarithmic values), and an OECD dummy to determine that the service sector's share appears to move significantly upward in developed countries with higher income levels in these figures. Rows (3), (4), (7), and (8) are estimations with different area dummies for developing countries in Asia, Latin America, and Sub-Saharan Africa.

From Table 1, one observes that the parameters of GDP per capita for the employment share are larger than those for the value-added share. The results are the same for both the pooled OLS and the panel estimations, which confirms that the degree of increase in the proportion of services' employment is larger than that of services' added value as economic development progresses.

Table 1 also indicates significant differences in the point estimates of the interaction terms between GDP per capita and regional dummies for these two estimation methods. These differences indicate that we should select panel estimations with fixed effects to analyze the causal relationship between income change and structural transformation and that, between developing and developed countries, significant differences exist in the impacts that an income increase has on structural transformation.

**Table 1:** Causal relationship between GDP per capita and structural transformation

| | Dependent variables | constant | | GDP per capita | | GDP per capita*OECD dummy | | GDP per capita*Asia dummy | | GDP per capita*Latin America dummy | | GDP per capita*Sub-Sahara Africa dummy | | Adjusted R-squared | Total panel observation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) | Value-added share | -17.893 | *** | 7.866 | *** | -0.140 | *** | | | | | | | 0.68 | 2069 | pooled OLS |
| | | (-13.05) | | (47.77) | | (-3.86) | | | | | | | | | | |
| (2) | Value-added share | -2.499 | * | 4.508 | *** | 4.357 | *** | | | | | | | 0.89 | 2069 | Fixed effect |
| | | (-1.70) | | (21.42) | | (12.43) | | | | | | | | | | |
| (3) | Value-added share | -16.95 | *** | 7.783 | *** | -0.073 | * | -0.265 | *** | 0.043 | | 0.085 | | 0.70 | 2069 | pooled OLS |
| | | (-11.84) | | (47.35) | | (-1.82) | | (-7.17) | | (1.04) | | (1.50) | | | | |
| (4) | Value-added share | -9.143 | *** | 12.129 | *** | 2.021 | *** | -7.256 | *** | -7.873 | *** | -9.601 | *** | 0.92 | 2069 | Fixed effect |
| | | (-5.75) | | (24.94) | | (5.39) | | (-15.57) | | (-11.69) | | (-16.10) | | | | |
| (5) | Employment share | -95.069 | *** | 15.895 | *** | -0.252 | *** | | | | | | | 0.91 | 2208 | pooled OLS |
| | | (-82.89) | | (111.19) | | (-6.84) | | | | | | | | | | |
| (6) | Employment share | -83.879 | *** | 11.508 | *** | 8.118 | *** | | | | | | | 0.98 | 2208 | Fixed effect |
| | | (-79.99) | | (78.91) | | (31.92) | | | | | | | | | | |
| (7) | Employment share | -90.362 | *** | 15.438 | *** | -0.178 | *** | -0.351 | *** | 0.398 | *** | -0.354 | *** | 0.91 | 2208 | pooled OLS |
| | | (-76.08) | | (106.43) | | (-4.13) | | (-8.45) | | (7.99) | | (-6.63) | | | | |
| (8) | Employment share | -99.072 | *** | 16.330 | *** | 3.958 | *** | -5.941 | *** | 7.496 | *** | -9.283 | *** | 0.98 | 2208 | Fixed effect |
| | | (-67.21) | | (44.35) | | (11.33) | | (-16.39) | | (13.78) | | (-14.99) | | | | |

Notes: t-values are in parentheses. *** indicates 1% significance, and * indicates 10% significance. The sample countries are the same as those used in Figures 1, 2, and 3. OECD countries are the United States, Germany, Denmark, Spain, France, the United Kingdom, Italy, the Netherlands, Sweden, Japan, South Korea, Chile, and Mexico. Asian countries are Japan, South Korea, China, Hong Kong, Taiwan, India, Singapore, Indonesia, Malaysia, the Philippines, and Thailand. Latin American countries are Argentina, Bolivia, Brazil, Colombia, Costa Rica, Chile, Venezuela, and Mexico. Sub-Saharan countries are Botswana, Ethiopia, Ghana, Kenya, Malawi, Mauritius, Nigeria, Senegal, South Africa, Tanzania, and Zambia. Benchmark countries for the estimations are Morocco and Egypt.

### 2.2. Structural Transformation and Income Distribution

In the previous section, we confirm that the degree of increase in the proportion of services employment is larger than that of service added value as economic development progresses. As previously mentioned, the smaller changes in the value-added share relative to changes in the employment share indicate a stagnant increase in per capita income in the service sector, which may result in interpersonal income inequality as economic development progresses and the service sector's share increases. Table 2 provides the estimation results of the fixed effects regression with an income inequality measure as a dependent variable and structural transformation measures as explanatory variables.

We prepare four explanatory variables for income inequality changes; GDP per capita (columns (1) and (2)), services share of employment (columns (3) and (4)), services share of GDP (columns (5) and (6)), and the relative structural transformation measure (columns (7) and (8)). All estimations include quadratic terms in theses variables to

check the confirmation of the Kuznets curve of the inverted U-shaped relationship between inequality and structural transformation. Columns (2), (4), (6) and (8) are estimations with a dummy variable which takes the value 1 for high income countries and is zero otherwise. The measure of income inequality represents the share of national income going to the top 10%. Unbalanced data for this estimation are from 1950 to 2013 for 21 countries, including 14 high-income countries (the United States, Germany, Denmark, Spain, France, the United Kingdom, Italy, the Netherlands, Sweden, Japan, Korea, Taiwan, Singapore, and Chile) and seven developing countries (Mauritius, South Africa, China, India, Thailand, Brazil, and Egypt). The income distribution data are obtained from the latest version of the World Inequality Database (WID).[2]

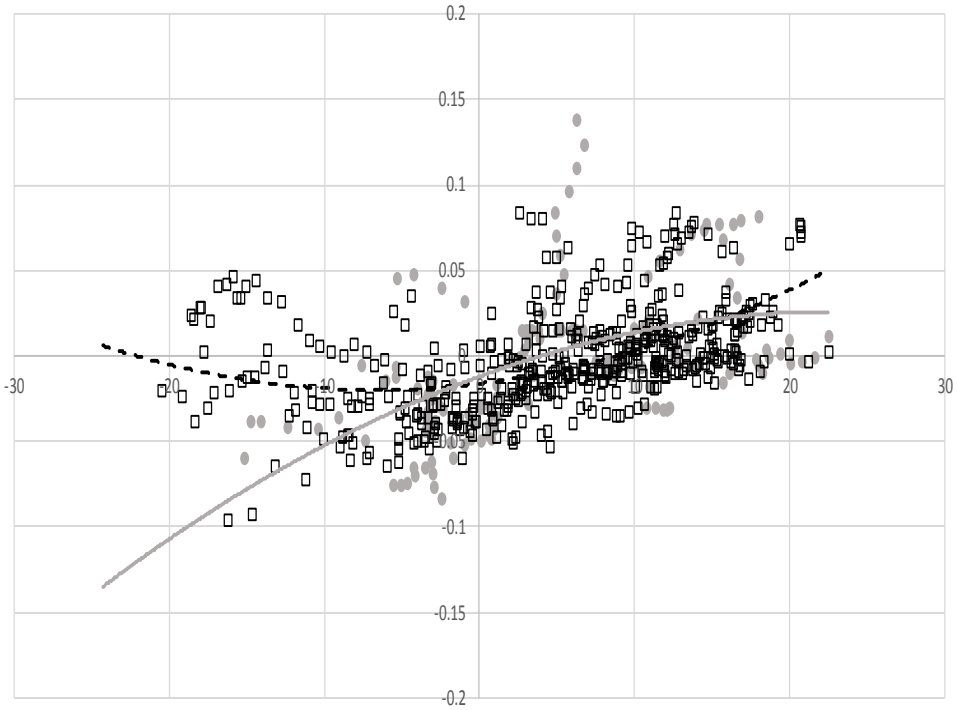
[2] The data on income distribution can also be taken from the UNU/WIDER World Income Database (WIID). This database, currently the most exhaustive compilation of secondary data, contains various types of inequality data, including income distributional shares and Gini coefficients, both of which are based on income and consumption data. The advantage of the WID database relative to the WIID database is its longer data collection period.

**Table 2.** Results of fixed-effects regression of income inequality

| | income inequality measure | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| constant | -0.0080 *** | -0.0095 *** | -0.0150 *** | -0.0146 *** | -0.0156 *** | -0.0117 *** | -0.0063 *** | -0.0063 *** |
| | (-6.05) | (-7.30) | (-9.36) | (-9.27) | (-15.09) | (-9.19) | (-4.67) | (-4.66) |
| GDP per capita | 1.6285 *** | 15.8539 *** | | | | | | |
| | (11.43) | (9.55) | | | | | | |
| GDP per capita^2 | 13.0505 * | -1675.687 *** | | | | | | |
| | (1.94) | (-6.83) | | | | | | |
| GDP per capita*high income dummy | | -14.3572 *** | | | | | | |
| | | (-8.62) | | | | | | |
| GDP per capita^2*high income dummy | | 1695.037 *** | | | | | | |
| | | (6.91) | | | | | | |
| Employment share | | | 0.0013 *** | 0.0033 *** | | | | |
| | | | (9.33) | (8.19) | | | | |
| Employment share^2 | | | 0.0000 *** | -0.0000 ** | | | | |
| | | | (5.26) | (-2.26) | | | | |
| Employment share*high income dummy | | | | -0.0022 *** | | | | |
| | | | | (-5.13) | | | | |
| Employment share^2*high income dummy | | | | 0.0001 *** | | | | |
| | | | | (4.88) | | | | |
| GDP share | | | | | 0.0031 *** | 0.0040 *** | | |
| | | | | | (18.39) | (9.17) | | |
| GDP share^2 | | | | | 0.0002 *** | 0.0002 *** | | |
| | | | | | (9.16) | (4.80) | | |
| GDP share*high income dummy | | | | | | -0.0012 *** | | |
| | | | | | | (-2.61) | | |
| GDP share^2*high income dummy | | | | | | -0.0001 *** | | |
| | | | | | | (-2.97) | | |
| Relative structural transformation measure | | | | | | | 0.1704 *** | 0.1623 *** |
| | | | | | | | (8.31) | (4.83) |
| Relative structural transformation measure^2 | | | | | | | -0.2989 *** | -0.3001 ** |
| | | | | | | | (-4.03) | (-2.52) |
| Relative structural transformation measure*high income dummy | | | | | | | | 0.01461 |
| | | | | | | | | (0.34) |
| Relative structural transformation measure^2*high income dummy | | | | | | | | 0.0123 |
| | | | | | | | | (0.08) |
| Adjusted R-squared (Within) | 0.25 | 0.33 | 0.22 | 0.25 | 0.55 | 0.45 | 0.11 | 0.10 |
| Total panel observation | 708 | 708 | 645 | 645 | 632 | 632 | 626 | 626 |

Notes: t-values are in parentheses. *** indicates 1% significance, and * indicates 10% significance. Sample countries are discussed in the text.

**Figure 4.** The relationship between services share of employment and income inequality




Notes: Circles and square dots depict developing and high-income countries respectively. The horizontal axis indicates the services share of employment. The vertical axis indicates the inequality measure. These are variables from which their average values are deducted for the fixed effects regression (Table 2, column (4)). Data source: The GGDC 10-Sector Database and the World Inequality Database (WID).

An inverted U-shaped pattern of inequality as income development progresses cannot be affirmed for high income countries in the estimations of (2), (4) and (6). In estimations of (7) and (8), the coefficients of interaction terms between the relative structural transformation measure and high-income dummies are insignificant. This means that the relative transformation measure can explain the changes in income inequality equally for developed and developing countries and the other three variables cannot.

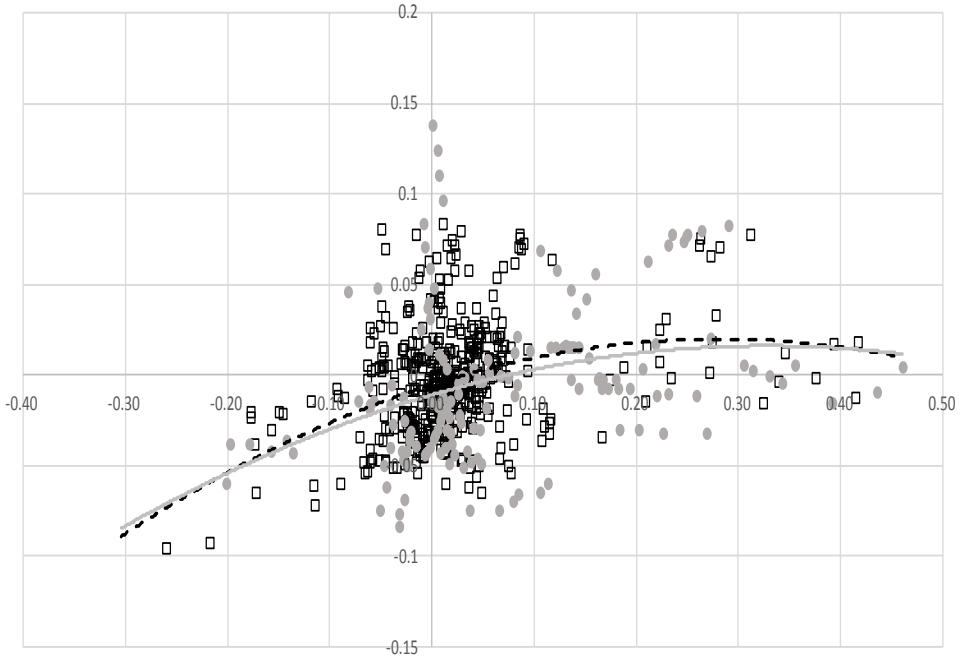



**Figure 5.** The relationship between relative structural transformation measure and income inequality

Notes: Circles and square dots depict developing and high-income countries respectively. The horizontal axis indicates the relative structural transformation measure. The vertical axis indicates the inequality measure. These are variables from which their average values are deducted for the fixed effects regression (Table 2, column (8)). Data source: The GGDC 10-Sector Database and the World Inequality Database (WID).

Figure 4 indicates the relationship between income inequality measure (vertical axis) and the services share of employment (horizontal axis). In Figure 5, the variable for the horizontal axis is replaced by the relative structural transformation measure. These are variables from which their average values are deducted for the fixed effects regression (within estimators). As Figure 4 and Table 2(4) indicate, the structural transformation (the increase in the services share of employment) works to rise inequality in the early developing phase. In the next developed phase, however, it turns to work oppositely; the inequality measure decreases and then rises again. Figure 5 shows the same changing pattern of inequality measure for developed and developing countries. It is because as Figure 1 and Table 2(2) indicate, the relative structural transformation measure moves the same way as inequality measure does in accordance with income.

This paper expects income inequality and the relative structural transformation measure are linearly correlated; the smaller changes in the value-added share relative to changes in the employment share indicate a stagnant increase in per capita income in the service sector, which may result in interpersonal income inequality as economic development progresses and the service sector's share increases. As Figure 5 indicates, income inequality can be regressed as a quadratic function of the relative structural

transformation measure. The inverted U-shaped function has a peak of income inequality where the transformation measure takes the value of around 0.30. The rate of income inequality keeps almost the same level even if the transformation measure exceeds 0.30 due to the shape of the quadratic function in Figure 5. We can conclude that the rise of relative transformation measure leads to higher income inequality equally for developed and developing countries.

The advantage of adopting the relative structural transformation measure as an explanatory variable for the estimation of income inequality change is its simplicity. The traditional explanatory variables, such as GDP per capita, and the closely related changes in structural transformation defined as the reallocation of economic activity among sectors cannot explain the income inequality change for developing countries in the same way as for developed countries, as indicated in Figure 4. In this traditional method of analysis on income inequality, we must detect reasons why the Kuznets curve holds only in developing countries and not in developed countries.

## 3. The Model

In this chapter, we introduce a simple static model to examine the factors behind the change in the relative structural transformation measure (the difference between the service sector's employment and value-added shares). The literature on macroeconomics and growth has factorized structural transformation into three components: a demand-side effect because of low income elasticity of demand for agricultural products (income effects) and two supply-side effects, one resulting from differential sectoral total factor productivity (TFP) growth rates and the other from differential sectoral capital deepening (relative price effects). These two supply-side components are combined to be labor productivity. The income effects focus on the lower income elasticity of demand for the consumption of agricultural products and the decreasing percentage of agricultural products in overall consumption as income rises. Regarding the supply-side effects, the service sector's lower labor productivity relative to the tradable sectors leads to a higher price level of services and thus to the sector's higher nominal value-added share in economic development (the elasticity of substitution between the consumption of tradable goods and services is assumed to be less than unity; i.e., a complementarity relationship between tradable goods consumption and services consumption is assumed). Supply-side effects also play a role in shifting production factors from highly productive to unproductive sectors.

*Production and Preferences*

Our model focuses solely on the implications for optimal consumption and production behavior within each period. The advantage of this "static" approach is that the first-order conditions for the stand-in household and the stand-in firm are given by only observed current variables, and we do not have to take a stand on the exact nature of intertemporal opportunities available to them (i.e., the appropriate interest rates for borrowing and lending). In what follows, subscript *t*, which indicates time, is omitted in each variable.

The model has two sectors of activity: tradable (*T*) and services (*S*). The tradable sector includes agriculture and manufacturing. The production function in each sector is

assumed to be Cobb–Douglas with constant returns to scale. Our static approach allows all variables to change in each period without exceptions, and capital intensity ($\theta_T$ $\theta_S$) is also assumed to change in each period. The service sector output can be used for consumption ($C_S$) and investment ($I_S$). The output of the tradable sector can be disaggregated into consumption ($C_T$), investment ($I_T$), and net exports ($NEX_T$). In each sector, the shares of investments and net exports are exogenously determined in the model. Production structures and their market clearings in each of the product markets are as follows:

$$Y_S = A_S K_S^{\theta_S} L_S^{1-\theta_S} = C_S + I_S$$

$$Y_T = A_T K_T^{\theta_T} L_T^{1-\theta_T} = C_T + I_T + NEX_T \qquad (1)$$

where $Y_i, A_i, K_i,$ and $L_i$ are the added value, TFP, capital stock, and employment in $i = T, S$, respectively. All production resources ($K_i$ and $L_i$) are fully used, meaning that

$$K_S + K_T = K$$

$$L_S + L_T = L \qquad (2)$$

We assume that the period utility function $u(C_S, C_T)$ is of the form

$$u(C_S, C_T) = \left[\omega^{\frac{1}{\varepsilon}} C_S^{\frac{\varepsilon-1}{\varepsilon}} + (1-\omega)^{\frac{1}{\varepsilon}} C_T^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}} \qquad (3)$$

where $\varepsilon$ is the elasticity of substitution between the consumption of services and tradable products.

Equation (3) is a homothetic constant elasticity of substitution preference and does not consider the income effects. This model focuses on the relative price effects to detect factors that cause long-term structural transformation.

*Optimality Conditions*

Next, production-side efficiency is derived. Perfect factor mobility exists across two sectors if sector-specific distortions to production factors (capital and employment) are cleared. The first-order conditions for the stand-in firm in sector *i* are given by

$$R = P_S\theta_S A_S\left(\frac{K_S}{L_S}\right)^{\theta_S-1} = P_T\theta_T A_T\left(\frac{K_T}{L_T}\right)^{\theta_T-1}$$

$$W = P_S(1-\theta_S)A_S\left(\frac{K_S}{L_S}\right)^{\theta_S} = P_T(1-\theta_T)A_T\left(\frac{K_T}{L_T}\right)^{\theta_T} \quad (4)$$

where $P_i$ is the price of sector *i* and *R* and *W* denote rental rates of capital and employment, respectively. Both are expressed in nominal currency.

Dividing these two equations by each other gives:

$$\frac{1-\theta_S}{\theta_S}\left(\frac{K_S}{L_S}\right) = \frac{1-\theta_T}{\theta_T}\left(\frac{K_T}{L_T}\right) \quad (5)$$

From the second equation in Equation (4), the implications for relative prices can be derived:

$$\frac{P_S}{P_T} = \frac{1-\theta_T}{1-\theta_S}\frac{A_T}{A_S}\frac{k_T^{\theta_T}}{k_S^{\theta_S}} \quad (6)$$

In this equation, $k_T = \frac{K_T}{L_T}$ and $k_S = \frac{K_S}{L_S}$.

If $C_S$ and $C_T$ and their prices, $P_S^C$ and $P_T^C$, are observed, the first-order condition for the stand-in household corresponds to

$$\left(\frac{P_S^C}{P_T^C}\right)^{\varepsilon}\frac{C_S}{C_T} = \frac{\omega}{1-\omega} \quad (7)$$

The two consumption prices, $P_S^C$ and $P_T^C$, are different from the GDP deflators, $P_S$ and $P_T$, because the former includes import prices and the latter does not. The proportion of relative consumption prices to relative GDP deflators, or the exogenous price effect (Φ), is defined as follows:

$$\frac{P_S^C}{P_T^C} = \Phi \frac{P_S}{P_T} \tag{8}$$

In what follows, we derive the relative consumption value of services to that of tradable products and the sectoral allocation of employment across the two sectors.

From Equations (6), (7), and (8), the relative consumption values across the two sectors are obtained as follows:

$$\frac{P_S^C}{P_T^C}\frac{C_S}{C_T} = \left(\frac{P_S^C}{P_T^C}\right)^{1-\varepsilon}\frac{\omega}{1-\omega} = \Phi^{1-\varepsilon}\left(\frac{P_S}{P_T}\right)^{1-\varepsilon}\frac{\omega}{1-\omega}$$

$$= \Phi^{1-\varepsilon}\left(\frac{1-\theta_T}{1-\theta_S}\right)^{1-\varepsilon}\left(\frac{A_T}{A_S}\right)^{1-\varepsilon}\left(\frac{k_T^{\theta_T}}{k_S^{\theta_S}}\right)^{1-\varepsilon}\frac{\omega}{1-\omega}$$

(9)

On the basis of Equation (1), we define the relationship between $Y_S$ and $C_S$ as $Y_S(1-\gamma S{=}CS$ and define the relationship between $YT$ and $CT$ as $YT1{-}\gamma T{-}\tau T{=}CT$, where $\gamma_S = \frac{I_S}{Y_S}$, $\gamma_T = \frac{I_T}{Y_T}$, and $\tau_T = \frac{NEX_T}{Y_T}$. By using these definitions and Equation (7), we derived the next equation, Equation (10):

$$\frac{Y_S}{Y_T}\frac{1-\gamma_S}{1-\gamma_T-\tau_T} = \frac{C_S}{C_T} = \left(\frac{P_S^C}{P_T^C}\right)^{-\varepsilon}\frac{\omega}{1-\omega} \tag{10}$$

To derive the implications for relative employment allocation, we substitute Equation (1) into Equation (10) and rearrange it to obtain:

$$\frac{A_S}{A_T}\frac{k_S^{\theta_S}}{k_T^{\theta_T}}\frac{L_S}{L_T}=\left(\frac{P_S^C}{P_T^C}\right)^{-\varepsilon}\frac{\omega}{1-\omega}\frac{1-\gamma_T-\tau_T}{1-\gamma_S}=\Phi^{-\varepsilon}\left(\frac{P_S}{P_T}\right)^{-\varepsilon}\frac{\omega}{1-\omega}\frac{1-\gamma_T-\tau_T}{1-\gamma_S}$$

$$=\Phi^{-\varepsilon}\left(\frac{1-\theta_T}{1-\theta_S}\right)^{-\varepsilon}\left(\frac{A_T}{A_S}\right)^{-\varepsilon}\left(\frac{k_T^{\theta_T}}{k_S^{\theta_S}}\right)^{-\varepsilon}\frac{\omega}{1-\omega}\frac{1-\gamma_T-\tau_T}{1-\gamma_S} \quad (11)$$

Equation (11) can be rearranged to obtain the next equation, Equation (12), for the relative employment allocation:

$$\frac{L_S}{L_T}=\Phi^{-\varepsilon}\left(\frac{1-\theta_T}{1-\theta_S}\right)^{-\varepsilon}\left(\frac{A_T}{A_S}\right)^{1-\varepsilon}\left(\frac{k_T^{\theta_T}}{k_S^{\theta_S}}\right)^{1-\varepsilon}\frac{\omega}{1-\omega}\frac{1-\gamma_T-\tau_T}{1-\gamma_S} \quad (12)$$

Then, we obtain some factors to decide the relative consumption and employment ratios of services.

From Equation (9), the relative consumption across the two sectors is factorized into the following three factors: (1) relative capital deepening $\left(\frac{1-\theta_T}{1-\theta_S}\right)^{1-\varepsilon}\left(\frac{k_T^{\theta_T}}{k_S^{\theta_S}}\right)^{1-\varepsilon}$, (2) relative TFP $\left(\frac{A_T}{A_S}\right)^{1-\varepsilon}$, and (3) exogenous price effects $\Phi^{1-\varepsilon}$. From Equation (12), the relative employment across the two sectors is decided by the following four factors: (1) the relative capital deepening $\left(\frac{1-\theta_T}{1-\theta_S}\right)^{-\varepsilon}\left(\frac{k_T^{\theta_T}}{k_S^{\theta_S}}\right)^{1-\varepsilon}$, (2) the relative TFP $\left(\frac{A_T}{A_S}\right)^{1-\varepsilon}$, (3) exogenous price effects $\Phi^{-\varepsilon}$, and (4) the demand composition $\frac{1-\gamma_T-\tau_T}{1-\gamma_S}$.[3]

### 3.1. Implications of the Model

From the empirical analyses in Section 2, the rate of increase in the services share viewed as employment share is larger than that when viewed as value-added share. In fact, this difference originates from the difference between Equations (9) and (12). The most important difference between these two equations is related to the contribution of relative capital deepening to sectoral structural change. In many countries, relative capital intensity $(\frac{\theta_T}{\theta_S})$ tends to increase as the tradable sector (especially the manufacturing sector) promotes capital deepening as economic development progresses.

[3] The nonnegative weight for services consumption ($\omega$) is assumed to be fixed and, thus, has no effect on the sectoral changes. The weight is usually calibrated as an averaged services consumption share in the entire period of analysis.

This increase leads to a decrease in relative labor intensity ($\frac{1-\theta_T}{1-\theta_S}$) and results in an increase in the relative capital–labor ratio ($\frac{k_T}{k_S}$) from Equation (5). In Equation (9) for relative consumption share, $\left(\frac{1-\theta_T}{1-\theta_S}\right)^{1-\varepsilon}$ and $\left(\frac{k_T^{\theta_T}}{k_S^{\theta_S}}\right)^{1-\varepsilon}$ move in the opposite direction if we assume that $\varepsilon$ is less than unity (gross complementarity). Thus, the magnitude of the change in the capital deepening factor $\left(\frac{1-\theta_T}{1-\theta_S}\right)^{1-\varepsilon}\left(\frac{k_T^{\theta_T}}{k_S^{\theta_S}}\right)^{1-\varepsilon}$ tends to be relatively small. In contrast, $\left(\frac{1-\theta_T}{1-\theta_S}\right)^{-\varepsilon}$ and $\left(\frac{k_T^{\theta_T}}{k_S^{\theta_S}}\right)^{1-\varepsilon}$ move in the same direction in Equation (12), and the magnitude of the change of the capital deepening factor $\left(\frac{1-\theta_T}{1-\theta_S}\right)^{-\varepsilon}\left(\frac{k_T^{\theta_T}}{k_S^{\theta_S}}\right)^{1-\varepsilon}$ tends to become relatively large.

This model analysis is supported by empirical data. Takeuchi (2019) decomposed the change in services share of added value and employment into the previous factors and found that the relative capital intensity factor is the most important for structural transformation in terms of value-added and employment shares. Moreover, the impact of the increase in relative capital intensity on the contribution rates of the capital intensity factor to sectoral changes is revealed to be larger when services' share is treated as employment share rather than value-added share. This finding indicates that the capital intensity factor plays a most important role in making a difference between value-added and employment shares of the service sector.

The relative capital intensity factor is also expected to affect economic development. According to Takeuchi (2019), the relationship between capital intensity and economic development differs between East Asia and other regions. For example, in Latin America, services' share grows quickly, along with a rapid increase in capital intensity. The productivity of the service sector is relatively low. Thus, macroeconomic growth rates stay relatively low. A rapid increase in capital intensity as such leads to lower economic growth and higher income inequality.

## 4. Conclusion

This paper examines the implications of the structural transformation for income distribution from a new perspective. We focus on the observed fact of structural transformation that the service sector's employment share tends to increase at a higher rate than does the sector's value-added share. The results reveal that this fact leads to a stagnant increase in per capita income in the service sector, resulting in interpersonal income inequality as economic development progresses and the sector's share increases. This distinctly differing pattern of structural transformation demonstrates superiority against the traditional Kuznets curve of the inverted U-shaped relationship between inequality and structural transformation; the change in income inequality can be regressed on the relative structural transformation measure in the same manner for developed and developing countries.

We introduce a simple static model to examine the factors behind the difference between the service sector's employment and value-added shares and find that the change in the relative capital intensity of the tradable sector versus that of the service sector is a key factor in causing the difference. The sectoral capital intensity is controlled by industrial policies, especially in developing countries. This examination has an important policy implication: that a slow-paced capital deepening in the tradable sector relative to the service sector in line with their comparative advantages (abundant labor force) is a favorable policy that results in relatively high economic growth and low-income inequality.

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