Labor Share and Economic Growth

September 2014

Yong Min Kim* and Ki Seong Park**

Abstract.

We extend Park's (2007) theoretical model to constant elasticity of substitution (CES) production function. The growth rate decreases with the labor share if the labor share is higher than that in the competitive labor market. Following Barro (2012), the annual growth rate of per capita GDP is regressed on the variables with country and year fixed effects. We show empirically the growth rate decreases with the labor share with using an unbalanced panel of 32 OECD countries for 1980-2010. The increase of 10 percentage points in the labor share decreases the annual growth rate of per capita GDP by 1.62 percentage points. To overcome the endogeneity problem, the lagged values of the independent variables are used as instruments. The IV estimated coefficient of labor share is not statistically different from that of OLS. We also show that the labor share increases with the union density and the relative level of minimum wage to the average wage.

JEL classification numbers: O49, J39, J59

Running title: Labor Share and Economic Growth

Correspondence address: Professor Ki Seong Park
Department of Economics
Sungshin University
Seoul, 136-742, South Korea

Email: kpark@sungshin.ac.kr

Tel: 82-2-920-7154 (w); 82-10-8898-6599 (c.p.)

Fax: 82-2-920-2042

* School of Business, Kookmin University, Seoul, 136-702, South Korea.
** Department of Economics, Sungshin University, Seoul, 136-742, South Korea. We would like to thank Professor Byung-Ho Song for his helpful comments.

I. Introduction

The portion of product attributed to employees is called the labor share. In terms of distribution of output between workers and firms, it has a great meaning. Employees or labor unions argue for high wages and large employment and hence favor a high labor share. In the neoclassical model of labor unions, they try to maximize the labor share (e.g. Lazear 1983).

The division of output between employees and firms has been studied by economists since Ricardo (1821) originally introduced the labor share. They have investigated how the labor share is determined and how it behaves over business cycles (e.g. Henley 1987, Sherman 1990, and Kang, Jeong, and Bae 1998). They have also examined how the labor share affects unemployment and inflation (e.g. Blanchard 1997, 1998, Caballero and Hammour 1998, and Batini, Jackson, and Nickell 2000). However, it has been rare to relate the labor share to the economic growth as far as we know.

If the labor market is competitive, the wage rate is equal to the marginal product of labor. Since the labor share is the wage rate multiplied by the labor amount divided by the value added, it becomes the marginal product of labor multiplied by the labor amount divided by the value added in the competitive labor market. Bentolila and Saint-Paul (2003) show three ways how a gap is generated between the observed labor share and that of competitive labor market. First, assuming firms have market power, they can set output prices over marginal costs and the labor share is smaller than that of competitive labor market. Second, firms and employees (or their unions) bargain over the wage rate and employment. In a simple Nash bargaining model the labor share is greater than that of competitive labor market (Blanchard and Fischer 1989, ch. 9). Third, employment protecting laws (EPL) impose high hiring and firing costs. New employees are hired through employment agencies, or they are to be trained by their seniors. Firing costs include severance payments, court and arbitration procedures payments. These adjustment costs should be included in the labor share and the labor share is greater than that of competitive labor

market.

Bentolila and Saint-Paul (2003) show empirically that labor adjustment costs affect the labor share and that employees' bargaining power, much less obviously, also affects the labor share with the OECD data. However, they do not relate the labor share with the economic growth.

With Cobb-Douglas production function, Park (2007) shows theoretically how the labor share affects the economic growth rate. If the labor share is greater than that of competitive labor market, the human-to-physical capital ratio is higher than the competitive one and the equilibrium wage and interest rates are lower than the competitive equilibrium ones. Since the higher equilibrium wage or interest rate, the higher economic growth rate,[1] the economic growth rate is lower than the competitive equilibrium one. And the larger the labor share, the lower the growth rate.

In this paper, we extend Park's (2007) theoretical model to constant elasticity of substitution (CES) production function and show empirically the growth rate decreases with the labor share with using an unbalanced panel of 32 OECD countries for 1980-2010. Also we investigate whether the labor share causes the growth rate or vice versa, and whether the relationship between the labor share and the economic growth is affected by the economic level or not.

According to Organization for Economic Cooperation and Development (OECD) statistics, a country's Gross Domestic Product (GDP) is divided into three categories: compensation of employees, gross operating surplus and gross mixed income, and taxes less subsidies on production and imports. Batini, Jackson, and Nickell (2000) points out three issues in computing the labor share.

First, the share should be measured relative to GDP net of indirect taxes. Indirect taxes are collected by the government and are not received by firms or employees. Hence we mainly

[1] This is implied by the intertemporal substitution.

focus on the ratio of compensation of employees to GDP net of taxes less subsidies on production and imports.

Second, in the literature, there has been the issue whether the remuneration of workers includes the remuneration of the self-employed or not when we compute the labor share. The renumeration of the self-employed is not always available for developing countries and is recorded as mixed income in national accounts (Lubker 2007). Gollin (2002) and Bentolila and Saint-Paul (2003) argue that incomes of self-employed should be included in the remuneration of workers and suggest how to compute the labor share when the remuneration of the self-employed is not available: Their labor share (Gollin 2002, p. 469) is

$$\left[\left(\frac{\text{compensation of employees}}{\text{GDP}}\right) \times \left(\frac{\text{total workforce}}{\text{number of employees}}\right)\right].$$

They impute the average compensation of the self-employed equal to the average wage of employees, but we are not convinced of this imputation. The ratios of employees to total workforce are very low in some countries and the above labor shares can be higher than 1. Gollin (2002, p. 469) also points out this potential problem and actually Bentolila and Saint-Paul (2003, p. 17), using an unbalanced panel of 13 industries in 12 OECD countries for 1972-1993, report that in 62 of 2,457 observations the labor shares exceed 1 and their maximum is 1.418.

In 1993 Spain of our data set, the compensation of employees takes 0.511 of GDP, the ratio of employees to total workforce is 0.560, and hence the above labor share is 0.913. If we use GDP net of taxes less subsidies on production and imports instead of GDP, the labor share is 0.995. These labor shares are unrealistic. Harrison (2005) and Lubker (2007) argue that the labor share excluding the remuneration of the self-employed has reasonably enough information on the amount of labor income in the formal sector relative to total income. We follow their argument to use the labor share excluding the remuneration of self-employed.

The third issue is on the public sector. It might be argued that the division of income between employees and firms really make sense only in the private sector of the economy. Batini, Jackson, and Nickell (2000) hence remove the public sector's input to compute the labor share. However, even in the public sector, the employees or their unions and employers conflict with each other when dividing total income. And the OECD statistics do not provide data on the compensation of employees and the gross value added by the government. Hence we include the public sector's input to derive the labor share.

The organization of the paper is as follows. In Section II, Park's (2007) model is extended to CES production function. Section III introduces the data and measurements of variables. In Section IV, the growth rate is regressed on the labor share and other variables. In Section V, we examine whether the labor share affects the growth rate or vice versa. In Section VI, we check the plausibility of the key assumption of our theoretical model by investigating how the labor share is affected by the union density and the level of minimum wage. In Section VII, we estimate how the relationship between the labor share and the economic growth is affected by the economic level. Section VIII concludes the paper with a summary.

II. Model

We represent and extend Park's (2007) model to CES production function instead of Cobb-Douglas production function. It is an AK model of the endogenous growth theory (Barro and Sala-i-Martin, 1995, pp. 172-4). The representative consumer maximizes

$$\int_0^\infty e^{-\xi t}\left[\frac{c^{1-\theta}-1}{1-\theta}\right]dt\,, \tag{1}$$

where c, $\frac{1}{\theta}$, and ξ are per-capita consumption, the elasticity of intertemporal substitution, and the discount rate, respectively.[2] The budget constraint is

$$\dot{a} + \dot{g} = ra + (w - \delta)g - c \,, \tag{2}$$

where a and g are per-capita financial and human assets, respectively, and r, w, and δ are the interest, per-human-capital wage, and depreciation rates, respectively.[3] $\dot{x}$ means the time derivative of x. The arbitrage condition between financial and human assets is

$$r = w - \delta \,. \tag{3}$$

Using equation (3) and the current-value Hamiltonian, we have the following maximizing condition:

$$\frac{\dot{c}}{c} = \frac{r - \xi}{\theta} \,. \tag{4}$$

This is implied by the interteporal substitution of consumption. The growth rate of consumption is the difference between the common yield rate of financial and human assets, r, and the discount rate, ξ, multiplied by the elasticity of intertemporal substitution, $\frac{1}{\theta}$.

To eliminate Ponzi-game possibilities, we assume

[2] Park (2007) is a revision of Park (2004).

[3] For simplicity, we assume that the depreciation rates of physical and human capital are the same (Barro and Sala-i-Martin, 1995, pp. 172-4).

$$\lim_{t\to\infty}\left\{a(t)\cdot\exp\left[-\int_0^t r(v)dv\right]\right\}\geq 0,$$

and

$$\lim_{t\to\infty}\left\{g(t)\cdot\exp\left[-\int_0^t \left(w(v)-\delta\right)dv\right]\right\}\geq 0.$$

The production function of the representative firm is the constant elasticity of substitution (CES) one.

$$y = A\left[\alpha h^{-\rho} + (1-\alpha)k^{-\rho}\right]^{-\frac{1}{\rho}}, \tag{5}$$

where y, h, and k are per-capita output, human capital, and physical capital, respectively. Parameter α is between 0 and 1 and parameter ρ is greater than -1.

If the labor market is competitive, the labor share is

$$\alpha\left[\alpha + (1-\alpha)\left(\frac{\alpha}{1-\alpha}\right)^{\frac{\rho}{1+\rho}}\right]^{-1}.$$

This labor share is determined only by parameters, α and ρ. Unless the two parameters are changed, the labor share is constant either in or off the steady-state. We consider the economy in which employees and firms bargain to divide the output. Hence the labor share (μ) is higher than that if the labor market is competitive:

$$\mu > \alpha\left[\alpha + (1-\alpha)\left(\frac{\alpha}{1-\alpha}\right)^{\frac{\rho}{1+\rho}}\right]^{-1}. \tag{6}$$

Since the labor share is μ, the wage rate per human capital (w) and the user cost of physical capital ($r+\delta$) become, respectively,

$$w = \mu\left(\frac{y}{h}\right), \tag{7}$$

and

$$r + \delta = (1-\mu)\left(\frac{y}{k}\right). \tag{8}$$

Equilibrium requires that supply equals demand in both physical and human capital:

$$a = k, \tag{9}$$

and

$$g = h. \tag{10}$$

Initial physical and human capital, $k(0)$ and $h(0)$, respectively, are given. We call this equilibrium the bargaining one in order to distinguish it from the competitive one.

From equations (3), (5), (7), and (8), we have

$$\frac{h}{k} = \frac{\mu}{1-\mu}, \tag{11}$$

and

$$r = A\mu\left[\alpha + (1-\alpha)\left(\frac{\mu}{1-\mu}\right)^{\rho}\right]^{-\frac{1}{\rho}} - \delta . \tag{12}$$

Plugging equation (12) into (4), equations (9) and (10) into (2), and rearranging them with using (5), we get the steady-state economic growth rate:

$$\frac{\dot{y}}{y} = \frac{\dot{k}}{k} = \frac{\dot{h}}{h} = \frac{\dot{c}}{c} = \frac{A\mu\left[\alpha + (1-\alpha)\left(\frac{\mu}{1-\mu}\right)^{\rho}\right]^{-\frac{1}{\rho}} - \delta - \xi}{\theta} . \tag{13}$$

Our main concern in this model is what effect the labor share, μ, which is determined by the bargaining between employees and firms, have on the economic growth rate. Under condition (6), the per capita human-to-physical capital ratio in this economy is higher than that in the competitive equilibrium. The ratio increases with the labor share, μ. The wage rate per human capital and hence interest rate in this economy are lower than those in the competitive equilibrium. They decrease with increasing labor share, μ. Since the lower equilibrium wage or interest rate, the lower economic growth rate,[4] the steady-state economic growth rate of the bargaining equilibrium is lower than that of the competitive equilibrium. The growth rate decreases with increasing labor share, μ: As the wage rate increasingly exceeds the marginal productivity of human capital, both physical and human capital accumulate increasingly more slowly (Figure 1).[5]

Labor unions do various activities including strikes in order to raise the per capita wage

[4] This is implied by the intertemporal substitution of consumption. See equation (4).

[5] If $\mu < \alpha\left[\alpha + (1-\alpha)\left(\frac{\alpha}{1-\alpha}\right)^{\frac{\rho}{1+\rho}}\right]^{-1}$, the growth rate increases with increasing labor share, μ.

rate (wh). These activities are expressed as raising the labor share, μ , in our theoretical model. Labor unions try to raise the labor share, μ , of the value added output, y , in $wh = \mu y$, so as to maximize the per capita wage rate. Our theoretical model, however, shows that the more distant the labor share is from that of competitive equilibrium, the lower the wage rate per human capital and per capita human capital growth rate $\left(\frac{\dot{h}}{h}\right)$ are (Figure 1). Therefore, the more bargaining power labor unions have, and hence the more the labor share exceeds that of competitive equilibrium, the shorter the wage rate per human capital and the economic growth rate fall of those of competitive equilibrium ($CE < \mu \leq 1$ in Figure 1).

III. Data and Measurements of Variables

We collect our data set from two sources. Per capita GDP based on purchasing power parity (PPP), fertility rate, life time expectancy at birth, investment ratio, government-consumption ratio, openness ratio, inflation rate, and labor share were downloaded from OECD statistics (http://stats.oecd.org/#) in September 2012. Female and male school years were downloaded from Barro and Lee data set (www.rbarro.com/data-sets) in September 2012. Our analysis is for 32 OECD countries except for Turkey whose per capita GDP is not available and Israel whose union density is not available. Many countries are analyzed for 1980-2010, but Belgium for 1980-2009, Chile for 1997-2010, Czech Republic for 1995-2009, Denmark for 1980-2009, Estonia for 2000-2010, France for 1980-2008, Greece for 1990-2008, Hungary for 1996-2008, Iceland for 1980-2002 and 2008, Luxembourg for 1980-2008, Mexico for 1992-2010, New Zealand for 1980-2009, Poland for 1992-2010, Portugal for 1996-2010, Slovak Republic for 1994-2008, Slovenia for 1998, 2003, and 2008-2009, Spain for 1981-2009, Switzerland for 1980-2009, and United Kingdom for 1980-2009.

Per capita GDP based on purchasing power parity (PPP) is measured by 2005 US dollars.

The growth rate is its annual growth rate. The investment ratio is the gross capital formation divided by GDP. The government-consumption ratio is the final government consumption expenditure divided by GDP. The openness ratio is the sum of export and import goods and services divided by GDP. The inflation rate is for the consumer price index. The data of female and male school years are for every 5 years. We fill vacant years by interpolation.

IV. Growth Regression

Table 1 shows empirical results for the panel of 32 OECD countries for 1980-2010. Here the labor share is the ratio of compensation of employees to GDP net of taxes less subsidies on production and imports. Following Barro (2012), the annual growth rate of per capita GDP is regressed on the variables of column (1) with country- and year-specific fixed effect dummies.

The country-specific dummies reflect and control the country's cultural characteristics, geographical conditions, law-abiding level, trust, corruption, governmental policy making and implementing capability, economic and social institutions, industrial relations, national traits, and other national characteristics. The year-specific dummies control the global economic crises, economic growth trend, business cycle phases.[6]

Although various X variables are used, there would be omitted variables to affect the economic growth. Country fixed effect dummies are included to mitigate this omitted-variables bias. Barro (2012) points out that the estimated coefficient of the log of lagged per capita GDP would be downward biased with the fixed effects due to Hurwicz (1950)-type bias in the estimated coefficient of a lagged dependent variable and that the estimated convergence rate hence tends to be overestimated, thereby offsetting the omitted-variables bias. However, our concern is not the estimation of convergence rate but that of the growth effect of the labor share. We include the log of lagged per capita GDP as a control variable in the regression. Also we

[6] The country- and year-specific fixed effect dummies are jointly highly statistically significant, respectively, in all Tables in this paper.

report the estimation results without this variable in Table 2. All estimations include year dummies for time fixed effects. The variations of OECD average growth rates over time are hence not explained by our analysis.

In column (2) of Table 1, the labor share is added to its column (1). The estimated coefficient of the variable is -0.1621 and statistically significant. The labor share increase of 10 percentage points decreases the annual growth rate of per capita constant prices GDP based on purchasing power parity by 1.621 percentage points.

In column (2), the estimated coefficient of log of lagged per capita GDP is -0.0792. This suggests conditional convergence at a rate of 7.92% per year. This convergence rate is not for variations of average growth rates across countries but for variations of growth rates over time within a country. Therefore the convergence rate is the measure of the speed of convergence to the steady-state of a country: the half-life is 8.75 years. The convergence is speedy enough to focus on the steady-state in our theoretical model.

The growth rate increases with a lower fertility rate, higher investment ratio, higher female relative to male school attainment, lower government-consumption ratio, higher openness to international trade, and lower inflation rate, as predicted by endogenous growth theory.

All the X variables suffer from the endogeneity problem. To overcome it, we need appropriate instruments for the variables. Barro (2012) argues that the instruments proposed by previous studies are usually almost fixed over time in the sample period within countries and thus do not serve when country fixed effects are included.[7] Instead, he proposes lagged values of the X variables as instruments even though these are not fully satisfactory instruments because many of X variables are so strongly serially correlated that the lagged variables are

[7] According to Barro (2012), examples of the instruments are country size and trade restrictions (Lee 1993), ethnolinguistic fractionalization (Mauro 1995), population density and settler mortality at the time of colonial settlement (Engerman and Sokoloff 1997, Acemoglu, Johnson, and Robinson 2001, 2002), the form of legal origins (La Porta, Lopez-de-Silanes, Shleifer, and Vishny 1998), absolute degrees latitude and primary language (Hall and Jones 1999), the presence of state religion (Barro and McCleary 2003), and physical characteristics of islands (Feyrer and Sacerdote 2009).

difficult to be assumed as orthogonal to the current error term. In column (3), the lagged values of the X variables are used as instruments. The estimated coefficient of the labor share is -0.1441 and statistically significant. This is, however, not statistically different from that of column (2). According to this coefficient, the labor share increase of 10 percentage points decreases the annual growth rate of per capita constant prices GDP based on purchasing power parity by 1.441 percentage points.

Table 2 reports the counterpart estimation of Table 1 without the log of lagged per capita GDP, which can cause Hurwicz (1950)-type bias. The estimated coefficients of labor share in columns (2) and (3) are lower than those in columns (2) and (3) of Table 1, respectively, although the differences are not statistically significant. Therefore Hurwicz -type bias would not be serious if any.

Table 3 uses the ratio of compensation of employees to GDP as the labor share. The estimated coefficients of labor share in columns (1) and (2) are also not statistically significantly different from those in columns (2) and (3) of Table 1, respectively. The higher the labor share is, the lower the economic growth rate is, regardless of whether taxes and subsidies on production and imports are considered for measuring the labor share or not.[8]

V. Causality between Labor Share and Economic Growth

Based on the theoretical model, we presume that the labor share affects the growth rate but not the other way around in Tables 1-3. Empirically, however, one can ask whether the labor share affects the growth rate, vice versa, or the both affect each other. To answer the question, we use Granger (1969) type causality test. In Table 4, the labor share, which is the ratio of compensation of employees to GDP net of taxes less subsidies on production and imports, is regressed on 1 up to 5 years lagged growth rates, 1 up to 5 years lagged logs of per capita GDP,

[8] See Table A1 for the growth regression with the alternative labor share and without the log of lagged per capita GDP.

and 1 up to 5 years lagged labor shares in addition to the X variables in column (2) of Table 1. We use 1 up to 5 years lagged variables because the period of business cycle is 4 to 5 years. Although in columns (3), the hypotheses that the estimated coefficients of 1 to 4 years lagged growth rates are jointly zero is marginally rejected, in columns (1), (2), and (4), the hypotheses that the estimated coefficients of 1 to 2, 3, and 5 years lagged growth rates are jointly zero, respectively, are not rejected. This implies that the labor share is not affected by the growth rate.

In Table 5, the growth rate is regressed on 1 up to 5 years lagged growth rates, 1 up to 5 years lagged logs of per capita GDP, and 1 up to 5 years lagged labor shares in addition to the X variables in column (2) of Table 1. In columns (1), (2), (3), and (4), the hypotheses that the estimated coefficients of 1 to 2, 3, 4, and 5 years lagged labor shares are jointly zero, respectively, are rejected. This implies that the growth rate is affected by the labor share.

VI. Evidence for Condition (6)

Is there any evidence for condition (6)? If the labor market is competitive, the labor share should be constant over time including off the steady-state. In reality, the labor share changes a lot in each country. In Japan, the labor share changes least for 1980-2010: its minimum is 53.7% in 1989 and its maximum is 57.7% in 1998.[9] In Sweden, it changes most: its minimum is 59.6% in 1995 and its maximum is 70.9% in 2002. Such variations in the labor share over time might imply that the labor market is not competitive.

Table 6 shows that the labor share increases with the union density and the relative level of minimum wage rate to the average wage rate. According to column (2), the union density increase of 10 percentage points increases the labor share by 1.055 percentage points and the minimum wage increase of 10 percentage points relative to the average wage increases it by

[9] The labor share is the ratio of compensation of employees to GDP net of taxes less subsidies on production and imports.

0.759 percentage points.[10] Table 7 uses the ratio of compensation of employees to GDP as the labor share and the estimated coefficients of the union density and the relative level of minimum wage rate to the average wage rate are not statistically different from those in Table 6, respectively.

Active labor unions and the minimum wage system increase the wage rate over that in the competitive labor market. If the labor share were lower than that in the competitive labor market, this is that labor unions would not be active and the labor share would not increase with the union density. The lower labor share than that in the competitive labor market also means that the minimum wage system would have no effect and the labor share would not increase with the relative level of minimum wage rate to the average wage rate. Since, however, according to our estimation, the labor share increases with the union density and the relative level of minimum wage rate to the average wage rate, it can be inferred that the labor share exceeds that in the competitive labor market. Therefore, the condition (6) is plausible.

Considering both the cases of condition (6) and footnote 5 together, the economic growth rate increases with the labor share when the labor share is lower than that in the competitive labor market, the rate reaches its maximum when the labor share is equal to that in the competitive labor market, and the rate decreases with the increasing labor share when the labor share is higher than that in the competitive labor market (Figure 1). In order to test this relationship, we regress the economic growth rate on the labor share and its square in addition to the other variables in Table 8.[11] Its column (1) is an OLS estimation and shows that the estimated coefficients of both the labor share and its square are statistically significant. From these estimated coefficients, the labor share maximizing the economic growth rate is 39.5 percent. The economic growth rate increases with the labor share if the labor share is lower than this level, and the rate decreases with the increasing labor share if the labor share is higher than

[10] Country and year fixed effect dummies are included in these regressions.
[11] The labor share is the ratio of compensation of employees to GDP net of taxes less subsidies on production and imports.

this level. However, the labor shares of each OECD country are higher than this level except for Mexico, 1990s', 2000, 2001, and 2006 Greece, and 2006 and 2007 Chile. Therefore, condition (6) is a plausible assumption and it is once again confirmed that the economic growth rate decreases with the increasing labor share.

In column (2) of Table 8, the one-year lagged variables are used as the instrumental variables, and the estimated coefficients of both the labor share and its square are statistically insignificant. After controlling the endogeneity of independent variables, the multicollinearity between the labor share and its square probably has such a large effect on the estimation that the standard errors can be highly estimated. If we accept the estimation, the labor share does not affect the economic growth rate in the quadratic form.

VII. Economic Level and Effect of Labor Share on Economic Growth

We have verified that the economic growth rate decreases with the increasing labor share. Does the economic level affect this relationship? What effect if any? To answer these questions, we estimate the growth regression with adding the labor share and its interaction term with the log of lagged per capita GDP as independent variables in Table 9.[12]

Aiken and West (1991) suggest that one makes the interaction term of two variables by multiplying the variables subtracted by their averages because the covariance between the multiplication of the variables and each variable depends partly on the means of each variable. They call subtracting the average from each variable centering. The interaction term in Table 9 is centered.

Columns (1) and (2) of the Table are OLS and IV estimations, respectively. The estimated coefficients of the labor share and its interaction term with the log of lagged per capita GDP, respectively, are not statistically different between the two estimations. Since they are all

[12] The labor share is the ratio of compensation of employees to GDP net of taxes less subsidies on production and imports.

negative, we know that the negative effect of the labor share on the economic growth rate increases with the economic level: The decreasing extent of the economic growth rate with the increasing labor share is higher in developed countries than in developing countries.

Specifically, according to column (2), the economic growth rate decreases by 1.392 percentage points with the 10 percentage points increase of the labor share at the average of the log of lagged per capita GDP (10.06897), and the economic growth rate decreases further by 0.163 percentage points with the $3,000 increase of per capita GDP, so that the economic growth rate decreases by 1.555 percentage points.

VIII. Conclusion

We extended Park's (2007) theoretical model to constant elasticity of substitution (CES) production function. In the economy where employers and employees or their unions bargain on splitting the output, the labor share exceeds that of in the competitive labor market. We theoretically showed that the economic growth rate of this economy is lower than that in the competitive economy, and that the growth rate decreases with the labor share. And we empirically verified this hypothesis with the 32 OECD countries' unbalanced panel for 1980-2010.

We regressed the annual growth rate of constant prices per capita GDP based on purchasing power parity on the labor share and the other variables with controlling country and year fixed effects and estimated that the labor share increase of 10 percentage points decreases the annual growth rate of per capita constant prices GDP based on purchasing power parity by 1.621 percentage points. To overcome the endogeneity problem, the lagged values of the independent variables are used as instruments. According to IV estimation, the labor share increase of 10 percentage points decreases the annual growth rate of per capita GDP by 1.441 percentage points. This is, however, not statistically different from that of OLS.

The growth rate increases with a lower fertility rate, higher investment ratio, higher female relative to male school attainment, higher government-consumption ratio, higher openness to international trade, and lower inflation rate.

Our theoretical model shows that the labor share affects the economic growth rate but not the other way around. Empirically, however, one can ask whether the labor share affects the economic growth rate, vice versa, or the both affect each other. To answer this question, the labor share is regressed on 1 up to 5 years lagged economic growth rates, logs of 1 up to 5 years lagged per capita GDP, and 1 up to 5 years lagged labor shares in addition to the other control variables. Although the hypotheses that the estimated coefficients of 1 to 4 years lagged growth rates are jointly zero is marginally rejected, the hypotheses that the estimated coefficients of 1 to 2, 3, and 5 years lagged growth rates are jointly zero, respectively, are not rejected. This implies that the labor share is not affected by the economic growth rate. And the economic growth rate is regressed on 1 up to 5 years lagged growth rates, logs of 1 up to 5 years per capita GDP, and 1 up to 5 years labor shares in addition to the other control variables. The hypotheses that the estimated coefficients of 1 to 2, 3, 4, and 5 years lagged labor shares are jointly zero, respectively, are rejected. This implies that the economic growth rate is affected by the labor share.

Active labor unions and the minimum wage system increase the wage rate over that in the competitive labor market. If the labor market is competitive, the labor share should be constant over time including off the steady-state. In reality, the labor share changes a lot in each country. In Sweden, for instance, its minimum is 59.6% in 1995 and its maximum is 70.9% in 2002. This might be an evidence for the bargaining labor market.

If the labor share were lower than that in the competitive labor market, this is that labor unions would not be active and the labor share would not increase with the union density. The lower labor share than that in the competitive labor market also means that the minimum wage system would have no effect and the labor share would not increase with the relative level of

minimum wage rate to the average wage rate. Since, however, according to our estimation, the labor share increases with the union density and the relative level of minimum wage rate to the average wage rate, it can be inferred that the labor share exceeds that in the competitive labor market. Therefore, the condition (6) is plausible.

Considering both the cases of condition (6) and footnote 5 together, the economic growth rate increases with the labor share when the labor share is lower than that in the competitive labor market, the rate reaches its maximum when the labor share is equal to that in the competitive labor market, and the rate decreases with the increasing labor share when the labor share is higher than that in the competitive labor market. In order to test this relationship, we regressed the economic growth rate on the labor share and its square in addition to the other variables. According to the OLS estimation, the labor share maximizing the economic growth rate is 39.5 percent. The economic growth rate increases with the labor share if the labor share is lower than this level, and the rate decreases with the increasing labor share if the labor share is higher than this level. However, the labor shares of each OECD country are higher than this level except for Mexico, 1990s', 2000, 2001, and 2006 Greece, and 2006 and 2007 Chile. Therefore, condition (6) is a plausible assumption and it is once again confirmed that the economic growth rate decreases with the increasing labor share.

And, according to the IV estimation with the one-year lagged variables as the instrumental variables, the estimated coefficients of both the labor share and its square are statistically insignificant. After controlling the endogeneity of independent variables, the multicollinearity between the labor share and its square probably has such a large effect on the estimation that the standard errors can be highly estimated. If we accept the estimation, the labor share does not affect the economic growth rate in the quadratic form.

Finally, to investigate whether the economic level affect the relationship that the economic growth rate decreases with the increasing labor share, we estimated the growth regression with adding the labor share and its interaction term with the log of lagged per capita

GDP as independent variables. Following Aiken and West's (1991) suggestion, we used the centered interaction term. According to the OSL and IV estimation, the negative effect of the labor share on the economic growth rate increases with the economic level: The decreasing extent of the economic growth rate with the increasing labor share is higher in developed countries than in developing countries. Specifically, according to the IV estimation, the economic growth rate decreases by 1.392 percentage points with the 10 percentage points increase of the labor share at the average of the log of lagged per capita GDP (10.06897), and the economic growth rate decreases further by 0.163 percentage points with the $3,000 increase of per capita GDP, so that the economic growth rate decreases by 1.555 percentage points.

The labor share generally increases with the economic level. According to our analysis results, in order to increase the economic growth rate, it is not advisable that the government tries to enhance the labor share institutionally or intentionally.

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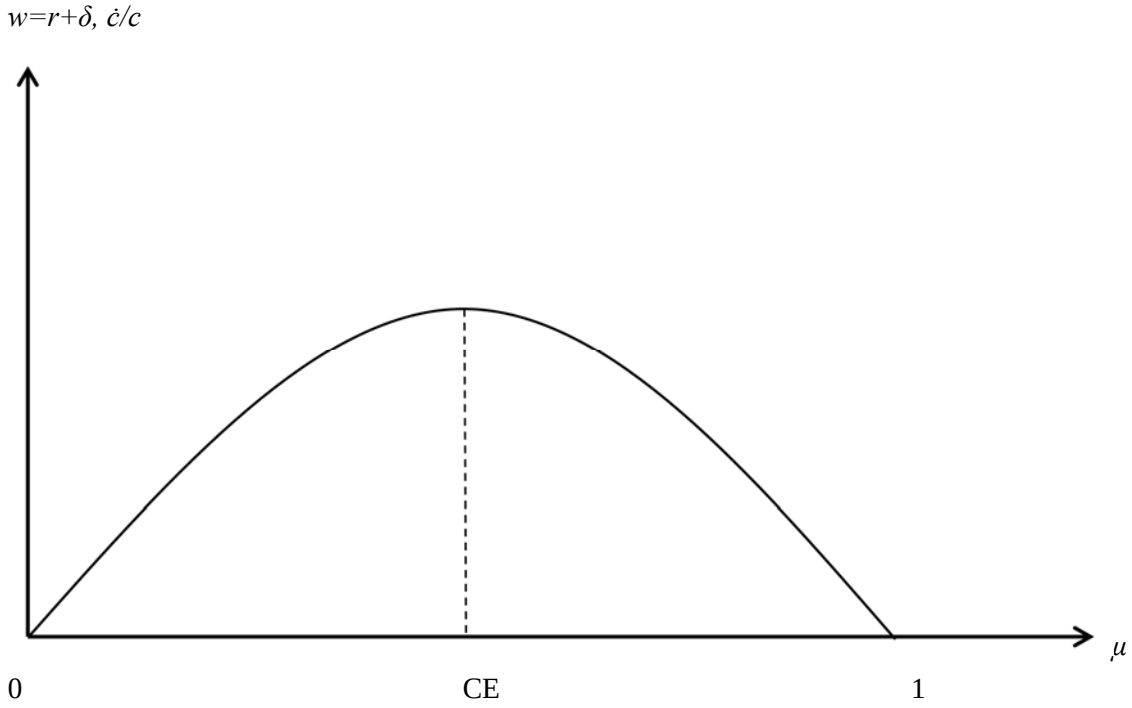

Figure 1. Labor Share, Wage Rate, and Economic Growth Rate

Table 1. Growth Regression

	(1) OLS	(2) OLS	(3) IV
Log (Lagged Per Capita GDP)	-0.0865*** (0.0089)	-0.0792*** (0.0089)	-0.0746*** (0.0105)
Log (Fertility Rate)	-0.0439*** (0.0085)	-0.0388*** (0.0084)	-0.0460*** (0.0100)
$(\text{Life Expectancy at Birth})^{-1}$	-8.9324 (7.0944)	-10.9709 (7.0182)	-5.4044 (8.3488)
Investment Ratio	0.2659*** (0.0287)	0.2953*** (0.0291)	0.0101 (0.0429)
Female School Years	0.0089** (0.0039)	0.0091** (0.0039)	0.0092** (0.0043)
Male School Years	-0.0095** (0.0038)	-0.0098*** (0.0037)	-0.0094** (0.0042)
Government Consumption Ratio	-0.3502*** (0.0056)	-0.1761*** (0.0067)	-0.1357 (0.0859)
Openness Ratio	0.0388*** (0.0062)	0.0333*** (0.0063)	0.0449*** (0.0076)
Inflation Rate	-0.0678*** (0.0139)	-0.0682*** (0.0137)	-0.0347* (0.0193)
Labor Share	-	-0.1621*** (0.0360)	-0.1441*** (0.0477)
R-Squared	0.6484	0.6578	0.5961
No. of Countries	32	32	32
No. of Observations	809	809	809

Notes. Country and year fixed effects dummies are included.

Numbers in parentheses are standard errors.

* < 0.1, ** < 0.05, *** < 0.01.

Table 2. Growth Regression without Log of Lagged Per Capita GDP

	(1) OLS	(2) OLS	(3) IV
Log (Fertility Rate)	-0.0314*** (0.0089)	-0.0285*** (0.0087)	-0.0302*** (0.0105)
$(\text{Life Expectancy at Birth})^{-1}$	29.6351*** (6.2482)	23.7027*** (6.2263)	24.5898*** (7.3705)
Investment Ratio	0.1732*** (0.0287)	0.2188*** (0.0294)	-0.0995** (0.0429)
Female School Years	0.0027 (0.0041)	0.0037 (0.0041)	0.0040 (0.0046)
Male School Years	-0.0031 (0.0040)	-0.0043 (0.0039)	-0.0040 (0.0044)
Government Consumption Ratio	-0.3221*** (0.0590)	-0.1098 (0.0698)	-0.0263 (0.0913)
Openness Ratio	0.0249*** (0.0065)	0.0182*** (0.0064)	0.0310*** (0.0078)
Inflation Rate	-0.0725*** (0.0148)	-0.0773*** (0.0145)	-0.0366* (0.0206)
Labor Share	-	-0.2249*** (0.0413)	-0.2103*** (0.0503)
R-Squared	0.6032	0.6186	0.5389
No. of Countries	32	32	32
No. of Observations	809	809	809

Notes. Country and year fixed effect dummies are included.

Numbers in parentheses are standard errors.

* < 0.1, ** < 0.05, *** < 0.01.

Table 3. Growth Regression with Alternative Labor Share

	(1) OLS	(2) IV
Log (Lagged Per Capita GDP)	-0.0796*** (0.0090)	-0.0762*** (0.0106)
Log (Fertility Rate)	-0.0410*** (0.0084)	-0.0483*** (0.0100)
(Life Expectancy at Birth)$^{-1}$	-9.9747 (7.0332)	-4.1108 (8.3687)
Investment Ratio	0.2899*** (0.0291)	-0.0038 (0.0431)
Female School Years	0.0091** (0.0039)	0.0092** (0.0044)
Male School Years	-0.0098*** (0.0038)	-0.0093** (0.0042)
Government Consumption Ratio	-0.2017*** (0.0672)	-0.1896** (0.0848)
Openness Ratio	0.0331*** (0.0064)	0.0462*** (0.0077)
Inflation Rate	-0.0715*** (0.0138)	-0.0372* (0.0194)
Alternative Labor Share	-0.1550*** (0.0400)	-0.1025** (0.0506)
R-Squared	0.6554	0.5915
No. of Countries	32	32
No. of Observations	809	809

Notes. The alternative labor share is the ratio of compensation of employees to GDP.

Country and year fixed effect dummies are included.

Numbers in parentheses are standard errors.

* < 0.1, ** < 0.05, *** < 0.01.

Table 4. Effect of Growth Rate on Labor Share

Labor Share	(1)	(2)	(3)	(4)
Lagged Growth Rate	-0.6790 (0.6242)	-0.4255 (0.6353)	-0.4237 (0.6375)	-0.3751 (0.6449)
2 Lagged Growth Rate	0.0190 (0.0230)	-1.4787* (0.8597)	-1.2549 (0.8701)	-1.3181 (0.8780)
3 Lagged Growth Rate	-	-0.0059 (0.0224)	-1.5412* (0.8241)	-1.4951* (0.8346)
4 Lagged Growth Rate	-	-	-0.0102 (0.0221)	-0.6014 (0.8169)
5 Lagged Growth Rate	-	-	-	0.0035 (0.0217)
F	0.95	1.36	1.96	1.61
Probability	0.3888	0.2526	0.0993	0.1563
No. of Countries	32	32	32	32
No. of Observations	804	798	792	786

Notes. Country and year fixed effect dummies are included.

Numbers in parentheses are standard errors.

* < 0.1, ** < 0.05, *** < 0.01.

Table 5. Effect of Labor Share on Growth Rate

Growth Rate	(1)	(2)	(3)	(4)
Lagged Labor Share	-0.1500*** (0.0570)	-0.1595*** (0.0588)	-0.1512** (0.0591)	-0.1501** (0.0585)
2 Lagged Labor Share	0.1236** (0.0531)	0.1263 (0.0787)	0.1255 (0.0816)	0.0931 (0.0811)
3 Lagged Labor Share	-	0.0196 (0.0551)	-0.0059 (0.0821)	0.0514 (0.0845)
4 Lagged Labor Share	-	-	0.0335 (0.0555)	-0.2020** (0.0813)
5 Lagged Labor Share	-	-	-	0.2400*** (0.0541)
F	3.51	2.86	2.12	5.74
Probability	0.0304	0.0360	0.0762	0.0000
No. of Countries	32	32	32	32
No. of Observations	804	798	792	786

Notes. Country and year fixed effect dummies are included.

Numbers in parentheses are standard errors.

* < 0.1, ** < 0.05, *** < 0.01.

Table 6. Labor Share Regression

	(1)	(2)
Log (Lagged Per Capita GDP)	0.3956*** (0.0089)	0.0948*** (0.0104)
Log (Fertility Rate)	0.0313*** (0.0084)	0.0488*** (0.0085)
$(\text{Life Expectancy at Birth})^{-1}$	-19.7972*** (7.2770)	41.7035*** (8.5707)
Investment Ratio	0.1882*** (0.0287)	0.0112 (0.0286)
Female School Years	0.0009 (0.0039)	0.0207*** (0.0060)
Male School Years	-0.0034 (0.0038)	-0.0242*** (0.0065)
Government Consumption Ratio	0.9815*** (0.0596)	0.7048*** (0.0607)
Openness Ratio	-0.0346*** (0.0062)	-0.0339*** (0.0055)
Inflation Rate	0.0016 (0.0139)	-0.0361* (0.0189)
Union Density	0.0622*** (0.0146)	0.1055*** (0.0174)
Relative Minimum Wage	-	0.0759*** (0.0218)
R-Squared	0.9513	0.9759
No. of Countries	32	22
No. of Observations	809	471

Notes. Country and year fixed effect dummies are included.

Numbers in parentheses are standard errors.

* < 0.1, ** < 0.05, *** < 0.01.

Table 7. Alternative Labor Share Regression

	(1)	(2)
Log (Lagged Per Capita GDP)	0.0384*** (0.0080)	0.0802*** (0.0097)
Log (Fertility Rate)	0.0187** (0.0076)	0.0315*** (0.0079)
$(\text{Life Expectancy at Birth})^{-1}$	-14.6920** (6.5300)	37.1639*** (8.0307)
Investment Ratio	0.1623*** (0.0257)	0.0181 (0.0268)
Female School Years	0.0010 (0.0035)	0.0185*** (0.0056)
Male School Years	-0.0036 (0.0034)	-0.0192*** (0.0061)
Government Consumption Ratio	0.8559*** (0.0535)	0.5676*** (0.0568)
Openness Ratio	-0.0373*** (0.0056)	-0.0357*** (0.0051)
Inflation Rate	-0.0191 (0.0125)	-0.0200 (0.0178)
Union Density	0.0686*** (0.0131)	0.0814*** (0.0163)
Relative Minimum Wage	-	0.0470** (0.0204)
R-Squared	0.9517	0.9746
No. of Countries	32	22
No. of Observations	809	471

Notes. The alternative labor share is the ratio of compensation of employees to GDP.

Country and year fixed effect dummies are included.

Numbers in parentheses are standard errors.

* < 0.1, ** < 0.05, *** < 0.01.

Table 8. Growth Regression with Labor Share × Labor Share

	(1) OLS	(2) IV
Log (Lagged Per Capita GDP)	-0.0775*** (0.0089)	-0.0740*** (0.0105)
Log (Fertility Rate)	-0.0425*** (0.0085)	-0.0477*** (0.0101)
(Life Expectancy at Birth)$^{-1}$	-8.6215 (7.0252)	-4.3666 (8.3834)
Investment Ratio	0.2978*** (0.0289)	0.0119 (0.0430)
Female School Years	0.0074* (0.0039)	0.0086* (0.0044)
Male School Years	-0.0089** (0.0037)	-0.0090** (0.0042)
Government Consumption Ratio	-0.1651** (0.0670)	-0.1351 (0.0857)
Openness Ratio	0.0345*** (0.0063)	0.0457*** (0.0076)
Inflation Rate	-0.0708*** (0.0137)	-0.0365* (0.0194)
Labor Share	0.4592** (0.2114)	0.1048 (0.2981)
Labor share × Labor Share	-0.5818*** (0.1951)	-0.2308 (0.2785)
R-Squared	0.6619	0.5993
No. Countries	32	32
No. Observations	809	809

Notes. Country and year fixed effect dummies are included.

Numbers in parentheses are standard errors.

* < 0.1, ** < 0.05, *** < 0.01.

Table 9. Growth Regression with the Centered Interaction Term

	(1) OLS	(2) IV
Log (Lagged Per Capita GDP)	-0.0883*** (0.0099)	-0.0860*** (0.0118)
Log (Fertility Rate)	-0.0387*** (0.0084)	-0.0455*** (0.0099)
$(\text{Life Expectancy at Birth})^{-1}$	-6.5335 (7.3224)	-0.0933 (8.8040)
Investment Ratio	0.2947*** (0.0290)	0.0088 (0.0428)
Female School Years	0.0081** (0.0039)	0.0082* (0.0044)
Male School Years	-0.0092** (0.0038)	-0.0088** (0.0042)
Government Consumption Ratio	-0.1886*** (0.0673)	-0.1651* (0.0861)
Openness Ratio	0.0351*** (0.0063)	0.0468*** (0.0077)
Inflation Rate	-0.0646*** (0.0138)	-0.0309 (0.0193)
Labor Share	-0.1603*** (0.0360)	-0.1392*** (0.0475)
(Labor Share–Its Average) × {Log (Lagged per capita GDP)-Its Average}	-0.1095** (0.0528)	-0.1361** (0.0677)
R-Squared	0.6598	0.5988
No. Countries	32	32
No. Observations	809	809

Notes. Country and year fixed effect dummies are included.

Numbers in parentheses are standard errors.

* < 0.1, ** < 0.05, *** < 0.01.

Table A1. Growth Regression with Alternative Labor Share and without Log of Lagged Per Capita GDP

	(1) OLS	(2) IV
Log (Fertility Rate)	-0.0285*** (0.0087)	-0.0327*** (0.0105)
$(\text{Life Expectancy at Birth})^{-1}$	23.7027*** (6.2263)	26.6863*** (7.3537)
Investment Ratio	0.2188*** (0.0294)	-0.1146*** (0.0432)
Female School Years	0.0037 (0.0041)	0.0039 (0.0046)
Male School Years	-0.0043 (0.0039)	-0.0038 (0.0044)
Government Consumption Ratio	-0.1098 (0.0698)	-0.0764 (0.0901)
Openness Ratio	0.0182* (0.0064)	0.0316*** (0.0079)
Inflation Rate	-0.0773*** (0.0145)	-0.0415** (0.0207)
Labor Share	-0.2249*** (0.0413)	-0.1784*** (0.0532)
R-Squared	0.6186	0.5342
No. of Countries	32	32
No. of Observations	809	809

Notes. The alternative labor share is the ratio of compensation of employees to GDP.

Country and year fixed effects are included.

Numbers in parentheses are standard errors.

* < 0.1, ** < 0.05, *** < 0.01.