Labor Market Institutions and Wage-led Growth: A Panel Cointegration Approach

Hochul Shin

This study analyzes the long-term effect of labor market institutions, such as minimum wage and union density, on inequality, investment, growth, and consumption, by using data of the member countries of the Organization for Economic Co-operation and Development since the 1970s. Labor market institution variables are used to test arguments on wage-led growth theory.

Panel cointegration approach was used to investigate the long-term effect of these variables. Results of panel cointegration test show that variables of labor market institutions are not robustly correlated to macroeconomic outcomes in the long run. This condition is not in accordance with the findings of the proponents and critics of wage-led growth. No robust evidence exists to show that increasing minimum wage and union density, which are representative policies for wage-led growth, are correlated to inequality, labor income share, consumption, investment, or growth in the long run. Estimation results of this study suggest that the empirical basis of support and criticism for wage-led growth theory is weak.

Keywords: Wage-led growth, Minimum wage, Union density, Panel cointegration

JEL Classification: J08, J30, J51

Hochul Shin, Center for Distributive Justice, Seoul National University, Seoul, Korea. (Email): s2h3c7@gmail.com.

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I. Introduction

The last global financial crisis from 2007 to 2008 placed the global economy into a deep depression. Moreover, many traditional economic perspectives were changed. One of these perspectives is the wage-led growth strategy proposed by Lavoie and Stockhammer (2012). Wage is a cost item from the firm viewpoint in traditional economics. However, this perspective emphasizes wage as a source of workers' income and argues that increasing wages or wage share can increase GDP or its growth rate while decreasing income inequality.

This theory is attractive to politicians because it argues for the possibility of simultaneously achieving important economic and social goals, which are growth and equality. Consequently, several politicians and governments in developed countries, such as the Obama Administration in the US and the Abe Administration in Japan, have conducted similar policies on the basis of wage-led growth theory. In addition, the Korean government, which began in May 2017, considers wage-led growth[1] as one of its key policy objectives.

A representative policy for wage-led growth is an increase in minimum wage. This policy is widely applied because it directly affects the income of low-paid workers and is relatively easy to implement compared with other policies, such as increase in union density or wage bargaining coverage. Since the global financial crisis, the US increased its federal hourly minimum wage from $5.15 in 2006 to $7.25 in 2009, and Japan increased its minimum wage from 713 yen in 2010 to 823 yen in 2017. Korea also increased its hourly minimum wage from 3,100 won in 2006 to 8,350 won in 2019.

Although wage-led growth is popular nowadays, only few studies test the effect of policies from wage-led growth on macro-economic outcomes. In the present study, the long-term effect of labor market institutions, such as minimum wage and union density, on macroeconomic outcomes, such as inequality, investment, growth, and consumption, was estimated using panel cointegration approach. As a result, the empirical basis of wage-led growth theory can be tested. In Section II, related literature is reviewed. In Sections III and IV, data and estimation

[1] The term "income-led growth" is frequently used in Korea to reflect a relatively high share of workers who are self-employed.

method are introduced. In Section V, estimation results are discussed. In Section VI, the conclusion is presented.

II. Literature Review

A. Wage-led Growth

Wage-led growth is proposed by several scholars, particularly those at the International Labour Organization (Lavoie and Stockhammer 2012; Onaran and Galanis 2012; Stockhammer and Onaran 2013). Their argument is simple. The marginal propensity of consumption for wage earners is higher than that of profit earners; thus, the increase in wage share to GDP can increase aggregate consumption and demand. These scholars admit that the increase in wage share can decrease investment and net export because it can decrease the future profitability of firms. However, they argue that these effects are less than the effect on consumption in many countries. These scholars divide the demand regime into two, namely, wage and profit led. If the increase in wage share increases the private demand, then the country has a wage-led demand regime, whereas if the increase in wage share decreases private demand, then the country has a profit-led demand regime. They also argued that determining whether a country is in the wage- or profit-led demand regime is an empirical issue and cannot be performed theoretically. For example, Onaran and Galanis (2012) conducted a time-series econometric analysis for 15 countries in G20 from 1961 to 2007 and argued that Germany, France, Italy, the UK, the US, Japan, Turkey, and Korea have wage-led demand regimes.

Although wage-led growth theory is simple and powerful, it is prone to criticism. The first problem is the endogeneity of wage share. Skott (2017) stated that the relationship between wage share and economic growth can be positive with some exogenous shocks, but it can be negative with other exogenous shocks. The second problem is the direction of causality. Kuznets (1955) argued that income level can affect distribution. As the sectoral transition from agriculture to manufacturing and service has been completed, inequality can decrease with income in developed countries, thereby generating a positive correlation between wage share and GDP. Thus, identifying the effect of wage share on GDP using time-series regression for one country is difficult, as shown by Onaran and Galanis (2012). The third problem is

that the amount of wage share that should be increased is unclear. An extremely high wage share cannot be beneficial to the GDP or growth because no entrepreneur would invest if the wage share is 100%. Thus, if wage-led growth theory is correct, then an optimal wage-share level likely exists, but the amount of wage share that is considered optimal is unclear. Furthermore, this point suggests that an increase in wage share might not be an effective long-term growth strategy and is like a short-run Keynesian effective demand policy even if wage-led growth theory is correct. The fourth problem is that finding proper policies for wage-led growth is difficult even if many countries have a wage-led demand regime, and an increase in wage share can lead to a GDP increase, as argued by proponents of wage-led growth. The easiest policy to implement is an increase in minimum wage, but whether such a policy increases GDP or wage share is unclear.

B. Minimum Wage

A classical study on minimum wage is that by Card and Krueger (1994), who estimated the effect of minimum wage on employment in the fast-food industry by comparing New Jersey and Pennsylvania. They found that an increase in minimum wage increases fast-food employment rather than the opposite, as the competitive labor market model posits. Card and Krueger (2000) reported similar results based on administrative data on restaurants in these states. Card (1992) also showed that an increase in federal minimum wage raises the wages of teenage workers but does not affect employment in the US. Metcalf (2008) summarized similar results in the case of British minimum wage, which was introduced in 1999.

The aforementioned studies suggest that the labor market for low-paid workers, which is affected by minimum wage, are more similar to a monopsony labor market than a competitive labor market. This condition is far from being a competitive labor market because most firms do not treat wages as given and can affect the wages to a certain extent. Metcalf (2008) examined 12 possible reasons for the zero to minimal impact of minimum wage on employment in the UK and suggested that five of these reasons are plausible. These reasons are increasing labor productivity due to increasing workers' effort or training, passing on high prices of products, decreasing profit share, decreasing working hours per worker, and modern monopsony in which

competition occurs among employers, but each employer has labor market power[2] over employees.

However, some studies have showed a negative effect of minimum wage on employment. For example, by using the monthly survey data of the current population from 1979 to 1997 in the US, Burkhauser *et al.* (2000) found a negative effect on teenage employment. Rama (2001) also observed a negative effect on employment in Indonesia, especially for small firms, by analyzing the doubled minimum wage case in the first half of the 1990s. Sabia *et al.* (2012) obtained similar results based on an increase in minimum wage in New York State from 2004 to 2006. They found that an increase in minimum wage leads to a decrease in employment rate for 16- to 29-year-old workers without a high school degree. Lee and Hwang (2016) observed a negative effect on employment in Korea from 2006 to 2014. This negative effect is stronger on vulnerable worker groups, such as young, old, or female workers, and workers in small businesses than other worker groups.

Studies on labor productivity have been conducted, especially in the UK. Forth and O'Mahoney (2003) tested the effect of national minimum wage on the growth rate of labor productivity and total factor productivity (TFP) in the UK by using 183 industry data from 1995 to 2000 and found that these effects were insignificant. Draca *et al.* (2011) also determined a similar insignificant effect on labor productivity in the UK by using 4,112 firm data from 1997 to 2002. However, Riley and Bondibene (2015) observed significant positive effects on labor productivity and TFP in the UK by using firm data from 1993 to 2013. The researchers argued that these effects may be due to the increased training and efforts of workers and the organizational change resulting from increased labor costs. Croucher and Rizov (2012) also found a similar positive effect on labor productivity in low-wage sectors, such as retail, hospitality, social care, cleaning, security, and textiles, in the UK.

In terms of growth, theoretical studies have been conducted by Fanti and Gori (2011), Askenazy (2003), and Cahuc and Michel (1996). These studies generally suggest the possibility of positive effect of minimum wage on growth under certain conditions. These conditions are the existence of externalities related to physical or human capital

[2] Metcalf (2008) argued that this power may come from various factors, such as incomplete information, mobility costs, or preferences of workers.

accumulation or R&D activities. However, the effect on growth is generally negative without these externalities because the minimum wage increases the unemployment rate in these models.

Nevertheless, few empirical studies[3] have been conducted on the effect of minimum wage on macroeconomic outcomes, such as wage share, aggregated income, or economic growth although it is the core of wage-led growth theory. Thus, the present study aims to fill the gap in the literature.

C. Labor Unions

Previous studies using firm-level data tend to report that unions have a negative effect on investment and productivity growth (Denny and Nickell 1992; Addison and Hirsch 1989; Fernie and Metcalf 1995). One reason cited by previous papers is that unions capture parts of the expected return of investment or new technology, which reduces the incentive of firms' investment. Another is that unions resist the introduction of new technology and change of working practices because union workers tend to increase their effort level and labor unions lose a certain degree of control over the workplace after the introduction of new technology.

However, limited evidence is available on the effects of unions on studies using country-level data (Nickell and Layard 1999). Most studies do not even consider labor unions as important determinants of growth or productivity. Nickell and Layard (1999) argued that the realization of the negative effect of unions depends on management response. If unions and managements have a cooperative relationship, then the introduction of new technology might be fast due to workers' cooperation.

In terms of inequality, several studies argue that decreasing union density is one reason for the recent increase in wage inequality or top 1% income share in the US (Card 2001; Volscho and Kelly 2012). However, in terms of wage share, the effect of union density is not strong. By using country-level data, Stockhammer (2013) found a positive correlation between union density and wage share to GDP, but

[3] Askenazy (2003) found a positive effect of the interaction term between minimum wage and exports on growth using a simple panel regression in 11 OECD countries.

this effect is not robust. The European Commission (EC) (2007) and International Monetary Fund (IMF) (2007) also observed small or non-robust effects on wage share. Similar to studies on minimum wage, few empirical studies are available on the effect of union density on economic growth or GDP per capita using country-level data.

III. Data

Data for the econometric analysis are briefly discussed in this section. Researchers generally measure inequality on the basis of personal income distribution (Gini coefficient), top 1% or 10% income share, or functional income distribution (labor-capital income share).

The top 10% income share in the national income, the adjusted wage share in GDP, and Gini coefficient were used as measures of inequality. Top 1% or 10% income share, as a general measure of inequality, is derived from administrative tax data and outperforms other available measures for estimating the income of the rich. Top 10% income share was used because this measure has numerous observations in the World Wealth and Income Database (WID). Income refers to the gross total income and includes labor, business, and capital income (excluding capital gains) before taxes and transfers. Adjusted wage share indicates the compensation per employee as a percentage of GDP at factor cost. The wage share data were collected from the annual macro-economic database (AMECO) in the EC. Gini coefficient, which was collected from the World Income Inequality Database (WIID) 3.3, is based on the household disposable income and total population of the country. WIID grades each of these data as high, average, low, or unknown, and only those data with high or average quality were retained.

Log private gross fixed capital formation (log private GFCF) per capita and log GDP per capita were used to measure investment and growth. Both are measured by using purchasing power parity (PPP). Private GFCF data were collected from the IMF and GDP per capita data from the Penn World Table (PWT) 9.0. Investment and growth are often measured on the basis of the ratio of investment to GDP and GDP growth rate. However, panel unit root tests (PURT) show that both measures are stationary;[4] thus, they were not used in this study. The

[4] Appendix 1 presents the PURT results for these variables.

adopted panel cointegration approach requires the dependent variable to be non-stationary because the linear combination of non-stationary dependent and independent variables is considered stationary. If all variables are stationary, then cointegration becomes trivial and meaningless. In terms of consumption, log private consumption per capita, which is a household final consumption expenditure as measured by PPP and collected from the World Bank database, was used.

As a widely used measure of minimum wage, the ratio of national (or federal) minimum wage to median wage of full-time workers was used. The related data were collected from OECD statistics. Another possible measure is the ratio of minimum wage to average wage, but given that this variable is affected by wage distribution, the ratio of minimum wage to median wage was used instead.

However, Card and Krueger (1995) criticized these measures because they use average or median wage as denominators, which can be correlated to GDP per capita or unobserved economic activities. They propose log minimum wage as a preferred measure for minimum wage. However, this variable was not used in the present study because PURT reveals that log minimum wage is a stationary variable. Furthermore, the panel cointegration methods applied are robust to omitted variable bias, such as that resulting from the correlation between median wage and unobserved productivity shock. Nevertheless, a robustness check was conducted by using the log real hourly minimum wage. The real hourly minimum wage and union density data were collected from OECD statistics.

When the linear combination of a set of non-stationary variables is stationary, these variables are "cointegrated," that is, they are closely related and do not diverge from their equilibrium relationship in the long run.

The basic estimation equation is illustrated as follows:

$$y_{it} = \alpha_i + \delta_i t + \beta' x_{it} + \gamma' z_{it} + \varepsilon_{it}, \quad (1)$$

where y_{it} denotes the dependent variable, which can be the inequality measure, log private GFCF per capita, log GDP per capita, and log private consumption per capita in country i and year t, and x_{it} refers to the labor market institution variable.

z_{it} represents a set of control variables that differ in accordance

with the dependent variables. For the inequality equation, these control variables include tertiary enrolment ratio, trade openness, and the capital compensation share of information and communication technology (ICT) in the total capital compensation. These variables represent the traditional factors of inequality in the literature, including insufficient supply of high-skilled workers, globalization, and skill-biased technological change, all of which drive the recent increase in inequality. Given the cointegration test of Pedroni (1999), the number of control variables is restricted in the present study.

For the investment equation, the control variables include savings rate, central government debt, lending interest rate by banks, and trade openness. Except for lending interest, all variables are expressed as a percentage of GDP. These variables are traditional determinants of investment (Ndikumana 2000) and are non-stationary, as shown in the PURT results presented in the following section. The other determinants of investment, such as GDP growth and inflation, are excluded in the analysis due to their stationarity.[5] The panel cointegration approach is robust to this omission, as discussed in the subsequent section.[6]

For the growth equation, the control variables include log private investment per capita, tertiary enrolment ratio, log triadic patent stock per million populations, and trade openness. These variables represent the traditional production factors of physical capital, human capital, technology, and external factors, respectively.

For the consumption equation, the control variables include log disposable income per capita, deposit interest rate, and trade openness. Log disposable income per capita was included, following the basic Keynesian consumption function. Deposit interest rate was included due to its possible influence on the consumption or savings decisions of households. Trade openness was also included to control the external factors and increase of consumption variety by foreign trade.

α_i is the country fixed effect, $\delta_i t$ denoted a country-specific linear trend, β represents the effect of labor market institutions on the dependent variable, and ε_{it} is an error term that is stationary if cointegration is present. If cointegration is present, then $(\beta', \gamma')'$ denotes the cointegrating vector. Table 1 presents the detailed definitions of

[5] Appendix 1 presents the PURT results for these variables.

[6] However, these variables are used in checking the robustness.

TABLE 1

DEFINITIONS OF VARIABLES AND SOURCES OF DATA

Variable	Definition	Source
Top 10% income share	Share of top 10% income among national income (%)	World Wealth and Income Database (WID)
Adjusted wage share	Compensation per employee as percentage of GDP at factor cost per person employed (%)	Annual Macro-Economic (AMECO) database
Gini coefficient	Ratio of the area that lies between the line of equality and the Lorenz curve over the total area under the line of equality (%)	World Income Inequality Database (WIID 3.3) database
Log private GFCF per capita	Log of private gross fixed capital formation per capita (PPP, 2005 US$)	IMF
Log GDP per capita	Log of expenditure-side real GDP at chained PPPs per capita (2011 US$)	Penn World Table 9.0
Log private consumption per capita	Log of household final consumption expenditure per capita (PPP, 2016 US$)	World Bank
Minimum wage	Ratio of national (or federal) minimum wage to median wages of full-time workers (%)	OECD Stat.
Union density	Trade union density (%)	OECD Stat.
Log disposable income per capita	Log of real household net disposable income per capita (PPP, 2016 US$)	OECD Stat.
Deposit interest rate	Deposit interest rate paid by commercial or similar banks (%)	World Bank
Log real hourly minimum wage	Log of real hourly minimum wage (PPP, 2015 US$)	OECD Stat.
ICT compensation	Share of Information and Communication Technology (ICT) capital compensation among total capital compensation (%)	EU-KLEMS database, November 2009 release
Trade openness	Export + import/GDP (%)	World Bank
Tertiary enrolment ratio	Gross enrolment ratio, tertiary, both sexes (%)	World Bank
Saving rate	Gross saving as percent of GDP (%)	World Bank
Lending interest rate	Lending interest rate by banks to the private sectors (%)	World Bank
Central government debt	Central government debt as percent of GDP (%)	OECD Stat.
Log triadic patent stock per million population	Log of triadic patent stock per million populations	OECD Stat.

these variables and the sources of data.

IV. Estimation Method

The panel cointegration methods were used to study the long-term effect of labor market institutions on the macroeconomic outcomes. Previous literatures tend to utilize country- or industry-level data and generally apply conventional econometric methods, such as panel fixed effect, generalized method of moments (GMM), or time series model. However, conventional models have problems, such as endogeneity or poor small sample property. Specifically, the sequential exogeneity assumption of independent variables in the GMM model cannot easily hold in the OECD panel data with a small number of countries.[7] Endogeneity can be controlled and the long-term effect can be estimated by using the panel cointegration method.[8]

The empirical estimation can be divided into three steps, namely, PURT, panel cointegration test, and group-mean fully modified ordinary least squares (group-mean FMOLS).

In the first step, the variables were checked whether they are stationary or non-stationary for the panel cointegration approach. Two widely used PURTs, namely, the Im, Pesaran, and Shin (2003) (IPS) and Pesaran (2007) tests, were conducted.

The IPS test uses the augmented Dicky-Fuller (ADF) test in the panel setting with heterogeneous AR (1) coefficient. However, the IPS tests assume the cross-sectional independence of error term. To check whether a variable has cross-sectional dependence (CD), a CD test of Pesaran (2004) was performed. Rejection of the CD test suggests the existence of CD in a variable. In this case, the Pesaran (2007) test, which allows the CD of the error term, was used. The rejection of IPS and Pesaran (2007) tests suggests that the time series are stationary in at least one country.

In the second step, if the non-stationarity of variables is confirmed, then a panel cointegration test is conducted to determine whether a

[7] The reason is that the GMM estimator requires the number of cross-sectional unit (n) to be large for asymptotic results. The GMM results presented in Appendix 2 show that the sequential exogeneity assumption is strongly rejected in all specifications.

[8] Similar discussions are in the study of Shin and Lee (2019).

cointegration relationship exists between variables in the long run. The Pedroni (1995) cointegration test, which uses the individual ADF regression for the residuals of each country datum, was performed. The residual comes from individual OLS regression. After estimating the residual, the Pedroni cointegration test checks whether this residual is stationary. The null hypothesis of the Pedroni cointegration test is that cointegration does not exist, whereas its alternative hypothesis is that cointegration exists for all countries.

In the third step, if the existence of cointegration is confirmed, then group-mean FMOLS can be applied to estimate the long-run coefficients. The group-mean FMOLS, which was developed by Pedroni (2001a, 2001b), has two advantages. First, its convergence rate is $T\sqrt{N}$, which is faster than the conventional $\sqrt{N}$ convergence rate. Second, group-mean FMOLS is robust to the omission of variables that are excluded in the cointegrating relationship (Pedroni 2007). Thus, omitting these stationary variables that might affect the dependent variable and be correlated to labor market institution variables will not present an issue because they cannot be part of the cointegrating relationship.

V. Estimation Results

A. Panel Unit Root Test (PURT)

Table 2 presents the PURT results.

The data coverage of each variable is the widest coverage that is used in the following analysis. For example, given that trade openness is used in the inequality, investment, growth, and consumption equations, widest coverage means that any country which is included in the inequality, investment, growth, or consumption equation should be included in the PURT for trade openness. If the IPS or Pesaran (2007) tests do not reject the null hypothesis of non-stationarity and if one variable is confirmed as non-stationary, then the smaller data coverage of the variable is also non-stationary because both tests posit in their null hypothesis that each time series of this variable is non-stationary. It decreases the burden on PURT.

First, Table 2 shows that all PURT statistics for deposit interest rate are significant at the 1% level, thereby suggesting that deposit interest rate is stationary. Therefore, the deposit interest rate was excluded from the control variables for the consumption equation.

TABLE 2
PURT

Variable \ Test	IPS	Pesaran (2007)			IPS	Pesaran (2007)			Pesaran (2004) CD test	Number of countries	Period
		lags = 0	lags = 1	lags = 2		lags = 0	lags = 1	lags = 2			
	With intercept				With intercept and trend						
Top 10% income share	2.43 (0.992)	−2.13* (0.016)	−1.89* (0.03)	−1.03 (0.152)	−3.57** (0.000)	−2.23* (0.013)	−0.19 (0.426)	0.44 (0.669)	19.68** (0.000)	13	1971-2007
Adjusted wage share	−0.4 (0.344)	−2.11* (0.017)	−2.57** (0.005)	−2.23* (0.013)	−1.72* (0.043)	−0.13 (0.448)	−0.79 (0.216)	−0.33 (0.372)	29.68** (0.000)	17	1979-2007
Gini	−1.71* (0.043)	−1.97* (0.024)	−1.71* (0.044)	1.63 (0.948)	−3.2** (0.001)	−2.64** (0.004)	−1.7* (0.045)	3.18 (0.999)	0.92 (0.359)	11	1979-2007
ICT compensation	−0.31 (0.377)	−2.92** (0.002)	−5.43** (0.000)	−2.54** (0.006)	−1.91* (0.028)	−1.55 (0.06)	−5.15** (0.000)	−1.2 (0.116)	34.43** (0.000)	17	1971-2007
Trade openness	3.7 (0.999)	−1.5 (0.066)	−2.88** (0.002)	−1.81* (0.035)	−3.67** (0.000)	−0.41 (0.339)	−2.76** (0.003)	−1.58 (0.057)	89.62** (0.000)	34	1971-2014
Union density	−4.01** (0.000)	−1.3 (0.097)	−2.08* (0.019)	−1.73* (0.042)	−4.64** (0.000)	1.15 (0.875)	0.6 (0.727)	1.47 (0.93)	66.49** (0.000)	34	1971-2014
Tertiary enrolment ratio	11.05 (1.000)	4.13 (1.000)	2.64 (0.996)	2.52 (0.994)	3.12 (0.999)	6.34 (1.000)	5.9 (1.000)	4.8 (1.000)	110.61** (0.000)	30	1971-2013
Minimum wage	−3.86** (0.000)	−0.63 (0.265)	−0.2 (0.42)	n. a.	−1.08 (0.14)	0.89 (0.814)	0.81 (0.792)	n. a.	5.2** (0.000)	22	1972-2014
Log private GFCF per capita	−0.41 (0.34)	0.79 (0.784)	−1.15 (0.126)	0.37 (0.643)	−1.62 (0.053)	2.72 (0.997)	1.67 (0.953)	3.24 (0.999)	87.52** (0.000)	30	1981-2013
Log GDP per capita	−1.7* (0.045)	0.15 (0.56)	−2.17* (0.015)	−0.9 (0.183)	−1.28 (0.1)	1.56 (0.941)	0.52 (0.698)	2.1 (0.982)	99.92** (0.000)	30	1986-2013
Saving rate	−2.94** (0.002)	−0.47 (0.318)	−0.24 (0.406)	n. a.	−2.32* (0.01)	−0.78 (0.217)	1.19 (0.884)	n. a.	12.09** (0.000)	29	1981-2010
Lending interest rate	−0.98 (0.164)	−3.88** (0.000)	−4.21** (0.000)	0.65 (0.743)	−3.6** (0.000)	−3.16** (0.001)	−5.3** (0.000)	1.04 (0.85)	57.83** (0.000)	27	1981-2010
Central government debt	−0.35 (0.362)	5.76 (1.000)	3.21 (0.999)	2.45 (0.993)	−0.05 (0.481)	2.09 (0.982)	2.45 (0.993)	4.36 (1.000)	13.37** (0.000)	29	1981-2010
Log triadic patent stock per million populations	−23.18** (0.000)	−16.4** (0.000)	−1.18 (0.12)	2.81 (0.998)	−12.66** (0.000)	−15.15** (0.000)	−1.54 (0.062)	2.77 (0.997)	106.97** (0.000)	30	1986-2013
Log private consumption per capita	0.51 (0.695)	−0.87 (0.191)	−1.89* (0.029)	−4.63** (0.000)	3.17 (0.999)	1.38 (0.917)	0.45 (0.673)	−1.27 (0.102)	103.81** (0.000)	31	1990-2014
Log disposable income per capita	−3.65** (0.000)	0.32 (0.624)	−0.96 (0.17)	2.27 (0.988)	2.64 (0.996)	1.9 (0.971)	1.53 (0.936)	6.43 (1.000)	87.03** (0.000)	31	1990-2014
Deposit interest rate	−8.21** (0.000)	−6.79** (0.000)	−7.91** (0.000)	−5.07** (0.000)	−4.8** (0.000)	−4.37** (0.000)	−5.85** (0.000)	−2.43** (0.008)	37.78** (0.000)	18	1990-2014

Note: ** and * denote statistical significance levels at 1% and 5%, respectively.
* p-value is in the parenthesis
* null hypothesis: variable is non-stationary
* IPS: lag length selection based on SIC, maximum lag length is observation-based, Newey-West automatic bandwidth selection and Bartlett kernel
* n. a.: not available due to limit of observations

Second, Table 2 shows that the CD statistic for Gini coefficient is insignificant. Therefore, the IPS test is better than the Pesaran (2007) test for the Gini coefficient because the former has a better small sample property than the latter if the cross-sectional independence holds (Pesaran 2007). The IPS test results reject the null hypothesis at the 1% or 5% significance level. Thus, the Gini coefficient is also stationary, and the cointegration test results for this variable is no longer presented.

Third, the CD test reveals a CD in all variables except for the Gini coefficient. The CD statistics are significant at the 1% level in all variables except for the Gini coefficient. Thus, the Pesaran (2007) test was performed for these variables instead of the IPS test.

In the Pesaran (2007) test, three lag structures of residual serial correlation were used, from no serial correlation to AR (2). The Pesaran (2007) test results show that tertiary enrolment ratio, minimum wage, log private GFCF per capita, savings rate, central government debt, and log disposable income per capita are non-stationary regardless of the lag structure or the existence of a linear trend. Thus, these variables are non-stationary. However, the Pesaran (2007) test generates mixed results for the remaining nine variables depending on the lag structure or the existence of linear trend. To investigate these results in detail, the Pesaran (2007) test was conducted for these variables up to five lags.

Table 3 shows that the Pesaran (2007) statistic and its p-value increase along with lag length for most variables, which indicates that the test statistics cannot reject the null hypothesis of non-stationarity when sufficient lags of the residual are considered. These findings also imply that the significant statistics in lag 0 or 1 are most likely caused by the inappropriately short lag structure. When two or more lags of the residual are considered, the Pesaran (2007) statistics are insignificant for top 10% income share regardless of the existence of a linear trend. Thus, top 10% income share tends to be non-stationary. The Pesaran (2007) statistics are also insignificant for the other variables if the linear time trends and sufficient number of lags are controlled. Thus, these variables seem to be non-stationary data with a linear trend. Given that the country-specific linear time trend was used as a default control variable, these variables can be considered non-stationary in the following analysis.

TABLE 3

PESARAN (2007) TEST RESULTS FOR THE SELECTED VARIABLES

Variable		Top 10% income share	Adjusted wage share	ICT compensation	Trade openness	Union density	Log GDP per capita	Lending interest rate	Log triadic patent stock per million populations	Log private consumption per capita
With intercept	lags = 0	−2.13* (0.016)	−2.11* (0.017)	−2.92** (0.002)	−1.5 (0.066)	−1.3 (0.097)	0.15 (0.56)	−3.88** (0.000)	−16.4** (0.000)	−0.87 (0.191)
	lags = 1	−1.89* (0.03)	−2.57** (0.005)	−5.43** (0.000)	−2.88** (0.002)	−2.08* (0.019)	−2.17* (0.015)	−4.21** (0.000)	−1.18 (0.12)	−1.89* (0.029)
	lags = 2	−1.03 (0.152)	−2.23* (0.013)	−2.54** (0.006)	−1.81* (0.035)	−1.73* (0.042)	−0.9 (0.183)	0.65 (0.743)	2.81 (0.998)	−4.63** (0.000)
	lags = 3	0.02 (0.508)	−2.23* (0.013)	2.65 (0.996)	−1.26 (0.103)	−0.73 (0.233)	−3.3** (0.000)	n. a.	0.7 (0.757)	−2.11* (0.017)
	lags = 4	2.41 (0.992)	n. a.	n. a.	0.62 (0.733)	−0.79 (0.215)	−2.09* (0.018)	n. a.	−2.82** (0.002)	−0.76 (0.223)
	lags = 5	2.18 (0.985)	n. a.	n. a.	1.28 (0.9)	3.89 (1.000)	−1.8* (0.036)	n. a.	−0.82 (0.207)	1.4 (0.919)
With intercept and trend	lags = 0	−2.23* (0.013)	−0.13 (0.448)	−1.55 (0.06)	−0.41 (0.339)	1.15 (0.875)	1.56 (0.941)	−3.16** (0.001)	−15.15** (0.000)	1.38 (0.917)
	lags = 1	−0.19 (0.426)	−0.79 (0.216)	−5.15** (0.000)	−2.76** (0.003)	0.6 (0.727)	0.52 (0.698)	−5.3** (0.000)	−1.54 (0.062)	0.45 (0.673)
	lags = 2	0.44 (0.669)	−0.33 (0.372)	−1.2 (0.116)	−1.58 (0.057)	1.47 (0.93)	2.1 (0.982)	1.04 (0.85)	2.77 (0.997)	−1.27 (0.102)
	lags = 3	1.52 (0.936)	4.27 (1.000)	3.45 (1.000)	−1.48 (0.069)	2.24 (0.987)	0.6 (0.725)	n. a.	0.59 (0.722)	0.77 (0.778)
	lags = 4	3.59 (1.000)	n. a.	n. a.	0.53 (0.703)	4.03 (1.000)	3.2 (0.999)	n. a.	−2.52** (0.006)	3.08 (0.999)
	lags = 5	4.71 (1.000)	n. a.	n. a.	1.27 (0.898)	6.16 (1.000)	5.11 (1.000)	n. a.	−0.66 (0.255)	3.74 (1.000)
Number of countries		13	17	17	34	34	30	27	30	31
Period		1971-2007	1979-2007	1971-2007	1971-2014	1971-2014	1986-2013	1981-2010	1986-2013	1990-2014

Note: ** and * denote statistical significance levels at 1% and 5%, respectively

* p-value is in the parenthesis

* n. a.: not available due to limit of observations

B. Cointegration Test

The following tables present the results of the Pedroni cointegration test.

Country-specific linear trend and country fixed effects were controlled in all specifications. Control variables are different based on the dependent variables and are presented in Section III.

Each column in Table 4 shows the results of the cointegration test when one of the two labor variables is included in each specification.

The Pedroni cointegration test produces mixed results. Most of Group PP and ADF statistics are significant at 1% or 5% level, but most of other statistics are insignificant. Although the empirical power of Panel v and rho and Group rho is weak at a small-sized sample, most of Panel PP and ADF statistics, which have relatively high empirical power at a small-sized sample, are also insignificant.[9] Results suggest that there is weak evidence that labor market institutions are cointegrated with macroeconomic outcomes in the long run.

C. Robustness Check

Previous results suggest that labor market institutions, such as minimum wage or union density, do not have long-term relationship with macroeconomic outcomes. However, the effect of labor market institutions could vary with countries. Specifically, critics of wage-led growth theory often argued that it might not be effective for countries that heavily depend on external trade because the negative effect of minimum wage or union density on net export can be strong in these countries. Thus, the effect of labor market institutions on growth was estimated country by country in this section. Two estimation methods,

[9] Pedroni (2004) computed the empirical power of these statistics by conducting a Monte Carlo simulation and found that the power of v and rho statistics was poor for a small-sized sample similar to the present study. When $N = T = 20$ and the AR (1) coefficient of the residual is 0.9 (which indicates a stationary residual and the existence of cointegration), the empirical power of panel v and group rho statistics is near zero whereas that of the panel rho statistic is around 0.2 for the 5% test. However, the empirical power of PP and ADF statistics is around 0.6. Such empirical power increases along with N or T, and the difference in the power of statistics becomes negligible when $T > 70$. Among all cases reported by Pedroni (2004), $N = T = 20$ is the closest to my sample.

TABLE 4
PEDRONI PANEL COINTEGRATION TEST

Dependent variable	Top 10% income share		Adjusted wage share		Log private GFCF per capita		Log GDP per capita		Log private consumption per capita	
Labor variables	Minimum wage	Union density	Minimum wage	Union density	Minimum wage	Union density	Minimum wage	Union density	Minimum wage	Union density
Panel v-Statistic	−1.44 (0.925)	−0.55 (0.710)	0.17 (0.431)	−1.62 (0.947)	3.72** (0.000)	1.63 (0.052)	1.6 (0.055)	5.60** (0.000)	−1.09 (0.861)	−0.85 (0.802)
Panel rho-Statistic	2.82 (0.998)	2.23 (0.987)	2.03 (0.979)	2.8 (0.997)	3.49 (1.000)	3.62 (1.000)	3.69 (1.000)	4.25 (1.000)	2.6 (0.995)	3.8 (1.000)
Panel PP-Statistic	1.12 (0.868)	−0.69 (0.247)	−0.29 (0.385)	0.08 (0.533)	−0.81 (0.209)	−0.72 (0.236)	0.36 (0.640)	−1.04 (0.149)	−0.14 (0.446)	1.22 (0.888)
Panel ADF-Statistic	0.55 (0.708)	−0.77 (0.222)	−1.38 (0.084)	−2.31* (0.011)	−1.21 (0.114)	−0.47 (0.319)	0.68 (0.753)	−0.31 (0.378)	−0.2 (0.420)	−0.88 (0.190)
Group rho-Statistic	3.60 (1.000)	2.92 (0.998)	3.26 (0.999)	4.47 (1.000)	5.78 (1.000)	6.42 (1.000)	5.66 (1.000)	5.89 (1.000)	3.85 (1.000)	4.74 (1.000)
Group PP-Statistic	−0.73 (0.234)	−8.15** (0.000)	−4.12** (0.000)	−1.92* (0.027)	−7.33** (0.000)	−8.11** (0.000)	−6.06** (0.000)	−6.34** (0.000)	−3.64** (0.000)	−1.41 (0.080)
Group ADF-Statistic	−1.04 (0.148)	−2.08* (0.019)	−2.5** (0.006)	−2.66** (0.004)	−2.81** (0.003)	−2.42** (0.008)	−1.65* (0.050)	−1.77* (0.038)	−1.81* (0.035)	−1.67* (0.047)
Number of countries	8	13	10	17	17	27	20	30	22	31
Number of obs. per country	21.38	23.77	20.6	22.53	19.06	21.26	21.15	23.8	17.59	18.16
Period	1972-2007	1971-2007	1979-2007	1979-2007	1981-2010	1981-2010	1986-2013	1986-2013	1990-2014	1990-2014

Note: ** and * denote statistical significance levels at 1% and 5%, respectively

* p-value is in parenthesis

* Null hypothesis: No cointegration

* Linear country-specific trends and fixed effects are controlled.

* Use d. f. corrected Dickey-Fuller residual variances

* Automatic lag length selection based on SIC with lags from 0 to observation-based maximum lag length

* Newey-West automatic bandwidth selection and Bartlett kernel

namely, OLS and FMOLS, were used. Given that variables in the growth equation are non-stationary, first-differenced data were used for OLS estimation. When the results of Johansen cointegration test suggest a cointegration relationship[10] among variables in the specific country,

[10] Johansen cointegration test was impossible for several countries due to the limit of observations. Results of Johansen cointegration test are available upon request to the author.

TABLE 5

COUNTRY-BY-COUNTRY ESTIMATION RESULTS FOR GROWTH EQUATION

Dependent variable	D. log GDP per capita				Log GDP per capita			
Data type	First difference				Level			
Estimation method	OLS				FMOLS			
Country name	D. minimum age		D. union density		Minimum wage		Union density	
	coef.	S.E.	coef.	S.E.	coef.	S.E.	coef.	S.E.
Australia	0.002	(0.002)	−0.013**	(0.003)	0.001	(0.002)	−0.015**	(0.001)
Belgium	0.008	(0.007)	0.004	(0.005)				
Canada	−0.024**	(0.003)	−0.020**	(0.004)				
Czech Republic	−0.002	(0.003)	0.002	(0.004)				
Estonia	−0.008	(0.004)	−0.008	(0.011)				
France	−0.001	(0.003)	0.005	(0.017)	−0.002	(0.003)	0.045	(0.032)
Greece	−0.004	(0.003)	−0.003	(0.006)	−0.006**	(0.001)	−0.003	(0.002)
Ireland	−0.002	(0.002)	−0.022*	(0.010)				
Israel	0.069	(0.037)	−0.174	(0.100)				
Japan	−0.001	(0.013)	−0.018	(0.010)				
Korea	−0.002	(0.002)	−0.010	(0.006)	−0.003**	(0.001)	−0.013*	(0.006)
Luxembourg	−0.024*	(0.011)	0.002	(0.010)				
Netherlands	−0.002	(0.002)	−0.002	(0.006)	−0.002	(0.002)	−0.004	(0.003)
New Zealand	−0.001	(0.002)	0.000	(0.002)	−0.003	(0.003)	−0.002	(0.001)
Poland	−0.005**	(0.001)	−0.009**	(0.002)				
Portugal	0.006	(0.004)	0.002	(0.005)				
Spain	0.004	(0.008)	0.008*	(0.003)	−0.002	(0.002)	0.015**	(0.003)
UK	−0.003	(0.010)	0.011	(0.024)				
USA	−0.002	(0.001)	−0.009	(0.007)	−0.002	(0.001)	−0.008	(0.010)

Note: ** and * denote statistical significance levels at 1% and 5%, respectively

* Constant, log private investment per capita, tertiary enrolment ratio, log triadic patent stock per million populations, and trade openness are omitted.

* OLS: robust standard error used

* FMOLS: Linear trend is controlled, long-run covariance estimates: Bartlett kernel, Newey-West fixed bandwidth, d. f. adjustment, one-year lag is used for Johansen cointegration test

country-specific FMOLS estimation was used for level data. When estimation results are different between OLS and FMOLS, FMOLS results were used because they can handle the endogeneity problem given the existence of cointegration as previously discussed.

Control variables are same as those in the previous panel cointegration tests and linear trend is controlled in the FMOLS estimation. Results of

estimation country by country for growth equation are as follows.

Table 5 presents the estimation results for labor market institutions. Results for other variables were omitted to save space. The results are similar to previous estimation results. Most of the estimated coefficients for minimum wage and union density are insignificant or negatively significant. The only estimated coefficient that is positive and significant is union density in Spain. Minimum wage is significant and negative in Canada, Luxembourg, Poland, Greece, and Korea. Union density is significant and negative in Australia, Canada, Ireland, Poland, and Korea.

Thus, estimation results do not seem to support wage-led growth theory. However, no tendency exists that the negative effect of minimum wage and union density on growth is strong for countries heavily dependent on external trade. Instead, Poland, Greece, and Korea have a relatively high share of self-employment.[11] Thus, the negative effect of minimum wage on employment or working hours might be considerable in these countries because the self-employed or small business owners could be sensitive to the wage increase of their employees through minimum wage increase. Employers might try to recover profits by firing their temporary workers given the negative shock from minimum wage increase (Hosono *et al.* 2015).

The effects of labor market institutions on private investment and consumption were estimated country by country as a robust check. Estimation results for investment equation are as follows.

Similar to Table 5, first-differenced data were used for OLS estimation, whereas level data were used for FMOLS estimation. For OLS estimation, two control variables, namely, inflation rate and growth rate of GDP per capita, were added. These variables were excluded in the previous sections due to their stationarity, but OLS estimation does not require non-stationarity of regressors; thus, including these variables as control variables is possible. These variables are stationary; hence, their level data were used. In the FMOLS estimation, these variables were excluded as before.

Estimation results show that minimum wage is significantly and negatively correlated to private investment in Canada, Portugal, and

[11] The average share of self-employment among total employment from 1970 to 2015 was 42.9% in Greece, 42.2% in Korea, and 26% in Poland, which are considerably higher than the OECD average (19%). Data are from the OECD.

TABLE 6
COUNTRY-BY-COUNTRY ESTIMATION RESULTS FOR INVESTMENT EQUATION

Dependent variable	D. log private investment per capita				Log private investment per capita			
Data type	First difference (except GDP per capita growth and inflation)				Level			
Estimation method	OLS				FMOLS			
Country name	D. minimum wage		D. union density		Minimum wage		Union density	
	coef.	S.E.	coef.	S.E.	coef.	S.E.	coef.	S.E.
Australia	−0.005	(0.008)	0.004	(0.016)				
Canada	0.014	(0.010)	−0.021**	(0.007)	−0.013**	(0.004)	−0.026**	(0.005)
Czech Republic	0.020	(0.012)	0.014	(0.017)				
Estonia	0.006	(0.009)	−0.040	(0.010)				
France	−0.001	(0.005)	0.023	(0.038)				
Greece	0.028	(0.030)	0.040	(0.032)				
Japan	−0.030	(0.024)	0.054	(0.062)				
Korea	0.011	(0.010)	0.023	(0.036)				
Netherlands	0.008*	(0.003)	0.001	(0.006)	0.013	(0.008)	−0.001	(0.008)
New Zealand	0.110	(0.049)	−0.064	(0.018)				
Poland	0.000	(0.006)	0.005	(0.006)				
Portugal	−0.026**	(0.008)	−0.010	(0.009)	−0.038**	(0.009)	0.010	(0.005)
Slovakia	0.008	(0.015)	−0.036*	(0.011)				
Spain	−0.011	(0.009)	−0.012	(0.006)	−0.043**	(0.013)	0.045**	(0.016)
UK	0.063	(0.053)	0.125	(0.163)				
USA	−0.003	(0.003)	0.017	(0.032)	−0.006	(0.005)	−0.027	(0.024)

Note: ** and * denote statistical significance levels at 1% and 5%, respectively
* Constant and other control variables are omitted
* OLS: robust standard error used, control variables: D. saving rate, D. lending interest rate, D. central government debt, D. trade openness, GDP per capita growth, inflation
* FMOLS: Long-run covariance estimates: Bartlett kernel, Newey-West fixed bandwidth, d. f. adjustment, one-year lag is used for Johansen test, control variables: linear trend, saving rate, lending interest rate, central government debt, trade openness

Spain. In the Netherlands, the OLS estimator of minimum wage is positive and significant, but the FMOLS estimator is insignificant. Union density is negative and significant in Canada and Slovakia, but it is positive and significant in Spain for FMOLS estimation.

Estimation results for consumption are as follows.

For OLS estimation, deposit interest rate, which was excluded in the previous section due to its stationarity, was added as a control variable. In the FMOLS estimation, deposit interest rate was excluded as before.

Estimation results show that the minimum wage is significantly and positively correlated to private consumption in Greece and Poland, but significant and negative in Canada, Hungary, and Korea. In Belgium, minimum wage is significant and positive for OLS estimation, but insignificant for FMOLS estimation.

Thus, minimum wage is positively correlated to consumption in two or three countries, which casts doubt on the thought that wage-led growth theory generally works. Minimum wage was significantly and positively correlated to private consumption per capita in Greece and Poland, but significantly and negatively correlated to GDP per capita in these countries. Thus, the increase in minimum wage might increase private consumption, but these effects might be insufficient to increase GDP. In Korea and Canada, minimum wage was negatively and significantly correlated to private consumption per capita and GDP per capita. Hence, if the minimum wage increase fails to increase private consumption, then the chance that wage-led growth theory actually works is small. Similar analysis was conducted from Tables 5 to 7 using log real hourly minimum wage, but the results are similar. Log real hourly minimum wage was insignificant for most countries.[12]

Union density is significant and negative in Australia, Hungary, and Spain, but significant and positive in the Netherlands and Portugal in Table 7.

The effect of union density in Spain is opposite to what wage-led growth theory argues. Union density is positively and significantly correlated to the GDP and private investment, but negatively correlated to private consumption in Spain.

Spain is an unusual case which did not show decrease in union density since the 1980s. Union density in Spain actually increased from 13.5% in 1980 to 16.9% in 2013. This increase might affect estimation results for Spain. This unusual pattern of Spanish union density might come from its late democratization after the death of dictator Francisco Franco in 1975. Union density was at its peak in the 1960s and 1970s and deceased consistently for most of OECD countries since the 1980s due to globalization and liberalization, but Spanish union density was at its peak in 1998 due to its late democratization process. Thus,

[12] Estimation results using log real hourly minimum wage are available upon request to the author.

TABLE 7
COUNTRY-BY-COUNTRY ESTIMATION RESULTS FOR CONSUMPTION EQUATION

Dependent variable	D. log private consumption per capita				Log private consumption per capita			
Data type	First difference (except deposit interest rate)				Level			
Estimation method	OLS				FMOLS			
Country name	D. minimum wage		D. union density		Minimum wage		Union density	
	coef.	S.E.	coef.	S.E.	coef.	S.E.	coef.	S.E.
Australia	0.002	(0.002)	−0.001	(0.003)	0.003	(0.001)	−0.005**	(0.001)
Belgium	0.007**	(0.002)	0.005	(0.003)	0.005	(0.003)	0.002	(0.003)
Canada	0.002	(0.005)	−0.004*	(0.001)	−0.006*	(0.002)	−0.006	(0.003)
Czech Republic	−0.003	(0.003)	0.002	(0.007)	−0.004	(0.003)	−0.002	(0.004)
Estonia	−0.001	(0.005)	−0.005	(0.017)				
France	0.001	(0.002)	−0.030	(0.017)	0.001	(0.002)	0.002	(0.007)
Greece	0.011*	(0.004)	−0.016	(0.009)	0.004**	(0.001)	−0.006	(0.003)
Hungary	−0.002	(0.001)	−0.001	(0.006)	−0.004*	(0.001)	−0.007**	(0.002)
Japan	−0.003	(0.009)	−0.007	(0.005)				
Korea	−0.003	(0.005)	0.020	(0.025)	−0.007*	(0.003)	0.029	(0.016)
Mexico	−0.001	(0.004)	0.012	(0.007)				
Netherlands	−0.000	(0.003)	0.006	(0.006)	−0.001	(0.002)	0.025*	(0.009)
New Zealand	−0.001	(0.005)	−0.005	(0.007)				
Poland	−0.000	(0.001)	0.004	(0.003)	0.003*	(0.001)	0.006	(0.003)
Portugal	−0.003	(0.005)	0.013	(0.010)	0.000	(0.002)	0.015**	(0.003)
Slovakia	−0.005	(0.005)	0.008	(0.007)	0.004	(0.005)	−0.002	(0.004)
Spain	−0.008	(0.004)	−0.077**	(0.016)				

Note: ** and * denote statistical significance levels at 1% and 5%, respectively
* Constant and other control variables are omitted
* OLS: robust standard error used, control variables: D.log disposable income per capita, D. trade openness, deposit interest rate
* FMOLS: Long-run covariance estimates: Bartlett kernel, Newey-West fixed bandwidth, d. f. adjustment, one-year lag is used for Johansen test, control variables: linear trend, log disposable income per capita, trade openness

the increase in trend of union density in Spain can generate a strong correlation between union density and GDP or investment, which might affect the estimation results for GDP and investment.

VI. Conclusion

This study investigates the long-term relationship between labor market institutions and macroeconomic variables, such as inequality, investment, growth, and consumption. Previous studies on wage-led growth have tested the effect of wage share on growth by using time series techniques (Onaran and Galanis 2012; Onaran and Obst 2016). However, given that wage share is not a policy variable, how the policies from wage-led growth theory function in practice remains unknown. Meanwhile, this study tests the effect of minimum wage and union density, which are representative policies for wage-led growth, to show the long-term effects. In addition, this study applies improved econometric methods to analyze the long-term effects using panel cointegration approach.

The estimation results provide weak support for the argument of wage-led growth strategy. Minimum wage and union density are not robustly correlated to any macroeconomic outcomes in the long run. When country-by-country estimations are used, a small number of countries show significant correlation between labor market institutions and GDP, investment, or consumption.

Various reasons may explain why minimum wage is not robustly correlated to consumption in the long run. First, increasing the minimum wage may decrease employment or working hours per employee (Bazen and Marimoutou 2002; Burkhauser *et al.* 2000; Stewart and Swaffield 2002, 2008). Increased minimum wage may have a negative effect on employment because employers can adjust labor easily by adopting new technologies or increasing the capital-labor ratio in the long-run. If an increase in minimum wage cannot drive an increase in wage share by reducing employment or working hours per employee, then the main channel for wage-led growth does not work. This finding is in line with the estimation results for the effect of minimum wage on labor income share because these variables have no cointegration relationship, as shown in Table 4. This finding can also explain why minimum wage is insignificant to private consumption for most of countries in the Table 7.

Second, the effect of minimum wage on labor income share can be minimal even if the increase in minimum wage drives an increase in labor income share because a small share of workers in total employment is affected by minimum wage. The share of workers

affected by minimum wage in total employment is less than 20% at most because minimum wage relative to median wage is less than two thirds at most and the self-employed is not covered by minimum wage.[13] Thus, the share of wage for affected workers in the total GDP tends to be small and can minimize the effect of minimum wage on labor income share even if minimum wage does not affect the employment and working hours per employee.[14]

The same reasons may explain why minimum wage is not robustly correlated to investment in the long run. However, in this study, minimum wage has an economy-wide effect on investment, and this effect may be highly robust for those firms or sectors that heavily depend on low-wage labor (*i.e.*, small firms, retailers, or restaurants).

Similar reasons may also explain why union density is not robustly correlated to investment in the long run. Nickell and Layard (1999) stated that the establishment of a cooperative relationship between union and management may be a more important factor for investment and productivity than the simple density of union.

In sum, these estimation results suggest that minimum wage and union density may not be good policy instruments for equality and growth in the long run and that wage-led growth theory may not have a strong empirical basis. Furthermore, estimation results in Table 5 suggest that the effect of minimum wage on GDP tends to be negative for countries that have a high share of self-employment, such as Greece, Korea, and Poland.

Nevertheless, the criticisms directed toward wage-led growth theory lack strong empirical basis because the negative effect of minimum

[13] For example, the share of workers affected by minimum wage in total employment in Korea gradually increased from 0.65% in 2001 to 13% in 2016. In the US, the share is between 1.15% and 7.54% from 1979 to 2014 (U.S. Bureau of Labor Statistics 2017). OECD (2015) also showed that the share is less than 15% in all 20 OECD countries in 2010.

[14] The ratio of minimum wage to median wage is 48% on average in the 26 OECD countries where data from 1970 are available. Therefore, the share of wage for affected workers in the total labor income is likely to be less than 10% because the share of workers affected by minimum wage in the total number of employees is less than 20% at most. Furthermore, the share of adjusted wage in the total GDP is 64% on average in 31 OECD countries since 1970, which means that the share of wage for affected workers in the total GDP is likely to be less than 6.4%.

wage and union density on investment and GDP is not robust.

Many governments and scholars have recently shown interest in wage-led growth theory and minimum wage, but the results of this study imply that the policy instruments for simultaneously achieving long-term equality and growth are difficult to find.

However, given that this study focuses on the long-term effect of labor market institutions, an increase in minimum wage or union density may possibly lead to an increase in GDP in the short run similar to other Keynesian effective demand policies.

This study uses OECD country data from the 1970s, but additional countries or time series data must be considered in future studies to conduct a further powerful panel cointegration analysis. Research using micro-data, such as firm or individual data, can also be conducted to understand the effect of labor market institutions in detail.

Appendix

1. Results of PURT for Selected Variables

Appendix Table 1

PURT for Growth Rates of GDP per Capita, Gross Capital Formation (GCF, % Of GDP), Inflation, and Log Real Hourly Minimum Wage (PPP, 2015 US$)

Variables \ Test	IPS	Pesaran (2007)			IPS	Pesaran (2007)			Pesaran (2004) CD test
		lags = 0	lags = 1	lags = 2		lags = 0	lags = 1	lags = 2	
	With intercept				With intercept and trend				
GDP growth	−19** (0.000)	−15.4** (0.000)	−9.6** (0.000)	−4.5** (0.000)	−16.2** (0.000)	−13.6** (0.000)	−8.2** (0.000)	−2.8** (0.000)	32.28** (0.000)
GCF	−4.9** (0.000)	−2.81** (0.002)	−3.98** (0.000)	−1.34 (0.091)	−4.8** (0.000)	−1.79* (0.037)	−2.9** (0.002)	−0.3 (0.381)	29.5** (0.000)
Inflation	−7.6** (0.000)	−6.19** (0.000)	−4.67** (0.000)	−3.03** (0.001)	−7.6** (0.000)	−4.78** (0.000)	−2.89** (0.002)	−1.27 (0.102)	57.93** (0.000)
Log real hourly minimum wage	−0.01 (0.494)	−3.48** (0.000)	−2.82** (0.002)	−2.04* (0.02)	−2.4** (0.008)	−3.1** (0.001)	−4.29** (0.000)	−2.3** (0.01)	3.21** (0.001)

Note: ** and * denote statistical significance levels at 1% and 5%, respectively

* Data: GDP growth, GCF: 34 countries, 1970-2007, inflation: 27 countries, 1975-2010, real hourly minimum wage: 8 countries, 1970-2007

* p-value is in the parenthesis

* Null hypothesis: variable is non-stationary

* IPS: lag length selection based on SIC, maximum lag length is observation-based, Newey-West automatic bandwidth selection and Bartlett kernel

2. Results of GMM Estimation

APPENDIX TABLE 2
RESULTS OF GMM ESTIMATION

Dependent variable	Top 10% income share		Adjusted wage share		GCF		GDP growth		Private consumption share (% of GDP)	
Variable	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
Minimum wage	−0.209**	0.003	0.085	0.444	−0.096**	0.008	0.013	0.491	0.095	0.146
Union density	−0.101	0.213	0.002	0.983	0.032	0.458	−0.029	0.110	0.081	0.162
Trade openness	0.009	0.812	−0.027	0.435	−0.005	0.747	0.015**	0.000	−0.093**	0.000
Tertiary enrolment ratio	0.073	0.070	−0.030	0.762	-	-	−0.001	0.917	-	-
ICT compensation	0.335	0.433	0.605	0.086	-	-	-	-	-	-
Saving rate	-	-	-	-	0.414**	0.000	-	-	-	-
Lending interest rate	-	-	-	-	−0.048*	0.018	-	-	-	-
Deposit interest rate	-	-	-	-			-	-	0.185**	0.000
Central government debt	-	-	-	-	−0.029	0.069	-	-	-	-
Inflation	-	-	-	-	0.249**	0.002	-	-	-	-
GDP growth	-	-	-	-	0.743*	0.018	-	-	0.357	0.321
Log triadic patent stock per million	-	-	-	-	-	-	0.275	0.109	-	-
GCF	-	-	-	-	-	-	0.142**	0.002	-	-
Lag of log GDP per capita	-	-	-	-	-	-	−2.462*	0.016	-	-
Number of observations	42		55		73		105		116	
Number of countries	9		11		22		24		24	
Number of periods per country	4.67		5		3.3		4.4		4.8	
AR (2)	0.291		0.391		0.403		0.332		0.488	
Sargan p-value	0.000		0.000		0.000		0.001		0.000	

Note: ** and * denote statistical significance levels at 1% and 5%, respectively
* Five-year average data is used. Averaging is applied if at least three observations on a country are within a certain period
* Constant and period dummies are omitted
* Robust standard error is used
* One-step system GMM estimator used

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References

Addison, John T. and Barry T. Hirsch. "Union Effects on Productivity, Profits, and Growth: Has the Long Run Arrived?" *Journal of Labor Economics* 7 (No. 1 1989): 72-105.

AMECO Database. Available at https://ec.europa.eu/info/business-economy-euro/indicators-statistics/economic-databases/macro-economic-database-ameco/ameco-database_en.

Andrea Garnero (OECD). Minimum Wages across OECD and EU Countries, Mutual Learning Programme-Learning Exchange, Minimum Wages in the Framework of Collective Bargaining Systems, Presented on September 11, 2015, Power Point.

Askenazy, Philippe. "Minimum Wage, Exports and Growth." *European Economic Review* 47 (No. 1 2003): 147-164.

Bazen, Stephen and Velayoudom Marimoutou. "Looking for a Needle in a Haystack? A Re-examination of the Time Series Relationship between Teenage Employment and Minimum Wages in the United States." *Oxford Bulletin of Economics and Statistics* 64 supplement (2002): 699-725.

Beck, Thorsten and Ross Levine. "Stock Markets, Banks, and Growth: Panel Evidence." *Journal of Banking & Finance* 28 (No. 3 2004): 423-442.

Beck, Thorsten, Asli Demirguc-Kunt, and Ross Levine. Finance, Inequality, and Poverty: Cross-country Evidence. National Bureau of Economic Research No. w10979, 2004.

Bun, Maurice JG and Frank Windmeijer. "The Weak Instrument Problem of the System GMM Estimator in Dynamic Panel Data Models." *The Econometrics Journal* 13 (No. 1 2010): 95-126.

Burkhauser, Richard V., Kenneth A. Couch, and David C. Wittenburg. "A Reassessment of the New Economics of the Minimum Wage Literature with Monthly Data from the Current Population Survey." *Journal of Labor Economics* 18 (No. 4 2000): 653-680.

Cahuc, Pierre and Philippe Michel. "Minimum Wage Unemployment and Growth." *European Economic Review* 40 (No. 7 1996): 1463-1482.

Card, David. "Using Regional Variation in Wages to Measure the Effects of the Federal Minimum Wage." *ILR Review* 46 (No. 1 1992): 22-37.

_____. "The Effect of Unions on Wage Inequality in the US Labor Market." *ILR Review* 54 (No. 2 2001): 296-315.

Card, David and Alan B. Krueger. "Minimum Wages and Employment: A Case Study of the Fast Food Industry in New Jersey and Pennsylvania." *The American Economic Review* 84 (No. 4 1994): 772-793.

_____. *Myth and Measurement*. Princeton, New Jersey: Princeton University Press, 1995.

_____. "Minimum Wages and Employment: A Case Study of the Fast-Food Industry in New Jersey and Pennsylvania: Reply." *The American Economic Review* 90 (No. 5 2000): 1397-1420.

Clarke, G., L.C. Xu, and H. Zou. "Finance and Income Inequality: Test of Alternative Theories." *Annals of Economics and Finance* 14-2(A) (2013): 493-510.

Croucher, Richard and Marian Rizov. "The Impact of the National Minimum Wage on Labour Productivity in Britain." *E-Journal of International and Comparative Labour Studies* 1 (Nos. 3-4 2012): 263-289.

Davis, L. E. The Financialization of the Nonfinancial Corporation in the Post-1970 U.S. Economy. University of Massachusetts, Amherst, 2014, Ph.D. Dissertation.

Denny, Kevin and Stephen J. Nickell. "Unions and Investment in British Industry." *The Economic Journal* 102 (No. 413 1992): 874-887.

Draca, Mirko, Stephen Machin, and John Van Reenen. "Minimum Wages and Firm Profitability." *American Economic Journal: Applied Economics* 3 (No. 1 2011): 129-151.

EU-KLEMS Database, November 2009 release. Available at www.euklems.net/euk09i.shtml.

European Commission. "The Labour Income Share in the European Union." *Employment in Europe*. Chapter 5, 2007.

Fanti, Luciano and Luca Gori. "On Economic Growth and Minimum Wages." *Journal of Economics* 103 (No. 1 2011): 59-82.

Fernie, Sue and David Metcalf. "Participation, Contingent Pay, Representation and Workplace Performance: Evidence from Great Britain." *British Journal of Industrial Relations* 33 (No. 3 1995): 379-415.

Forth, John and Mary O'Mahony. *The Impact of the National Minimum Wage on Labour Productivity and Unit Labour Costs*. London: National Institute of Economic and Social Research, 2003.

Godechot, Olivier. "Is Finance Responsible for the Rise in Wage Inequality in France?" *Socio-Economic Review* 10 (No. 3 2012):

447-470.

Hacker, Jacob S. and Paul Pierson. "Winner-take-all Politics: Public Policy, Political Organization, and the Precipitous Rise of Top Incomes in the United States." *Politics & Society* 38 (No. 2 2010): 152-204.

Hosono, Kaoru, Miho Takizawa, and Kotaro Tsuru. "The Impact of Demand Shock on the Employment of Temporary Agency Workers: Evidence from Japan during the Global Financial Crisis." *Seoul Journal of Economics* 28 (No. 3 2015): 265-284.

Im, Kyung So, M. Hashem Pesaran, and Yongcheol Shin. "Testing for Unit Roots in Heterogeneous Panels." *Journal of Econometrics* 115 (No. 1 2003): 53-74.

IMF. "World Economic Outlook." *The Globalization of Labor*. Chapter 5, Washington, D.C., IMF, 2007.

_____. *Making Public Investment More Efficient.* Washington, D.C., IMF, 2015.

King, Robert G. and Ross Levine. "Finance and Growth: Schumpeter Might Be Right." *The Quarterly Journal of Economics* 108 (No. 3 1993): 717-737.

Kus, Basak. "Financialisation and Income Inequality in OECD Nations: 1995-2007." *The Economic and Social Review* 43 (No. 4 2012): 477-495.

Kuznets, Simon. "Economic Growth and Income Inequality." *The American Economic Review* 45 (No. 1 1955): 1-28.

La Porta, Rafael, Florencio Lopez-de-Silanes, and Andrei Shleifer. "Government Ownership of Banks." *The Journal of Finance* 57 (No. 1 2002): 265-301.

Lavoie, Marc and Engelbert Stockhammer. "Wage-led Growth: Concept, Theories and Policies." *ILO Condition of Work and Employment Series No. XX* (2012): 1-42.

Lee, Jungmin and Seungjin Hwang. "The Effect of the Minimum Wage on Employment in Korea." *Korean Journal of Labor Economics* 39 (No. 2 2016): 1-34. (in Korean)

Levine, Ross and Sara Zervos. "Stock Markets, Banks, and Economic Growth." *American Economic Review* 88 (No. 3 1998): 537-558.

Levine, Ross, Norman Loayza, and Thorsten Beck. "Financial Intermediation and Growth: Causality and Causes." *Journal of Monetary Economics* 46 (No. 1 2000): 31-77.

Levine, Ross. "Finance and Growth: Theory and Evidence." In Philippe

Aghion and Steven Durlauf (eds.), *Handbook of Economic Growth.* Chapter 12, Vol. 1, Elsevier, pp. 865-934, 2005.

Lin, Ken-Hou and Donald Tomaskovic-Devey. "Financialization and US Income Inequality, 1970-2008." *American Journal of Sociology* 118 (No. 5 2013): 1284-1329.

Metcalf, David. "Why Has the British National Minimum Wage Had Little or No Impact on Employment?" *Journal of Industrial Relations* 50 (No. 3 2008): 489-512.

Ndikumana, Leonce. "Financial Determinants of Domestic Investment in Sub-Saharan Africa: Evidence from Panel Data." *World Development* 28 (No. 2 2000): 381-400.

Nickell, Stephen and Richard Layard. "Labor Market Institutions and Economic Performance." *Handbook of Labor Economics* 3 (1999): 3029-3084.

OECD. *Structural Analysis* (*STAN*) *Database* (ISIC Rev. 3). Available at https://stats.oecd.org/Index.aspx?DataSetCode=STAN08BIS.

OECD. *Statistics*. Available at stats.oecd.org/.

OECD. Minimum Wages across OECD and EU Countries, "Mutual Learning Programme - Learning Exchange 'Minimum Wages in the Framework of Collective Bargaining Systems'," Presented on September 11, 2015.

Onaran, Özlem and Giorgos Galanis. "Is Aggregate Demand Wage-led or Profit-led? National and Global Effects." *ILO Conditions of Work and Employment Series* 31, 2012.

Onaran, Ozlem and Thomas Obst. "Wage-led Growth in the EU15 Member-states: The Effects of Income Distribution on Growth, Investment, Trade Balance and Inflation." *Cambridge Journal of Economics* 40 (No. 6 2016): 1517-1551.

Orhangazi, Özgür. "Financialisation and Capital Accumulation in the Non-financial Corporate Sector: A Theoretical and Empirical Investigation on the US Economy: 1973-2003." *Cambridge Journal of Economics* 32 (No. 6 2008): 863-886.

Pedroni, Peter. Panel Cointegration; Asymptotic and Finite Sample Properties of Pooled Time Series Tests, with an Application to the PPP Hypothesis. Indiana University Working Papers in Economics No. 95-013, 1995.

_____. "Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors." *Oxford Bulletin of Economics and Statistics* 61 (No. S1 1999): 653-670.

_____. "Fully Modified OLS for Heterogeneous Cointegrated Panels." In Badi H. Baltagi, Thomas B. Fomby, R. Carter Hill (eds.), *Nonstationary Panels, Panel Cointegration, and Dynamic Panels*. Emerald Group Publishing Limited, pp. 93-130, 2001a.

_____. "Purchasing Power Parity Tests in Cointegrated Panels." *Review of Economics and Statistics* 83 (No. 4 2001b): 727-731.

_____. "Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the PPP Hypothesis." *Econometric Theory* 20 (No. 3 2004): 597-625.

_____. "Social Capital, Barriers to Production and Capital Shares: Implications for the Importance of Parameter Heterogeneity from a Nonstationary Panel Approach." *Journal of Applied Econometrics* 22 (No. 2 2007): 429-451.

Penn World Table 9.0 Database. Available at https://www.rug.nl/ggdc/productivity/pwt/.

Pesaran, M. Hashem. General Diagnostic Tests for Cross Section Dependence in Panels. IZA Discussion Paper 1240, 2004.

_____. "A Simple Panel Unit Root Test in the Presence of Cross-section Dependence." *Journal of Applied Econometrics* 22 (No. 2 2007): 265-312.

Phillips, Peter CB and Bruce E. Hansen. "Statistical Inference in Instrumental Variables Regression with I (1) Processes." *The Review of Economic Studies* 57 (No. 1 1990): 99-125.

Rama, Martin. "The Consequences of Doubling the Minimum Wage: The Case of Indonesia." *ILR Review* 54 (No. 4 2001): 864-881.

Riley, Rebecca and C. Rosazza Bondibene. Raising the Standard: Minimum Wages and Productivity. NIESR Discussion Paper 449, 2015.

Sabia, Joseph J., Richard V. Burkhauser, and Benjamin Hansen. "Are the Effects of Minimum Wage Increases Always Small? New Evidence from a Case Study of New York State." *ILR Review* 65 (No. 2 2012): 350-376.

Shin, Hochul and Keun Lee. "Impact of Financialization and Financial Development on Inequality: Panel Cointegration Results Using OECD Data." *Asian Economic Papers,* forthcoming, 2019.

Skott, Peter. "Weaknesses of 'Wage-led Growth'." *Review of Keynesian Economics* 5 (No. 3 2017): 336-359.

Stewart, Mark B. and Joanna K. Swaffield. "Using the BHPS Wave 9 Additional Questions to Evaluate the Impact of the National

Minimum Wage." *Oxford Bulletin of Economics and Statistics* 64 supplement (2002): 633-652.

_____. "The Other Margin: Do Minimum Wages Cause Working Hours Adjustments for Low-wage Workers?" *Economica* 75 (No. 297 2008): 148-167.

Stockhammer, Engelbert. "Financialisation and the Slowdown of Accumulation." *Cambridge Journal of Economics* 28 (No. 5 2004): 719-741.

_____. "Why Have Wage Shares Fallen." *ILO Conditions of Work and Employment Series* 35, 2013.

Stockhammer, Engelbert and Ozlem Onaran. "Wage-led Growth: Theory, Evidence, Policy." *Review of Keynesian Economics* 1 (No. 1 2013): 61-78.

U.S. Bureau of Labor Statistics, BLS Reports, 2017.

Volscho, Thomas W. and Nathan J. Kelly. "The Rise of the Super-rich Power Resources, Taxes, Financial Markets, and the Dynamics of the Top 1 Percent, 1949 to 2008." *American Sociological Review* 77 (No. 5 2012): 679-699.

Worldbank Database. Available at https://data.worldbank.org/.

World Income Inequality Database 3.3. Available at https://www.wider.unu.edu/project/wiid-world-income-inequality-database.

World Wealth and Income Database. Available at http://wid.world/data/.