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AN ECONOMETRIC ANALYSIS OF THE IMPACT OF REAL WAGES ON ECONOMIC GROWTH IN OECD COUNTRIES USING THE ARDL-PMG MODEL (2002-2022)

EKONOMETRYCZNA ANALIZA WPŁYWU PŁAC REALNYCH NA WZROST GOSPODARCZY W KRAJACH OECD Z WYKORZYSTANIEM MODELU ARDL-PMG (2002-2022)

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B. Data collection/ Zebranie danych
C. Statistical analysis/ Analiza statystyczna
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Abstract

Subject and purpose of work: This study aimed to analyze the impact of real wages, human capital, and public expenditure as a percentage of Gross Domestic Product (GDP) on economic growth in six Organization for Economic Co-operation and Development (OECD) countries over the period (2002-2022).

Materials and methods: The Panel ARDL model using PMG estimation was employed to test short- and long-term relationships among the variables.

Results: It was found that real wages have a negative and significant impact on long-term economic growth, while human capital has a positive and significant impact. Public expenditure as a percentage of GDP showed a negative but insignificant impact in the long term.

Conclusions: The studies' results show that real wages have a prominent role in determining the economic growth rate within the OECD countries. Moreover, the research reveals that the governmental expenditure is a very important factor in stimulating the economic growth.

Keywords: Real wages, Human capital, Public expenditure, Economic growth, Panel ARDL

Streszczenie

Przedmiot i cel pracy: Niniejsze badanie miało na celu analizę wpływu realnych płac, kapitału ludzkiego oraz wydatków publicznych jako procentu Produktu Krajowego Brutto (PKB) na wzrost gospodarczy w sześciu krajach Organizacji Współpracy Gospodarczej i Rozwoju (OECD) w latach 2002-2022.

Materiały i metody: Zastosowano model Panel ARDL z estymacją PMG w celu zbadania krótkookresowych i długookresowych zależności między zmiennymi.

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Wyniki: Stwierdzono, że realne płace mają negatywny i istotny wpływ na długookresowy wzrost gospodarczy, podczas gdy kapitał ludzki wykazuje pozytywny i istotny efekt. Wydatki publiczne jako procent PKB miały negatywny, ale nieistotny wpływ w długim okresie.
Wnioski: Wyniki badania pokazują, że realne płace odgrywają istotną rolę w kształtowaniu tempa wzrostu gospodarczego w krajach OECD. Ponadto badanie wskazuje, że wydatki rządowe są istotnym czynnikiem stymulującym wzrost gospodarczy.

Słowa kluczowe: realne płace, kapitał ludzki, wydatki publiczne, wzrost gospodarczy, Panel ARDL

Introduction

The relationship between real wages and economic growth is an important and vital topic as it occupies a large space in economic studies. Real wages are "the purchasing power of workers' wages in terms of goods and services. It is measured as the ratio of the money wage rate to the consumer price index" (Paul A, William D, 2010). That is, the actual value of wages after considering the effect of inflation. Studying this relationship allows us to shed light on the role of real wages as a key element in stimulating aggregate demand. Some studies, such as that conducted by Keynes (1936), indicate that rising real wages enhance consumption expenditure, leading to increased aggregate demand. It provides a deep understanding of the relationship between changes in wages and consumption tendencies. He pointed out that effective demand is the key to stimulating employment and economic activity. The theory emphasizes that the change in real wages has direct and indirect effects on consumption. When real wages rise, individuals' purchasing power increases, motivating them to consume more goods and services, which in turn boosts aggregate demand. Conversely, when real wages decline, purchasing power decreases, leading to reduced consumption. Since the rate of consumption growth is usually lower than income growth because part of this income is saved, the increase in disposable income promotes consumption, contributing to driving economic growth (Krugman, Obstfeld , 2002).The role of real wages in enhancing productivity is due to their close relationship. Productivity reflects how efficiently inputs are converted into outputs. Skilled or highly productive workers receive higher wages because they contribute more to the overall output of the establishments they work for, and the opposite is true for less productive workers (Mankiw N. G., 2020). Referring to the ideas of the neoclassical school supported by Mankiw, it is said that increasing productivity is necessary to increase real wages, as it can offset the effects of inflation.

Real wages express workers' purchasing power, making them a key factor in boosting economic growth and increasing aggregate demand for goods and services. Higher real wages stimulate productivity and investment in human capital, enhancing long-term economic growth. On the other hand, the effect of economic growth on real wages occurs when productivity and employment rates grow, especially when technological advancements and improved worker skills are used (Acemoglu, Autor, 2011). Borjas (2020) noted that investing in education and skill development directly increases real wages, thus improving income distribution and promoting sustainable economic growth. It is worth noting that inflation, when rising, erodes real wages if nominal wages do not keep pace with rising prices. This issue is prevalent in emerging economies (OECD, 2025). On the other hand, growth in real wages contributes to increased local consumption, stimulating economic growth, as happened in China in the past decade (Krugman, Obstfeld, 2002). Additionally, higher wages enhance social stability by reducing income disparities within society (Piketty, 2014). Government policies play a role in the relationship between real wages and economic growth, such as setting minimum wages and taxes, which can improve wage values but increase labor costs (Blanchard, Katz, 1997). External factors such as international competition and technology affect companies' ability to raise wages, making this relationship dynamic and complex (Acemoglu, Autor, 2011). Lastly, some studies suggest that job motivation resulting from higher wages increases productivity rates and boosts economic growth (Pfeffer, 1998). Thus, it can be said that the relationship between real wages and economic growth is reciprocal and complex, influenced by internal factors like government policies and external factors like technology and international competition. This makes it a key factor in achieving sustainable growth and economic welfare.

The OECD countries provide an ideal environment for studying this relationship due to the diversity of their economic systems and varying levels of development. The organization was established in 1961 (OECD, 2025) and includes both developed and emerging countries, allowing us to explore different and diverse economic policies to analyze the impact of these policies on the nature of the relationship between real wages and economic growth. In this context, this study seeks to explore the impact of real wages on economic growth in a selected group of OECD countries, namely Brazil, South Korea, the United States, France, Japan, and Mexico, focusing on determining the impact in both the short and long term. By referring to previous studies, we notice that wages (whether minimum or real) play a crucial and decisive role in economic growth through their direct impact or by improving human capital, productivity, and income distribution. Despite this, there is a clear difference in the effects of economic policies related to wages depending on the economic context (open or closed economy) and the growth rate. We also note from these previous studies that investment in human capital is a key and vital variable in raising development rates.

Despite this general agreement among studies, they differed in their focus, with each study concentrating on a particular aspect of the relationship between wages and growth. Some focused on the relationship between minimum wages and growth in open economies, while other studies focused on the local effects of wages such as poverty and unemployment. Some studies have examined the varying impacts of wages in developed economies, such as the study related to the G7 industrialized countries, which studied the nature of the relationship between wages and productivity. The research gap lies in the scarcity of studies linking real wages and economic growth in developing countries compared to developed ones, and the lack of focus on the interaction between wages and investment in technology and innovation in those economies. We observed that most studies used the analytical approach with little use of econometric methods, relying on well-known econometric models such as ARDL or VAR. This study aims to fill the research gaps by using the Panel ARDL model to analyze the nature of the relationship between wages and economic growth, along with investment and government expenditure, in both developed and emerging countries. Additionally, it will compare countries with different development levels, such as Brazil and the United States.

Literature review and hypothesis development

Researchers and economic policymakers have increasingly focused on analyzing the relationship between real wages and economic growth due to its importance in improving the living standards and well-being of individuals (Mankiw, Romer, Weil, 1992) . Due to this importance, it has received considerable attention in the economic literature, with many studies and research conducted to understand and explore the impact of wages on economic growth in both developed and emerging countries (Askenazy, 2003). Mankiw, Romer, Weil. (1992) studied and examined the role of wages as a stimulus for investment in human capital, one of the main factors contributing to enhancing economic growth. This study relied on the classical economic growth model (Solow, 1956), adding the human capital variable. The study's key findings indicate that higher wages are positively correlated with investment in education and training, meaning skilled labor receives higher wages, which in turn contributes to enhancing economic growth in the long term. The study also showed that adding human capital to the Solow model improved its ability to explain differences in economic growth rates among countries. Based on the endogenous growth theory, Askenazy (2003) analyzed the impact of minimum wages on economic growth within an open economy framework. The results showed that the relationship between growth and minimum wages was positive when minimum wages were linked to exports. The study provided evidence that minimum wages in the context of economic openness might contribute to increasing economic growth by up to 0.2% annually. In another study, Wakeford (2004) investigated the relationship between real productivity, real wages, and unemployment rates in South Africa. The results showed a long-term relationship between real productivity and real wages. The study recommended enhancing economic efficiency without causing significant harm to employment to ensure sustainable economic and social growth.

Sonmez, Smithin (2006) analyzed the relationship between real wages, labor productivity, and economic growth in G7 countries from 1960 to 2002. One of the key findings of the study is that there is a clear

positive relationship between real wages and economic growth in some countries, while it is less evident in others. The study also recommended that economic policies related to minimum wages should consider the cyclical nature of economic growth to ensure a clear and positive impact of wages on economic development. In another study, Marques (2008) analyzed wage and price dynamics in the Portuguese economy. The results showed that real wages respond relatively slowly to import price shocks due to wage adjustment rigidities. The findings also indicated high elasticity of real wages to unemployment shocks, suggesting a rapid response in the labor market to address these shocks. Pfister, Riedel, Uebele (2012). analyzed the relationship between real wages and population size in Germany from 1500 to 1850. The results showed that the relationship between population size and real wages was negative until the mid-17th century, but it became less evident in the 18th century. The study also confirmed that demographic and economic factors have a significant impact on real wages.

Abd Karim, Chan, Hassan. (2016) analyzed the impact of minimum wage policy on the technical efficiency of the economy. The results showed that the presence of a minimum wage policy does not necessarily lead to a decline in the technical efficiency of the economy. The study also recommended that the minimum wage should be moderate to ensure an increase in technical efficiency. Dritsaki (2016) presented an analytical study on Bulgaria and Romania, and concluded that real wages are one of the main factors that affect labor productivity, more than inflation, which underscores the importance of adopting policies that improve wage levels to enhance economic performance. As for Cruz (2019), he conducted a comprehensive study on 25 economies from the Organization for Economic Co-operation and Development (OECD) countries during the period 1960-2019, where the results proved the existence of a two-way causal relationship between real wages and labor productivity, with a negative short-term impact on employment, which reflects The complexity of the relationship between wages and economic growth. From a long-term historical perspective, Bengtsson and Stockhammer (2021) analyzed the evolution of wage distribution and growth in Scandinavian countries during the period 1900-2010, showing a weak positive relationship, especially after World War II, supported by Keynesian economics models and the Rehn-Meidner model, reflecting the importance of wages in Supporting productivity. Przekota et al. (2023) concluded that labor compensation frequently follows economic growth instead of preceding it, suggesting that growth is the primary cause of wage increases rather than the other way around. This demands a re-examination of wage-based policies. a tool to stimulate growth.

Based on the aforementioned reasons and arguments, the following hypotheses have been formulated:
H_1. There is a positive impact of real wages on economic growth in the long term;
H_2. There is a positive impact of human capital on economic growth in the long term;
$H_{3.}$ There is an impact of public expenditure as a percentage of GDP on economic growth in the long term;
H_4. The impact of real wages on economic growth differs among countries.

Study methodology

The study focuses on six OECD countries: Brazil, South Korea, the United States, France, Japan, and Mexico. These countries were selected based on the availability of trustworthy data on the studied variables during the study period. Furthermore, these countries reflect significant economic diversity (developed and emerging countries), allowing for a comparative investigation of the impact of real wages on economic growth in various economic contexts.

The study attempts to measure the impact of real wages on economic growth for the period from 2002 to 2022. This period was chosen because it represents a sufficient time frame to analyze short- and long-term dynamics, covering major and diverse economic events such as financial crises (the global financial crisis of 2008 and the impact of the COVID-19 pandemic). Real wages data was collected from the OECD database, while the World Bank database was used to source data on economic growth and additional macroeconomic factors, including human capital and government expenditure. Given the characteristics of the data and the diversity in development levels between selected countries, the Autoregressive Distributed Lag (ARDL) model in the Pooled Mean Group (PMG) framework, proposed by Pesaran et al. (1999), was adopted.

Measuring the impact of real wages

In this study, the growth rate of real wages was used as an independent variable (Sonmez & Smithin, 2006) (Robalo Marques, 2008).
According to Economics, CORE. (2025), Real wages is calculated using the following formula:

$$\textbf{real wage rate} = \frac{\textbf{Nominal wage rate in current year}}{\textbf{CPI in current year}} \textbf{ x 100}$$

Where:
Nominal Wages: The cash amount received by an individual before adjusting for inflation.
Consumer Price Index: A measure reflecting the average change in price level of goods and services over time.

The dependent variable THAT WE used was the economic growth rate (Mankiw, Romer, Weil, 1992; Askenazy, 2003; Sonmez, Smithin, 2006). To determine the actual impact of the independent variable on the dependent variable, control variables were used to isolate external influences, improve estimate accuracy, reduce bias, and increase the explanatory power of the model. These control variables include the growth rate of human capital (Mankiw, Romer, Weil, 1992) and the government expenditure rate (using public expenditures as a percentage of GDP) (Shkodra, Krasniqi, Ahmeti, 2022).

Table 1 - Variables definition and descriptive statistics

Variable Name	Definition	Source	Obss	Mean	Median	Max	Min	Std, Dev,
GDP	Economic Growth Rate (% Annual)	World Data Bank	126	1.87	2.10	7.73	-8.62	2.67
RW	Real Wage Growth Rate (% Annual)	OECD	126	2.14	1.04	16.04	-7.41	3.99
GDI	Gross Fixed Capital Formation (% Annual Growth)	World Data Bank	126	1.85	2.24	17.85	-17.30	5.30
DAB	Total National Expenditure (% of GDP)	World Data Bank	126	100.98	100.91	107.32	93.15	2.96

Source: Own elaboration based on data from (World Bank Group, 2024), (OCED, 2024).

Before delving into the econometric study, a simple descriptive analysis of the study variables is conducted, and the results are shown in Table 1 for descriptive statistics, and Table 2 for correlation matrix.
According to the results presented in Table 1., we notice that the average growth rate of real wages was 2.14%, which is higher than the average economic growth rate of 1.87%. This indicates that real wages are growing at a relatively faster rate than economic growth in the studied countries. The results also show significant variability in real wage growth rates, with a standard deviation of 3.99, which can be attributed to the role of real wages in economic activity fluctuations. Observing the minimum and maximum boundaries, we notice that the minimum real wage growth rate (-7.41%) coincided with a decline in economic growth (-8.62%), which may suggest a positive relationship between the variables. However, the maximum real wage growth rate (16.04%) did not directly reflect the maximum economic growth rate (7.73%), indicating that other factors may affect the relationship between real wages and economic growth, such as productivity, inflation, or changes in capital formation.

Table 2. Correlation Matrix

	GDP	RW	GDI	DAB
GDP	1	-0.01595	0.81348	-0.11743
RW	-0.01595	1	-0.15662	-0.37357
GDI	0.81348	-0.15662	1	-0.05465
DAB	-0.11743	-0.37357	-0.05465	1

Source: Own elaboration based on outputs from EVIEWS13 software.

Based on the results shown in Table 2, there is a weak relationship between RW and GDP, with a correlation coefficient of -0.016. This shows that improving GDP does not always equal improving RW. In contrast, GDP and GDI are tightly associated, with a coefficient correlation of 0.813. However, the association between GDI and RW is weak and negative, with a coefficient correlation of -0.157. While DAB is adversely associated with RW with a coefficient correlation of (-0.374), increasing DAB does not always increase RW.

Study model: Panel ARDL using PMG (Pesaran, Shin, Smith, 1999)

The Panel ARDL model is a powerful tool used to analyze time-related economic relationships due to its features that make it suitable for econometric studies. Among these features, it can handle temporal dynamics by estimating short- and long-term effects between variables, helping us understand the relationship between real wages and economic growth (Pesaran, Shin, Smith, 1999).The model can handle time series that contain a mix of level-stationary I(0) and first-difference stationary I(1), without requiring all variables to be stationary at the same degree (Chudik, Pesaran, 2015).One of the advantages of this model is its flexibility in dealing with homogeneous and heterogeneous data. It allows the use of the PMG (Pooled Mean Group) method, which enables the estimation of common long-term coefficients among countries while allowing short-term effects to vary between different countries. This makes it suitable for multi-country studies. Given that the study period covers 21 years (2002-2022), applying the Panel ARDL model helps capture long-term changes in the studied relationship, increasing the accuracy of analysis and conclusions. Therefore, the study model will be as follows: Formulation of the mathematical model:

$$\Delta GDP_{it} = \lambda_i\left(GDP_{i,t-1} - \beta_{1i}RW_{i,t-1} - \beta_0 - \beta_{2i}GDI_{i,t-1} - \beta_{3i}DAB_{i,t-1}\right) + \sum_{j=1}^{p} \phi_{ij}\,\Delta GDP_{i,t-j}$$

$$+ \sum_{k=0}^{q1} \theta_{1ik}\,\Delta RW_{i,t-k} + \sum_{l=0}^{q2} \theta_{2il}\,\Delta GDI_{i,t-l} + \sum_{m=0}^{q3} \theta_{3im}\,\Delta DAB_{i,t-m} + \varepsilon_t$$

Where:

Δ denotes the first difference operator, $\boldsymbol{\beta_1}$ represents country-specific fixed effects, $\boldsymbol{\lambda_i}$ is the error correction term coefficient, indicating the speed of adjustment to long-run equilibrium;

$\boldsymbol{\beta_{1i}}$,$\boldsymbol{\beta_{2i}}$,$\boldsymbol{\beta_{3i}}$ are the long-run coefficients for RW, GDI, and DAB, respectively;

$\boldsymbol{\Phi_{ij}}$ are the short-run coefficients for the lagged differences of GDP;

$\boldsymbol{\theta_{1ik}}$,$\boldsymbol{\theta_{2il}}$,$\boldsymbol{\theta_{3im}}$ are the short-run coefficients for the lagged differences of RW, GDI, and DAB, respectively;

is the error term.

Testing the Stationarity of the Study Variables' Time Series

The first step in estimating the study model data is to test the stationarity of the panel time series data for the different variables used in the model. Therefore, unit roots of this data will be examined using advanced tests for analyzing and examining the unit root of panel data. The most common tests are the Levin, Lin, Chu test, and the Pesaran, Shin, Smith (1999) test. After application on the EVIEWS 13 software, we obtained the unit root tests for the panel data used in the study, as shown in the table below:

Table 3. Panel unit root tests results (P-values)

Variables	Level &1st Diff	Intercept/trend	LLC	IPS	Decision
GDP	**Level**	Intercept	0.0000***	0.0000***	**I(0)**
		Interc. & trend	0.0000***	0.0000***	
RW	**Level**	Intercept	0.8877	0.7921	**I(1)**
		Interc. & trend	0.3975	0.0999*	
	1st diff	Intercept	0.0000***	0.0000***	
		Interc. & trend	0.0000***	0.0000***	
GDI	**Level**	Intercept	0.0000***	0.0000***	**I(0)**
		Interc. & trend	0.0000***	0.0030***	
DAB	**Level**	Intercept	0.1204	0.0885	**I(1)**
		Interc. & trend	0.7005	0.5903	
	1st diff	Intercept	0.0000***	0.0000***	
		Interc. & trend	0.0000***	0.0000**	

Source: Own elaboration based on outputs from EVIEWS13 software.

Note: *, **, *** indicates 10%, 5% and 1% respectively

The unit root estimation results show that the variables economic growth rate (GDP) and public expenditure as a percentage of GDP (DAB) are stationary at the level I(0). However, the variables real wage growth rate (RW) and human capital (GDI) are stationary at the first difference I(1). According to Pesaran, Shin, Smith. (1999), we can apply the Panel ARDL model.

Cointegration

To study the possibility of cointegration among the study variables, we will use two important tests: the Pedroni test (Pedroni, 1999) (Appendices 1 and 2). The results show that most probabilities are significant at the 5% significance level in the fixed effect model and the fixed effect with trend model. Therefore, we reject the null hypothesis, which states that there is no cointegrating relationship, and accept the alternative hypothesis, which states that there is a cointegrating relationship among the study variables. As for the Kao test, the results shown in the table below indicate that the Kao statistic is significant at 5%, which indicates the existence of a cointegrating relationship among the study variables.

Table 4-Kao residual cointegration test

Prob	t-Statistic	ADF
0.0000	-5.45241	

Source: Own elaboration based on outputs from EVIEWS13 software.

Estimating the long-term and short-term relationship of the ARDL panel model

The results of the Pedroni and Kao tests indicate that there is a cointegrating relationship among the study variables. This means that there is a long-term equilibrium relationship among these variables, allowing us to extract the long-term and short-term relationships among the study variables.

Long-term relationship estimation results

After estimating the long-term relationship, the results are shown in table 4:

Table 5. Panel ARDL long-Run PMG estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RW	-0.16	0.05	-3.58	0.0005
GDI	0.34	0.03	10.47	0.0000
DAB	0.15	0.07	2.04	0.0434

Source: Own elaboration based on outputs from EVIEWS13 software.

From Table 5., we notice that the variable real wage growth rate is statistically significant (0.0005) at 5%. We also observe that real wages negatively impact economic growth (an inverse relationship) in the long term (Sonmez & Smithin, 2006).This means that a 1% increase in real wages results in a 0.16% decrease in economic growth. This suggests that rising real wages can lead to increased production costs or reduced competitiveness, especially in export-oriented industries, thus negatively affecting economic growth.

As for the gross domestic investment/human capital index (GDI), we notice a positive relationship between investment in human capital and economic growth (Mankiw, Romer, & Weil, 1992; Abd Karim, Chan, & Hassan, 2016). A 1% increase in human capital leads to a 0.34% increase in economic growth. This can be explained by the fact that investment in human capital or productive activities boosts growth by increasing productivity and efficiency in the economy.

Moving to public expenditure as a percentage of GDP (DAB), we find a positive relationship between public expenditure and economic growth (Shkodra, Krasniqi, & Ahmeti, 2022).A 1% increase in public expenditure as a percentage of GDP leads to a 0.15% increase in economic growth. This is because effectively directing public expenditure towards productive sectors can enhance growth by creating public economic benefits.

Short-term relationship estimation results

table 6. Short-run (Mean-Group) coefficients

Variable	Coefficient	Std, Error	t-Statistic	Prob,
COINTEQ	-1.22	0.14	-8.45	0.0000
D(GDP(-1))	-0.08	0.15	-0.55	0.5860
D(GDP(-2))	-0.15	0.11	-1.36	0.1755
D(RW)	0.21	0.07	3.17	0.0020
D(DAB)	0.12	0.23	0.53	0.5962
C	-15.91	2.48	-6.42	0.0000
@TREND	-0.06	0.07	-0.89	0.3760

Source: Own elaboration based on outputs from EVIEWS13 software.

We can summarize the short-term estimation results in the table 6., it presents the short-term model estimation results using the Mean Group (MG) method within the Panel ARDL model framework. The results explain the impact of independent variables and long-term equilibrium on short-term economic growth. The error correction term (Cointeq) appears with a negative value (-1.22), meaning that the model returns to equilibrium in the long term at a rate of 122% per period. This reflects a high adjustment speed towards equilibrium after shocks, highlighting the crucial role of the long-term relationship in explaining economic growth dynamics. For the effects of the first and second lags of economic growth DGDP(-1) and D(GDP(-2), the results indicate a statistically insignificant negative impact on current growth, suggesting that short-term economic growth is less dependent on its previous developments. This may be due to the variable's long-term impact or its variability among the six countries studied.

The study also find that real wages D(RW) in the short term, have a positive and statistically significant (0.0020) impact ON economic growth (Sonmez, Smithin, 2006). A 1% increase in real wages leads to a 0.21% rise in economic growth. This can be explained by the fact that real wage growth raises purchasing power and increases consumer demand, stimulating economic activity. As for public expenditure D(DAB) in the short term, its effect is positive but weak and statistically insignificant. This can be interpreted as the short-term impacts of public expenditure on growth being intangible or dependent on the efficiency of resource use. The reason for this is either due to the possibility of a long-lasting impact of this variable, or due to the fact that its effect differs across the six countries studied. Finally, the constant C is statistically significant (0.0000), reflecting other unexplained effects by the included variables, indicating a substantial reduction in economic growth when all variables are null.

Short-term estimation results by sections (countries)

Appendix 3 shows that the short-term estimates vary significantly among the countries studied. Where the error correction index cointeq01(-1) shows negative and significant values at the 5% significance level for all countries, indicating a strong correction mechanism for deviations from the long-term balance of economic growth (GDP). In Brazil, the deviation is corrected by 105.2247% over a period of approximately 11 months and 12 days, followed by South Korea with a rate of 60.6090% over a year, 7 months and 24 days, while the United States achieves a correction of 119.7373% over 10 months, followed by France with a rate of 166.2272% over 7 months and 6 days, Japan with a rate of 143.76% over approximately 7 months and 10 days, then Mexico with a rate of 133.5066% over 8 months and 29 days. As for the relationship between real wages and economic growth, it is noted from the lagged values of real wages (D(RW)) that wages have a positive impact on growth in some countries such as Brazil, South Korea, and Mexico, while they do not represent a constant influencing factor in all countries, as indicated by both Sonmez and Smithin (2006). Past economic growth, based on lagged values of D(GDP(-1)) growth, shows its role in enhancing current growth in most cases, especially in the late one-year term. Regarding the impact of public spending as a percentage of GDP on growth, the results are unclear in most countries, with the exception of South Korea, where a significant positive impact has emerged. As for human capital (investment), no short-term effect on growth is apparent in all the sections (countries) analysed.

Diagnostic tests

To determine the suitability of the study model, we conduct the following diagnostic tests: Cross-Section Dependence Test: (Yves & Giovanni , 2019).This test posits the following hypotheses:
Null Hypothesis H0: Sections are not dependent on each other.
Alternative Hypothesis H1: Sections are dependent on each other.

According to the results in Table 7, all tests are statistically significant at the 1% level. Therefore, we reject the null hypothesis and accept the alternative hypothesis, indicating a significant statistical association between the six countries studied.

Table 7. Cross-section dependence test

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	42.26130	15	0.0002
Pesaran scaled LM	4.977210		0.0000
Bias-corrected scaled LM	4.800740		0.0000
Pesaran CD	5.668389		0.0000

Source: Own elaboration based on outputs from EVIEWS13 software.

Jarque-Bera Normality Test: (Gujarati, 2004).

The hypothesis states the following:
Null Hypothesis H0: Model residuals do not follow a normal distribution.

Alternative Hypothesis H1: Model residuals follow a normal distribution.

Referencing the figure below, we find that the Jarque-Bera test yielded JB = 1.3117 with a probability of 51.89%, which is higher than the 5% significance level. Therefore, we reject the null hypothesis and accept the alternative, indicating that the model residuals follow a normal distribution. This suggests that the estimation coefficients are efficient and unbiased.

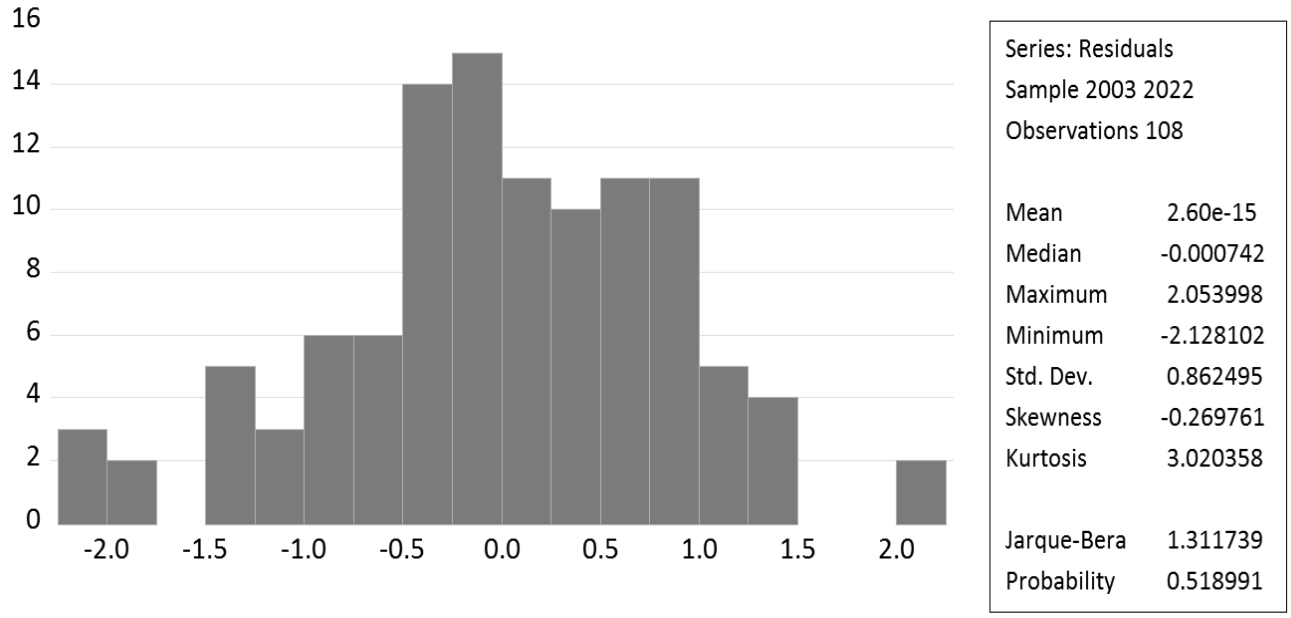

Figure 1. Jarque-Bera normal distribution test of residuals
Source: Own elaboration based on outputs from EVIEWS13 software.

Conclusion

The study aimed to analyze the impact of real wages, human capital, and public expenditure as a percentage of GDP on economic growth in six OECD countries over the period (2002-2022). The Panel ARDL model estimated using PMG was used to test short- and long-term relationships between the variables. The results of the study showed a set of quantitative indicators that enhance our understanding of the nature of the relationship between real wages and economic growth, whether in the long or short term, taking into account the pivotal role of other factors such as human capital and public spending. In the long term, the results showed an inverse relationship between real wages and economic growth, which intersects with the findings of Sonmez, Smithin (2006), where higher wages can lead to increased production costs and reduced competitiveness, especially in open economies of an export nature, which explains the negative impact recorded in the study. However, this effect does not contradict what was indicated by other studies such as Mankiw, Romer, Weil (1992) and Askenazy (2003), which emphasized the role of wages in stimulating investment in human capital and improving the quality of the labor force, but it seems that this positive effect does not It appears in the short term only under appropriate institutional and market conditions. In the short term, real wages have shown a positive and significant impact on economic growth, which is in line with the hypothesis that increasing wages raises purchasing power and enhances aggregate demand, as pointed out by Wakeford (2004) and Dritsaki (2016). However, this impact remains uneven among countries, as highlighted by the study's results when analyzed by transects, reflecting the specificity of national and institutional contexts, which was also confirmed by Cruz's (2019) study, which indicated a different relationship according to countries and their economic conditions. As for the other variables, investment in human capital proved a positive long-term effect on growth, in harmony with traditional and extended theoretical models of growth such as the modified

Solow model and the results of Abdul Karim et al. (2016), while public spending showed a positive but limited and non-lasting impact in the short term, calling for a review of the efficiency of public resource allocation, findings that are partly consistent with those of Shkodra et al. (2022). The results of diagnostic tests indicate the existence of a strong interconnection between the countries under study, which can be explained by the effects of global economic factors, such as crises and inflation, which enhances the structural nature of economic relations between countries. The model residuals also follow a normal distribution, which confirms the reliability of the estimates obtained from model. Taken as a whole, this study confirms that the relationship between real wages and economic growth is neither fixed nor uniform, but rather influenced by the economic and institutional context, and varies between the long and short term. Thus, it is consistent with the proposition presented by most previous studies, which states that the relationship is complex and changes over time and space. Thus, wage-related economic policies should be carefully formulated, balancing the strengthening of purchasing power and ensuring competitiveness, with a focus on supporting investment in human capital and improving the effectiveness of public spending as supportive mechanisms for sustained growth.

Based on the study's results, we may suggest some recommendations to enhance the positive impact of real wages on economic growth. First, the study recommends adopting a flexible wage policy that considers the equilibrium of economic development and the competitive advantage among the organization's member countries. Second, the study advises raising investment in human capital by increasing education and training expenditures, which will boost productivity and increase pay purchasing power. Finally, the report proposes directing government spending toward productive projects in order to encourage economic growth.

In light of the study's limitation, which encompassed six OECD countries, the author recommends broadening the research to include additional emerging economies to compare the influence of real wages on economic growth across diverse economies. Furthermore, the author advocates for the application of established economic models to examine the correlation between wages and economic growth, incorporating additional variables such as technology, or assessing the impact of real wages on specific sectors (industry, services, advanced technology…).

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Appendices

Appendix 01

Pedroni Residual Cointegration Test
Series: GDP RW GDI DAB
Date: 01/10/25 Time: 20:21
Sample: 2002 2022
Included observations: 126
Cross-sections included: 6
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
Automatic lag length selection based on SIC with a max lag of 3
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-0.696911	0.7571	-1.348537	0.9113
Panel rho-Statistic	-1.911711	0.0280	-1.935732	0.0265
Panel PP-Statistic	-6.428961	0.0000	-5.953811	0.0000
Panel ADF-Statistic	-6.214927	0.0000	-5.864646	0.0000

Appendix 02

Pedroni Residual Cointegration Test
Series: GDP RW GDI DAB
Date: 01/10/25 Time: 20:37
Sample: 2002 2022
Included observations: 126
Cross-sections included: 6
Null Hypothesis: No cointegration
Trend assumption: Deterministic intercept and trend
Automatic lag length selection based on SIC with a max lag of 3
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	-1.742392	0.9593	-2.461740	0.9931
Panel rho-Statistic	-0.442838	0.3289	-0.444060	0.3285
Panel PP-Statistic	-11.10794	0.0000	-10.37069	0.0000
Panel ADF-Statistic	-6.940952	0.0000	-5.829897	0.0000

Appendix 03

⊟ 1

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ	-1.052247	0.110954	-9.483630	0.0000
D(GDP(-1))	0.000613	0.104973	0.005837	0.9954
D(GDP(-2))	-0.318525	0.114277	-2.787314	0.0177
D(RW)	0.302955	0.080500	3.763424	0.0031
D(DAB)	0.586447	0.395898	1.481309	0.1666
C	-11.63198	1.086450	-10.70641	0.0000
@TREND	-0.185994	0.065854	-2.824319	0.0165

⊟ 2

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ	-0.636090	0.185488	-3.429287	0.0056
D(GDP(-1))	-0.639182	0.216790	-2.948389	0.0132
D(GDP(-2))	-0.115583	0.170672	-0.677226	0.5123
D(RW)	0.231052	0.073339	3.150451	0.0092
D(DAB)	0.807519	0.202712	3.983575	0.0021
C	-5.962050	1.788362	-3.333805	0.0067
@TREND	-0.100612	0.058011	-1.734363	0.1107

⊟ 3

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ	-1.197373	0.207487	-5.770829	0.0001
D(GDP(-1))	-0.321789	0.129315	-2.488405	0.0301
D(GDP(-2))	-0.577695	0.162090	-3.564028	0.0044
D(RW)	0.135826	0.120222	1.129794	0.2826
D(DAB)	-0.762364	0.576779	-1.321760	0.2131
C	-16.02313	2.851530	-5.619135	0.0002
@TREND	-0.066454	0.048155	-1.379992	0.1950

⊟ 4

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ	-1.662272	0.145067	-11.45863	0.0000
D(GDP(-1))	0.387550	0.148509	2.609615	0.0243
D(GDP(-2))	0.065960	0.157380	0.419115	0.6832
D(RW)	0.390683	0.314692	1.241478	0.2403
D(DAB)	-0.053806	0.274619	-0.195929	0.8482
C	-20.87153	1.839168	-11.34835	0.0000
@TREND	-0.200125	0.057222	-3.497339	0.0050