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The Relationship Between Financial Development and Brazilian GDP per Capita

La relación entre el desarrollo financiero y el PIB per cápita de Brasil

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Abstract

Introduction

The relationship between financial development and economic growth is widely discussed, emphasizing the role of financial institutions in resource allocation. In Brazil, analyzing the evolution of these institutions and their correlation with per capita GDP shows how policies and reforms can affect the population's average income.

Objective

This paper presents the findings of a study investigating the connection between financial development, measured by the evolution of financial institutions, and per capita GDP in Brazil.

Methodology

The research employed the Autoregressive Distributed Lag (ARDL) model to analyze short- and long-term relationships, capturing the dynamics of adjustment over time. Variables related to access, depth, and efficiency of financial institutions, as well as per capita GDP, were evaluated. The confirmation of cointegration indicated a long-term link among these factors.

Results

Over the long term, all variables showed statistical significance: access to financial institutions was negatively associated, while depth and efficiency were positively correlated with per capita GDP. In the short term, only the depth variable remained significant, but with an opposite sign. This suggests that, over time, improvements in depth and efficiency can foster economic growth, while limited access may constrain it. Therefore, structural factors are pivotal to the relationship between financial development and average income.

Conclusions

In summary, the results underscore the importance of financial development in promoting Brazil's per capita GDP. Understanding the dimensions of access, depth, and efficiency within financial institutions can guide policies aimed at sustainable expansion, contributing to higher average income.

Keywords:

financial development; economic growth; GDP per capita; average income; access; depth; efficiency; resource allocation; ARDL Model; Autoregressive Distributed Lag (ARDL); cointegration; Brazil.

JEL Classification: G19; G29; O47.

Resumen

Introducción

La relación entre el desarrollo financiero y el crecimiento económico se discute ampliamente, enfatizando el rol de las instituciones financieras en la asignación de recursos. En Brasil, analizar la evolución de estas instituciones y su correlación con el PIB per cápita muestra cómo las políticas y reformas pueden afectar el ingreso promedio de la población.

Objetivo

Este artículo presenta los hallazgos de un estudio que investiga la conexión entre el desarrollo financiero, medido por la evolución de las instituciones financieras, y el PIB per cápita en Brasil.

Metodología

La investigación empleó el modelo Autoregressive Distributed Lag (ARDL) para analizar las relaciones de corto y largo plazo, capturando la dinámica de ajuste a lo largo del tiempo. Se evaluaron variables relacionadas con el acceso, la profundidad y la eficiencia de las instituciones financieras, así como el PIB per cápita. La confirmación de la cointegración indicó un vínculo a largo plazo entre estos factores.

Resultados

A largo plazo, todas las variables mostraron significancia estadística: el acceso a las instituciones financieras se asoció de manera negativa, mientras que la profundidad y la eficiencia se correlacionaron positivamente con el PIB per cápita. A corto plazo, solo la variable de profundidad mantuvo su significancia, pero con un signo opuesto. Esto sugiere que, con el tiempo, las mejoras en profundidad y eficiencia pueden impulsar el crecimiento económico, mientras que un acceso limitado podría restringirlo. Por lo tanto, los factores estructurales son fundamentales para entender la relación entre el desarrollo financiero y el ingreso promedio.

Conclusiones

En síntesis, los resultados enfatizan la importancia del desarrollo financiero en la promoción del PIB per cápita de Brasil. Comprender las dimensiones de acceso, profundidad y eficiencia dentro de las instituciones financieras puede orientar políticas dirigidas a una expansión sostenible, contribuyendo a elevar el ingreso promedio de la población.

Palabras clave:

desarrollo financiero; crecimiento económico; PIB per cápita; ingreso promedio; acceso; profundidad; eficiencia; asignación de recursos; Modelo ARDL; Modelo Autorregresivo con Rezagos Distribuidos (ARDL); cointegración; Brasil.

Clasificación JEL: G19; G29; O47.

1. Introduction

The notion that money is neutral is prevalent in classical and neoclassical economic theory, where it is believed that monetary variables do not affect the actual variables of the economy in the long term. However, this perspective has been challenged by theorists such as John Maynard Keynes and subsequent Keynesian economists.

Keynes's contribution to the non-neutrality of money is intimately connected to his general theory of employment, interest, and money (Keynes, 2017). He argued that aggregate demand, influenced by changes in the money supply, plays a significant role in determining employment levels and output. In this context, money is not neutral because changes in the money supply can directly influence the real economy.

Later, Neo-Keynesian economists strengthened the notion of money's non-neutrality by identifying the roles of wage and price rigidities in the economy (Mankiw & Romer, 1991). Money has an active role in the economic system by interacting with these rigidities, thereby influencing production and employment.

Monetarist economists, led by Milton Friedman, reject many of Keynes's ideas and do not fully subscribe to the neutrality of money either. Friedman (1968) recognized that money could have real short-term effects due to monetary illusions and the slow adjustment of prices and wages. In contrast, the new classical economic theory advocates for the superexogenous neutrality of money, wherein money is entirely neutral even in the short term due to the rationality of economic agents (Lucas, 1972). However, this view has been widely criticized for its assumption of rational expectations and perfect information.

In summary, while the neutrality of money is a valid simplifying assumption in specific economic models, the concept of money's non-neutrality, as proposed by Keynes and others, provides a more realistic and complex perspective on the interaction between money and the real economy.

The relationship between financial development and economic growth remains contentious in this context. Some authors view finance as an essential element of growth, as suggested by Goldsmith (1969), King & Levine (1993a; 1993b), McKinnon (2010), and Schumpeter (1934). Others, such as Robinson (1952), argue for a lesser impact, asserting that economic growth drives financial development. Still, others, like Lucas (1988), contend that the role of finance has been overstated.

Blum et al. (2002) propose five hypotheses regarding the relationship between the financial system and economic growth and development: (i) the supply-leading approach, which posits that the development of the financial system drives economic growth and that a deficient system can create barriers to a country's productive dynamics. In this context, banking institutions' capacity to generate money for productive and innovative projects is emphasized. (ii) The demand-following approach asserts that financial development is initiated by economic growth. If productive dynamics are robust, there will be an increased demand for financial services. (iii) The bi-causality approach suggests mutual causality between financial development and economic growth. (iv) The approach that indicates financial development can have adverse effects on economic growth under certain circumstances, based on the occurrence of financial crises. (v) The approach that claims no connection exists between financial development and economic growth.

However, the preponderance of theoretical reasoning and empirical evidence suggests a positive relationship between financial development and economic growth. There is an argument that the level of development is a good predictor of future growth rates, capital accumulation, and technological change (Levine, 1997).

The work of Goldsmith (1969) was the first to empirically analyze and verify a positive relationship between financial development and income growth (GDP per capita). Specifically, the author used data from 35 countries from

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1860 to 1963 to reach this conclusion. Another seminal work was the book by McKinnon (2010), which investigated the relationship between the financial system and economic development, considering the post-World War II period in Argentina, Brazil, Chile, Germany, Korea, Indonesia, and Taiwan. Although there are divergences regarding individual cases, the author found evidence that more effectively functioning financial systems contribute to faster economic growth.

Even in the early 20th century, Schumpeter (1934) viewed the banking sector as an engine of economic growth by financing productive investments. Financial intermediaries can exert a positive impact on productivity growth, which can increase GDP rates (Beck et al., 2000).

Financial development can impact sustainable socioeconomic growth and development (Demirguc-Kunt, 2006). According to King and Levine (1993a), financial development fosters economic growth by increasing the rate of capital accumulation.

The financial system can enhance productivity by selecting higher-quality entrepreneurs and projects, mobilizing external financing for these entrepreneurs, providing improved alternatives for diversifying risk in innovative activities, and more accurately revealing the profitable potentials associated with an innovative firm. These functions can influence savings, investment decisions, and economic growth (King & Levine, 1993b; Levine, 2005).

Greenwood and Jovanovic (1990) modeled dynamic interactions between finance and economic growth, finding bidirectional causality. They argue that financial intermediaries can produce better information, which, in turn, optimizes resource allocation, promotes economic growth, and reduces income inequality.

The development of the financial system can be defined as the enhancement of access, size, efficiency, and stability of financial institutions and markets, channeling resources from an economy into profitable investments, reducing information and corporate governance costs, as well as fostering technological innovation and entrepreneurship (Diamond, 1984; Stiglitz & Weiss, 1983).

According to Valickova et al. (2015), most empirical studies find a positive and statistically significant relationship between financial development and economic growth. Demetriades et al. (1996) studied 16 countries using time series and identified a significant role of the financial system in promoting economic growth in terms of real GDP. Ahmed and Ansari (1998) examined three major South Asian economies: India, Pakistan, and Sri Lanka. Utilizing the Granger causality test, they found that financial development causes economic growth. Fry (1988) contends, for a sample of 14 developing countries in Asia, that financial development has a positive relationship with economic growth.

The positive correlation between financial development, economic growth, and productivity enhancement has also been confirmed in China (Guillaumont Jeanneney et al., 2006; Hye & Dolgopolova, 2011; Liu & Shu, 2002). Hsueh et al. (2013), using a sample of Asian countries between 1980 and 2007, found that financial development positively influences economic growth, with a more pronounced effect in China.

Sehrawat and Giri (2015), through cointegration tests, confirmed a long-term relationship between financial development and India's economic growth. Additionally, their ARDL tests show that bank- and market-based financial development indicators positively impact the latter variable. Thus, their results support the supply-leading hypothesis and highlight the importance of financial development in economic growth. Kandil et al. (2017) investigated the drivers of economic growth in China and India using annual data from 1970 to 2013, and the results indicate that financial development enhances economic activity in these two countries.

Some African countries were analyzed using panel data regression, and a positive relationship between financial development and eco-

nomic growth was found (Ikhide, 1993). Seck and El Nil (1993), from a sample of 30 African countries, identified a favorable compatibility between the variables. However, when individual countries from the continent are investigated separately, the results vary, as shown below. Focusing on Nigeria, Ujunwa and Salami (2010) and Alajekwo and Achugbu (2012), from the capital market perspective, find a negative relationship between the financial system in this aspect and economic growth. Abu et al. (2013) and Adusei (2013), focusing on Ghana, also detected a negative relationship between financial development and economic growth.

Baliamoune-Lutz (2008) argues that for certain North African countries, such as Algeria, Egypt, and Morocco, there is a long-term relationship between financial development and income growth. Acaravci (2009) maintains that in 24 Sub-Saharan African countries, economic growth acceleration can be achieved by improving financial systems. Uddin et al. (2013), focusing on Kenya, suggest a positive relationship between these variables. Bist (2018) also shows a positive relationship between financial development and economic growth in 16 low-income African countries.

Bittencourt (2012) conducted a study in Latin America to evaluate the Schumpeterian hypothesis that finance promotes entrepreneurship and productive activities. Their findings confirm this hypothesis and conclude that financial development positively affects economic growth. Caporale et al. (2015), based on an analysis of 10 new European Union countries between 1994 and 2007, found evidence that the credit capital markets are still underdeveloped in these economies and that their contribution to economic growth is limited due to the lack of financial depth.

Asteriou and Spanos (2019) investigated the relationship between financial development and economic growth in 26 European Union countries during and after the subprime crisis of 2008 and 2009. Their results show that before the crisis, financial development promoted economic growth, while after the crisis, it hindered economic activity. Beck et al. (2000), using a sample of 74 developed and developing countries, demonstrate that the development of financial intermediaries positively affects economic growth.

Christopoulos and Tsionas (2004) argue that, for the 10 developing countries analyzed, financial development positively affects long-term economic growth in the form of financial depth. Beck and Levine (2004) examined the impact of capital markets and banks on economic growth between 1976 and 1998, using a panel of 40 countries. They found that both variables positively influence economic growth.

Lee and Chang (2009) explored 37 countries using annual data from 1970 to 2002 and found evidence that financial development has a long-term relationship with economic growth. Pan and Wang (2013), with a sample of 89 countries from different groups –industrialized countries (INDs)– emerging market economies (EMEs), and other developing countries (ODCs– for the period between 1970 and 2009, indicate that financial development contributes to economic growth in INDs and EMEs, but not in ODCs. Durusu-Ciftci et al. (2017) analyzed 40 countries from 1989 to 2011, finding in their empirical estimates that financial development positively impacts economic growth in the form of credit and capital markets.

Ruiz (2018) analyzed data from 116 economies obtained from the World Bank database between 1991 and 2014. The author examined industrialized and developing economies, revealing that countries below the financial threshold grow less and those above the threshold grow more rapidly. Guru and Yadav (2019) examined the BRICS countries (Brazil, Russia, India, China, and South Africa) during the period from 1993 to 2004, finding a positive relationship between the variables of financial development (banking institutions and stock market) and economic growth.

In this context, this study sought to investigate the following research question:

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* What is the relationship between financial development and Brazil's per capita income growth?

Specifically, it assumed the following objective:

* To investigate the relationship between the development of financial institutions and per capita GDP in Brazil.

Based on the preceding empirical findings, the following research hypothesis was raised:

* The development of financial institutions has a positive and significant impact on per capita economic growth in Brazil.

This issue is relevant because, if the hypothesis is confirmed, it may generate recommendations for policies to be formulated to promote a more democratic, inclusive, and consequently developed financial system so that it can contribute to the increase of income for the Brazilian population.

2. Data and Methodology

Secondary data were employed in this study, collected from the International Monetary Fund (IMF) database, specifically the Financial Development Index Database (IMF, 2021), for variables related to financial development. As summarized in Table 1, the per capita GDP variable data, measured in millions of dollars, was also sourced from the World Bank national accounts data and OECD National Accounts data files (World Bank, 2021).

Per capita GDP is the gross domestic product divided by the mid-year population. The GDP represents the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for the depreciation of fabricated assets or for the depletion and degradation of natural resources. The data are in current US dollars (World Bank, 2021).

As defined by the IMF (2021), the 'access to financial institutions' variable compiles data on the number of banking branches per 100,000 adults and automated teller machines (ATMs) per 100,000 adults. The 'depth of financial institutions' variable aggregates data on bank credit to the private sector as a percentage of GDP, pension fund assets to GDP, mutual fund assets to GDP, and life and non-life insurance premiums as a percentage of GDP. The 'efficiency of financial institutions' variable compiles data on the banking sector's net interest margin, the spread between deposit and lending rates, non-interest income to total income, overhead costs to total assets, return on assets, and return on equity.

The data originate from a time series from 1980 to 2019. They were organized in Micro-

Table 1. The variables employed for the operationalization of the proposed model include the following

Identification	Variable	Explanation	Source
IA	Access to Financial Institutions	Measures the level of population access to financial services, such as bank accounts.	International Monetary Fund (IMF)
IP	Depth of Financial Institutions	Evaluates the depth of financial services, including credit and deposits relative to GDP.	International Monetary Fund (IMF)
IE	Efficiency of Financial Institutions	Indicates the efficiency of financial systems in allocating resources and managing risks.	International Monetary Fund (IMF)
GDP	Gross Domestic Product per capita (GDP per capita)	Refers to the total value of goods and services produced per person in a country.	Organisation for Economic Co-operation and Development (OECD)

Source: prepared by the authors.

soft Excel and operationalized through Stata. The variables related to the development of financial institutions (financial development) range from 0 to 1, with 0 being the worst outcome and 1 the best. The GDP per capita variable is expressed in monetary terms. To avoid biases due to different magnitudes, the variables were normalized using their respective natural logarithms for estimation purposes. In selecting the most suitable model, a check for the stationarity of the variables was performed, as the presence of unit roots in the series can lead to spurious results (Gujarati & Porter, 2011).

2.1 Autoregressive Distributed Lag (ARDL) Model

The Autoregressive Distributed Lag (ARDL) Model was developed in the works of Pesaran et al. (1997; 2000; 2001) and Pesaran and Shin (1995). The ARDL model is initially estimated to analyze if there is a long-term cointegration among the variables. Following this, the long-term and short-term coefficients are estimated, as well as the speed of adjustment to the long-term equilibrium, which is denoted as ECM (-1).

The ARDL model is more flexible in terms of the variables' integration order, as while traditional cointegration methods require series to be integrated of order zero, I(0), the ARDL methodology accommodates series with integration of an order less than 2, that is, I(1) and I(0). Additionally, as previously shown, it is a model that allows the simultaneous estimation of short-term and long-term parameters, more comprehensively extracting information from the data set.

Equation 1 presents the general specification of the ARDL:

$$yt = \alpha + \beta_{xt} + \delta_{zt} + e_t \qquad [1]$$

The error correction version of the ARDL model is specified as follows:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{n} \beta_i \Delta y_{t-i} + \sum_{i=1}^{n} \delta_i \Delta x_{t-1} + \sum_{i=1}^{n} \varepsilon_i \Delta z_{t-i} + \lambda_1 y_{t-1} + \lambda_2 x_{t-1} + \lambda_3 z_{t-1} + \cdots + \lambda_n z_{t-n} + u_t \qquad [2]$$

The parameters β, δ, and ε r represent the short-term dynamics of the model. The second part with the λs coefficients represents a long-term relationship. The null hypothesis in the equation is λ1 + λ2 + λ3 = 0, which signifies the non-existence of a long-term relationship.

2.1.1 ARDL and ECM Empirical Strategy

The mathematics of the model is given as follows:

$$GDP=f(IA;IP;IE) \qquad [3]$$

So GDP per capita is a function of the development of financial institutions (in their dimensions of access, depth, and efficiency). The empirical modeling of the ARDL is thus structured:

$$\Delta LnPIB_t = \alpha_0 + + \sum_{i=1}^{n} \beta_1 \Delta \mathrm{LnPIB}_{t-1} + \sum_{i=0}^{n} \beta_2 \Delta \mathrm{LnIA}_{t-1} + \sum_{i=0}^{n} \beta_3 \Delta \mathrm{LnIP}_{t-1} + \sum_{i=0}^{n} \beta_4 \Delta \mathrm{LnIE}_{t-1} + \lambda_1 LnPIB_{t-1} + \lambda_2 LnIA_{t-1} + \lambda_3 LnIP_{t-1} + \lambda_4 LnIE_{t-1} + u_{t1} \qquad [4]$$

To reveal the existence of a long-term cointegration among GDP, IA (Access to Financial Institutions), IP (Financial Institutions Depth), and IE (Financial Efficiency), the null hypothesis H0 was tested:$\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$ e a H_a: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$. The F-test (Wald test) is used to compare the

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result with the critical values. Exact critical values for the F-test are not available for an arbitrary mix of I(0) and I(1) variables. However, Pesaran et al. (2001) provide bounds for the critical values for the asymptotic distribution of the F-statistic. For various situations, the authors offer lower and upper bounds for the critical values. If the F-value is below the lower bound, it is concluded that the variables are I(0); thus, there is no possibility of cointegration. If the F-value is above the upper bound, it can be concluded that there is cointegration.

If cointegration among the variables is confirmed, the Error Correction Model (ECM) estimation is warranted. The empirical modeling of the ECM within the ADRL approach is as follows:

$$\Delta LnPIB_t = \alpha_0 + + \sum_{i=1}^{n} \beta_1 \Delta \mathrm{LnPIB}_{t-1} + \sum_{i=0}^{n} \beta_2 \Delta \mathrm{LnIA}_{t-1} + \sum_{i=0}^{n} \beta_3 \Delta \mathrm{LnIP}_{t-1} + \sum_{i=0}^{n} \beta_4 \Delta \mathrm{LnIE}_{t-1} + \sigma ECM_{t-1} \quad [5]$$

The error correction model demonstrates the empirical speed of adjustment back to long-term equilibrium following a short-term shock. A negative and significant coefficient for the ECMt-1 implies that short-term disequilibria between the dependent and explanatory variables have converged to the long-term equilibrium.

3. Results and Analysis

Table 2 presents the results of the Bounds Cointegration Test. Given that the F-statistic returned a value higher than the critical values for both I(0) and I(1) across all specifications, one can infer the rejection of the null hypothesis of no cointegration among the variables, thus indicating a long-term relationship between GDP per capita and the development of financial institutions in terms of access, depth, and efficiency. With this result, it is possible to proceed with estimating the long-term and short-term coefficients, and the speed of adjustment.

Table 2. Bound Test

Statistic F	**Critical Values**					
	I(0) *Bound*			I(1) *Bound*		
F = 7.809	10%	5%	1%	10%	5%	1%
	2.72	3.23	4.29	3.77	4.35	5.61

Source: prepared by the authors.

The ARDL and ECM results for the relationship between GDP per capita and the development of financial institutions are presented in Table 3. Notably, the best-fitting model had the following lag orders: (1, 3, 2, 3).

Regarding the long-term coefficients, all variables representing the development of financial institutions showed statistical significance in their relationship with Brazilian GDP per capita. The variables representing Financial Institutions Depth (IP) and Efficiency (IE) displayed a positive relationship. Precisely, a 1% increase in financial depth results in a 2.93% rise in per capita income, and a 1% increase in the efficiency of financial institutions leads to a 0.77% increase in per capita income. However, the variable representing access to financial institutions had a negative relationship, such that a 1% increase in access results in a 1.74% decrease in per capita income.

This result is noteworthy because it suggests that access alone does not guarantee an increase in the income of the Brazilian population and may even be detrimental. This leads to the following hypothesis: access to financial products and services unsuitable for the social

Table 3. Results of the ARDL (1, 3, 2, 3) regression and ECM

Variable	Coefficient	Standard Error	t-Statistic	P > | t |	95% Confidence Interval	
Long-Term Coefficients						
IA	-1.730275	0.3894417	-4.44	0.000	-2.534043	-0.9265067
IP	2.927643	0.3137137	9.33	0.000	2.280169	3.575116
IE	0.7635208	0.256669	2.97	0.007	0.2337821	1.29326
Short-Term Coefficients						
dIA	0.4521554	0.4551084	0.99	0.330	-0.4871422	1.391453
dIP	-1.301215	0.2554765	-5.09	0.000	-1.828492	-0.7739368
dIE	-0.4009141	0.243684	-1.65	0.113	-0.9038531	0.102025
Adjustment						
ECM (-1)	-0.6203118	0.1146376	-5.41	0.000	-0.8569121	-0.3837115
Additional Information						
Constant	8.146924	1.502961	5.42	0.000	5.044965	11.24888
Adjusted R-squared		0.5229		Log likelihood		62.49556

Source: prepared by the authors.

reality may lead to indebtedness, for example, hampers GDP per capita growth. It is important to note that further studies should be conducted to test this hypothesis.

As for the short-term relationships, the variables representing Access to Financial Institutions (IA) and Efficiency (IE) were not statistically significant. In contrast, the variable representing Financial Institutions Depth (IP) showed statistical significance, but unlike the long-term coefficient, it returned a negative result. This could be because credit (one of the main components of this variable) is typically a long-term economic leverage instrument, as it tends to consume a portion of income in the short term as a form of compensation.

Regarding the ECM (-1), the coefficient of the error correction term was negative and significant at the 1% level, which is expected since the model's variables are cointegrated. Specifically, the adjustment speed of short-term shocks towards the long-term equilibrium was 62.04% per year. The model's adequacy is assessed using tests for serial correlation, heteroskedasticity, normality, and specification, with the results displayed in Table 4 and Table 5.

Table 4. Goodness-of-fit tests (autocorrelation and heteroskedasticity)

Autocorrelation		Heteroskedasticity	
Test	**Prob > Chi2**	**Test**	**Prob > Z**
Breusch-Godfrey	0.5570	White	0.4226
Alternative Durbin-Watson	0.6417	Breusch-Pagan	0.7889

Source: prepared by the authors.

Table 5. Goodness-of-fit tests

Normality Test		Specification Test	
	Prob > Z		**Prob > F**
Shapiro-Wilk Test	0.79791	Ramsey RESET Test	0.6591

Source: prepared by the authors.

Based on the Breusch-Godfrey and alternative Durbin-Watson tests, the null hypothesis is not rejected (p-values > 5%), indicating that the model does not present problems of serial autocorrelation. The White and Breusch-Pagan tests also do not reject the null hypothesis (p-values > 5%), suggesting no heteroscedasticity issues. The Shapiro-Wilk test confirms the normality of residuals, as the null hypothesis is not rejected (p-value > 5%). Lastly, the Ramsey RESET test shows that the model is correctly

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specified, as evidenced by the non-rejection of the null hypothesis (p-value > 5%).

The Cumulative Sum of Recursive Residuals (CUSUM) test was conducted to analyze the estimated model's structural stability. The results of this test are presented in Figure 1 and Table 6. The CUSUM test is used to detect the presence of structural breaks in regression models. Suppose the plot of the cumulative sum of the recursive residuals stays within the boundaries of the confidence intervals, typically at the 5% significance level. In that case, this suggests that the model is structurally stable over time. If the plot crosses these boundaries, it may indicate that a structural break has occurred, and the model may not be stable.

Table 6. Goodness-of-fit tests – CUSUM Test

Test Statistic	Critical Value (1%)	Critical Value (5%)	Critical Value (10%)
0.2839	1.1430	0.9479	0.850

Source: prepared by the authors.

The structural stability of the estimated coefficients is achieved, as shown in Figure 1, since the critical limits were not exceeded. Furthermore, Table 6 indicates the non-rejection of the null hypothesis that the parameters are stable over time because the test statistic showed results lower than the critical values, even at the 1% level. Thus, all the applied tests indicate that the model is adequate and statistically stable.

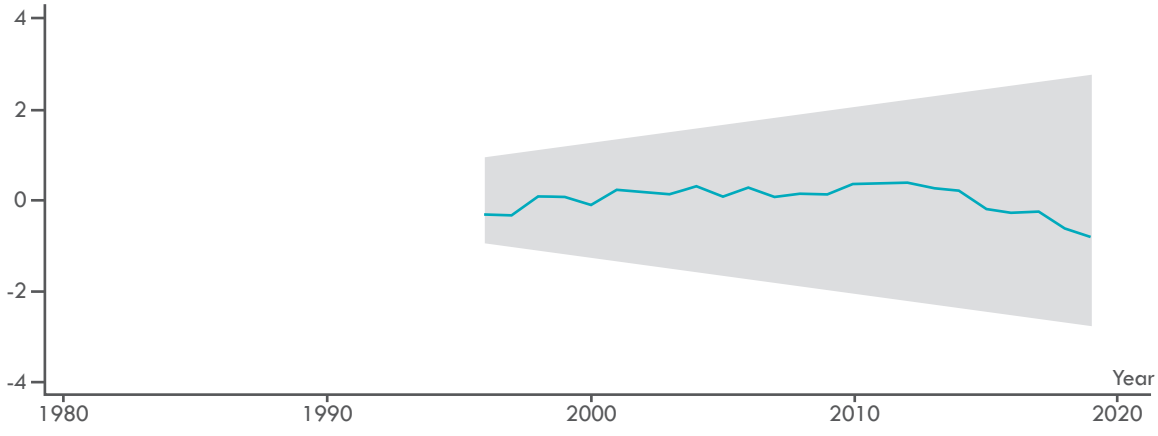
In statistical modeling, especially in time-series analysis, ensuring that the relationships between variables are consistent over the studied period is crucial. Tests like the CUSUM and the analysis of the stability of parameters over time are essential to validate that the model's assumptions hold throughout the data range, which supports the reliability of the model's predictions and conclusions.

4. Conclusion

The findings of this study align with those presented in various empirical studies mentioned in the introduction section. Specifically, they demonstrate that financial development can lead to an increase in the GDP per capita rate. This provides some evidence supporting the propositions made by Beck and Levine (2004), Demirguc-Kunt (2006), King and Levine (1993a), Levine (2005), and Schumpeter (1934) that financial systems contain key components for promoting economic growth. This is also consistent with Keynes's (2017) assertion that money is non-neutral.

Therefore, with the confirmation that the development of financial institutions is positively related to the promotion of Brazilians' per capita income rate, especially in the long run, this work may have significant implications for policymakers. It highlights the need for necessary measures to leverage finance to foster economic growth.

Figure 1. CUSUM Test



Source: prepared by the authors.

Authors' contributions

João Guilherme participated in all stages of the research. Francisco Vidal and Bruno Pérez participated in the stages of conceptualization, validation, and visualization.

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