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INVESTIMENTOS E SUA RELAÇÃO COM O CRESCIMENTO ECONÔMICO PARANAENSE: UMA ANÁLISE ESTRATIFICADA

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ABSTRACT

The present study aims to assess the effects of private and public investments on the economic growth of the state of Paraná, adopting a stratified approach based on different income levels. The relevance of this debate lies in the fact that both theoretically and pragmatically, there has been extensive discussion about the role of investments in economic growth. In considering this theme, this study seeks to demonstrate how investment decisions originating from the private sphere influence the economy, thereby aiding in the understanding and foundation of efficient and equitable policies aimed at promoting sustainable economic growth. To achieve this objective, the methodology applied in this study is quantile regression, a statistical tool that allows for the analysis not only of the average effects but also their variations across the distribution. Data were obtained from the Parana Institute of Economic and Social Development (IPARDES) for the year 2019 for municipalities in Paraná. The main results indicate that both public and private investment variables are important for the economy, with private investment standing out, although this impact varies depending on the municipal economic level.

Keywords: Gross Domestic Product. Investment. Public Investment. Private Investment.

RESUMO

O presente estudo visa realizar uma avaliação dos efeitos dos investimentos privados e públicos no crescimento econômico do estado do Paraná, adotando uma abordagem estratificada por diferentes níveis de renda. A relevância deste debate se deve ao fato de que tanto teórica como pragmaticamente, há muito se discute o papel dos investimentos para o crescimento econômico. Ao considerar tal temática, o presente trabalho busca demonstrar como as decisões de investimento, oriundas do âmbito privado, influenciam a economia, o que auxilia na compreensão e embasamento de políticas eficientes e equitativas orientadas a promover um crescimento econômico sustentável. Para atingir tal objetivo, a metodologia aplicada neste estudo é a regressão quantílica, uma ferramenta estatística que permite analisar não apenas a média dos efeitos, mas também suas variações ao longo da distribuição. Os dados foram obtidos no Instituto Paranaense de Desenvolvimento Econômico e Social (IPARDES) referentes ao ano de 2019 para os municípios do Paraná. Os principais resultados demonstram que as variáveis de investimento público e privado são importantes para a economia e o investimento privado se destaca, embora tal impacto seja distinto dependendo do nível econômico municipal.,

Palavras-chave: Produto Interno Bruto. Investimento. Investimento Público. Investimento Privado.

INTRODUCTION

Economic growth is understood as an emergent system resulting from the process of industrialization, and this debate originates in the importance attributed to private investment since the early development of economic science. In addition to constituting a mechanism that contributes to wealth accumulation at national and state levels, economic growth is conceived as a prospective path to mitigate deficiencies inherent in the economic structure (Nakabashi, 2006). In the field of regional development studies, this discussion gains particular relevance when considering that processes of economic expansion are not evenly distributed across space, being influenced by structural, sectoral, and spatial factors that differentiate the performance of localities.

At the municipal level, the analysis presents an advantage over more aggregated studies, since cities are characterized by openness to trade and greater mobility of production factors. This makes it possible to examine the heterogeneities that exist among municipalities, which should not be overlooked, given that several factors, such as size and location (especially in the case of cities positioned as regional hubs, capable of attracting larger volumes of investment), affect the process of regional growth. This perspective is directly aligned with the regional approach, as it recognizes that structural and spatial differences influence the economic transformation capacity of territories.

Within this debate, investment shows a clear association with economic growth, and thus analyzing the relationship between the two becomes a way of understanding growth dynamics at the municipal level. When exploring this topic, it is possible to identify the existence of several theories that seek to explain the determinants of this phenomenon (Mussolini; Teles, 2010). In this sense, the present study is situated within the analytical tradition of regional development by investigating how territory-specific factors affect the relationship between investment and economic performance, thereby contributing to the understanding of local growth dynamics.

In this context, it becomes necessary to examine this issue in the state of Paraná, whose productive dynamics are marked by strong regional heterogeneity, the presence of consolidated industrial hubs, and different rhythms of expansion across its regions, as highlighted by Trintin and Campos (2013). This configuration reinforces the need to understand how private investments are spatially distributed and how they relate to municipal economic performance, given that the structural diversity observed in the state suggests that investments may exert different impacts depending on local income levels, thus justifying an investigation focused on the Paraná reality.

Given the importance of this approach, this article aims to analyze the impact of private investments on economic growth in the state of Paraná, adopting an income-level perspective. Quantile regression is employed in the data analysis, allowing the identification of differences in the impact of investment on the economy across municipalities with distinct economic levels. The municipalities of Paraná were allocated to the 0.25, 0.50, and 0.75 quantiles of state GDP per capita.

The study is organized into five sections, in addition to this introduction. The second section presents a theoretical and empirical review of the topic, followed by a description of the methodology and data sources. The subsequent section discusses the results, and the final section presents the concluding remarks.

THEORETICAL AND EMPIRICAL REVIEW

In the field of economic theory, scholars have, since the origins of the discipline, devoted themselves to the construction and analysis of theories aimed at clarifying the determinants of decision-making processes that enable economic growth. It is worth emphasizing, however, that given the nature of the economic phenomenon, no isolated action can, by itself, provide a comprehensive explanation for the full set of such determinants. Each action, nevertheless, plays an important role in the construction of a conceptual framework, facilitating the understanding of why a given region may improve its economic performance.

In this context, investment has always occupied a central place in explanations of economic growth, and the consideration of this financial phenomenon is of substantial importance for understanding the underlying mechanisms that drive economic advancement and prosperity.

According to Keynes (1936), investment is determined by the interaction between the marginal efficiency of capital and the interest rate. Some essential points of his theory deserve attention. Keynes does not conceive the interest rate merely as a cost of borrowing or financing, as in neoclassical theory, nor as an opportunity cost compatible with the return provided by financial assets, with respect to investment in productive capital goods. Rather, the interest rate is understood as a measure of people's reluctance to relinquish liquid control of money; in this sense, it represents the premium received for giving up liquidity.

Economic agents demand liquid money not only because of their expected levels of economic transactions, but also for speculative motives. The preference for liquidity is justified by uncertainty regarding future economic events and the outcomes of past and present investments. As a result, the interest rate constitutes a limit to productive investment, insofar as it represents an alternative use of capital, allowing investors to allocate resources in a broad portfolio of assets and thus linking investment decisions to liquidity considerations (Keynes, 1936).

The decline in the marginal efficiency of capital occurs due to its decreasing scarcity as the quantity demanded increases, as is the case with other capital assets. For investment goods (productive capital), the main constraint on investment is determined by the market for the goods produced with that capital. The reduction in marginal returns stems from rising financial

costs associated with amortization and corporate debt, as well as from the outflow of resources required to pay for capital goods, which reduces firms' liquidity positions. As these factors intensify, the financial risks borne by investors increase, leading to lower expected returns. Consequently, the level of investment in the economy is directly proportional to optimistic expectations and inversely proportional to liquidity preference, as reflected in the interest rate, which embodies the degree of risk and uncertainty in the economic environment (Keynes, 1936).

According to Jorgenson (1963), the central idea of the neoclassical investment model is that firms decide to invest in productive assets when the expected return on investment is equal to or greater than the market interest rate. In this framework, investment behavior is derived from the firm's optimization problem, which results in the choice of production inputs, capital and labor, and leads to the determination of the desired capital stock. The desired stock of fixed capital is a function of output levels and the user cost of capital, which in turn depends on the prices of capital goods, the net financial costs of capital after taxes, the corporate tax rate, and the discounted value of the planned depreciation rate (Servén; Solimano, 1993).

Within the neoclassical models proposed by Jorgenson (1963, 1971), the investment equation is derived from the firm's optimization problem. Ultimately, firms are treated as assets owned by households, which gives rise to a broader framework of household optimization. Starting from the intertemporal consumption model, saving is understood as the purchase of financial assets by households, including the acquisition of capital goods. Since the decision to invest is made by households and determines future consumption possibilities, the purchase of capital goods becomes an option within their intertemporal income allocation.

In turn, Tobin's (1969) theory is regarded as one of the first attempts to model investment behavior as being positively related to the ratio between the market value of the firm and the replacement cost of the existing capital stock. This ratio, known as Tobin's q, centralizes relevant information about future supply and demand conditions that influence investment decisions, incorporating adjustment costs and the desired capital stock. According to Caballero (1999), the investment rate can be determined solely by the contemporaneous value of q and by unexpected shocks.

Thus, the stock market provides a timely and readily available signal of investment incentives for firms. When stock market prices are high, the market indicates that the capital stock should be expanded to move from the current level of capital (K) toward the optimal capital stock (K*). Conversely, when stock prices decline, the market signals the need to reduce capital accumulation. When q exceeds one, the market price of capital is higher than its physical replacement cost. Under these conditions, firms can issue new shares, invest in physical capital, and distribute the remaining profits to shareholders in the form of dividends.

As can be observed, the study of investment in economic theory is essential for understanding economic growth and for guiding policies aimed at stimulating productive activity. For this reason, a substantial body of empirical work has been devoted to this subject, either to test theoretical assumptions or to provide evidence that supports the formulation of economic policy.

Mendonça and Almeida (2011) expanded this debate by developing a theoretical model that considered the direct and indirect effects transmitted by public infrastructure and taxation on private investment between 2001 and 2011. Using a Vector Autoregressive (VAR) model, the authors analyzed variables such as capital taxation, labor taxation, and changes in direct taxes. Their results indicated that infrastructure influences the process of capital accumulation, especially in land transportation and energy sectors, and that its expansion was associated with higher levels of private investment, reinforcing the role of infrastructure-oriented policies.

Luporini and Alves (2014) examined the determinants of private investment in Brazil between 1970 and 2005 from a long-term perspective. The authors found a positive relationship between interest rates and private investment, a result that remained close to zero in sectoral models, suggesting that increases in real interest rates did not produce a significant negative effect on investment. They also observed that the expansion of credit supply, particularly through subsidies from the Brazilian Development Bank (BNDES) to industrial sectors, was associated with increased private investment, while economic instability exerted a negative effect during the period analyzed.

In the study by Lélis, Bredow, and Cunha (2015), the focus was on the macroeconomic determinants of private investment in machinery and equipment between 1996 and 2012. Based on a Vector Error Correction Model, the authors sought to test elements associated with neoclassical and

Keynesian approaches. Their analysis suggested that variables related to the prices of capital goods and interest rates did not show strong explanatory power, whereas demand behavior, credit conditions, and expectations played a more prominent role. These findings linked capital formation in the 2000s to the expansion of consumer markets.

Vasques (2018) introduced an international perspective by evaluating the effects of public and private investments on GDP per capita in 81 countries between 2008 and 2016, using quantile regression. The variables included GDP per capita, household consumption, government spending, private investment, public investment, exports, and imports. The results indicated that investments followed GDP trends, with stagnation in 2008–2009 due to the global financial crisis, especially in the private sector. Public investments did not show statistical significance in the estimated model, and no clear relationship was identified between growth rates and the relative shares of public or private investment in GDP.

In turn, Orair and Siqueira (2018) analyzed the trajectory of public investment in the Brazilian economy and its relationship with the business cycle and the fiscal regime, using Vector Autoregressive models with series of public spending, public revenues, and GDP. Their results showed that during recessions, output responded more strongly to public investment shocks, whereas in expansions this response was less persistent. The authors highlighted that when public investment is related to the economic cycle and the fiscal regime, it tends to contract during crises, generating negative repercussions, as observed during the slowdowns of 2011–2014 and in the 2015 crisis, when fiscal multipliers reached high values.

Continuing the debate on the interaction between public and private investment, Bredow, Cunha, and Lélis (2022) examined the dynamic effects of public investment on private investment in machinery and equipment in Brazil between 1996 and 2018. Using a Vector Autoregressive model, the authors investigated variables such as private investment, federal government and state-owned enterprise investment, public investment in transportation, energy, and communications, GDP, capacity utilization, external debt, real exchange rates, and tax burden. The results indicated that increases in public investment stimulated private investment and that productivity was associated with investment behavior.

Finally, Meyer and Paula (2023) examined the determinants of private investment in Brazil between 2007 and 2017 from a post-Keynesian perspective. The estimated model was an Autoregressive Distributed Lag model using the Generalized Method of Moments estimator, with variables such as the investment rate, profit rate, financial leverage, financialization, uncertainty, interest rates, and capacity utilization. The results confirmed a negative relationship between financialization and productive investment and showed that higher levels of financial fragility negatively affect investment. Capacity utilization exhibited a positive relationship across all groups analyzed.

Within the context of Paraná, the focus of this article, studies by Gonçalves Júnior et al. (2010), Vieira et al. (2012), Silva and Ferrera de Lima (2015), and Lima (2018) indicate that the state's regional dynamics reinforce the need to understand how private investments and economic growth interact across space. Since the 1990s, Paraná has undergone a process of productive restructuring characterized by the consolidation of regional hubs, the dispersion of traditional industries into the interior, and the concentration of more dynamic industrial activities in specific areas, especially in the Metropolitan Region of Curitiba. This productive rearrangement intensified structural differences across the state's regions, leading to distinct patterns of employment generation and regional competitiveness.

Gonçalves Júnior et al. (2010), for example, found that between 2005 and 2009, 33.33% of Paraná's microregions experienced employment growth above the state average, and in most of them, differential factors outweighed structural components. Sectors such as construction, food and beverage manufacturing, textiles, retail and wholesale trade, public administration, and education were among the most relevant contributors to this dynamism. This regional heterogeneity, combined with different local capacities to absorb investment and generate economic externalities, reinforces the importance of analyzing how private investment relates to economic growth in Paraná.

Similarly, Vieira et al. (2012), when investigating the municipal distribution of per capita income and convergence mechanisms between localities from 1999 to 2006, identified a strong spatial component in the economic performance of Paraná's municipalities. Using exploratory spatial data analysis and spatial econometric models, the authors found evidence of absolute and conditional convergence in per capita income, albeit at a slow pace. This indicates that although municipalities share common structural characteristics, their development trajectories depend on

local idiosyncrasies and potentials that shape their growth capacity in different ways.

Silva and Ferrera de Lima (2015) approached the analysis from the concept of structural rupture, understood as a set of changes in the social division of labor and the sectoral composition of regions that may signal transitions to new development patterns. Their objective was to examine whether and how such ruptures occurred in Paraná's microregions between 1985 and 2012. Using regional analysis methods based on localization measures and employment indicators, the authors found that most microregions maintained a high concentration of employment in the primary sector, indicating that this segment remains significant in the state's economic structure and that many regions have not fully experienced, or completed, a process of structural rupture. More intense changes were observed between 1985 and 1999, while the subsequent period showed signs of saturation in productive restructuring, suggesting internal limits to further regional transformations.

Another contribution to understanding economic disparities in Paraná is provided by Ferrera de Lima (2018), who examined municipal inequalities through statistical analysis of fiscal value added, using this indicator to measure the magnitude of territorial asymmetries and to discuss alternatives for mitigating them. The study argues that although the state has a legal framework oriented toward urban and regional development, its instruments display weaknesses in addressing persistent structural inequalities among municipalities. The findings suggest that traditional policies, while necessary, are insufficient to reduce territorial disparities, pointing to the importance of strategies focused on strengthening human and social capital, such as support for entrepreneurship, professional training, increased school attendance, and incentives for small businesses. This perspective reinforces the need for development policies grounded in local dynamics, articulating state instruments with initiatives aimed at expanding municipalities' internal capacities.

Given the context outlined above, it is possible to observe a systematic investigation of the factors that influence investment decisions, using quantitative methods such as regression analysis and econometric models to provide evidence on this variable and its impact on economic growth at both national and state levels. In line with the objective of the present research, the next section presents the methodology and the database employed.

METHODOLOGY AND DATABASE

The econometric approach adopted in this study is quantile regression, a methodological tool designed for the analysis of heterogeneous data. The definition of the methodological strategy employed derives directly from the theoretical and empirical framework discussed in the previous section, since the reviewed literature indicates that the impact of private and public investments is not uniform across regions, whether due to structural, sectoral, institutional, or spatial differences. Studies focusing on the state of Paraná highlight persistent heterogeneity among municipalities, variations in growth trajectories, and differences in the capacity to absorb capital, elements that suggest that the effects of investment do not manifest homogeneously across the territory.

In light of this body of evidence, it becomes appropriate to employ an approach capable of capturing variations in the effects of explanatory variables across different points of the distribution of municipal output. Quantile regression meets this requirement by allowing the estimation of how investment affects municipalities with distinct levels of GDP per capita. This approach is therefore consistent with the literature that emphasizes the asymmetric nature of regional growth and the structural differences observed in Paraná. Consequently, the choice of this method is grounded in theoretical and empirical contributions that point to the relevance of examining heterogeneity in the impacts of investment on municipal economic growth.

The coefficients derived from quantile regression can demonstrate robustness under weaker stochastic assumptions when compared to those obtained through ordinary least squares estimation (Cameron; Trivedi, 2005). Koenker and Bassett (1978) emphasize that this technique has the ability to describe the varying impacts of explanatory variables at different points of the outcome distribution.

Unlike ordinary least squares, which assumes homogeneity, quantile regression does not rely on such assumptions, explicitly recognizing heterogeneity in the sample distribution. This approach allows for the identification of how the impact of investment varies according to the economic level of a given region, here, the municipalities of Paraná. Thus, quantile regression enables the analysis of different estimates across distinct scenarios of economic growth in the state. It is a statistical technique focused on modeling the relationship between variables, particularly when the objective

is to understand how different quantiles of a response variable are affected by independent variables. This methodology is especially useful when data do not follow a normal distribution and when the relationship between variables is not homogeneous across the entire range of values.

The quantile regression model can be expressed as follows:

$$Q_{\tau(y|x)} = x'\beta_\tau \qquad (1)$$

where $Q_{\tau(y|x)}$: quantile τ of the dependent variable y conditioned on the values of the independent variables x; x: vector of independent variables, and; β_τ: vector of coefficients to be estimated.

A fundamental component of quantile regression is the loss function, which, according to Koenker and Bassett (1978), is used to measure the deviation between observed values and those predicted by the model, and is represented as:

$$L_\tau(\mu) = \begin{cases} \tau\mu & se\ \mu \geq 0 \\ (\tau - 1)\mu & se\ \mu < 0 \end{cases} \qquad (2)$$

where μ denotes the difference between the observed and predicted values. This loss function penalizes deviations differently depending on the sign of the deviation and the quantile e τ. In the regression, according to Koenker and Bassett (1978), the parameters β_τ are estimated by minimizing this loss function, as defined by the optimization problem shown below:

$$\hat{\beta} = \arg_\beta min \sum_{i=0}^{n} L\tau(y_i - x'\beta) \qquad (3)$$

In addition to coefficient estimation, quantile regression also allows for the assessment of estimator variability in order to evaluate the uncertainty associated with the estimated coefficients. Bootstrap techniques are commonly employed for this purpose.

In this study, regressions were estimated for the 0.25, 0.50, and 0.75 quantiles of GDP per capita across municipalities in Paraná. Beyond coefficient estimation, quantile regression enables the evaluation of the variability of estimators using bootstrap techniques, providing more robust standard errors and greater reliability for hypothesis testing regarding the statistical significance of

the estimated parameters (Koenker; Bassett, 1978).

The relationship between investment variables and their impact on the economy is represented by the following regression:

$$y_i = \beta_0 + \beta_1 CFI_i + \beta_2 CFP_i + \beta_3 CH_{1i} + \beta_4 CH_{2i} + \beta_5 CH_{3i} + \beta_4 CH_{4i} + \mu_i \quad (4)$$

Where: i) y_i: GDP per capita; ii) CFI_i: private investment; iii) CFP_i: public investment; CH_1: basic human capital; iv) CH_2: intermediate human capital; v) CH_3: higher human capital; vi) CH_4: health dimension of human capital, and; vii) μ_i: error term.

According to Koenker (2005), the use of bootstrap methods has become increasingly common in quantile regression applications due to their effectiveness in modeling distributions that are independent but not necessarily identical. In addition, the method can be applied to relatively small samples and provides a flexible covariance matrix that accommodates different forms of heterogeneity. Thus, when applied, quantile regression is well suited for modeling data in which heteroskedasticity is expected to be present.

In this research, bootstrap standard error correction with 1,000 replications was employed. That is, a resampling process was repeated one thousand times, in which new simulated samples were generated by randomly selecting observations from the original sample, allowing the same data points to be selected more than once. This iterative procedure enables the assessment of variability and uncertainty in statistical estimates, since one thousand different estimates are obtained through repeated sampling.

All variables used in the study were obtained from the Paraná Institute of Economic and Social Development (IPARDES). GDP per capita (Y_i), the share of industrial GDP in total GDP as a proxy for private investment (CFI_i), the share of municipal capital expenditures representing public investment (CFP_i), and the human capital variables $CH1_i$, $CH2_i$, and $CH3_i$, corresponding, respectively, to the number of workers with completed primary, secondary, and tertiary education per one hundred thousand inhabitants, were all transformed using the natural logarithm. The variable $CH4_i$, referring to the health dimension of the Municipal Development Index (IPDM), was also obtained from IPARDES and did not require additional transformation.

RESULTS AND DISCUSSION

In order to better understand the database and the characteristics of the population analyzed, a brief descriptive analysis of the main variables of interest is presented, namely GDP per capita and the variables of public and private investment. The objective is to identify the municipalities that exhibited the lowest and highest values for these variables. Table 1 presents the distribution of the absolute and relative frequency of GDP per capita in the municipalities of Paraná in 2019.

As can be observed, Paraná has 333 municipalities with GDP per capita ranging from R$ 12,365.00 to R$ 42,203.80, corresponding to a relative frequency of 83.46%. There are 57 municipalities with GDP per capita between R$ 42,203.80 and R$ 72,042.60, with a relative frequency of 14.29%; six municipalities with GDP per capita between R$ 72,042.60 and R$ 101,881.40, with a relative frequency of 1.50%; one municipality with GDP per capita between R$ 101,881.40 and R$ 131,720.20, with a relative frequency of 0.25%; and finally, two municipalities with GDP per capita between R$ 131,720.20 and R$ 161,559.00, with a relative frequency of 0.50%.

Table 1 | Frequency distribution of GDP per capita in the municipalities of Paraná in 2019

GDP *per capita*			Absolute frequency	Relative frequency
R$ 12.365,00	|-	R$ 42.203,80	333	83,46%
R$ 42.203,80	|-	R$ 72.042,60	57	14,29%
R$ 72.042,60	|-	R$ 101.881,40	6	1,50%
R$ 101.881,40	|-	R$ 131.720,20	1	0,25%
R$ 131.720,20	|-|	R$ 161.559,00	2	0,50%

Source: Research results, the authors.

In the state of Paraná, most municipalities fall within the lowest GDP per capita range, from R$ 12,365.00 to R$ 42,203.80. Approximately 64 municipalities are in the middle range, with GDP per capita between R$ 42,203.80 and R$ 131,720.20, while only two municipalities are in the highest range, from R$ 131,720.20 to R$ 161,559.00. Table 2 presents the five municipalities with the highest and lowest GDP per capita in Paraná in 2019.

The municipalities of Piraquara, Doutor Ulysses, Tunas do Paraná, Almirante Tamandaré, and Guaraqueçaba recorded the lowest GDP per capita values, respectively R$ 12,365.00, R$ 12,380.00, R$ 13,597.00, R$ 13,735.00, and R$ 13,831.00. Based on the data in Table 1, these municipalities are among the 333 municipalities with GDP per capita between R$ 12,365.00 and R$ 42,203.80.

The municipalities of Saudade do Iguaçu, Ortigueira, Araucária, Indianópolis, and São José dos Pinhais stand out as the five leaders in terms of GDP per capita in the state of Paraná. According to the data provided, Saudade do Iguaçu and Ortigueira occupy the first two positions, with values of R$ 161,559.00 and R$ 131,014.00, respectively. These figures indicate a high concentration of income per inhabitant in these locations.

Table 2 | Five municipalities with the highest and lowest GDP per capita in Paraná in 2019

Municipalities with the 5 lowest GDP per capita	
Piraquara	R$ 12.365,00
Doutor Ulysses	R$ 12.380,00
Tunas do Paraná	R$ 13.597,00
Almirante Tamandaré	R$ 13.735,00
Guaraqueçaba	R$ 13.831,00
Municipalities with the 5 highest GDP per capita	
Saudade do Iguaçu	R$ 161.559,00
Ortigueira	R$ 131.014,00
Araucária	R$ 130.033,00
Indianópolis	R$ 118.880,00
São José dos Pinhais	R$ 92.654,00

Source: Research results, the authors.

The other municipalities mentioned also present substantial values, with GDP per capita values ranging from R$ 130,033.00 to R$ 92,654.00. It is noteworthy that these municipalities are among the seven with the highest GDP per capita in the state, as shown in Table 1. This income distribution highlights the economic importance of these specific areas within the Paraná context, suggesting a concentration of prosperous economic activities and a high standard of living for their residents.

Table 3 presents the five municipalities with the highest and lowest proportions of industrial output in GDP in 2019. As can be seen, the five municipalities with the lowest proportions were São Jerônimo da Serra, Cruz Maltina, São Jorge do Ivaí, Nossa Senhora das Graças, and Laranjal, with industrial shares of 2.95%, 2.97%, 2.98%, 3.07%, and 3.10%, respectively.

The data indicate that the municipalities of Saudade do Iguaçu, Capitão Leônidas Marques, Ortigueira, Pinhão, and Diamante do Norte stand out for presenting the highest industrial shares of GDP in the state of Paraná. For example, Saudade do Iguaçu leads with 85.54%, followed by Capitão Leônidas Marques with 74.01%, Ortigueira with 67.00%, Pinhão with 63.25%, and Diamante do Norte with 62.85%. These figures suggest a strong presence of the industrial sector in these areas, and according to the theoretical framework presented, such municipalities are expected to show better economic performance.

Table 3 | Five municipalities with the highest and lowest proportions of industrial output in GDP in 2019

Municipalities with the 5 lowest proportions of industry in GDP	
São Jerônimo da Serra	2,95%
Cruz Maltina	2,97%
São Jorge do Ivaí	2,98%
Nossa Senhora das Graças	3,07%
Laranjal	3,10%
Municipalities with the 5 highest proportions of industry in GDP	
Saudade do Iguaçu	85,54%
Capitão Leônidas Marques	74,01%
Ortigueira	67,00%
Pinhão	63,25%
Diamante do Norte	62,85%

Source: Research results, the authors.

As emphasized in the economic literature, industrial activity tends to stimulate regional economic growth by generating employment, increasing productivity, and promoting technological progress. Therefore, it can be inferred that municipalities with a higher share of industry in GDP may also enjoy higher economic levels compared to those with a lower industrial presence. Conversely, municipalities with a low industrial share in GDP may face challenges in terms of economic growth, since limited private investment in industry may restrict employment opportunities, reduce economic diversification, and slow the adoption of more advanced technologies.

Given the objective of this research, to assess the impact of private investment on economic growth considering different income levels, Tables 4 and 5 present the estimates of the quantile regressions, starting with the approach without bootstrap correction for the 0.25, 0.50, and 0.75 quantiles of GDP per capita in the state. This allows the analysis of the responses of private and public investment in relation to GDP per capita according to the economic level of each municipality.

Table 4 reports the results of the quantile regression for the municipalities of Paraná by quantile, without bootstrap correction. As indicated in the methodology, quantile regression can be estimated without bootstrap correction; however, this may result in less robust standard errors and, consequently, less reliable significance tests.

In the first quantile, it is possible to verify that the private investment variable shows a greater contribution to GDP per capita than public investment. A 1% increase in private investment can raise economic growth by 1.71%, whereas public investment generates an impact of 0.66%. In the second quantile, the same pattern is observed, although with different magnitudes: a 1% increase in private investment raises GDP per capita by 1.70%, while the impact of public investment increases to 0.79%. This indicates that for municipalities in this quantile, private investment exerts a greater effect on GDP per capita than public investment. Finally, in the third quantile, public investment becomes more relevant than private investment, thus presenting different effects from the previous quantiles.

Table 4 | Estimation of the model without bootstrap correction

Variables	1st quantile (0.25)	2nd quantile (0.50)	3rd quantile (0.75)
CFI_i	1.7138***	1.7090***	1.5779***
CFP_i	0.6685**	0.7901*	1.8422***
CH_{1i}	0.0502	-0.0025	0.0473
CH_{2i}	0.0809	0.0560	0.0770
CH_{3i}	0.3449***	0.3659***	0.2943***
CH_{4i}	0.2017	0.3969**	0.4436**
Constant	5.815	6.240	6.310
Regression diagnostics			
Wald test	50.52***	50.52***	50.52***
Coefficient of determination (R^2)	0.5187	0.5202	0.5046
Number of replications	0	0	0

Source: Research results, the authors.
Notes: *** significant at 1%; ** significant at 5%; * significant at 10%; and ns = not significant.

Other variables that exhibited relevance were human capital at level three and human capital related to health. Human capital at level three, represented by workers with completed higher education per one hundred thousand inhabitants, showed statistical significance in all three quantiles, although with different magnitudes. In the first quantile, a 1% increase in this variable results in a 0.34% increase in GDP per capita. In the second quantile, this effect rises to 0.36%, while in the third quantile it declines to 0.29%. Thus, regardless of the municipality, higher education contributes positively to GDP per capita.

Human capital related to health showed statistical significance in the second and third quantiles. A 1% increase in health-related human capital leads to a 0.39% increase in GDP per capita for municipalities in the second quantile and a 0.44% increase for those in the third quantile.

The study by Sanches and Rocha (2010) demonstrated the importance of public and private investment acting jointly in economic growth, a result also highlighted by Cruz, Teixeira, and Braga (2010), who found that higher levels of education are associated with better health conditions and greater contributions to per capita income growth. These empirical studies converge with the findings of the present research by emphasizing the relevance of private investment, as well as public investment, for economic performance.

Table 5 presents the quantile regression estimates for the municipalities of Paraná by quantile, now including bootstrap correction. As indicated in the methodology, this procedure allows for more robust standard errors and, consequently, greater validity in hypothesis testing regarding the statistical significance of the estimated parameters.

Table 5 | Estimation of the model with bootstrap correction

Variables	1st quantile (0.25)	2nd quantile (0.50)	3rd quantile (0.75)
CFI_i	1.7138***	1.7090***	1.5779***
CFP_i	0.6685*	0.7901*	1.8422***
CH_{1i}	0.0502	-0.0025	0.0473
CH_{2i}	0.0809	0.0560	0.0770
CH_{3i}	0.3449***	0.3659***	0.2943***
CH_{4i}	0.2017	0.3969**	0.4436**
Constant	5.815	6.240	6.310
Regression diagnostics			
Wald test	335.45***	238.83***	162.04***
Coefficient of determination (R^2)	0.5188	0.5202	0.5047
Number of replications	1000	1000	1000

Source: Research results, the authors.

Notes: *** significant at 1%; ** significant at 5%; * significant at 10%; and ns = not significant.

The first quantile represents municipalities with the lowest GDP per capita in Paraná. The results show that private investment and human capital represented by workers with completed higher education are more relevant than the other variables. A 10% increase in private investment can raise GDP per capita by 17.13%, while a 10% increase in public investment raises GDP per capita by 6.68%. In this quantile, private investment contributes more to GDP per capita than public investment.

In the second quantile, private investment and higher-education human capital again stand out relative to the other variables. A 10% increase in private investment can raise GDP per capita by 17.09%, while a 10% increase in public investment increases GDP per capita by 7.90%. As in the first quantile, private investment shows greater significance than public investment.

In the third quantile, which represents municipalities with the highest GDP per capita in Paraná, different results emerge. Private investment, public investment, and higher-education human capital all show greater relevance than the remaining variables. A 10% increase in public investment can raise GDP per capita by 18.42%, while a 10% increase in private investment raises GDP per capita by 15.77%.

Rigolon (1998) found that private investment is effective in promoting economic growth and employment. Vasques (2018) showed that investment followed GDP trajectories, although public investment exhibited lower values than private investment. Luporini and Alves (2010) emphasized that economic instability affects private investment in the industrial sector, leading entrepreneurs to seek economic and political stability in order to make more secure forecasts.

As presented in the theoretical and empirical framework, public and private investment variables are relevant to the economy. Through the methodological approach adopted, it was possible to verify that these variables, especially private investment, contribute to GDP per capita, although their impact varies according to the economic level of the municipality.

The results therefore contribute to the field of regional development by demonstrating that the effects of investment on economic growth are not uniformly distributed across Paraná's territory, but rather vary according to municipal income levels. This finding aligns with the literature that emphasizes heterogeneous productive structures, differentiated local trajectories, and

distinct capacities for capital absorption across regions. By showing that private investment exerts a greater impact in municipalities located in the lower quantiles of GDP per capita, while public investment becomes more important in the upper quantiles, the study reinforces the idea that regional development policies should account for structural inequalities and contextual differences when designing strategies. Moreover, the application of quantile regression enriched the empirical debate by revealing effects that would not be captured by mean-based approaches, allowing the inference that the relationship between investment and growth in Paraná is asymmetric, and that this asymmetry is a relevant element for understanding regional development dynamics.

FINAL CONSIDERATIONS

The present study sought to evaluate the influence of public and private investments on economic growth in the state of Paraná, also examining the behavior of other variables that determine the growth of GDP per capita. As evidenced throughout the analysis, the study of investment in economic theory emerges as a central element for understanding economic growth and for the formulation of public policies capable of fostering the growth of a country or region. From this perspective, a considerable body of empirical research has been conducted with the aim of validating theoretical principles and guiding investment strategies and economic policies.

Empirical studies, in turn, reveal a systematic approach to investigating the determinants of investment decisions, employing quantitative methods in order to provide evidence on this variable and its impact on economic growth.

Through a descriptive analysis of the state, it was observed that the municipalities with the five highest GDP per capita in Paraná were São José dos Pinhais, Indianópolis, Araucária, Ortigueira, and Saudade do Iguaçu, while those with the five lowest were Piraquara, Doutor Ulysses, Tunas do Paraná, Almirante Tamandaré, and Guaraqueçaba. With respect to private investment, the municipalities with the five highest proportions of industry in GDP in 2019 were Diamante do Norte, Pinhão, Ortigueira, Capitão Leônidas Marques, and Saudade do Iguaçu. Conversely, the municipalities with the five lowest proportions of industry in GDP in 2019 were São Jerônimo da

Serra, Cruz Maltina, São Jorge do Ivaí, Nossa Senhora das Graças, and Laranjal. Regarding public investment, the five municipalities with the highest municipal capital expenditures in 2019 were Santa Terezinha de Itaipu, Juranda, Formosa do Oeste, Pitanga, and Itaipulândia, while the five with the lowest were Godoy Moreira, São Carlos do Ivaí, Cruz Machado, Uraí, and Enéas Marques.

The methodological approach adopted was quantile regression, with the objective of assessing the impact of investment on GDP per capita while considering the distinct economic levels of each municipality. Through this methodology, and in line with economic theory, investment proved to be an important factor in shaping economic growth, such that both public and private investment are relevant variables in determining economic growth in the state of Paraná, with positive effects. In the first and second quantiles, corresponding to municipalities in the 0.25 and 0.50 quantiles of GDP per capita, private investment was shown to be significant for product growth. In the third quantile, corresponding to municipalities in the 0.75 quantile of GDP per capita, public investment exhibited greater significance for product growth.

It can therefore be inferred that, as proposed in the objective of this research, the importance attributed to investment, whether public or private, in the context of economic growth in the state of Paraná varies according to the specific economic level of each municipality. Such diversity results in differentiated effects, contributing to the understanding of specific patterns that emerge in the interaction between investment and economic development across distinct regions of Paraná.

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