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A Note on the Relationship between Public and Private Investment in Brazil

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Abstract

This study reexamines the relationship between public investment and private investment in Brazil from January 2007 to February 2023, with a focus on the asymmetries observed during periods of elevated public debt. The findings indicate that the effects of public investment—whether substitution (crowding-out) or complementarity (crowding-in) with private investment—are contingent upon the prevailing economic conditions. Specifically, in contexts of high public debt, crowding-out effects tend to dominate. The analysis underscores the importance of aligning public investment programs with the country's fiscal and debt dynamics. Failure to do so may undermine their effectiveness, given the asymmetric nature of these interactions.

Keywords: Crowding-out; Crowding-in, Public Debt

1. Introduction

The debate surrounding the role of public investment in Brazil's economic development has intensified in the aftermath of the Covid-19 pandemic. On August 11, 2023, the New Growth Acceleration Program (New PAC) was introduced, earmarking R$ 1.7 trillion for investments across all Brazilian states. Central to the program's rationale is the assumption that public spending can stimulate private investment, a phenomenon commonly referred to as the crowding-in effect.

From a Keynesian perspective, particularly within the IS-LM framework, fiscal policy is effective in stimulating aggregate demand in conditions of underemployment. However, under full employment, public spending may exert upward pressure on wages and prices, potentially triggering the opposite phenomenon, known as crowding-out.

In neoclassical models, Barro (1997) identifies two primary channels of impact: an expansion of labor supply and the provision of public services as inputs for private production. Public investments that substitute private capital can reduce the latter's productivity, causing crowding-out. Conversely, investments in infrastructure that complement private capital may foster crowding-in (Kumahara, 2017).

Empirical studies on Brazil's economic dynamics yield mixed results. Evidence of crowding-out effects has been presented by Rocha & Teixeira (1996), Melo & Rodrigues Júnior (1998), Bicudo (2007), Jacinto & Ribeiro (1998), and Sonaglio, Braga & Campos (2010), indicating that public investments displace private ones. On the other hand, studies by Sanches & Rocha (2010) and Fernandez, Shikida, Menezes & Almeida (2017) highlight strong complementarities, where public investments drive private sector expansion. These diverse findings underscore the complex and multifaceted nature of the relationship between public and private investments in Brazil's economic development.

Kumahara (2017) further highlights sectoral asymmetries in these dynamics. Evidence suggests that crowding-in effects are prominent in sectors such as Communication, Health and Sanitation, Education, and Public Defense and Security. In contrast, crowding-out effects dominate in sectors like Transport, Energy, and Mineral Resources.

The challenge of assessing the efficacy of public investments is compounded by Brazil's high levels of federal government debt. Elevated debt can constrain public investment through two main mechanisms. First, high debt levels often erode investor confidence, raising public financing costs due to heightened default risk. This, in turn, drives up interest rates across the economy, discouraging private investment. Second, under Ricardian equivalence, substantial public debt signals the likelihood of future tax increases, thereby suppressing private consumption and investment.

Brazil's Gross General Government Debt (GGGD) peaked at 89% of GDP in October 2020 during the global economic downturn caused by the Covid-19 pandemic. Between January 2014 and December 2018, public debt increased at an average rate of 0.66 percentage points per month, signaling a structural shift to higher debt levels. These trends highlight the critical importance of accounting for public debt levels when analyzing the crowding-in or crowding-out effects of public investment.

This study revisits the relationship between public investment spending and private investment in Brazil over the period from January 2007 to February 2023, with a particular focus on asymmetries during periods of high public debt. Employing the Dynamic Ordinary Least Squares (DOLS) methodology, the analysis explores long-term relationships among key variables, including public investment, gross fixed capital formation, and National Development Bank (BNDES) disbursements, alongside fiscal and credit indicators. The study's primary contribution lies in its use of DOLS with high-frequency monthly data and its exploration of whether these investment effects persist under conditions of elevated public debt—a dimension that remains underexplored in Brazil's existing literature.

2. Literature Review

The discussion on the effects of public spending on private investment dates back to studies by Friedman (1978), who, using an IS-LM model, argues that fiscal policy should focus on the real side of the economy, as resource constraints and productivity increases may limit its effectiveness. Aschauer (1989) suggests that public deficits impact real interest rates, private investment decisions, and economic performance. Rocha & Teixeira (1996) find evidence of "crowding-out" in Brazil, where an increase in public investment displaces private investment. Melo & Rodrigues Júnior (1998) also observe this effect between 1970 and 1995, linked to the government's inability to invest in infrastructure, which is crucial to complement private investments.

Jacinto & Ribeiro (1998) corroborate this finding, showing a "crowding-out" effect between public and private investment in Brazil. Ahmed & Miller (2000) highlight that public spending financed by taxes has a greater impact on private investment than that financed by debt. Other studies, such as Ho (2001), Bilgili (2003), and Sonaglio et al. (2010), also identify substitution effects between public and private investments, although some find crowding-in effects depending on the type of expenditure.

Furceri & Sousa (2011) analyze the impact of public spending on private consumption and investment, finding negative effects, while Mahmoudzadeh & Sadeghi (2013) observe that government capital formation has a positive effect on private investment, especially in developed countries. However, studies by Tan, Huang & Woo (2016) and Kumahara (2017) suggest that certain public investments, such as in communication and health, can complement private investment.

Bicudo (2007) and Sanches & Rocha (2010) also confirm that, under certain circumstances, public investments in Brazil complement private investments, particularly in sectors such as infrastructure. However, other studies, such as those by Hammad (2023) and Rizkallah (2019), continue to observe the "crowding-out" effect in various economies. Furthermore, Al-Husseini (2022) and Jang (2019) confirm this effect in specific contexts, such as the United States and Algeria.

This study aims to contribute to the existing literature by using the approach of Bicudo (2007) and Kumahara (2017) to analyze the long-term dynamic effects between public and private investments in the Brazilian economy, with a focus on possible asymmetries generated by changes in public debt.

3. Methodological Strategy

3.1 Data

This study investigates the impact of public investment on private investment using monthly data spanning from January 2007 to February 2023. The analysis adopts the methodological framework established by Fernandez et al. (2017) and Kumahara (2017). A summary of the variables utilized in the study is provided in Table 1. All monetary variables were adjusted for inflation using the Wholesale Price Index (IPA-DI)[1].

Chart 1: Variables Description

Variable	Description and Source
Private Investment (FBCF)	Gross Fixed Capital Formation (GFCF). Measures the increase in companies' capital assets, including machinery, equipment, and construction materials. It serves as an indicator of private investment in the economy. Source: Ipeadata.
Crédit Volume (BNDES)	Measures the total disbursements granted by BNDES, expressed in millions of Brazilian Reais. *Source: BNDES*.
Public Investment (IPUB)	Public Investment**.** Represents the actual payments made by the Executive, Legislative, and Judiciary branches, covering the expenditure group "Investment." *Source: Monthly Debt Report - National Treasury Secretary*.
Capacity Utilization (UTCAP)	Defined as the limit or capacity of industrial production, representing the amount of output that installed machinery and equipment can produce. *Source: Ipeadata*.
Inflation (IGPM)	A weighted arithmetic mean of three price indices: the Broad Producer Price Index (IPA), the Consumer Price Index (IPC), and the National Construction Cost Index (INCC). Used in this model to capture price variation effects. *Source: Ipeadata*.

Source: Developed by the author.

3.2 Econometric Strategy

This study employs the Dynamic Ordinary Least Squares (DOLS) method proposed by Stock & Watson (1993). DOLS efficiently estimates cointegration vectors, accommodating variables with different integration orders and addressing simultaneity within demand systems. Monte Carlo simulations indicate that DOLS estimators are more robust in small samples compared to alternatives (Stock & Watson, 1993). The model is suited to measure the long-term effects of independent variables on Gross Fixed Capital Formation (FBCF) and handle series with distinct integration orders. The following equation will be estimated:

$$FBCF_t = X_t M_t' + \sum_{i=-m}^{i=m} \phi_i \Delta IPUB_{t+i} + \sum_{i=-n}^{i=n} \rho_i \Delta \mathrm{BNDES}_{t+i} + \sum_{i=-l}^{i=l} \psi_i \Delta \mathrm{UTCAP}_{t+i} + \sum_{i=-p}^{i=p} \omega_i \Delta \mathrm{IGPM}_{t+i} \qquad (1)$$

Which M captures the long run relationship between the variables, $X_t = [1, IPUB_t, \mathrm{BNDES}_t, \mathrm{UTCAP}_t, \mathrm{IGPM}_t]$ and $\pm m, \pm n, \pm l \; e \; \pm p$ represent the leads and lags of the first difference regressors.

As a robustness check, Fully Modified OLS (FMOLS) models, proposed by Phillips & Hansen (1990), will also be estimated. The DOLS and FMOLS approaches outperform conventional OLS by effectively addressing endogeneity through the inclusion of leads and lags and accounting for heteroskedasticity, with FMOLS using a non-parametric approach (Arize, Malindretos & Ghosh, 2015). Additionally, these methods offer advantages over Error Correction Models (ECM), as they do not require weak exogeneity of the regressors (Soave, Gomes & Sakurai, 2016), which would be an overly restrictive assumption given the endogenous relationship among the variables in this study.

The Dynamic Ordinary Least Squares (DOLS) model, proposed by Stock & Watson (1993), offers several advantages over Vector Error Correction (VEC) and Autoregressive Distributed Lag (ARDL) models for time series analysis and long-term relationship modeling. One key advantage of DOLS is its flexibility in handling non-stationary time series of different orders of integration, including those higher than 1. While VEC models require variables to be integrated of order 1, I(1), necessitating differentiation for higher-order series, and ARDL accommodates only I(0) and I(1) variables, DOLS allows variables to remain in their original form. This preserves information and simplifies interpretation, especially when variables have distinct or higher integration orders.

Moreover, DOLS provides consistent estimates of long-term parameters, making it particularly suitable for cointegration analysis. In comparison, VEC and ARDL models are more sensitive to misspecifications, making DOLS a robust choice for time series with distinct integration orders. According to Stock & Watson (1993), the inclusion of lags and leads of variables as regressors not only addresses endogeneity but also mitigates autocorrelation issues, further enhancing the model's reliability.

3.3 Incorporating the Effects of Brazil's New Public Debt Levels

In recent years, particularly following the 2015–2016 economic recession, a shift in Brazil's Debt-to-GDP ratio has been observed. The Gross General Government Debt (GGGD), which averaged 55.27% of GDP before 2014, has risen to an approximate average of 72.26% over the past nine years.

Two key factors contributed to this increase: the recession and the government's leverage through interventions in various markets. Programs such as the Growth Acceleration Program (PAC) and the Investment Support Program (PSI) aimed to enhance infrastructure investment and promote the acquisition and export of capital goods in strategic industrial sectors crucial for economic growth.

Additionally, initiatives like *Minha Casa Minha Vida* (MCMV) and *Minha Casa Melhor* subsidized housing financing, enabling the emerging middle class to access this market, thereby stimulating the Construction sector. Educational programs like the Student Financing Fund (FIES), expanded to facilitate access to higher education, and the Science Without Borders program, launched in 2011 to fund academic scholarships abroad, further contributed to the government's financial liabilities.

The combined weight of these programs accelerated public debt growth, as shown in Figure 1, which highlights the shift in Brazil's debt trajectory starting in 2015. This new debt level affects public investment expectations and financing. High debt economies face increased interest rates for long-term investment financing, which can lead to higher costs for fund allocation, depreciation of machinery, and reduced societal returns on projects over time.

Thus, it is essential to include the effects of public debt in discussions about the relationship between public and private investments. Two approaches can be used to evaluate this effect. The first, and most common, involves models that account for endogeneity among variables and an exogenous threshold, as in Caner & Hansen (2004). However, this approach assumes variable stationarity.

The second approach considers the presence of a structural break, whose effects can be incorporated into the model through dummies variables. Given the overlap between the analysis period and a historic political transition and economic policy shift, as shown in Figure 1, the second approach was chosen.

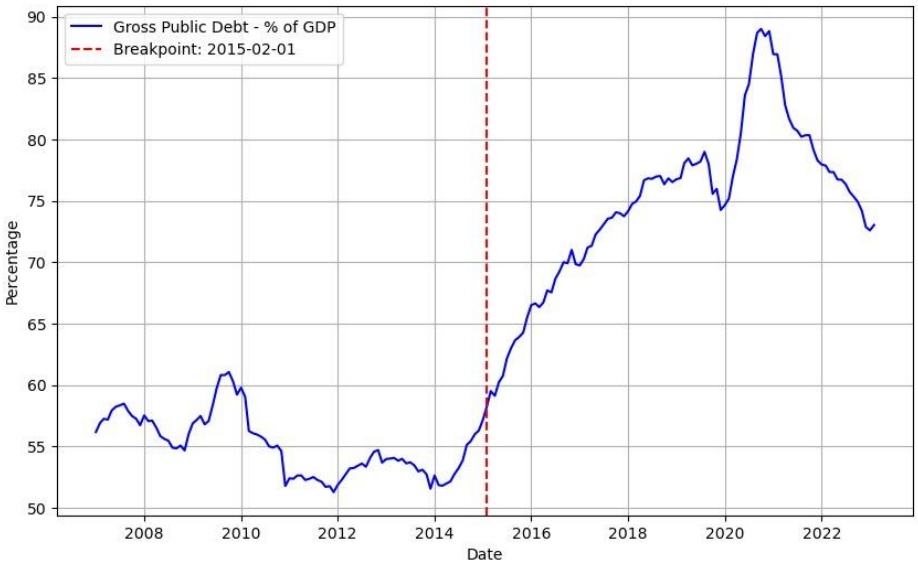

Figure 1. Evolution of Brazilian Public Debt (% GDP)

Source: Developed by the author.

Using the structural break test by Vogelsang (1997) on the General Government Debt series, February 2015 was identified as the breakpoint for the debt level shift. To detect asymmetries in the relationship between public and private investments, a dummy variable was introduced. This dummy equal 1 for observations after February 2015 and 0 for earlier periods, interacting with variables such as public investment, BNDES credit volume, IGP-M, and Capacity Utilization. Thus, the model incorporating the public debt shift is represented as:

$$FBCF_t = X_t M_t' + DX_t M_t' + \sum_{i=-m}^{i=m} \phi_i \Delta IPUB_{t+i} + \sum_{i=-n}^{i=n} \rho_i \Delta \mathrm{BNDES}_{t+i} + \sum_{i=-l}^{i=l} \psi_i \Delta \mathrm{UTCAP}_{t+i} + \sum_{i=-p}^{i=p} \omega_i \Delta \mathrm{IGPM}_{t+i} \quad (2)$$

Where the component $DX_t M_t'$ captures the effects of the model's variables on private investment after February 2015. The econometric strategy can be summarized as follows: first, the order of integration of the series will be analyzed using ADF and KPSS tests. Next, the Johansen procedure will be applied to verify cointegration. Benchmark models will then be estimated using DOLS and FMOLS methods. Finally, models incorporating interactions between the variables and the post-public debt shift dummy will be introduced to identify potential asymmetric effects.

4. Results

To assess the stationarity of the model's variables, the Augmented Dickey-Fuller (ADF) and KPSS tests were applied. The ADF test evaluates the null hypothesis of a unit root presence, while the KPSS test examines the null hypothesis that the time series is stationary. Table 1 summarizes the unit root test results. Both tests indicate that all variables used in the study are I(1), except for the capacity utilization series (UTCAP), which was found to be stationary.

Table 1. Results from Unit Root Tests

Variable	ADF		KPSS	
	Level	First Difference	Level	First Difference
FBCF	-2.2	-15.11*	0.23*	0.11
IGPM	0.54	-6.53*	1.63*	0.18
BNDES	-0.2	-13.74*	1.26*	0.21
IPUB	-0.02	-8.70*	0.80*	0.1
UTCAP	-3.56*	-13.91*	0.11	0.02

Source: Developed by the author. * Significant at 5%.

Next, a cointegration analysis was conducted using trace and maximum eigenvalue tests. The results, presented in Table 2, confirm the existence of a long-term relationship among the variables. Following this confirmation, the models specified in Equation 1 were estimated.

Table 2. Trace and Maximum Eigenvalue Tests

Test Structure		Eigenvalue	Trace Test	P-value	Max Eigenvalue	P-value
H0	H1					
r = 0	r ≥ 1	0.31	123.95*	0.00	81.68*	0.02
r ≤ 1	r ≥ 2	0.10	42.27	0.15	21.32	0.25

Source: Developed by the author. * Significant at 5%.

Table 3 displays the estimated coefficients of the Benchmark model using DOLS and FMOLS. The selection of lags and leads was based on minimizing information criteria, with a maximum reference of 6, resulting in the choice of 2 lags and 2 leads for the model estimation.

Table 3. Results from the Benchmark Model

Variable/Model	DOLS		FMOLS	
	Coefficient	P-value	Coefficient	P-value
IPUB	0.10*	0.02	0.02*	0.03
IGPM	0.46*	0.00	0.47*	0.00
BNDES	0.12*	0.00	0.18*	0.00
UTCAP	3.11*	0.00	2.37*	0.00
Intercept	-13.57*	0.00	-10.35*	0.00
R^2	0.86		0.35	
D(lags)	2		-	
D(leads)	2		-	

Source: Developed by the author. * Significant at 5%.

In general, the Benchmark models report a positive and statistically significant effect of aggregate public investment expenditures on private investment. Since the variables are logarithmically transformed, the coefficients can be interpreted as elasticities. For instance, the estimated DOLS model indicates that a 10% increase in public investment leads to a 1% increase in private investment.

Thus, the evidence from the Benchmark models suggests that during the period under analysis, public investment acted as a driver of private investment in Brazil, exhibiting a *crowding-in* effect. These findings align with those of Fernandez et al. (2017) and Sanches & Rocha (2010).

The estimation also highlights the positive coefficient for BNDES disbursements, indicating a 1.2% increase in private investment for every 10% rise in BNDES credit. As expected, capacity utilization positively influences private

investment, with an elasticity of approximately 31%. The positive effect of the IGP-M on private investment, with an estimated elasticity of 4.6%, suggests that additional price level pressure would not necessarily reduce investment decisions.

Next, the effects of Brazil's public debt shift were analyzed by estimating Model 2, introducing dummy variables interacted with the regressors, hereafter referred to as "post-break variables." The Vogelsang (1997) test identifies February 2015 as the break date. Table 4 summarizes the results.

Compared to the Benchmark model, the BNDES variable remains significant only in the FMOLS estimation. However, when considering the effects of these variables after Brazil's debt shift, as identified by the Vogelsang (1997) test, some asymmetries emerge.

Regarding the effect of public investment on private investment, a change in the relationship's direction is observed post-break, indicating a *crowding-out* effect in a high public debt environment. These findings suggest an asymmetry in the relationship between public and private investment under different public debt scenarios.

It is noteworthy that Huang, Pagano & Panizza (2020) observed that private firms tend to invest less in cities with higher public debt. Similarly, authors such as Rocha & Teixeira (1996), Melo & Rodrigues Júnior (1998), Ahmed & Miller (2000), Bilgili (2003), Sonaglio et al. (2010), and Bahal, Raissi & Tulin (2018) also found evidence of *crowding-out* effects.

Indeed, a scenario of higher public debt or uncontrolled public debt tends to impact the expectations of economic agents, discouraging private investment. In terms of magnitude, a 10% increase in public investment in the post-break environment reduces private investment by 2.1%.

Another variable that exhibited an asymmetric effect was the price level. In the post-break period, the impact of inflation became negative and statistically significant. A possible explanation for this asymmetry lies in the changing interpretation by economic agents, who now associate inflation with unanchored expectations and uncertainties regarding fiscal policy management.

Table 4. Results with post-break variables

Variable/Model	DOLS		FMOLS	
	Coefficient	P-value	Coefficient	P-value
IPUB	0.16*	0.02	0.05**	0.07
IGPM	0.48*	0.00	0.69*	0.00
BNDES	0.07	0.28	0.12*	0.00
UTCAP	1.68*	0.00	1.70*	0.00
DUMIPUB	-0.21*	0.01	-0.006**	0.09
DUMIGPM	-0.30**	0.08	-0.45*	0.00
DUMBNDES	-0.02	0.8	-0.07	0.26
DUMUTCAP	0.74*	0.00	0.73*	0.00
Intercept	-7.28*	0.00	-7.9*	0.00
R^2	0.92		0.61	
D(lags)	2		-	
D(leads)	2		-	

Source: Developed by the author. * Significant at 5%. ** Significant a 10%.

Capacity utilization continued to have a positive and statistically significant effect in the post-break period, though its impact magnitude was substantially reduced. Lastly, the credit variable (BNDES) was found to be statistically insignificant in the new model, possibly indicating that the effect of this channel on private investment has diminished.

In summary, the evidence from this study suggests that the occurrence of substitution (*crowding-out*) or complementarity (*crowding-in*) effects between public and private investments depends on the economic context faced by agents. In environments of higher public debt, *crowding-out* appears to prevail.

4.1 Policy Implications

The findings highlight the need for public investment strategies that account for fiscal constraints. Policymakers should prioritize countercyclical investment approaches, ensuring that public spending does not exacerbate debt levels that could undermine private sector confidence. A key recommendation is to enhance the efficiency of public investment through improved project selection and implementation frameworks. Targeting infrastructure sectors that exhibit strong crowding-in effects may maximize private sector participation while minimizing potential displacement effects.

Moreover, fiscal responsibility laws should incorporate investment-friendly provisions to balance short-term stimulus

with long-term sustainability. Strengthening the institutional framework, particularly in budget transparency and project evaluation, could mitigate uncertainty and enhance the credibility of public investment initiatives.

5. Concluding Remarks

This study revisited the discussion on the effects of central government investment expenditures on private investment in the Brazilian economy, using monthly data from January 2007 to February 2023 and applying the Dynamic Ordinary Least Squares (DOLS) method. In addition to employing a technique not previously used in this context, the study's potential contribution lies in investigating possible asymmetries in these relationships under varying public debt levels.

The benchmark models generally indicated a crowding-in effect, with public investment acting as a driver of private investment, showing an elasticity of approximately 1%. Capacity utilization, BNDES disbursements, and the IGP-M also demonstrated positive and statistically significant impacts on private investment, with elasticities of 31%, 1.2%, and 4.6%, respectively, for 10% increases.

Using the Vogelsang (1997) test, February 2015 was identified as the breakpoint for Brazil's public debt trajectory. Subsequently, the models were re-estimated with variables capturing the effects of this shift to identify potential asymmetries.

The updated estimations revealed asymmetric effects. In the post-break period, the results pointed to a crowding-out effect, where public investment negatively impacted private investment, with a negative elasticity of 2.1%. This underscores the importance of considering fiscal and debt conditions when analyzing the impact of public investment on private investment.

Price levels also exhibited asymmetries post-break, suggesting that inflation is perceived differently under high debt levels, likely due to unanchored expectations and fiscal policy uncertainties.

Capacity utilization retained a positive effect on private investment in the post-break period, though with reduced magnitude. Conversely, the BNDES credit variable lost significance, indicating a potential exhaustion of its influence on private investment.

In conclusion, the study highlights that public investment programs, often based on the assumption of their ability to attract private investment, must carefully consider the country's fiscal and debt conditions. Otherwise, these policies risk failing to achieve their objectives due to asymmetric effects.

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The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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Notes

Note 1. All variables included in the models are logarithmically transformed. The variables for BNDES disbursements, public investment, private investment and capacity utilization were seasonally adjusted.