Revista **Cadernos de Finanças Públicas**

02 | 2025





BUDGETARY REALISM AND GUARANTEES FOR THE MAINTENANCE OF PUBLIC INVESTMENTS IN BRAZILIAN STATES

Fernando Correia

Universidade Federal do Paraná

ABSTRACT

The article examines the relationship between investment spending and CAPAG indicators in Brazilian states between 2001 and 2018. The empirical evidence is based on the *threshold* panel regression approach that shows the existence of a threshold effect for parameters associated with personnel expenses in the relationship between public investment and CAPAG indicators. The main results of the research suggest that an improvement in CAPAG indicators does not necessarily result in an increase in public investment.

Keywords: Public investment. CAPAG. Personnel costs. Brazilian states.



SUMMARY

1. INTRODUCTION	4
2. OVERVIEW OF PUBLIC FINANCES IN BRAZILIAN STATES	5
3. THEORETICAL MODEL AND EMPIRICAL STRATEGY	12
3.1. The Government's Budget Constraint and the Allocation of Public Expenditure.	12
3.2. Empirical Strategy	15
3.3. Data	17
4. ANALYSIS OF RESULTS	18
5. FINAL CONSIDERATIONS	22
BIBLIOGRAPHICAL REFERENCES	23



1. INTRODUCTION

In recent decades, Brazil's federative fiscal structure has experienced a set of rules aimed at harmonizing the relationship between budgetary functions and fiscal balance. The set of fiscal rules to which federative entities in Brazil are subject has been associated with uncertainties and economic crises over the last thirty years. Three legal frameworks can be established that sought to introduce fiscal instruments with the aim of minimizing uncertainties in the preparation and definition of the public budget. Firstly, the 1988 Constitution itself, which defined short and medium-term budget planning documents such as the Multi-Year Plan, the Budget Guidelines Law and the Annual Budget Law. Secondly, the Fiscal Responsibility Law (LRF) in the early 2000s, which set limits on public spending and indebtedness. Thirdly, the system for monitoring the credit and payment capacity (CAPAG) of subnational entities, created by the National Treasury in 2012, with the aim of reducing the asymmetry of information when assessing credit with subnational entities.

It is unsatisfactory to accept that, although Brazilian states have experienced a downward trend in some important fiscal indicators over the last two decades (such as Consolidated Net Debt, which on average in 2002 was around 150% of their Net Current Revenue, and this figure fell to 75% in 2018, according to data from the National Treasury), there has been a loss of capacity to generate public investment in these sub-national entities. In 2002, according to data from the National Treasury, the average investment expenditure in Brazilian states, proportional to Net Current Revenue, was 11%, while in 2018 this figure fell to 5%.

It can be said that the budgetary control instruments have not, at least when it comes to sub-national state entities, provided a greater capacity to generate public investment. One reason for this may be the definition of budget parameters in the fiscal rules, which was restricted to the duo of personnel expenses and net consolidated debt, turning investment expenses into an adjustment variable. In addition, the process of building the set of fiscal instruments and indicators in Brazil was concerned with harmonizing public sector accounting standards, targeting the need for accountability with a focus on fiscal balance conditions and without taking into account budgetary parameters that prioritize the capacity to generate public investment.

Even with fiscal rules that set limits for personnel expenses, the current parameters, defined since the implementation of the LRF, have not created the conditions for an increase in public investment. Therefore, for which levels of personnel expenditure does an improvement in payment capacity have a positive impact on the expansion of public investment in Brazilian



states? The answer to the research problem requires the application of a methodology that can identify parameters that explain the non-linear relationship between public investment and payment capacity.

The aim of this research is to examine the relationship between investment spending and CAPAG indicators in Brazilian states between 2001 and 2018. The aim is to identify and measure budgetary parameters that can guarantee the maintenance of public investment in the states.

The paper is divided into four sections, in addition to this introduction. The next section presents an overview of public finances in the Brazilian states, with the aim of understanding the process of constructing the current set of fiscal indicators. The third section presents the empirical strategy of the research, using *threshold* panel analysis. The fourth section presents the results and the fifth section, the final considerations of the research.

2. OVERVIEW OF PUBLIC FINANCES IN BRAZILIAN STATES

The formulation of fiscal indicators has received attention in the literature insofar as the attempt to harmonize public accounting and the management of financial resources is aimed at increasing accountability, transparency and budgetary control (PINA; TORRES; YETANO, 2009). According to Manes Rossi (2011), greater financial autonomy in local governments has led them to resort to different forms of borrowing, which in turn may require a thorough assessment of their solvency in order to comply with international standards and agreements, such as Basel II.

In the last two decades, the world has witnessed recurring crises and exogenous events, which makes it increasingly necessary to assess the vulnerability of local government finances and thus infer their resilience to exogenous crises, such as the 2008 credit crisis or the 2020 pandemic (AHRENS; FERRY, 2020; HRUZA, 2015).

There are numerous approaches to assessing the financial health of public organizations, among them indices derived from financial statements (HRUZA, 2015; RIVENBARK; ROE-NIGK, 2011). The so-called fiscal or budgetary indicators are based on a variety of methodologies ranging from basic approaches, such as accounting indices, to more complex statistical models (CARUANA et al., 2019; COHEN et al., 2012).

The literature confirms that financial performance measures and assessments require multidimensional and multi-indicator approaches (CARINI; TEODORI, 2019; CLARK, 2015).₅



There is some consensus on the use of long-term solvency, short-term liquidity/solvency and budget solvency to assess financial condition in local governments, but not on the indicators to be used to measure such dimensions (HRUZA, 2015; WOJTASIAK-TERECH; MAKOWSKA, 2017). The analysis of fiscal indicators should explore models that can assess the overall sustainability and not just the financial sustainability of local authorities (ARUNACHALAM; CHEN; DAVEY, 2017).

Iacuzzi (2022) points out that it is a challenging task to analyze the credit rating of local governments based on the debt that can be spent on investments and that favors a positive condition in the solvency of local governments. Thus, given that the literature associated with fiscal indicators in local governments has suggested a multidimensional and multi-indicator approach based on the use of long-term solvency, short-term liquidity/solvency and budget solvency to assess the financial condition of local governments, it seems appropriate to establish a relationship between solvency conditions and investment capacity in local governments.

In the second half of the 1990s, the fiscal fragility of Brazil's sub-national federative entities became apparent as a result of negotiations between state governments and the federal government over the growing debts of Brazilian states. The start of these negotiations can be traced back to the state of São Paulo, which in 1997 sought to renegotiate its debt with the federal government. The so-called Program to Support the Restructuring and Fiscal Adjustment of States emerged as the states' financial crisis worsened.

The scenario of indebtedness and the generation of successive fiscal deficits led to the enactment of Law 9496 of September 11, 1997, in accordance with the parameters defined in Resolution 162/95 of the National Monetary Council, which established the criteria for the consolidation, assumption and refinancing by the Federal Government of various financial debts for which the states and the Federal District were responsible, including movable debt.

The main feature of the 1997 Restructuring and Fiscal Adjustment Program was the refinancing of state debts with the definition of annual targets for a three-year period.

At the time of the Restructuring and Fiscal Adjustment Program, according to data from the Central Bank of Brazil, from 1988 to 1997, the total debt of the states had grown about tenfold. Changes in the profile of the bonds are seen as a relevant factor in understanding the increase in state debts. From 1988 onwards, the bonds were readjusted in line with the *overnight* yield. As the *over* tended to be higher than the monetary correction, the debt balance began to grow at higher rates, and the effects of interest rates from the end of 1991, when a positive interest rate policy was adopted, contributed to the rise in the *over* yield and, consequently, in the



balance of government bonds. In addition, the existence of a perverse renegotiation mechanism, whereby states were able to transfer a significant part of their debts with the private sector into new debts with the federal government, contributed to the increase in state debts.

Until the end of the 1990s, two characteristics of state budgets can be established in order to understand their behavior: the profile of state debt and the negotiating mechanisms between the federal government and the states for fiscal consolidation.

A little over ten years after the 1988 Constitution was enacted, in 1999, with the worsening of the monetary stability economic policy instruments of the Real Plan, the new Brazilian economic policy model was designed: inflation targets, flexible exchange rates and fiscal responsibility.

The characteristics of the new economic policy tripod demanded the imposition of fiscal rules that would help maintain the macroeconomic stability achieved so far with the advent of the Real Plan. The institutionalization of the LRF addressed this gap with the aim of disciplining the three federal entities (the Union, states and municipalities) in order to maintain this stability.

Between 2003 and 2008, state public finances experienced fiscal relief as a result of the favorable economic growth scenario witnessed at the national level with the so-called *commodities boom*. During this period, according to Pellegrini (2020), state revenue growth was higher than expenditure growth, which contributed to an improvement in the primary result of 0.2% of GDP. From 2009 to 2014, revenues fell by around 0.3% of GDP, as a result of a 0.5% decrease in federal transfers and a 0.2% increase in own revenues. Expenditure grew by 0.8% of GDP, 0.7% of which was personnel and 0.1% investment, while costing remained constant in relation to GDP. Based on the analysis of revenue and expenditure movements, the primary result fell by 1.1% of GDP between 2009 and 2014.

The post-2008 phase brought an environment of uncertainty and an increased risk of fiscal fragility in the public finances of subnational entities, which was reflected in the construction of a credit monitoring and evaluation mechanism by the National Treasury. In 2012, Ordinance No. 306 of the National Treasury Secretariat sought to standardize the payment capacity of subnational entities (CAPAG), gauging their ability to obtain external credit operations, associating a classification of their fiscal situation to the respective federal entity, in other words, associating a *rating* to subnational governments. According to Manoel, Neto and Neto (2016), with this ordinance, the fiscal situation of a given state can be officially assessed - from the point of view of the federal government. In 2017, Ordinance 501 of the Ministry of₇



Finance reformulated the methodology for classifying payment capacity, making the CAPAG calculation simpler. As of 2017, the methodology is based on debt, current savings and liquidity indicators.

It can therefore be seen that over the last twenty years, a set of fiscal tools has been developed in an attempt to shield state budgets from a scenario of budgetary fragility. At first, the Fiscal Responsibility Law, by establishing fiscal limits for personnel expenses and net consolidated debt, sought to harmonize public accounting and the management of sub-national entities in line with an international trend. On the other hand, the aftermath of the 2008 crisis gave rise to a credit monitoring and evaluation system developed by the National Treasury, CAPAG, in an attempt to mitigate the uncertainties in contracting external credit and thus give subnational entities a fiscal boost to increase their capacity to make public investments.

However, with all the instruments available to state subnational entities, although the analysis of fiscal indicators brings satisfactory results, such as an improvement in debt, savings and liquidity indicators, there is no improvement in public investment capacity.

Graph 1 shows the average expenditure on personnel and investment in Brazilian states between 2001 and 2018. The data is proportional to net current revenue and takes into account expenditure associated with the Executive Branch. The first piece of information that can be extracted is that over these eighteen years there has been a loss in the generation of public investment, especially since 2010.

When considering the relationship between the budgetary control tools, the LRF and the CAPAG, at first glance these management instruments are not related when assessing the fiscal solvency of state governments. If we take a closer look at the rules established for personnel expenditure, we are struck by the implications in the case of an excess of expenditure of more than 60% of net current revenue, so that there is a need for adjustment in two quarters which, if not adopted, results in the suspension of voluntary transfers and guarantees for credit operations. The suspension of guarantees on credit operations, due to non-compliance with the limits on personnel expenses, weakens the attraction of external resources, even with good CAPAG indicators.





Graph 1 - Average expenditure on personnel and investment in Brazilian states (2001-2018) (% RCL)

Source: own elaboration based on data from the National Treasury.

Graph 2 shows the average of the three CAPAG *rating* indicators in Brazilian states between 2001 and 2018: indebtedness, savings rate and liquidity. There was an improvement in the evolution of the indicators over the period considered. The improvement in the indicators was concentrated in the period before the 2008 crisis. From 2010 onwards, indebtedness, measured by the ratio of net consolidated debt to net current revenue (DCL/RCL), and liquidity remained relatively stable, with a slight upward and downward movement in liquidity between 2014 and 2017. The savings indicator evolved positively until 2006 and remained stable after 2008. One justification for the improvement in the indicators in the period before the 2008 crisis may be associated with the significant growth observed in the Brazilian economy, which contributed to an increase in state revenues of around 1.2% in relation to GDP between 2003 and 2008, according to Pellegrini (2020). As transfers represent an important slice of state revenues, the favorable result of economic growth contributed to the growth of state revenues, so that of the 1.2% increase, transfers contributed 0.8%, while own revenues contributed 0.4%.



0.25

0.20

0.15

0.10

0.05

0.00



Graph 2 - Average CAPAG rating indicators in Brazilian states



DCL/RCL

3.00 2.50 2.00

1.50 1.00

0.50 0.00

The fall in federal transfers since 2008 has reorganized the revenue structure of state governments. Graph 3 shows tax revenue and federal government transfers from the State Participation Fund (FPE) in relation to net current revenue from 2001 to 2018. The movement of these two sources of revenue corroborates the previous statement that from 2008 onwards, own revenue, via tax revenue, began to have an increasing relative weight in net current revenue, while transfers had a decreasing weight.

2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

— Líquidez

Poupança





Source: own elaboration based on data from the National Treasury.



In a scenario of low economic growth, with state federative entities having a significant degree of budgetary dependence on federal transfers, according to Assunção, Ortiz and Pereira (2012), the transfer system distributed the risk to the more local levels of government in times of crisis.

The loss of revenue due to the fall in federal transfers to the states, coupled with the increase in personnel expenses, raises questions about the ability of subnational governments to adjust to changing the magnitude of cash outflows, i.e. the ability to cut spending in the face of financial difficulties. Furthermore, as federal transfers represent a significant portion of the states' net current revenue, the relative reduction in federal transfers is increasingly reflected in a loss of relevance of net current revenue as a parameter in defining fiscal rules, such as the parameters defined in the LRF for personnel expenses and Net Consolidated Debt. For example, as there is a relative increase in tax revenue to the detriment of transfer revenue, the definition of new fiscal parameters associated with tax revenue would more reliably reflect the capacity to finance expenditure. Graph 4 shows the spending flexibility indicator and the Personnel Expenses/Tax Revenue ratio. The spending flexibility indicator is calculated from the ratio of non-personnel expenses to personnel expenses. The spending flexibility indicator shows the ability to cut spending in the face of financial difficulty, and the higher its value, the greater the government's ability to make spending adjustments in the face of financial difficulty.



Graph 4 - Average spending flexibility and personnel expenses/tax revenue ratio in Brazilian states (2001-2018)

Source: own elaboration based on data from the National Treasury.

From 2010 onwards, according to Graph 4, there was a loss of capacity on the part of the states to make spending adjustments, as can be seen in the movements of the spending flexibili-



ty indicator. The movement observed for personnel expenses in relation to tax revenue reflected stability throughout the period from 2005 onwards.

In summary, based on the analysis of the public finances of the Brazilian states, some preliminary conclusions can be drawn. Firstly, the improvement in credit indicators has not been reflected in an increase in the states' investment capacity; on the contrary, there has been a significant reduction in the levels of public investment by sub-national state entities. Secondly, the relative loss of the share of federal transfers as a source of funds in the states raises questions about the viability of maintaining net current revenue as a parameter for establishing fiscal targets, such as the limits set for personnel expenses and consolidated net debt. Parameters associated with tax revenue and spending flexibility could more realistically reflect the states' ability to cope with crises, as well as their real capacity to provide resources to generate public investment.

3. THEORETICAL MODEL AND EMPIRICAL STRATEGY

The previous section drew attention to the set of fiscal rules and instruments for monitoring credit conditions in Brazilian states, built up over the last few decades. Fiscal rules are important for governments to have a comfortable budget so that they can expand their public investment capacity. However, in the case of the Brazilian states, the movement has been the opposite: since the implementation of the LRF, there has been a gradual reduction in the investment capacity of state sub-national entities. The current budget parameters do not seem to reflect the true capacity to generate resources, since the relative reduction in federal transfers as a source of funds transforms net current revenue into an indicator that does not reflect the fiscal robustness of the states. So how can we ensure that investment spending maintains positive growth? What fiscal parameters should be taken into account when drawing up a budget plan that guarantees the maintenance of public investment in the states? The answer to these questions requires the formulation of an empirical strategy that must take into account certain elements associated with the government's budget constraint.

3.1. The Government's Budget Constraint and the Allocation of Public Expenditure

Consider the following budget constraint of a state government entity defined by the following accounting relationship:



$$B_{it} \equiv (1+r) B_{it-l} - (T_{it} - G_{it})$$
(1)

According to the above equation, B_{it} is the debt of the *ith* state in period *t*; B_{it-1} , the debt of the *ith* state in period *t*-1; G_{it} , the aggregate spending of the *ith* state; and T_{it} , the current revenue of the ith state in year *t*; (1+r) is the interest factor that affects government debt.

Aggregate spending, G_{it} , can be broken down into current spending, G^{C}_{it} , and investment spending, G^{I}_{it} :

$$G_{it} \equiv G^{c}_{it} + G^{l}_{it} \tag{2}$$

Then,

$$B_{it} \equiv (1+r) B_{it-l} - (T_{it} - G^{C}_{it} - G^{I}_{it})$$
(3)

Isolating capital expenditure from the previous equation, we get

$$G_{it}^{I} \equiv \mathbf{B}_{it} - (1+r) \, B_{it-1} + (T_{it} - G_{it}^{C}) \tag{4}$$

We can rewrite the previous restriction in terms of current revenues, which we'll call T_{it} , like this:

$$\frac{G_{it}^{l}}{T_{it}} \equiv \frac{B_{it}}{T_{it}} - (1 + r)\frac{B_{it-1}}{T_{it}} + \frac{T_{it} - G_{it}^{c}}{T_{it}}$$
(5)

The left-hand side of equation (5) can be rewritten taking into account Brazil's fiscal rules which, according to the LRF, established Net Current Revenue as the benchmark for some variables, such as personnel expenditure. Consider $\frac{G_{it}^{P}}{T_{it}} = \rho$, where G_{it}^{P} is the personnel expenditure ture of the *i*-th state in year t, and is a parameter that measures the size of personnel expenditure in the state budget, represented here by the ratio of personnel expenditure to current revenue. Based on this latter ratio, we can rewrite equation (5) by working with the denominator on the left-hand side of the equation:



$$\frac{G_{it}^{l}}{\frac{G_{it}^{P}}{Q}} \equiv \frac{B_{it}}{T_{it}} - (1 + r) \frac{B_{it-1}}{T_{it}} + \frac{T_{it} - G_{it}^{C}}{T_{it}}$$
(6)

In the case of Brazilian sub-national entities, current revenue, T_{it} , is the sum of tax revenue, contributions (property, agricultural, industrial), services, current transfers and other current revenue. To calculate net current revenue, contributions from civil servants and financial compensation are deducted from current revenue. To this subtotal is added the financial compensation relating to the exemption from the ICMS tax burden, as well as the amounts received from Fundeb. Therefore, it can be established that current revenue is a multiple of net current revenue, i.e. $T_{it} = l.T_{it}^{L}$, with T_{it}^{L} being net current revenue and the parameter that captures deductions from current revenue.

Now, some components of the right-hand side of equation (6) can be presented in terms of net current revenue, i.e:

$$\frac{\frac{G_{it}^{l}}{G_{it}}}{\frac{G_{it}^{l}}{\rho}} \equiv \frac{B_{it}}{LT_{it}^{L}} - (1 + r)\frac{B_{it-1}}{LT_{it}^{L}} + \frac{T_{it} - G_{it}^{c}}{T_{it}}$$
(7)

With a few adjustments, equation (7) can be rewritten in the following format:

$$\frac{G_{it}^{l}}{G_{it}^{P}} \equiv \left(\frac{1}{\rho \cdot l}\right) \frac{B_{it}}{T_{it}^{L}} - \left(\frac{1+r}{\rho \cdot l}\right) \frac{B_{it-1}}{T_{it}^{L}} + \left(\frac{1}{\rho}\right) \frac{T_{it} - G_{it}^{C}}{T_{it}}$$
(8)

Equation (8) establishes that the allocation of spending, investment over personne $\frac{G_{it}}{G_{it}^{p}}$ is determined by the three components of the government's budget constraint: the debt/net current revenue ratio, $b_{it} = \frac{B_{it}}{T_{it}^{b}}$; the liquidity indicator, $li_{it} = \frac{B_{it-1}}{T_{it}^{b}}$, where the ratio between the previous period's debt and net revenue represents a *proxy* for the relationship between financial obligations and cash availability; and the government's savings rate, $s_{it} = \frac{T_{it} - G_{it}^{c}}{T_{it}}$. For all three indicators, their effects on the allocation of public expenditure, the ratio $\frac{G_{it}^{l}}{G_{it}^{p}}$, will depend on the parameter , which captures the size of personnel expenditure in the public budget. Therefore,

$$\frac{G_{it}^{l}}{G_{it}^{p}} \equiv \left(\frac{1}{\rho \cdot l}\right) b_{it} - \left(\frac{1+r}{\rho \cdot l}\right) li_{it} + \left(\frac{1}{\rho}\right) s_{it}$$

$$\tag{9}$$

The result of the analysis of the government's budget constraint, equation (9), provides important elements for understanding public spending, especially investment spending. Equa-



tion (9) shows that public spending choices depend on a set of fiscal indicators associated with the government's budget constraint, such as the size of the debt, liquidity and the savings rate. In addition, equation (9), as it stands, defines which fiscal parameters should be taken into account, based on a balanced budget, when determining public spending. The left-hand side of equation (9) represents the choice of expenditure, investment rather than personnel, while the right-hand side represents the fiscal indicators that influence the allocation of this expenditure. For example, what is the effect of an improvement in the fiscal indicators of debt, savings and liquidity on investment spending, based on the size of personnel spending? The answer to this question is essential in order to achieve the objective of the research in question: to identify and measure budgetary parameters that can guarantee the maintenance of public investments in Brazilian states.

3.2. Empirical Strategy

Equation (9), although useful for understanding public spending options, does not faithfully reflect the movements in investment spending in Brazilian states.

The first reason for this is that equation (9) assumes a balanced budget. Based on the accounting relationship shown above, it is known that in determining public spending there are pressures not only associated with fiscal constraints; socio-economic elements that have an impact on spending movements must be taken into account.

A second justification is the fact that investment spending is not necessarily associated with a simultaneous improvement in the three fiscal indicators. For example, the savings indicator shows the capacity to generate positive operating results, assuming one of the following situations at the end of each financial year: (i) current budget surplus, when current revenues are higher than current expenses; and (ii) current budget deficit, when current revenues are lower than current expenses. This indicator is measured by dividing the current budget result by current revenue. Thus, the higher this ratio, the more the government has the capacity to generate internal savings. A positive result for this indicator shows that the entity produces internal savings that contribute to increasing the level of internal resources. However, a negative result does not mean that budget execution was unfavorable, as financial reserves accumulated from previous years may have been used to finance part of current expenditure. Therefore, the liquidity position should influence the behavior of the savings indicator. The liquidity position based on the cash budget is assessed using the ratio between projected inflows and outflows.



When cash inflows exceed outflows, the liquidity of internal resources is in a good position. However, the entity can have good liquidity of internal resources even when inflows are lower than outflows due to financial reserves from previous periods.

The relationship between savings and liquidity can produce atypical reactions, given that financial reserves from previous years can be allocated to finance current expenses, which contributes to an improvement in the savings indicator. A positive result for the savings indicator, due to the use of financial reserves from previous years, could produce a relief in debt conditions, since it is expected that savings will be converted into investment spending, thus reducing the contracting of resources via credit operations. This last relationship presupposes the conversion of savings into investment for a given level of personnel expenditure. The government's budget constraint has shown that a balanced budget is associated with spending choices and that an improvement in fiscal indicators such as debt, savings and liquidity is not necessarily reflected in an expansion in investment spending. Equation (9) draws attention to the influence of personnel expenses in measuring the relationship between investment expenses and the three fiscal indicators, given the impact of the parameter on the three components on the right-hand side of equation (9). So, for what levels of personnel expenditure does an improvement in fiscal indicators result in an increase in investment expenditure?

An alternative way of answering the above question is to use the *threshold* panel methodology. The attempt to capture a non-linear effect in investment spending involves the choice of panel analysis with a *threshold* effect. The use of panel regressions with a *threshold* effect makes it possible to assess structural breaks in the relationship between variables, such as the formation of *clusters*, i.e. two or more classes of observations can be extracted from the value of an observable variable. Estimating the *threshold* panel requires the panel to be balanced and in accordance with the following structural equation (HANSEN, 1998):

$$\mathbf{y}_{it} = \boldsymbol{\mu} + \beta_1 \mathbf{x}_{it} I(q_{it} \leq \gamma) + \beta_2 \mathbf{x}_{it} I(q_{it} > \gamma) + \boldsymbol{\mu}_i + \epsilon \mathbf{i} t$$
(10)

In (10), y_{it} is the dependent variabl, q_{it} is the *threshold* variable, and γ is the threshold parameter that divides the equation into two regimes, regime 0 and regime 1. The parameter μ_i is the individual effect, while ϵ_{it} is the error term $\sim i.i.d.$, with zero mean and variance σ^2 .

Equation (10) can be rewritten in the following compact form:

$$\mathbf{y}_{it} = \{\boldsymbol{\mu}_{i} + \boldsymbol{\beta}_{1} \boldsymbol{x}_{it} + \boldsymbol{\epsilon}_{it}, \quad \boldsymbol{q}_{it} \leq \boldsymbol{\gamma} \; \boldsymbol{\mu}_{i} + \boldsymbol{\beta}_{2} \boldsymbol{x}_{it} + \boldsymbol{\epsilon}_{it}, \quad \boldsymbol{q}_{it} > \boldsymbol{\gamma}$$
(11)



Equation (11) shows that the sample observations can be divided into two distinct regimes, depending on whether the value of the variable q_{it} above or below the *threshold* parameter (γ) (HANSEN, 1998).

If the parameter γ is known, the model will be a conventional linear model with no *threshold* effect. Otherwise, the estimator of γ will be a naive estimator, violating the assumption of normality of the residuals (WANG, 2015). To overcome this problem, Hansen (1998) demonstrates that it is possible to consistently identify the γ parameter by estimating *bootstrap* confidence intervals using the maximum likelihood method from the LR statistic. The null hypothesis to be tested is whether the two regression models have the same slope (the *threshold* is not identified and the model is linear), i.e. test $H_0 = \beta_1 = \beta_2 X H_a = \beta_1 \neq \beta_2$. If the linearity hypothesis is not accepted, a model with two *threshold* effects must be estimated, under the null hypothesis that the model with only one *threshold* is adequate.

To examine the relationship between investment spending and fiscal indicators, under the hypothesis of a *threshold* variable determining non-linearity, equation (12) captures the contributions of the theoretical model, equation (9), and the econometric analysis, equation (11):

$$lnG_{it}^{I} = Const + \beta_{2}lnPIBPC_{it} + \beta_{3}lnRCL_{it} + \beta_{4}DummyLRF + \{\beta_{0}Z_{it} + e_{it}\beta_{1}Z_{it} + e_{it}\}$$
$$\frac{q_{it} \leq \rho}{q_{it} > \rho} (12)$$

 lnG_{it}^{I} is the dependent variable, the natural logarithm of investment spending in the Brazilian states; $lnPIBPC_{it}$ is the natural logarithm of the states' GDP *per capita*; $lnRCL_{it}$ is the natural logarithm of the states' Net Current Revenue; and *DummyLRF* is a binary variable in time, 0 for the years before the LRF and 1 for the years after the LRF. These last three variables are the model's control variables. The variable q_{it} is the variable that divides the sample into different regimes. For this study, three different parameters for personnel expenses were considered as *threshold* variables to determine the non-linearity between investment expenses and fiscal indicators. The *threshold* variables are as follows: the Personnel Expenditure/Net Current Revenue ratio, the Personnel Expenditure/Tax Revenue ratio and the spending flexibility indicator. The dependent variables of the *threshold* regime, Z_{it} , are: the Consolidated Net Debt/CNR ratio, the savings rate and the liquidity indicator.

3.3. Data



The source of the research data is the National Treasury's information base on the public accounts of Brazilian states. The research covers the period from 2001 to 2018. The time horizon is justified for two reasons: firstly, it seeks to capture the effects of the Fiscal Responsibility Law in an attempt to consolidate information in the pre- and post-FRA phases; secondly, it works exclusively with accounts already approved by the Courts of Auditors.

The GDP and demographic data for the state federative units were taken from the Brazilian Institute of Geography and Statistics (IBGE). The survey data has been deflated to 2021 prices.

4. ANALYSIS OF RESULTS

Table 1 shows the results of the estimation of equation (12) using three personnel expenditure indicators as the *threshold* variable: the personnel expenditure/RCL ratio, the personnel expenditure/Tax Revenue ratio and the Flexibility of Expenditure, the latter calculated from the ratio of non-staff expenditure to personnel expenditure itself. The statistical significance of the *threshold* estimate is assessed by the p-value calculated using the *bootstrap* method with 299 replications and a 1% cut-off. As shown in all the models, the *p-bootstrap* test values indicate that all the *thresholds* are statistically significant, so that no *threshold* effect can be rejected. Thus, the sample can be divided into two regimes, regime 0 and regime 1.

For each of the three models, the CAPAG variables were used as the regime's dependent variables. In other words, the effect of the CAPAG variables Debt, Savings Rate and Liquidity on investment spending in the Brazilian states depends on the *threshold* variable for each of the three models.

For all the models, 1, 2 and 3, the control variables, $lnPIBPC_{ii}$ (natural logarithm of the GDP *per capita* of the Brazilian states), $lnRCL_{ii}$ (natural logarithm of the Net Current Revenue of the Brazilian states) and *DummyLRF* (binary variable in time, 0 for the years before the LRF and 1 for the years after the LRF) showed statistical significance.



Table 1 - Results of the threshold	d panel for the Brazilian	states (logarithm	of investment
expenditure as the dependent variable)			

	Modelo 1 <i>Threshold</i> Pessoal/RCL Variável Dependente do Regime			Modelo 2 <i>Threshold</i> Pessoal/RT Variável Dependente do Regime			Modelo 3 <i>Threshold</i> Flexibilidade dos Gastos Variável Dependente do Regime		
	Dívida	Poupança	Liquidez	Dívida	Poupança	Liquidez	Dívida	Poupança	Liquidez
Threshold	0,494	0,450	0,359	0,866	0,694	0,700	1,067	1,224	1,265
Bootstrap pvalue	0,013**	0,000***	0,000***	0,030**	0,009***	0,000***	0,000***	0,000***	0,007***
Número de replicações	299	299	299	299	299	299	299	299	299
Porcentagem de corte	1%	1%	1%	1%	1%	1%	1%	1%	1%
Regime 0	- 0,145 (- 2,308)**	0,791 (3,473)***	0,119 (7,397)***	- 0,184 (- 2,958)***	0,579 (2,576)**	0,050 (5,882)***	- 0,167 (- 5,461)***	0,091 (4,371)***	0,002 (3,482)***
Regime 1	- 0,314 (- 4,742)***	- 0,252 (4,742)***	- 0,013 (- 1,821)**	- 0,484 (- 5,580)***	- 0,565 (- 1,916)**	- 0,010 (- 1,927)**	- 0,364 (- 2,682)**	1,676 (6,595)***	0,061 (6,234)***
Const	- 4,784 (- 1,164)	- 9,801 (- 2,586)**	- 9,868 (- 2,629)**	- 4,281 (- 1,033)	- 6,941 (- 1,760)*	- 8,937 (- 2,354)**	- 4,595 (- 1,136)	- 10,656 (- 2,937)**	- 8,579 (- 2,251)**
β ₂	0,974 (3,925)***	1,368 (5,998)***	1,375 (6,061)***	0,955 (3,834)***	1,296 (5,612)***	1,233 (5,405)***	1,021 (4,172)***	1,164 (5,310)***	1,314 (5,741)***
β	0,698 (4,154)***	0,731 (4,413)***	0,729 (4,465)***	0,687 (4,065)***	0,641 (3,733)***	0,753 (4,576)***	0,670 (4,044)***	0,851 (5,379)***	0,702 (4,233)***
β ₄	- 0,836 (- 6,908)***	- 0,836 (- 7,046)***	- 0,808 (- 6,945)***	- 0,917 (- 7,739)***	- 0,833 (- 6,855)***	- 0,934 (- 8,102)***	- 0,782 (- 6,494)***	- 0,780 (- 6,850)***	- 0,803 (- 6,774)***
Within R ²	0,513	0,520	0,532	0,510	0,506	0,523	0,526	0,557	0,521
LR test	28,460	42,962	49,485	25,227	28,719	39,764	42,132	87,652	37,441
Test (p-value)	94,864 (0,000)***	156,888 (0,000)***	121,478 (0,000)***	153,136 (0,000)***	96,796 (0,000)***	92,995 (0,000)***	140,074 (0,000)***	77,558 (0,000)***	116,820 (0,000)***

Note: significance at the *10%, **5%, ***1% level. Source: own elaboration.

The result for Model 1, which takes into account the Personnel Expenditure/RCL ratio as the *threshold* variable, must take into account the three results associated with the dependent variables of the *threshold* regime, Debt, Savings Rate and Liquidity. The point estimates were 0.494, 0.450 and 0.359.

The figure of 0.494 means that for levels of personnel expenditure, proportional to RCL, below 49.4%, a 1% reduction in net consolidated debt generates two effects: in regime 0, an increase in investment expenditure of around 0.145%, and for a level of personnel expenditure above 49.4%, regime 1, an expansion in investment expenditure of around 0.314%. This first result indicates that an improvement in the debt indicator is reflected in an improvement in the rate of expansion of public investment, regardless of the level of personnel expenditure, although debt relief is more strongly reflected in public investment for levels above 49.4% of the Personnel Expenditure/RCL ratio.



For the savings rate, still referring to the results of model 1, the *threshold* value indicated a Personnel Expenditure/RCL ratio of 0.450, with opposite signs for the two regimes: in regime 0, an increase in the savings rate by 1%, for a level of personnel expenditure below 45% of the RCL, the effect on investment expenditure is positive at around 0.791%, while for personnel expenditure above 45%, regime 1, the effect is negative at 0.252%. Thus, an improvement in the public savings rate of state subnational entities is favorably reflected in an expansion in the public investment rate when the Personnel Expenses/RCL ratio is less than 45%, 4% below the limit set by the LRF for executive personnel expenses.

The results associated with the liquidity indicator, the third regime-dependent variable, showed different movements from the estimated *threshold*, as was observed for the savings rate. The value of 0.359 means that for personnel costs of less than 35.9% of RCL, regime 0, an increase in liquidity leads to an increase in investment spending of 0.119%, while for values of more than 35.9%, regime 1, the effect is negative, at around 0.013%. Thus, an improvement in the liquidity indicator is positively reflected in the rate of expansion of public investment for a level of personnel expenditure below 35.9%.

The statistical significance of a *threshold* for the Personnel Expenditure/RCL ratio, for all three different regime-dependent variables, Debt, Savings and Liquidity, leads to a preliminary conclusion that the improvement in CAPAG indicators will not necessarily be reflected in an expansion of the public investment rate in Brazilian states; the expansion of investment expenditure will depend on the level of personnel expenditure in relation to RCL.

For model 2, the Personnel Expenditure/Tax Revenue ratio was statistically significant as a *threshold* variable for all three of the regime's dependent variables, Debt, Savings Rate and Liquidity. The point estimates were 0.866, 0.694 and 0.700. The effect of net consolidated debt on investment expenditure shows similar signs, but with different intensities. For values of personnel expenditure in relation to tax revenue of less than 0.866, regime 0, a 1% reduction in net consolidated debt generates an increase in investment expenditure of around 0.184%; and for a level of personnel expenditure proportional to tax revenue of more than 86.6%, regime 1, a 1% relief in the indebtedness of state governments provides an expansion in investment expenditure of around 0.484%.

For the results that consider the savings rate as the dependent variable of the regime, still in model 2, the *threshold* value found for Personnel Expenditure/Tax Revenue was 0.694 with opposite signs for the two regimes: in regime 0, an increase in the savings rate by 1%, for a level of personnel expenditure below 69.4% of tax revenue, regime 0, the effect on investment ex_{20}



penditure is positive by around 0.579%, while for personnel expenditure above 69.4%, regime 1, the effect is negative by 0.565%.

For the liquidity indicator, defined as the regime's dependent variable, the signs were also opposite from the estimated *threshold*. The value of 0.700 means that for staff costs of less than 70% of tax revenue, regime 0, an increase in liquidity leads to an increase in investment costs of 0.05%, while for values of more than 70%, regime 1, the effect is negative, at around 0.01%.

For the second set of results using the Personnel Expenditure/Tax Revenue ratio as the threshold variable, model 2, the *p*-bootstrap statistical significance identified three levels of personnel expenditure, proportional to tax revenue, as parameters in the generation of public investment in Brazilian states. For values of personnel expenses in relation to tax revenue below a range between 69.4% and 86.6%, an improvement in the CAPAG indicators has a favorable impact on the generation of public investment.

According to the results of model 3, still in Table 1, where the *threshold* variable is the spending flexibility indicator and the regime-dependent variables are the CAPAG, Debt, Savings and Liquidity indicators, the estimated and significant values, according to the p-bootstrap statistic, were 1.067, 1.224 and 1.265 respectively for the spending flexibility indicator. However, there was no change in the signs for the two regimes from the estimated threshold. For the results of debt, as a dependent variable of the regime, values below 1.067 of the spending flexibility indicator, regime 0, a 1% reduction in the degree of indebtedness generates a positive effect on the investment rate of around 0.167%, while for values above 1.067, regime 1, the effect is an expansion of 0.364% in the public investment rate for a 1% reduction in debt.

For the savings rate as a regime-dependent variable, the threshold of 1.224 for the spending flexibility indicator means that below this value, regime 0, a 1% increase in the savings rate has a positive impact of 0.091% on investment spending, while for values above 1.224 in the spending flexibility indicator, a 1% increase in the savings rate generates a positive impact of 1.676% on investment spending.

The results for the liquidity indicator as a regime-dependent variable estimated a *threshold* for the spending flexibility indicator of 1.265, so that for values below this level of spending flexibility, regime 0, an improvement in the liquidity indicator by 1% is reflected in an expansion in the public investment rate of around 0.002%, while in regime 1, for values above 1.265 in the spending flexibility indicator, an increase in the liquidity indicator has a positive impact on investment spending of 0.061%.

. The purpose of the *threshold* panel analysis was to identify the extent to which an im-21



provement in credit indicators in Brazilian states, CAPAG, is reflected in a positive stimulus in the generation of public investment. The result suggests that even with an improvement in credit indicators, the response of public investment will depend on the size of personnel expenses and the capacity to adjust public spending.

5. FINAL CONSIDERATIONS

The aim of the research was to examine the relationship between investment spending and CAPAG indicators in Brazilian states between 2001 and 2018. The work identified and measured budget parameters that contribute to maintaining public investment in the states.

Over the period analyzed, it was observed that the improvement in credit indicators was not reflected in an increase in the states' investment capacity; on the contrary, there was a reduction in public investment levels. The research made use of new parameters to define levels of personnel expenditure that would guarantee an expansion and maintenance of public investment. Parameters associated with tax revenue and spending flexibility could more realistically reflect the states' ability to cope with crises, as well as their real capacity to provide resources to generate public investment.

The result of the *threshold* panel showed statistical significance for all the *threshold* variables, the Personnel Expenditure ratio based on different parameters, such as net current revenue, tax revenue and spending not associated with personnel expenditure. The *threshold* panel identified the extent to which an improvement in credit indicators in Brazilian states, CAPAG, was reflected in a positive stimulus in the generation of public investment. The result suggests that even with an improvement in credit indicators, the response of public investment will depend on the size of personnel expenses and the capacity to adjust public spending.

Point estimates for personnel expenditure levels offer instruments and alternatives for budgetary planning documents, such as the Multi-Year Plan (PPA), Budget Guidelines Law (LDO) and Annual Budget Law (LOA), in defining fiscal targets that can guarantee the maintenance of public investments. The results of the research provide a reflection on the definition of public investment targets associated with different indicators for personnel expenses, in an attempt to mitigate the use of investment expenses as a budget adjustment variable.



BIBLIOGRAPHICAL REFERENCES

AHRENS, T.; FERRY, L. Financial resilience of english local government in the aftermath of COVID-19. Journal of Public Budgeting, Accounting and Financial Management, v. 32, n. 5, p. 813-823, 2020.

ARUNACHALAM, M.; CHEN, C.; DAVEY, H. A model for measuring financial ustainability of local authorities: model development and application. Asia-Pacific Management Accounting Journal, v. 12, n. 1, p. 39-76, 2017.

ASSUNÇÃO, J. J.; ORTIZ, F. A. T.; PEREIRA, L. F. V. N. The 2008 financial crisis and tax collection: lessons for the design of transfers and fiscal federalism. Textos para Discussão, n. 8. Brasília: Tesouro Nacional, 2012.

CARINI, C.; TEODORI, C. Making financial sustainability measurement more relevant: an analysis of consolidated financial statement. In: CARUANA, J.; BRUSCA, I.; CAPERCHIO-NE, E.; COHEN, S.; MANES ROSSI, F. (Eds.). Financial sustainability of public sector entities. The Relevance of Accounting Framework. Cham: Palgrave Macmillan, 2019. p. 103-122.

CARUANA, J.; BRUSCA, I.; CAPERCHIONE, E.; COHEN, S.; MANES ROSSI, F. Exploring the relevant of accounting frameworks in the pursuit of financial sustainability of public sector entities: a holistic approach. In: CARUANA, J.; BRUSCA, I.; CAPERCHIONE, E.; COHEN, S.; MANES ROSSI, F. (Eds.). Financial sustainability of public sector entities. The Relevance of Accounting Framework. Cham: Palgrave Macmillan, 2019. p. 1-18.

CLARK, B. Y. Evaluating the validity and reliability of the financial condition index for local governments. Public Budgeting and Finance, v. 35, n. 2, p. 66-88, 2015.

COHEN, S.; DOUMPOS, M.; NEOFYTOU, E.; ZOPOUNIDIS, C. Assessing financial distress where bankruptcy is not an option: an alternative approach for local municipalities. European Journal of Operational Research, v. 218, n. 1, p. 270-279, 2012.

HANSEN, E. B. Threshold effects in non-dynamic panels: estimation, testing and inference.



Journal of Econometrics, v. 93, p. 345-368, 1999.

HRUZA, F. Public sector organization financial ratios' recent development as a matter of financial innovation. **Investment Management and Financial Innovations**, v. 12, n. 2, p. 88-95, 2015.

IACUZZI, S. An appraisal of financial indicators for local government: a structured literature review. **Journal of Public Budgeting, Accounting & Financial Management**, v. 34, n. 6, p. 69-94, 2022.

MANES ROSSI, F. Analysis of solvency in Italian local governments: the impact of Basel II. **Journal of Financial Risk Management**, v. 8, n. 3, p. 17-42, 2011.

MANOEL, A.; NETO, A. R.; NETO, A. M. Analysis of the ratings of Brazilian states: should they all go into debt? **Technical Note**, n. 10. Brasília: IPEA, 2016.

PELLEGRINI, J. Analysis of the fiscal situation of the states. **Special Study**, n. 14. Brasília: Independent Fiscal Institution, 2020.

PINA, V.; TORRES, L.; YETANO, A. Accrual accounting in EU local governments: one method, several approaches. **European Accounting Review**, v. 18, n. 4, p. 765-807, 2009.

RIVENBARK, W. C.; ROENIGK, D. J. Implementation of financial condition analysis in local government. **Public Administration Quarterly**, v. 35, n. 2, p. 241-267, 2011.

WANG, Q. Fixed-effect panel threshold model using Stata. The Stata Journal, v. 15, n. 1, p. 121-134, 2015.

WOJTASIAK-TERECH, A.; MAKOWSKA, A. Assessing financial condition of municipalities using taxonomic methods. In: NESLEHA, J.; PLIHAL, T.; URBANOVSKY, K. (Eds.). **Europe-an Financial Systems 2017**: Proceedings of the 14th International Scientific Conference. Brn:o Masaryk University, 2017. p. 466-473.