REVISTA

CADERNOS DE FINANÇAS PÚBLICAS

TESOURO NACIONAL

Volume 03
2021

DOES THE LAFFER CURVE HYPOTHESIS APPLY TO THE CASE OF RIO GRANDE DO SUL?

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Abstract

The article presents a descriptive analysis on the evolution of revenue of ICMS and IBCR-RS from January 2003 to December 2019. From the analysis of co-integration and an error correction model, are estimated the short term and long-term elasticities between revenue of ICMS in relation to the IBCR-RS and the nominal rates on blue-chips. The results indicate that the revenue of ICMS is more sensitive to changes in economic activity in the long run than in the short run. Furthermore, there is evidence of the existence of the Laffer Curve in the case under study.

Keywords: elasticities; cointegration; Laffer curve; Rio Grande do Sul

JEL: H2, C22, H7.

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SUMMARY

1 Introduction

The Laffer Curve hypothesis states that there is a critical nominal rate beyond which rate increases imply a drop in revenue. This paper seeks to test this conjecture for the State of Rio Grande do Sul's Tax on Operations Related to the Circulation of Goods and Services and Interstate and Intercity Transportation and Communication (ICMS).

The study also aims to measure the sensitivity of the Rio Grande do Sul State ICMS tax collection to economic activity and to the nominal rate on blue-chips (fuels, communication, and electricity), estimating the respective elasticities using the Engle and Granger approach.

Marques Junior and Oliveira (2015) analyzed the evolution of ICMS collection and Gross Value Added (GVA), a proxy for the level of economic activity in the state of Rio Grande do Sul, over the period 1995 to 2012 using annual data. Using econometric models, the short- and long-term elasticities of ICMS collection in relation to GVA were estimated. The results indicate that the collection of ICMS is elastic in the long run, but inelastic in the short run. The present study follows this line, however, the data sample is larger, since the analysis period comprises the month of January 2003 to December 2019, in addition, other explanatory variables for ICMS collection are considered.

The paper is divided as follows: in the second section, there is an introduction to the theoretical model. In the third section, the econometric models are presented. In the fourth section, there is an analysis of the databases. The fifth section presents the estimation results. The sixth and last section presents the final considerations.

2 Brief characterization of the Laffer Curve[1]

The Laffer Curve postulates that the same tax collection can be obtained by two different nominal tax rates, the only exception being the revenue-maximizing rate (Figure 1). The realized collection of a tax during a given period depends on the tax base and the nominal rate of the respective tax. Given a tax base, if the nominal tax rate is zero, the tax collection is also zero. However, as the rate increases, the collection grows to a critical point, where collection is maximum (T^{MAX}), but above this point, if the rate continues to rise, revenue declines to zero.

Following the example of Oliveira et al. (2012), a Laffer Curve with a concave total tax revenue function in relation to the nominal tax rate is proposed. A simple way of modeling is through a total tax revenue function given by: $T= t.Y(t)$, where T represents total tax revenue, t the nominal tax rate, and Y(t) represents the tax base.[2]

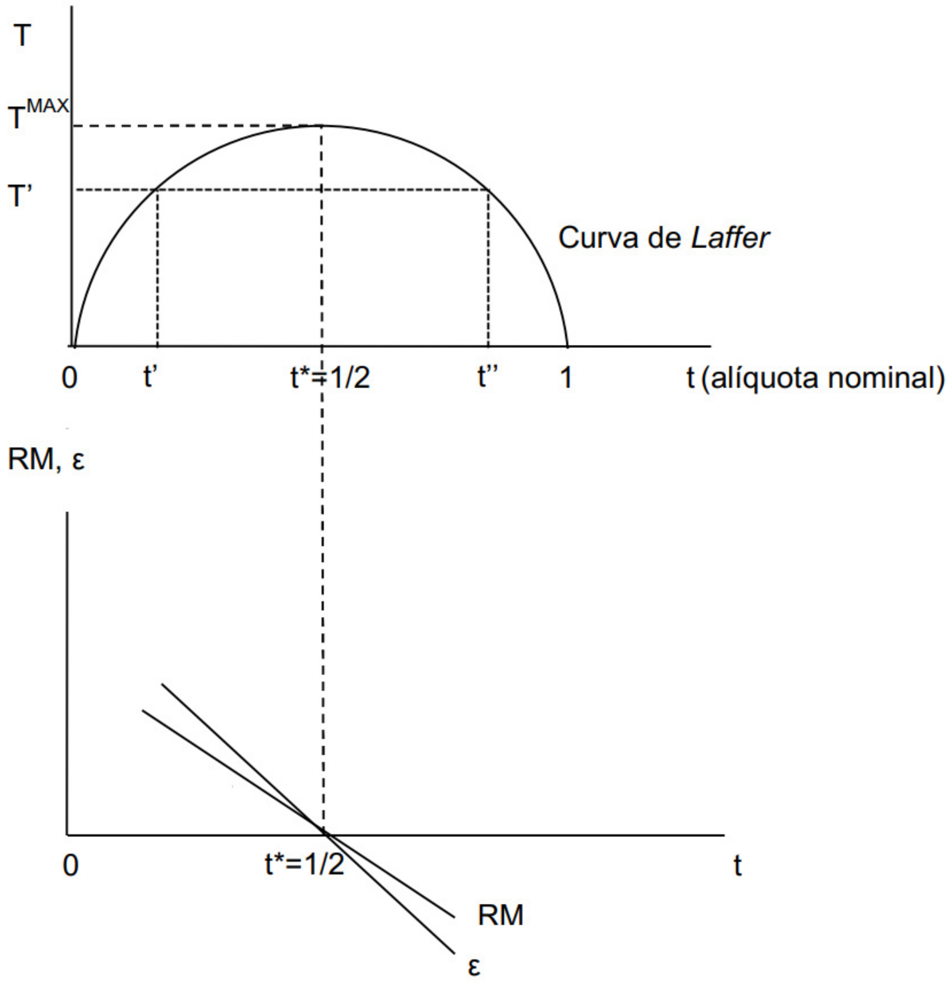
Assuming that the tax base is a linear decreasing function of the nominal tax rate, $Y(t)=1-t$,[3] then the total tax revenue is given by $T=t.(1-t)$. From the latter function, we have the marginal revenue (MR) function, $MR=1-2t$, and the function of the elasticity of total tax revenue with respect to the nominal tax rate, $\varepsilon = (1 - 2t)$. where ε denotes the elasticity. The maximum tax revenue, T^{MAX}, is obtained when $t^*=1/2$ as shown in the foreground of Figure 1.

1 It is not the purpose here to review the numerous studies that present the argument of the so-called Laffer curve, so many others seek to empirically test the hypothesis. For a summary of the discussion, see Silveira and Gadelha (2018).

2 For the concavity condition to hold, it is sufficient that $Y'(t)<0$ and $Y''(t)=0$.

3 This function limits the nominal tax rate to the interval [0, 1].

Figure 1 - Maximum total tax revenue and marginal revenue curves and elasticity



Source: own elaboration.

In the second plane of Figure 1 we have the curves of marginal revenue and elasticity of total tax revenue in relation to the nominal tax rate. Three points are highlighted:[4] i) when the nominal tax rate is equal to 1/2, both marginal revenue and elasticity equal zero; ii) for nominal rates in the interval (1/10, 1/2), elasticity is positive and higher than marginal revenue; iii) for nominal rates in the interval (1/2, 3/5), marginal revenue and elasticity become negative, elasticities being more negative than marginal revenue. After the theoretical introduction of the Laffer curve, we now move on to the empirical analysis.

3 Cointegration and error correction model

According to Bueno (2011), the notion of cointegration, proposed by Engle and Granger (1987), has the following definition: if two variables are integrated of the same order, there is a linear combination between two variables that follows a common stochastic trend. However, in the short run, there are deviations from the common trend, i.e., the respective variables may temporarily devia-

4 In the second plane, the illustration of the MR and elasticity curves considers the nominal tax rate to be between 1/10 and 3/5, corresponding to the relevant range in terms of tax policy.

te from long-term equilibrium. The return to equilibrium occurs due to the error correction term that directs the variables back to the long-term situation.

In the case of the Laffer Curve, it is assumed that the tax base and tax revenue, individually, are nonstationary variables and have the same order of integration. It is also assumed that there is a linear combination between the two variables that generates stationary residuals, and it can therefore be stated that the tax base and tax revenue are cointegrated (or have a cointegrating relationship).

From Silveira and Gadelha (2018), the static model (or long-run equilibrium relationship) to be estimated for the case at hand is:

$$log(ICMS_t) = \alpha_1 + \beta_1\, log(IBCR\text{-}RS_t) + \beta_2\, log(a_t) + \beta_3[log(a_t)]^2 + e_t \quad (1)$$

Where log(.)denotes the natural logarithm; ICMS tis the ICMS collection in period t; α_1 is the intercept; IBCR-RSt is the proxy variable of the tax base in period t; a is the nominal ICMS rate in effect in period t;[5] and e tis the stationary error.

The elasticity of ICMS collection in relation to economic activity, measured by the IBCR-RS, is given by:

$$\varepsilon^{icms}_{ibcr\_rs_t} = \frac{\partial\, lo\quad(ICMS_t)}{\partial\, log(IBCR\text{-}RS_t)} = \beta_1 \quad (2)$$

Therefore, β_1 measures the long-run elasticity of ICMS collection in relation to the IBCR-RS, i.e., it estimates, ceterisparibus, the effect of a variation in economic activity on state collection. In the long run, a positive coefficient is expected and greater than one, $\beta_1>1$.

The elasticity of ICMS collection with respect to the nominal rate is given by:

$$\varepsilon^{icms}_{a_t} = \frac{\partial\, log(ICMS_t)}{\partial\, log(a_t)} = \beta_2 + 2\beta_3[log(a_t)] \quad (3)$$

That is, the elasticity of revenue depends on the nominal ICMS rate. A positive elasticity is expected up to a certain critical level of the nominal rate, above which the elasticity becomes negative. Based on (3), equaling the elasticity to zero yields the nominal rate that maximizes ICMS revenue.

Building on the discussion of Wooldridge (2006) and Silveira and Gadelha (2018), an error correction model (ECM) is proposed that captures the short-run dynamics in the relationship between ICMS collections and economic activity:[6]

$$\Delta log(ICMS_{t-12}) = \gamma_1 \Delta log(IBCR\text{-}RS_{t-12}) + \gamma_2\, log(a_t) + \gamma_3[log(a_t)]^2 + \lambda\, \hat{e}_{t-12} + u_t$$
(4)

Where log(.) denotes the natural logarithm; $\hat{e}_{t-12}$ represents the estimated residuals in period

5 The nominal ICMS rate was chosen as the explanatory variable because it is a fiscal policy choice made by the State Government. The variables considered in the model are discussed in more detail below.

6 Since the data to be worked with are in monthly frequency, the model with the corresponding lag is presented. Note that the contemporaneous change in IBCR-RSt, Δlog(IBCR-RS), was omitted in the ECM to simplify the analysis.

(t12) of the long-run relationship (1), in other words, the residual measures the deviation from the long-run equilibrium in period (t-12); λ is the adjustment coefficient; $\lambda\hat{e}_{t-12}$ is the so-called error correction term; and ut is an I(0) process with zero mean.

The adjustment coefficient is expected to be significantly different from zero and negative, λ<0. If it were zero, the ICMS collection would not respond to the deviations from equilibrium that occurred at (t–12). Moreover, a small value of the coefficient λ would indicate a relatively weak relationship, leading to a long time to return to equilibrium.

If $\hat{e}_{t-12}$ >0, then at time (t–12) the collection has exceeded the equilibrium level; and since λ<0, the error correction term will lead to a reduction in collection until equilibrium is restored. On the other hand, if $\hat{e}_{t-12}$ <0, then at time (t–12), the activity level is above the equilibrium level; and since λ<0, the error correction term will induce a rise in collections until equilibrium is returned.

Considering equation (4) of the error correction model, the short-run elasticities are given by:

$$\varepsilon_{ibcr_{rs_t}}^{icms} = \frac{\partial\, \Delta lo\ \ (ICMS_{t-12})}{\partial \Delta log\ (IBCR\text{-}RS_{t-12})} = \gamma_1 \qquad (5)$$

$$\varepsilon_{a_t}^{icms} = \frac{\partial\, \Delta log(ICMS_{t-12})}{\partial\, log(a_t)} = \gamma_2 + 2\gamma_3[log(a_t)] \qquad (6)$$

Therefore, according to (5), a positive relation is expected between ICMS collection and the IBCR-RS and, according to (6), a positive elasticity up to a certain critical level of the nominal rate, above which the elasticity becomes negative. From (6), equaling the elasticity to zero, we obtain the nominal rate that maximizes ICMS collection.

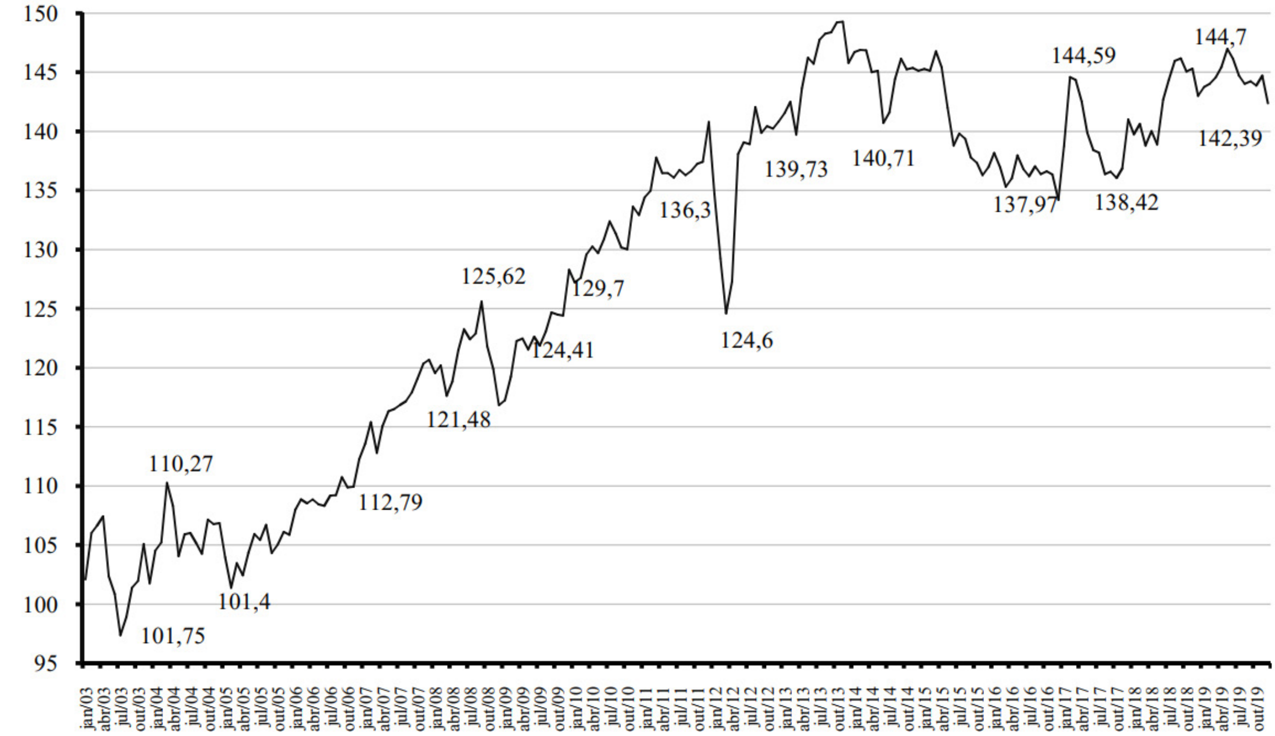
4 Database and descriptive analysis

The period between January 2003 and December 2019 is analyzed. The seasonally adjusted IBCR-RS is sourced from the Central Bank. It is a monthly indicator of the level of economic activity at the regional level. The IBCR-RS is built from proxies for the economic activities: Agriculture and Livestock; Manufacturing and Extractive Industry; Electricity Production and Distribution; Construction; Trade; Transportation Services; Information Services; Financial Intermediation; Business Services; Public Administration, Health and Education; Market Health and Education; Household Services; and Household Services.[7] It is worth noting that the IBCR-RS does not include ICMS tax collection in its calculation, thus avoiding possible problems associated with variable endogeneity.

Chart 1 presents the evolution of the IBCR-RS. It is a panorama of economic activity in the state of Rio Grande do Sul. The figures that appear were selected at random, aiming to provide an illustration of how the indicator captures the economic situation over the period, highlighting particularly the recessions in the years 2003, 2008 and 2012. Chart 1 suggests that the IBCR-RS series is non-stationary and does not indicate a priori the presence of a deterministic trend.

7 For more details on the index methodology, see the Time Series Management System of the Central Bank, Regional Economy item. Available at: https://www3.bcb.gov.br/sgspub/localizarseries/localizarSeries.do?method=prepararTelaLocalizarSeries. Accessed on: September 30, 2020.

Chart 1 - Evolution of the IBCR-RS - Jan./2003-Dec./2019



Source: BCB-Depec (CENTRAL BANK OF BRAZIL, 2020).

As a proxy for the ICMS tax rate, we use the nominal rate on the so-called blue-chip products and services (fuels, energy and communications) that was in effect during the period under analysis. Since it is determined by government decision and is not the effective rate, the problem of endogeneity of variables is practically eliminated.

The blue-chip rates are higher than the rates applied in other sectors and were increased over time to raise or maintain the level of ICMS collection. According to a study by the Finance Department of Rio Grande do Sul (Sefaz-RS), the participation of blue-chips in the total ICMS collection varied in the period under analysis, reaching a peak in 2006, with 46% of the total, and currently represents around 33% of the total, basically because of the reduction in importance of telephone services, which started to suffer competition from new communication technologies.[8]

The legislation pertaining to ICMS, including the nominal rates, is gathered in Decree No. 37,699, of August 26, 1997, where we have the ICMS Regulations (RICMS).[9]

Table 1 - Evolution of nominal rates on blue-chips in Rio Grande do Sul - 1999-2020

(%)

8 The referenced study is available at: https://fazenda.rs.gov.br/upload/1599677676_ESTUDO_Beneficios_Fiscais_RS_08_setembro_2020.pdf. Accessed September 30, 2020.

9 Available at: http://www.legislacao.sefaz.rs.gov.br/. Accessed on: 30 Sep. 2020.

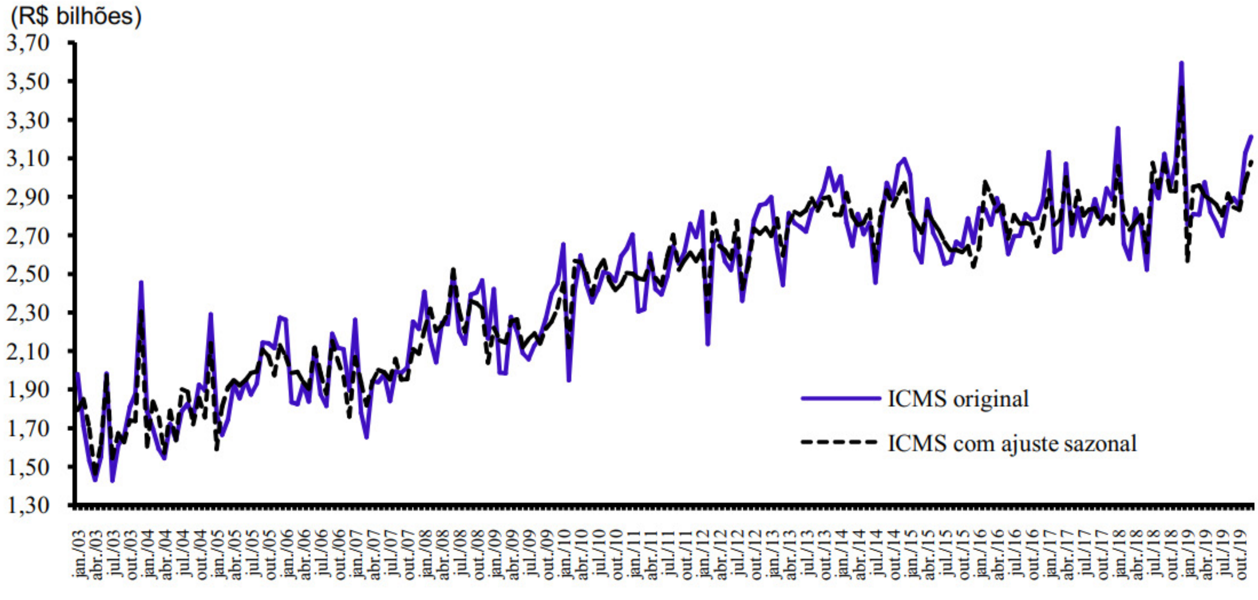
BLUE-CHIPS	1999-2004	2005	2006	2007-15	2016-20
Fuels	25	30	29	25	30
Communications	25	30	29	25	30
Electricity	25	30	29	25	30

Source: RICMS (RIO GRANDE DO SUL, 2020a).

Table 1 shows the evolution of the nominal rates on blue-chips. As can be seen, in the period from 1999 to 2004, the nominal rate remained at 25%, being raised to 30% in 2005, and having a reduction of 1 p.p. in 2006. Between 2007 and 2015, the rate returns to 25%, however, between 2016 and 2020, it returns to the 30% level.

The collection of the Principal ICMS (without the amounts referring to active debt, fine and interest) was deflated by the National Wide Consumer Price Index (IPCA) at December 2019 prices. The source of the raw data is the Finance Department of the State of Rio Grande do Sul. Chart 2 provides an overview of the original (solid line) and seasonally adjusted (dashed line) series over time.[10] Chart 2 suggests that the seasonally adjusted ICMS series is not stationary and embodies a process with a stochastic trend and, a priori, without the presence of a deterministic trend.

Graph 2 - ICMS collection in Rio Grande do Sul - Jan./2003-Dec./2019



Source: Treasury Department of the State of Rio Grande do Sul (RIO GRANDE DO SUL, 2020b).

The X13-ARIMA-SEATS program was used for the seasonal adjustment procedures. Table 2

10 I thank my colleague from DOF, Adi Collazuol, for making available the raw data of the Main ICMS collection whose source is SEFAZ-RS through the site: <https://www.sefaz.rs.gov.br/Site/MontaMenu.aspx?MenuId=92>.

presents the output of the "seasonal" package for R. This[11] is an ARIMA model of order (0, 1, 1)(0, 1, 1)$_{12}$, seasonally adjusted and automatically selected by the program.

Table 2 - Output generated in R

Component	Estimated Coefficient	Standard error	Pr(>|z|)
AO2003.Dec.	0,5899	0,12980	5,51e-06 ***
AO2018.Dec.	0,5888	0,12843	4,54e-06 ***
MA-Nonseasonal-01	0,7593	0,04517	< 2e-16 ***
MA-Seasonal-12	0,8554	0,03985	< 2e-16 ***
Number of observations: 204	QS: 0	Box-Ljung: 20,43	Shapiro: 0,9916

Note: ***0.1% significance level.

Source: own elaboration.

The column for Pr(>|z|) indicates that all estimated coefficients are significant. In Table 1, we have the seasonal moving average component with 12 lags (MA-Seasonal-12), the non-seasonal moving average component with one lag (MA-Nonseasonal-01) and two additive outliers: in December 2003 and in December 2018. Such "out of the curve" points are explained because of discretionary revenue anticipation measures, as per Decrees No. 42,826, dated January 15, 2004, and No. 54,348, dated November 26, 2018.

The QS statistic tests whether there is seasonality in the series after the final adjustment of the data. As QS is zero, there is no seasonality left. The Box-Ljung test indicates no evidence of autocorrelation in the residuals and the Shapiro test suggests normality of the residuals. Finally, it should be noted that there was no transformation of the original series.

The performance of ICMS collection is associated with both the economic situation, which varied over time, and the changes in tax rates on blue-chip sectors. The main legal changes, and which had an impact on ICMS collection, occurred in 2004, 2015, and 2018, though, respectively, Laws No. 12,209, of December 29, 2004, No. 14,743, of September 24, 2015, and No. 15,238, of December 21, 2018.

5 Estimation Results

Adopting the Engle and Granger methodology for the cointegration test, the first step is to perform the unit root tests for the ICMS and IBCR-RS revenue series (in natural log).

Two-unit root tests were performed for the log (ICMSt) series at level: the Augmented

11 As per Sax and Eddelbuettel (2018).

Dickey-Fuller test and the Phillips-Perron test.[12] In Table 3, the value of the statistic, 2.67, corresponding to the model with constant, is higher than the critical values at 1%, 5% and 10% significance level.[13] Therefore, the null hypothesis is not rejected, so the log series (ICMSt) has a unit root. In the Phillips-Perron test, referring to the model with constant, the value of the statistic, -2.24, is greater than the critical values at the 1%, 5% and 10% significance levels, so the null hypothesis is accepted and it is concluded that the series has a unit root. Thus, both tests conclude that the log series (ICMSt) has unit root.

Table 3 - log($ICMS_t$) unit root tests

Augmented Dickey-Fuller Test			**Phillips-Perron test**		
Statistics-test		-2,02	Z-tau test-statistic		-2,24
	1%	-3,46		1%	-3,46
Critical values	5%	-2,88	Critical values	5%	-2,88
	10%	-2,57		10%	-2,57

Source: own elaboration.

Table 4 shows the tests for the series Δlog($ICMS_t$), in first difference, with the same model specifications considered above. Since the values of the statistics are lower than the critical values, both tests indicate that the series in first difference has no unit root. Therefore, from the results presented, it can be stated that the log ($ICMS_t$) series is integrated of order one, I(1).

Table 4 - Unit root tests Δlog($ICMS_t$)

Augmented Dickey-Fuller Test			**Phillips-Perron test**		
Statistics-test		-7,54	Z-tau test-statistic		-34,8
	1%	-3,46		1%	-3,46
Critical values	5%	-2,88	Critical values	5%	-2,88
	10%	-2,57		10%	-2,57

Source: own elaboration.

Table 5 presents the tests for the log(IBCR-RSt) series in level. The model considered in the

12 The package used is 'urca' for R, whose reference Pfaff (2008). For a formal presentation of these tests, see Bueno (2011).

13 The maximum p is equal to 15 for a sample with 204 observations. The value was calculated according to Schwert's formula (1989), see Bueno (2011, p.121). By Akaike's criterion, the final lag is equal to 6.

Augmented Dickey-Fuller test is with the drift term. The value of the statistic, -1.46, is higher than the critical values at all three significance levels.[14] In the Phillips-Perron test, the model with a constant was considered, and since the value of the statistic, -1.56, is greater than the critical values at the three levels of significance, the null hypothesis that the series has a unit root is not rejected. Therefore, the two tests indicate that the series at the level has a unit root.

Table 5 - log(IBCR-RS_t) unit root tests

Augmented Dickey-Fuller Test			Phillips-Perron test		
Statistics-test		-1,46	Z-tau test-statistic		-1,56
	1%	-3,46		1%	-3,46
Critical values	5%	-2,88	Critical values	5%	-2,88
	10%	-2,57		10%	-2,57

Source: own elaboration.

Table 6 shows the mm-tests for the Δlog(IBCR-RS_t) series in first difference. The model considered in the Augmented Dickey-Fuller test is with the drift term and in the Phillips-Perron test with a constant. In both tests, the values of the statistics are less than the critical values for all three significance levels, indicating that both tests reject the hypothesis of unit root presence (Table 6). Thus, based on the results presented, the log(IBCR-RS_t) series can also be considered as integrated of order one, I(1).

Table 6 - Unit root tests Δlog(IBCR-RS_t)

Increased Dyck-Fuller test			Phillips-Perron test		
Statistics-test		-8,95	Z-tau test-statistic		-13,68
	1%	-3,46		1%	-3,46
Critical values	5%	-2,88	Critical values	5%	-2,88
	10%	-2,57		10%	-2,57

Source: own elaboration.

Given that the ICMS and IBCR-RS series (in natural log) are I(1), the second step of the Engle and Granger methodology is to test for cointegration between the variables, taking into account the nominal tax rate changes on the blue-chip sectors.

14 The maximum p is equal to 15 for a sample with 204 observations. The value was calculated according to Schwert's formula (1989), see Bueno (2011, p.121). By Akaike's criterion, the final lag is equal to 4.

Table 7 presents the regression results of the static model or cointegration relationship (1).[15] The estimated long-run elasticity of ICMS revenue in relation to the IBCR-RS is 1.36, which means that a 1% increase in the IBCR-RS generates a 1.36% increase in ICMS revenue in the long run. The result of a positive long-term elasticity greater than one is in agreement with the studies of Bouthevillain et al. (2001), Wolswijk (2007), Koester and Priesmeier (2012), Marques Junior and Oliveira (2015), Silveira and Gadelha (2018).

Table 7 - Long-term relationship for the RS

Dependent Variable: $\log(ICMS_t)$			
Explanatory variables	**Coefficients**	**Standard Error**	**T-statistic**
$\log(IBCR\text{-}RS_t)$	1,36 ***	0,035	39,36
log (alíquot$_t$)	-1,22***	0,056	-22,04
$[\log(rate_t)]^2$	-0,61***	0,040	-15,19
F-statistic	14.620 (0,0000)	Adjusted R^2	0,99

Source: own elaboration.

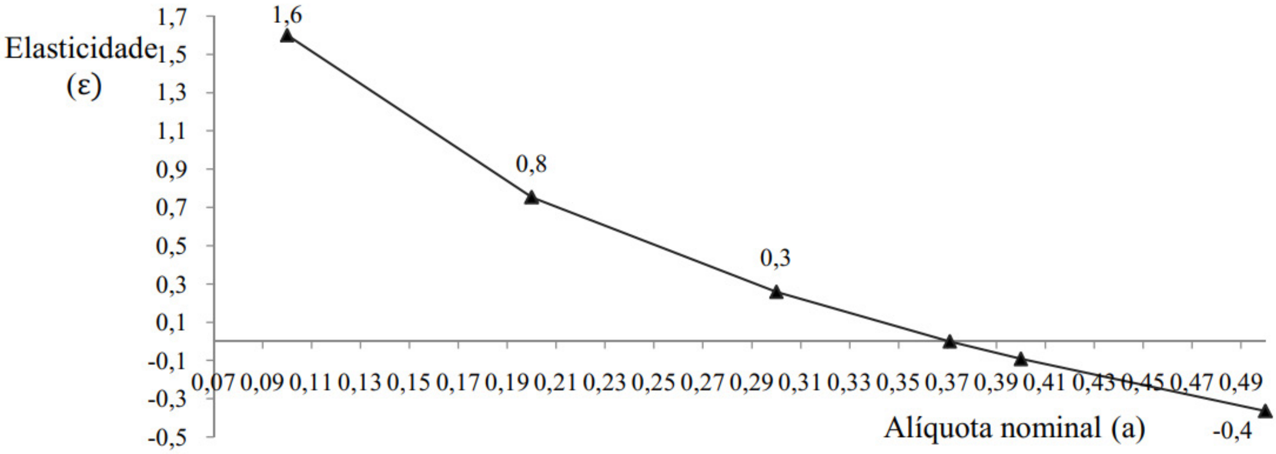
Note: ***statistical significance level of 0.1%; p-value in parentheses.

The third step is to perform the unit root test of the residuals of the long-run relationship using the augmented Dickey-Fuller procedure. In the model with no intercept and no deterministic trend, the statistic obtained, -9.2, is lower than the critical values (-2.58; -1.95; and -1.62) for the respective significance levels (1%, 5%, and 10%), implying that the residuals have no unit root and thus one has evidence that the $\log(ICMS_t)$ and $\log(IBCR\text{-}RS_t)$ variables are cointegrated.

With the estimated coefficients (Table 7) and equating (3) to zero, we obtain the critical nominal ICMS rate, which is 37% (Chart 3). Increases in the rate above this percentage reduce the collection of ICMS, because the elasticity becomes negative. Note that for any rate below the critical level, the elasticity is positive. Equaling (3) to one, we arrive at the result that the ICMS tax collection is elastic with respect to the rate, that is, the elasticity is greater than one for rates below 16%. Therefore, between rates of 16% and 37%, the elasticity is between zero and one, that is, the ICMS tax collection is inelastic with respect to variations in the nominal rate.

Graph 3 - Elasticity of ICMS tax collection with respect to the nominal rate on a blue-chip sector in RS

15 The package used to estimate the regressions is "dynlm" for R whose reference is Zeileis (2019).



Source: own elaboration.

Since the ICMS tax collection and the IBCR-RS are cointegrating variables, we proceed to the fourth and last step, which is to estimate the error correction model (4). Table 8 presents the estimation results.

The error correction coefficient λ is negative and significant (Table 8). Thus, if ICMS collection is above its long-term level, the correction term will lead to a decrease in collection of 0.95 points, on average, over the one-year period. And if collection is below the long-term equilibrium, the correction term will be positive with collection increasing by 0.95 points on average over one year. In other words, the adjustment term indicates that virtually all deviation from equilibrium is corrected within one year. Of course, the adjustment does not depend only on the state's economic situation, but on factors not considered in the analysis, among which the political and institutional stability of Brazil stands out.

Table 8 - Error correction model for the RS

INDEPENDENT VARIABLE	DEPENDENT VARIABLE: $\Delta\log(ICMS_{t-12})$		
	Coefficient	**Standard Error**	**T-statistic**
$\Delta\log(\text{IBCR-RS}_{t-12})$	0,75***	0,111	6,679
$\log(a_t)$	-0,11*	0,055	-1,981
$[\log(a_t)]^2$	-0,07[.]	0,041	-1,736
λ	-0,95***	0,717	-13,282
F-statistic	63,28 (0,0000)	Adjusted R^2	0,5647

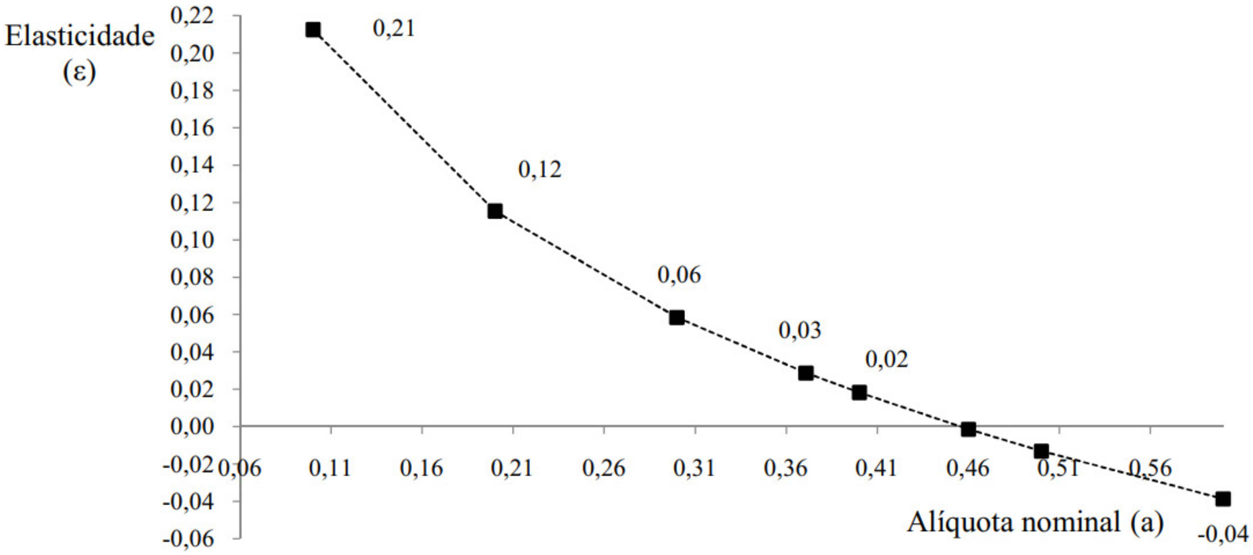
Source: own elaboration.

Note: ***0.1% significance level; *5% significance level; [.] 10% significance level; p-value in parentheses.

The coefficient of the variable log(IBCR-RS_{t-12}) is 0.75 and statistically significant (Table 8). Thus, a decrease in the IBCR-RS generates a reduction of 0.75 points in ICMS collection, whereas an increase in the indicator is associated with an increase of 0.75 points in ICMS collection. Therefore, ICMS collection is inelastic in relation to the IBCR-RS in the short term. Such result of elasticity is in accordance with the studies of Bouthevillain et al. (2001), Marques Junior and Oliveira (2015).

In relation to the error correction model (ECM), see Chart 4, the elasticity of ICMS collection in relation to the nominal rate is given by (6) and the estimated values in Table 8. Note that the elasticities calculated from the ECM are lower than those in Chart 3 for the different rate levels.

Graph 4 - Elasticity of ICMS collection to the nominal rate (MCE)



Source: own elaboration.

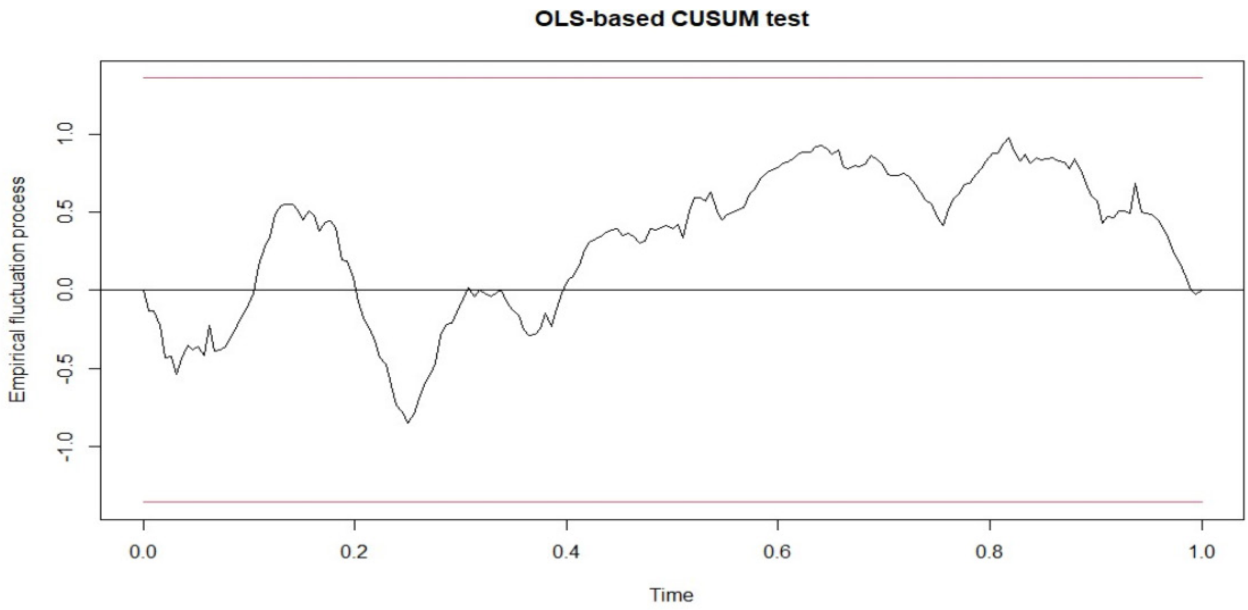
Considering the short-term dynamics, the critical nominal ICMS rate rises to 46% when the elasticity is zero. Increases in the rate above this percentage reduce the collection of ICMS, because the elasticity becomes negative. Note that for any rate below the critical level, the elasticity is positive.

Equaling (6) to one, we arrive at the result that the ICMS tax collection is elastic with respect to the rate, that is, the elasticity is greater than one for rates lower than 0.04%, which is well below 16%. Therefore, between the rate levels, 0.04% and 46%, the elasticity is between zero and one, i.e., the ICMS collection is inelastic with respect to nominal rate variations.

To test the hypothesis of structural change in the EER, the procedure proposed by Zeileis et al. (2002) is followed. We assume the null hypothesis of "no structural change", that is, we admit that the MCE residuals are stationary over time, so we proceed with the test by establishing the OLS-CUSUM process that contains the cumulative sums of the residuals.[16] Figure 2 presents the results for the MCE residuals.

16 For more details, see Zeileis et al. (2002).

Figure 2 - OLS-CUSUM process of the residuals and their limits for the MCE



Source: own elaboration.

As the process fluctuates within the limits, not exceeding any positive or negative limit, it is concluded that the data do not present evidence of structural change. This result is expected considering that the data analyzed do not present abrupt changes in the series or in the relationship between the series. Furthermore, in the period under analysis there are no phenomena such as war, political regime change or major changes in economic policy at either the national or regional level.

6 Concluding remarks

When considering the long-term relationship, the econometric results indicated a high sensitivity of ICMS collection to the IBCR-RS; however, in the short term, ICMS collection is less sensitive to changes in the level of economic activity. The same happens with the sensitivity of the ICMS collection in relation to the nominal tax rate that falls on the so-called blue-chip sectors.

Both in the long-term equilibrium model and in the error correction model, the results indicated a negative relationship between the elasticity of ICMS collection and the tax rate, and it is possible to identify a critical nominal rate beyond which rate increases result in a reduction in ICMS collection, as predicted by the Laffer Curve. The results indicate that the critical rate of the correction model, 46%, is much higher than the cointegration rate, 37%. Another important difference refers to the degree of inelasticity of ICMS collection in relation to the rate, being higher when considering the short-term dynamics than in the long-term relationship.

To conclude, the results suggest that both the IBCR-RS and the nominal rate on blue-chips contribute to the collection of ICMS, which is widely discussed in theory, and this is shown in both the long-run and the short-run relationship.

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