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A further deterioration of the Brazilian fiscal reaction in view of COVID-19*

Uma nova deterioração da reação fiscal brasileira diante da Covid-19

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RESUMO: A função de reação fiscal mede como o superávit primário do governo reage à evolução da dívida pública. Campos e Cysne (2019b) observaram que a função de reação vem diminuindo quase constantemente desde 2012 e passou de valores positivos para negativos em 2017 e 2018. No período seguinte, a melhora de alguns indicadores econômicos conduziu a reação fiscal a uma recuperação. Todavia, em 2020, com o advento da Covid-19, as despesas com saúde e auxílios emergenciais provocaram uma forte deterioração fiscal, levando o coeficiente de reação fiscal a atingir, novamente, valores negativos.
PALAVRAS-CHAVE: Brasil; reação fiscal; Covid-19; razão Dívida/PIB; sustentabilidade fiscal; filtro de Kalman.

ABSTRACT: The fiscal reaction function measures how the government's primary surplus reacts to the evolution of public debt. Campos and Cysne (2019b) observed that the reaction function has been almost steadily decreasing since 2012 and it has turned from positive to negative values in 2017 and 2018. In the subsequent period, the improvement of some economic indicators led the fiscal reaction to a recovery. Nevertheless, in 2020, with the advent of COVID-19, health spending and emergency aids caused a sharp fiscal deterioration, leading the fiscal reaction coefficient to assume, again, negative values.

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KEYWORDS: Brazil; fiscal reaction; COVID-19; Debt/GDP ratio; fiscal sustainability; Kalman filter.
JEL Classification: H30; H60; E50.

INTRODUCTION

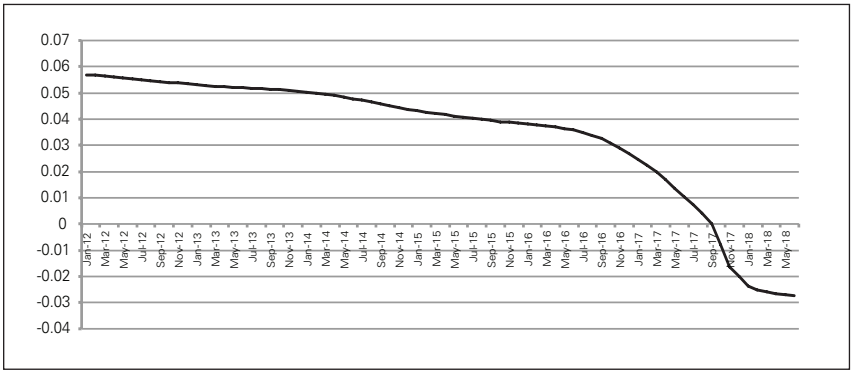
According to Blanchard (2004), a public debt is sustainable if the discounted sum of anticipated future primary surpluses is sufficient to pay off its current value. The use of econometrical analysis to evaluate the sustainability of public debt is advisable for at least two reasons: first, future values of GDP growth and interest rates are subject to uncertainty; second, past data may provide a hint about the future institutional, legal and political conditions under which the control of public revenue and expenses is to be achieved. Econometrics allows to address these points by specifying a causal relationship between variables, from well-founded assumptions about their behavior, besides controlling for other variables.

Some works used econometric methods in order to investigate the sustainability of the Brazilian public debt in the recent period. Nevertheless, despite the strong and growing deterioration of public accounts in Brazil as of early 2012, there is no conclusive results about this topic. For example, Luporini (2015), using a rolling window regression model, found a sustainable public debt throughout all her study period, from January 2001 to August 2013. Triches & Bertussi (2017), using the multicointegration method, concluded that the Brazilian public debt was weakly sustainability from 2015 onwards, but draw attention to a possible transition to an unsustainable path in a subsequent period. On the other hand, Campos & Cysne (2019a), using a time-varying fiscal reaction function, concluded that the public debt may have assumed an unsustainable trajectory as of 2014. This conclusion was corroborated by these authors, using another econometrical method (see, for example, Campos & Cysne, 2022). In the present work, we focus on the first approach used by them: the fiscal reaction function.

A fiscal-reaction function (Bohn, 1998) establishes a relationship between primary surpluses and the debt-to-GDP ratio. The underlying idea is to assess if, and to what extent, fiscal revenues and expenses react to the evolution of the indebtedness. Roughly speaking, a fiscal reaction function assumes positive values when public deficit reacts negatively to increases on the debt/GDP ratio. Campos & Cysne (2019a) estimated a time-varying fiscal-reaction function, using data up to 2016. Posteriorly, the authors re-estimated this function, updating the data to 2018, and found that the fiscal reaction coefficient had become negative as of October 2017 (Campos & Cysne, 2019b), meaning that primary surplus decreases (or primary deficit increases) as public debt increases, thus contrary to desired. In this new work, the authors called this situation "an alert on the fiscal reaction in Brazil".

Figure 1 illustrates the abovementioned fiscal reaction estimated by Campos & Cysne (2019b) up to June 2018.

Figure 1: Fiscal Reaction Estimated
by Campos & Cysne (2019b)



Note: Figure 3 of Campos & Cysne (2019b).

In the subsequent period, the recovery of some economic indicators – although gradual – led the fiscal reaction to a recovery and to a return to positive values throughout 2019. Nevertheless, in 2020, because of the COVID-19 pandemic, health spending and emergency aids led to a sharp deterioration of the Brazilian fiscal situation, thus motivating another alert on a new – and stronger – drop in the Brazilian fiscal reaction.

Based on the concepts addressed by Campos Cysne (2019a) and Bohn (1998), and considering the variables public debt, primary surplus, interest, inflation and risk premium, the present work updates the fiscal reaction for Brazil, with data up to 9/2020, thus including the period of the COVID-19 pandemic.

DEBT SUSTAINABILITY

This section draws on Campos & Cysne (2019a) to derive a condition on debt sustainability in the present framework. It requires the fiscal-reaction coefficient to be big enough to compensate for the positive difference between interest and GDP-growth rates.

The government budget constraint, in nominal terms, is represented as follows:

$$B_t = G_t - T_t + (1 + i_t)B_{t-1} \qquad (1)$$

where B_t stands for net debt[1], G_t for government's primary expenditures (consumption, investment and transfers, not including interest payments), T_t are the primary revenues (tax plus other net current revenues) – all computed at the end of time t – and i_t is

[1] Equation (1) applies only to net debt, assuming an equal interest rate accruing on government's both assets and liabilities. Considering B_t as the gross debt would imply bypassing government assets and their remuneration, making equation (1) an approximation for the debt evolution.

the nominal interest rate, associated with a public security purchased at time $t - 1$ and remunerated at t.

A public debt series or, accordingly, the fiscal policy associated with it, is characterized as sustainable if the present value of future surpluses is sufficient to offset the present debt value. To formalize this condition, the budget constraint in (1) must be solved iteratively for t = 1,2,...T (it is considered, for simplicity, that $i_t = i \ \forall \ t$):

$$B_t = (1+i)^t B_0 + \sum_{k=1}^{t} (1+i)^{t-k} (G_k - T_k)$$

or even:

$$B_0 = \frac{B_t}{(1+i)^t} + \sum_{k=1}^{t} \frac{S_k}{(1+i)^k}$$

Where $S_k = T_k - G_k$ is the primary surplus at $t = k$.

The condition for debt sustainability is:

$$\lim_{t\to\infty} \frac{B_t}{(1+i)^t} = 0 \qquad (2)$$

At (2), $B_0 = \sum_{k=1}^{\infty} \frac{S_k}{(1+i)^k}$, i.e., the discounted sum of primary surpluses at present value is equal to the current debt.

The following notation is now defined: Let Z be any variable (representing, for instance, B, G, or T), Y be the GDP and $Z = {}^{Z}/_{Y}$ Divide both sides of (1) by Y_t, to obtain:

$$b_t = g_t - t_t + (1+i_t) b_{t-1} \frac{Y_{t-1}}{Y_t} \qquad (3)$$

Define the GDP growth rate as θ_t:

$$Y_t = (1+\theta_t) Y_{t-1} \qquad (4)$$

Use (4) in (3) and make $s_t = t_t - g_t$ stand for the primary surplus as a fraction of GDP to obtain:

$$b_t = -s_t + \frac{(1+i_t)}{(1+\theta_t)} b_{t-1} \qquad (5)$$

Here, we use a fiscal reaction mechanism similar to that of Bohn (1998), defined as follows:

$$s_t = \rho b_{t-1} + \gamma X_t + \varepsilon_t \qquad (6)$$

where X_t is a vector of control variables and ε_t is the error term.

With the purpose of evaluating the sustainability condition for the simplest case, the parameters ρ, i and θ are considered constant[2]. Replacing (6) in (5):

$$b_t = \left(\frac{1+i}{1+\theta} - \rho\right) b_{t-1} \qquad (7)$$

Solving (7) iteratively:

$$b_t = \left(\frac{1+i}{1+\theta} - \rho\right)^t b_0 \qquad (8)$$

Under the approximation $\frac{1+i}{1+\theta} \cong 1 + i - \theta$, the debt sustainability condition implies:

$$\rho > i - \theta \qquad (9)$$

DATA

We used monthly data from January 2003 to September 2020. Concerning scopes for calculating debt and primary results, we considered two usual concepts. The first one is the Consolidated Public Sector (CPS), which includes federal, state and local governments, social security, Central Bank and government-controlled companies – except Petrobras and Eletrobras. The other sector considered is the General Government (GG), which includes only federal, state and local governments and social security, thus excluding Central Bank and government-controlled companies from the computation of variables.

For S_1 we used the primary result of the consolidated public sector accumulated for the previous 12 months. This is the reference used in the Budget Guidelines Law for the elaboration of the annual primary-income targets. To calculate the Debt-to-GDP ratio $b_t = B_t / Y_t$ and the primary surplus-to-GDP ratio $s_t = S_t / Y_t$ it was considered that Y_t = monthly nominal GDP estimated by the Central Bank – based on IBGE quarterly data – also accumulated for 12 months (in order to attenuate impacts of seasonality).

Bohn (1998) suggests, as control variables for the fiscal reaction function, the output gap – to capture the effect of oscillations in economic activity – and a variable indicative of sudden rises in spending. Both effects were considered. In order to calculate the output gap of period t we used the monthly estimated GDP, Y^r_t, provided by the IBRE/FGV GDP monitor[3]. The potential GDP Y* was obtained by using the Hodrick-Prescott filter. The output gap is then defined as: $h_t = (Y^r_t - Y^*_t) / Y^*_t$. To represent the cycles of sudden rises in expenses, two binary variables were used: one indicates the national election years and the other indicates the pandemic pe-

[2] The reaction function does not establish whether surpluses are generated by either an increase in revenue or a decrease in expenses.

[3] Some studies use the industrial production index or IBC-Br of the Brazilian Central Bank, but these series are only *proxies* for the Real GDP.

riod, this is, assumes value 1 from March 2020 to the end of the sample. The latter is a new variable in relation to the fiscal reaction function estimated in Campos & Cysne (2019b).

The sources for all data used are shown in Annex 1.

We list below some other controls important for the Brazilian case:

i_t: basic interest rate (SELIC);

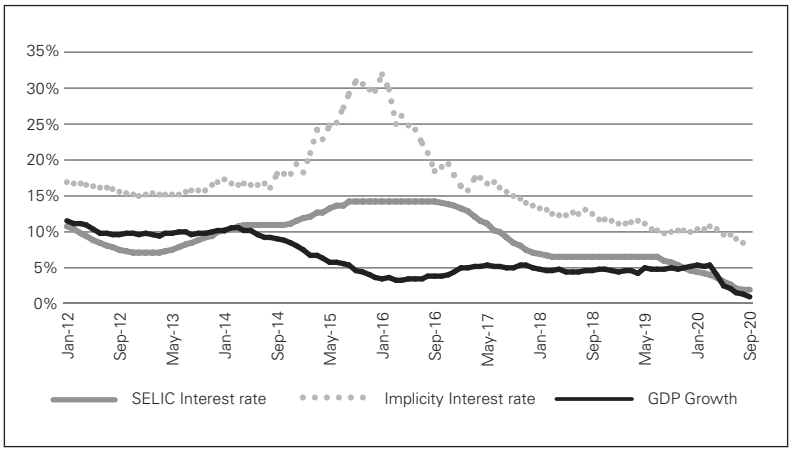
i^*_t: implicit interest rate[4];

rp_t: debt risk-measure of risk perception associated with debt insolvency, calculated as a ratio between EMBI+ (monthly average) and the rating risk assigned by Standard & Poors[5];

π_t: inflation – IPCA monthly relative variation for the previous 12 months.

Figure 2 shows the evolution of the interest rate (SELIC and implicit) and GDP growth.

Figure 2: GDP Growth, SELIC Interest Rate and Implicit Interest Rate



One can see a sharp drop in both the basic interest rate and in the implicit interest rate, as well as a fall of the 12-month GDP growth rate up to September 2020.

Figure 3 illustrates the worsening of the fiscal surplus and the debt-to-GDP ratio (net debt). This graph shows both the consolidated public sector (CPS) and the general government (GG) results.

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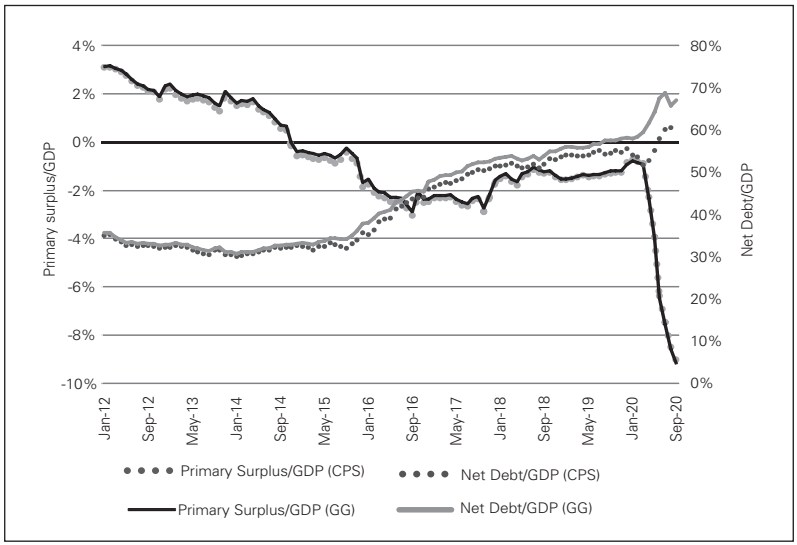
[4] The implicit interest rate on the debt is provided by the Central Bank. For further details, please refer to the link provided in Annex 1. It is assumed throughout this paper that i_t is the gross rate on public debt, i.e., without deducing the portion that returns to the government in the form of taxes on interest. It is worth to mention that the alternative of considering it as the net rate did not change the results.

[5] See Megale (2003). The EMBI+ is an index based on debt securities issued by emerging countries, reflecting the difference between the rate of return on these securities and the return on US Treasury bills. The classifications have been converted into a numerical variable as follows: D (defaulter) = 0; SD = 1; CC = 2; CCC- = 2.5; CCC = 3; CCC+ = 3.5; B- = 4; adding 1 point for each promotion. For the positive (negative) concepts attributed by S&P, an increase (decrease) of 0.25 is considered.

Figure 3: Primary Surplus/GDP x Net Debt/GDP (CPS and GG)



We can see a little difference between the two definitions of government, concerning the paths of the relevant variables. Therefore, very close results should also be expected from the empirical analysis.

THE COVID-19 EFFECTS

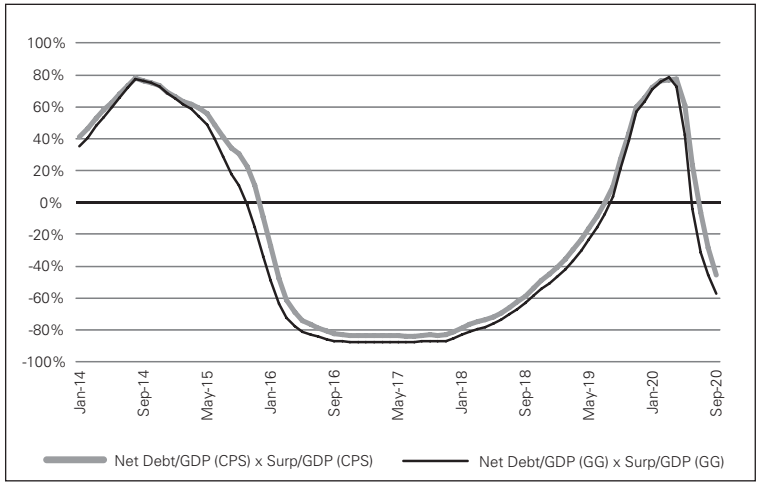
The advent of the COVID-19 led the Brazilian fiscal situation to a strong worsening. In Figure 3, we observe a sharp fall in primary surplus in 2020 – or an increase in primary deficit – at the end of the sample. This may be explained by two factors: 1) a strong fall in the government tax collection, due to the decreasing level of the economic activity; 2) the increase in public expenses to deal with the impacts of the pandemic. For example, higher investments in health system, wage compensations for unemployment and emergency aid for many people, among other measures.

To be able to finance the new expenses, the government needed to increase its net debt. Therefore, the Brazilian public debt strongly increased as of March 2020. Furthermore, the GDP decreasing also contributed to the sharp increase of the debt-to-GDP ratio. In September 2020, last point of available data for this study, the general-government net debt reached 67.1% of the GDP[6], while the public sector net debt was 61.4% of GDP.

Figure 4 shows the 48-month moving-average correlations between Debt and Primary Surplus, both as proportions of the GDP.

[6] Although it is not the focus of the present work, the general-government gross debt reached 90.6% in September 2020.

Figure 4: Debt-to-GDP and Primary Surplus-to-GDP correlations (48-month moving window)



Note: Month's t correlation corresponds to the interval [t - 47, t]

From October 2017, we verify the effects of the economic and fiscal recovery that started in mid-2016. Correlations start increasing, becoming positive in mid-2019. Nevertheless (as we will check further), the sustainability condition (9) was not reached – and neither would be – even at the beginning of 2020, although the correlation assumed its maximum value since 2014. As of the first quarter of 2020, the effects of the pandemic started to show up, leading the correlations to a strong fall, with a returning to negative values as of July 2020.

We proceed with the estimation of the Brazilian fiscal-reaction function. The data covers the period from January 2003 to September 2020. The specification follows Bohn (1998), but adapted to specificities of the Brazilian case and allowing time-varying coefficients. The fiscal reaction coefficient and other parameters are estimated by Kalman Filter. For technical details regarding this method of estimation, see Campos & Cysne (2019a).

ESTIMATED FISCAL REACTION IN THE LAST MONTH OF SAMPLE (SEPTEMBER 2020)

There are two possible approaches to analyze the fiscal reaction function in view of the pandemic. The first one follows Campos & Cysne (2019a), presenting the estimated function only for the last month of the sample. The second approach considers the means of estimated coefficients in the pandemic period. In this section we follow the first approach. The other one will be considered in the next section.

The fiscal-reaction function estimated for the Consolidated Public Sector in

September 2020 (last point of the sample) is given below. We report only the statistically significant coefficients, at the 0.05 level (standard errors in parenthesis)[7]:

$$\underset{}{s_t} = \underset{(0.003)}{0.009} + \underset{(0.361)}{0.962}s_{t-1} - \underset{(0.018)}{0.051}b_{t-1} + \underset{(0.025)}{0.061}h_{t-1} - \underset{(0.007)}{0.019}rp_t - \underset{(0.006)}{0.021}D_t - \underset{(0.002)}{0.007}D_t b_{t-1} \quad (10)$$

For comparison, we show the fiscal reaction function estimated by Campos & Cysne (2019b) for June 2018 (again, only significant estimates at the 0,05 level, standard errors in parenthesis):

$$\underset{}{s_t} = \underset{(0.009)}{0.021} + \underset{(0.416)}{0.947}s_{t-1} - \underset{(0.010)}{0.027}b_{t-1} + \underset{(0.014)}{0.029}h_{t-1} - \underset{(0.004)}{0.011}rp_t \quad (11)$$

In addition to the differences in magnitude between the coefficients of the common variables[8], another remarkable difference between equations (10) and (11) is the presence of a statistically significant dummy variable related to the pandemic, D_t – and its interaction term with b_{t-1} – in equation (10)[9].

Furthermore, we see, in both functions, the lagged surplus (S_{t-1}) coefficient is significant, thus indicating a stable and strong inertial component of the primary surplus, as expected (see Bohn, 1998). Besides, the coefficient of the output gap h_{t-1} remains positive and significant. In fact, in periods of expansion, a larger primary surplus is generated, either by increasing revenues (e.g., tax) or by reducing public spending (e.g., unemployment insurance), the opposite happening in recession periods. Finally, the risk premium coefficient remains significant at the considered statistical level, and its signal remains negative, as would be expected.

THE FISCAL REACTION FUNCTION DURING THE PANDEMIC PERIOD (MARCH 2020 TO SEPTEMBER 2020)

The fiscal-reaction function during the pandemic period considers the means of the estimated coefficients from March 2020 to September 2020. The result is

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[7] Given the similarity of the results for the Consolidated Public Sector (CPS) and for the General Government spheres (see also Figure 3), we focus only on the CPS. Nevertheless, it may be important to know that the estimated fiscal reaction coefficient for the general government resulted -0.049, not only very similar but also non statistically different from the -0,052 for the CPS in the equation (10), at the 0.05 level.

[8] As a "pre-test", we checked the stability of the coefficients of a standard regression model over the corresponding time interval (this is, from June 2018 to September 2020), by using a Chow test to compare the coefficients of a (standard) regression for the full sample (up to September 2020) with those corresponding to a sub-sample (up to June 2018). The hypothesis of parameter stability was rejected at the 0.05 level. Description and results in Annex 2.

[9] The other dummy considered, for the election years, was not significant at the 0.05 level, as in the 2018 case. The effect of inflation was non-significant when considering both specifications, meeting the related literature for the case of Brazil in the post-stabilization period (1994).

given below (again, only significant estimates at the 0.05 level, with their standard errors in parenthesis)[10]:

$$s_t = \underset{(0.002)}{0.013} + \underset{(0.244)}{0.958}s_{t-1} - \underset{(0.007)}{0.034}b_{t-1} + \underset{(0.016)}{0.054}h_{t-1} - \underset{(0.005)}{0.017}rp_t - \underset{(0.005)}{0.016}D_t - \underset{(0.002)}{0.006}D_t b_{t-1} \quad (12)$$

From equation (12), we see that, given the GDP and rp_t, rp_t, an increase of 1 percentage point in debt-to-GDP ratio in the pandemic period (as of March 2020) leads to an expected reduction in primary surplus of exactly 4 percentage points (the sum of the coefficients of b_{t-1} and $D_t\, b_{t-1}$), thus representing a strongly negative reaction. This conclusion matches Figure 3, which showed the strong decrease in surplus in 2020.

The coefficient of the dummy variable associated with the pandemic period, D_t, indicated an expected fall of 1.6 percentage points in the surplus-to-GDP ratio, for each month in which this dummy variable assumes a value of 1 (this is, over the pandemic period). There is also here a significant interaction term between D_t and b_{t-1}, meaning that not only the surplus, but also the fiscal reaction, are affected by the pandemic.

Another point to be observed is that the effect of the output gap is stronger than in June 2018. This indicated that 1 percentage point of decreasing in GDP leads to nearly 5 percentage points of expected decreasing in surplus-to-GDP ratio. Nevertheless, over 2020, unlike 2018, there is a (strong) fall in GDP, and it amplified the effect of the negative fiscal reaction, instead of compensating it, as observed in 2018.

THE EVOLUTION OF THE FISCAL REACTION

Figure 5 shows the evolution of the fiscal reaction coefficient (Consolidated Public Sector) over time, estimated by Kalman filter. Although the sample used for estimation begins in 2003, the coefficient is shown only from 2012 on, in order to make the visualization of the relevant aspects easier.

We can see the first inversion of the sign of the fiscal reaction coefficient in October 2017, as alerted by Campos & Cysne (2019b), with a minimum point reached in March 2018. However, after that work, the subsequent recovery of some indicators of the economy – as well as a higher control of the expenses – led the fiscal reaction to a new sign inversion in September 2019. From this point to the end of the year, the fiscal reaction remains positive and following an upward path.

This recovery might indicate a more optimistic outlook for Brazilian fiscal policy. Even the slight drop in the first two months of 2020 did not, initially, change this perspective. Nevertheless, from March 2020 onwards, the COVID-19 led again the fiscal reaction to reach negative values.

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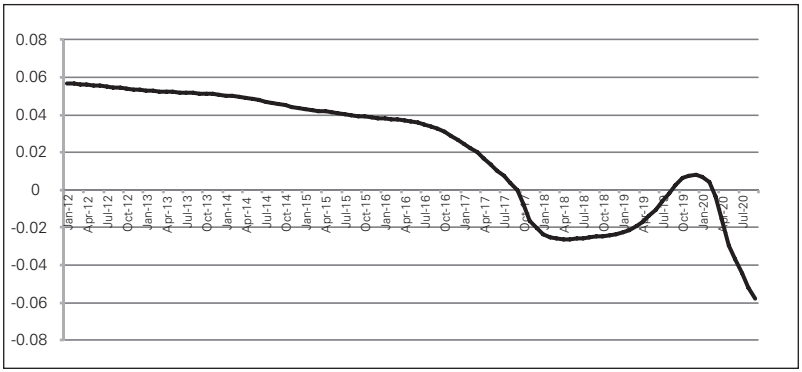
[10] All estimates used for the calculation of the mean effects were significant at the 0.05 level over the estimation horizon. As in the case of equation (10), we report the estimated fiscal reaction coefficient for the general government: -0.032 (again very similar to CPS result).

Figure 5: Estimated Fiscal Reaction Coefficient (CPS)



Source: Elaborated by the authors.

It will be necessary to accelerate post-pandemic economic and fiscal recovery, thus making it possible to put the debt-to-GDP ratio on a sustainable path and bring the fiscal reaction back to positive values.

ANALYSIS OF SUSTAINABILITY

From equation (9), we see, under the framework presented, that debt sustainability requires the fiscal reaction coefficient to be greater than the difference between the interest rate and the GDP growth.

First, observe that the exercises developed in this section are simply indicative of possible trends and derived under the strong assumption that the underlying variables, such as interest rates and GDP growth, remain constant at their mean values over each study period considered.

Since interest rates accruing on the net public debt – be SELIC or the implicit rate – are now clearly higher than the GDP growth, a negative fiscal reaction function, as observed in the more recent period, indicates (very clearly) the non-sustainability of the present fiscal policy.

Table 1 summarizes the sustainability results, based on condition (9), considering GDP growth rate, the SELIC and the implicit interest rate on the net debt, taking simple average in two different periods. Note that all rates considered here are logarithmic, which allows for sums and subtractions to translate exact values.

We verified that not even the short recovery from April 2018 to December 2019 was enough to make the sustainability condition to be satisfied in the first period. In 2020, with the advent of pandemic, the negative fiscal reaction also led to unsustainability, as expected. Besides, from the period 2016-19 to 2020, although the fiscal reaction has fallen, the interest rate has also dropped a lot, and for this reason, during the COVID-19 pandemic, the sustainability condition seems closer (or less distant) to be reached.

Table 1: Public Debt Sustainability (CPS) (16-20) – Jan/16-DEC/19 and Jan/20-Sep/20

Variables	Jan/16-DEC/19	Jan/20-Sep/20
SELIC Interest Rate (i)	9.15	3.09
Implicit Interest Rate (i*)	15.52	9.66
GDP % Growth (θ)	4.51	3.08
i-θ	4.64	0.01
i*-θ	11.02	6.58
Fiscal Reaction ρ (mean)	0.20	-2.13
Sustainability when SELIC rate is used	ρ – (i – θ) = - 4.43 Unsustainable	ρ – (i – θ) = - 2.14 Unsustainable
Sustainability when implicit rate is used	ρ – (i* – θ)) = -10.81 Unsustainable	ρ – (i* – θ) = -8.72 Unsustainable

The information accruing from such exercises is that, if the interest rate increases in the future (due, for example, to the necessity to control inflation), it will be much more difficult, when compared to the situation before pandemic, to maintain the debt/GDP ratio in a sustainable trajectory. Tax increases and the reduction of government expenses would have to be sharper[11].

CONCLUSIONS

This paper draws attention to the effects of the COVID-19 pandemic over the Brazilian fiscal reaction function. The main impact was a sharp deterioration, because of the increased spending with health and emergency aids – to attenuate the adversities caused by the pandemic – and the decreased government revenues, caused by a lower level of GDP growth. The fiscal reaction coefficient turned to a strong drop as of March 2020 – reaching -0.34% – and remains decreasing until the end of the study period.

This work indicates, even with the recent decrease in the interest rate, Brazil is still far from meeting the sustainability condition for the debt/GDP ratio. Therefore, the country should be prepared for sharp changes regarding the conduction of its fiscal policy in the post-pandemic period.

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[11] Furthermore, unlike countries such as United States, Germany, and Japan (which are able to finance their debts with negative real interest rates by selling long-term securities), Brazil, in order to sell 10-year bonds, carries real interest rates above 4% per year. Another problem in Brazil is its very high tax burden, around 33% of GDP, 11 percentage points above the average in Latin America.

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ANNEX 1: SOURCES OF THE DATA

Variable	Source	Link	Code
Primary Result of the Consolidated Public Sector	Central Bank	https://www3.bcb.gov.br/sgspub/localizarseries/localizarSeries.do?method=prepararTelaLocalizarSeries	5793
General Government Net Debt	Central Bank	https://www3.bcb.gov.br/sgspub/localizarseries/localizarSeries.do?method=prepararTelaLocalizarSeries	4536
Public Sector Net Debt	Central Bank	https://www3.bcb.gov.br/sgspub/localizarseries/localizarSeries.do?method=prepararTelaLocalizarSeries	4513
GDP	Central Bank	https://www3.bcb.gov.br/sgspub/localizarseries/localizarSeries.do?method=prepararTelaLocalizarSeries	4382
GDP Monitor	IBRE	https://portalibre.fgv.br/estudos-e-pesquisas/indices-de-precos/monitor-do-pib	—
Basic Interest Rate	Central Bank	https://www3.bcb.gov.br/sgspub/localizarseries/localizarSeries.do?method=prepararTelaLocalizarSeries	4189
Implicit Interest Rate	Central Bank	https://www.bcb.gov.br/estatisticas/historicoestatisticas	-
EMBI+	Ipeadata	http://www.ipeadata.gov.br/ExibeSerie.aspx?serid=40940&module=M	—
Rating Risk	S&P ratings	https://www.standardandpoors.com	—
Inflation	IBGE	https://www.ibge.gov.br/estatisticas/economicas/precos-e-custos/9256-indice-nacional-de-precos-ao-consumidor-amplo.html?=&t=downloads	9256
Exchange Terms	Funcex	http://www.funcexdata.com.br/	—

ANNEX 2: CHOW TEST

As mentioned in footnote 8, we describe here the Chow test (Chow, 1960) to compare the coefficients of a (standard) regression for the full sample considered in equation (10) (up to T = September 2020) with those corresponding to the sub-sample considered in equation (11) (up to T_1 < T, = June 2018). The test of parameter stability is based on the residual sums of squares from the two equations, denoted as RSS_1 and RSS_2. The statistical test is:

$$F_0 = \frac{(RSS_1 - RSS_2)}{RSS_2} \frac{T - \mathrm{k}}{T - T_1} \sim F_{T - T_1, T - \mathrm{k}}$$

where k is the number of coefficients. For our purposes, T_1 = 187, T = 213 and the statistical test resulted 6.6835, with a p-value of $8.11 * 10^{-16}$. This led to the rejection of the null hypothesis of parameter stability at the usual levels, thus reinforcing the importance to update the estimation.