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A note on the Brazilian cross-state debt connectedness*

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Contents

Keywords
regional influences, excessive indebtedness, relations between state governments, revisiting fiscal rules

JEL Codes
H61, H63, H74

Abstract · Resumo

We address the cross-state indebtedness (DCL/RCL) variation connectedness using 89 bimonthly data from 2006b6 to 2021b4, based on the indices proposed by Diebold and Yilmaz (2009, 2012, 2014). This framework enables us to infer about the direction, and the strength of bilateral spillovers for a large number of simultaneously interacting variables in a clear and compact manner. We are able to identify the most influential states in each region, as well as the region with the highest total connectedness. This empirical exercise allows us to discuss the possible influence between state governments in conducting public policies associated with indebtedness. The results help us to better understand the consequences of total and directional indebtedness spillover across states in Brazil.

1. Introduction

The economic literature usually attributes to the public sector a vector of functions: regulation, stabilize shocks, redistribute income, and promote economic activity and well-being. More specifically in Brazil, the subnational federative entities—26 states and the Federal District and 5,570 municipalities—are seen by society as

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essential service providers, with emphasis on health, education, public safety and social security. There is, however, another function of the state also seen by society as essential: the state as a public investor.

According to Bonomo, Frischtak, and Ribeiro (2021),[1] about 2/3 of public investments (excluding from state enterprises) are undertaken by subnational governments. Thus, the relation between fiscal rules and public investment must involve the study of the subnational fiscal framework and outcomes, which is no easy task given the number and diversity of regions, states and municipalities. Moreover, Brazilian subnational entities are facing a fiscal crisis, with more than half of the states with insufficient cash to pay their short-term liabilities. As a consequence, states have also reduced substantially their investment, with few exceptions.

This context on public investments associated with the fiscal situation of the state governments suggests some essential and fundamental reflections. First, we highlight the rationale behind positive long-term consequences of public investment on economic growth.[2] To summarize, we mention a classic theoretical framework in Barro (1990), which builds a growth model including services and public investments as a productive input for private producers. Second, it is important to emphasize that the state can conduct its investment policy with alternative sources of revenue (internal or external credit operations) or with its own resources (current surplus). Thus, based on the premise that the counterpart of public investment is also in obtaining alternative sources of revenue from domestic and foreign credit operations, the management of domestic and foreign debt and its relationship with economic growth needs our attention.

This context imposes not only on state executive managers, but also on courts of control, an indispensable challenge to make efforts to allocate resources in the sense of both monitoring and predicting fiscal imbalances among jurisdictions. Furthermore, this issue has been the object of study by lawmakers. In this scenario, a relevant legal milestone in the last two decades was Complementary Law No. 101, of 05/04/2000, the Fiscal Responsibility Law (LRF), which defined an alert limit of 180% for the ratio between the Net Consolidated Debt (DCL) and the respective adjusted Net Current Revenue (RCL), provided for by §1, item III, of art. 59. There is also a second limit (200%), established by the same law.

This subject also requires the participation of researchers. From the perspective of public finance literature applied to Brazilian states, it is opportune to measure the impact of public investment, when it is financed through the primary current surplus, or through the granting of loans. Matos and Santos (2020) report to a

[1] This paper is very informative about the temporal dynamics of investments by federal and state governments during the period from 2002 to 2019.

[2] We are convinced of the specific role of the state as an investor, aiming to "complete markets", by investing in areas that seem to attract less attention and interest from the private sector, but which are relevant for a better business environment.

panel containing all 27 states/DF, during the period 2004 to 2017, that the impact of capital expenditure on the growth of the real Gross Domestic Product (GDP) per capita is significantly positive, with an elasticity of 1.0128. However, it is important that this investment is not associated with obtaining credit by the state, but the result of a primary current surplus, since credit granted to the state reduces the same GDP per capita according to an elasticity of −0.8658. In other words, when associated with indebtedness, there is a considerable reduction in the effect caused by the growth associated with public investment.

This context suggests the relevance of monitoring the debt of regional governments, in view of its benefits and consequences, paying attention to aspects of the debt, such as: i) average cost, ii) average term, iii) framework of guarantees, iv) solvency, v) transparency, vi) resilience, vii) composition, viii) risk management, ix) relationship with macroeconomic variables, x) analysis of cycles, xi) optimal level modeling, xii) modeling of volatility, xiii) scenario analysis, xiv) impact of key drivers, and xv) monitoring of debt service flow.

Once more looking at the public finance literature applied to Brazilian states, the most common seems to be the study of debt solvency, as one can see in Mora and Giambiagi (2005), for example. An interesting exception is Matos (2018), which proposes a discussion on the Brazilian states, based on the estimation of three different approaches used in the international literature in order to measure the impact of the Governmental Corruption Index on the DCL to GDP ratio. The elasticity-corruption of debt is significant at 1% and ranges from 0.015 to 0.020. The empirical exercise suggested here still allows us to infer that the reduction of the indebtedness in the states through the fight against corruption is more efficient if combined with fiscal austerity than when combined with other economic policies.

Given this scenario, this note adds to the empirical public finance literature by proposing to address the cross-state indebtedness (DCL/RCL) variation connectedness using 89 bimonthly data from 2006b6 and 2021b4, extracted from Brazilian Public Sector Accounting and Tax Information System (SICONFI) of the National Treasury Secretariat (STN). Our main motivation lies in the argument of Blanchard, Leandro, and Zettelmeyer (2021) that historically, the need for European Union fiscal rules in addition to national rules was justified by debt externalities across countries—adverse effects of unsustainable sovereign debt in one member country on other member countries, either through the spillovers of fiscal crises or through fiscal dominance of monetary policy.

Concerning this methodology, first we need to tell that financial connectedness has been measured using a variety of approaches as dynamic conditional correlation (DCC) of Engle (2002), CoVaR of Adrian and Brunnermeier (2016) and concepts of network topology, being related to terms as spillovers and contagion. However, this is not a technique usually employed in public finance. In fact, it was used extensively during the pandemic in studies covering different areas of the economy. For instance, Fasanya, Oyewole, Adekoya, and Odei-Mensah (2020) measure the connectedness between COVID-19 and global foreign exchange markets, while Costa, da Silva, and Matos (2021) measure volatility connectedness of US sectoral indices using daily data from January 01, 2013 to December 31, 2020. More related to our macroeconomic purpose, Pham and Sala (2021) address connectedness applied to inflation and unemployment, while Karkowska and Urjasz (2021) examine the connectedness structures of sovereign bond markets in Central and Eastern Europe, and Matos, Sampaio, Costa, Silva, and Jesus Filho (2021) analyze the debt connectedness during the last 20 years, for PIIGS (Portugal, Ireland, Italy, Greece and Spain).

We are the first to apply the specific framework proposed by Diebold and Yilmaz (2009, 2012, 2014), aiming to find quantitative (levels) and qualitative (roles/directions) changes on cross-state debt occurred during the last 15 years, which are characterized by some fiscal crises and adversities of the Brazilian economy.[3]

This paper is structured as follows. Section 2 illustrates the setup of the empirical model. Section 3 analyzes the dataset and reports main findings. Section 4 is devoted to the discussion and final remarks.

2. Connectedness Methodology

The core methodology used in this study is the connectedness indices of Diebold and Yilmaz (2009, 2012, 2014). The method choice enables us to fulfil our objectives—highlight both quantitative (levels) as qualitative (roles/directions) changes in debt connectedness occurred, as well as any unusual behavior of specific sates—by means of static and dynamics analysis of the proper connectedness indices. More specifically, Diebold and Yilmaz (2009) formulate and examine precise and separate measures of return spillovers and volatility spillovers, which facilitates study of both non-crisis and crisis episodes, including trends and bursts in spillovers. In Diebold and Yilmaz (2012), they use a generalized vector autoregressive framework in which forecast-error variance decompositions are invariant to the variable ordering, and they propose measures of both the total and directional volatility spillovers.

As discussed in Corbet, Goodell, and Günay (2020), this model has a number of advantages, since it allows bilateral spillovers unlike the SAMEM model of Otranto (2015), and it allows displaying the strength of spillovers and enable proper comparisons among alternative model configurations and variable sets. Regarding concurrent correlation-based methods, as Wavelet analysis and the multivariate GARCH models, this methodology is advantageous because it is able to infer direction of spillovers for a large number of simultaneously interacting variables in a clear and compact manner. Consider a covariance stationary N-variable VAR(p),

[3] Refer to Diebold and Yilmaz (2015) for a detailed comparison of concurrent approaches.

$x_t = \sum_{i=1}^{p} \Phi_i x_{t-i} + \varepsilon_t$, with MA representation $x_t = \sum_{i=0}^{\infty} A_i \varepsilon_{t-i}$, where $\varepsilon \sim (0, \Sigma)$ is a vector of i.i.d. disturbances with covariance matrix . Using the generalized[4] VAR (GVAR) framework of Koop, Pesaran, and Potter (1996) and Pesaran and Shin (1998), the H-step-ahead error variance in forecasting x_i, variation of debt to RCL of state i, that are due to shocks in x_j, $i, j = 1, 2, \dots, N$, is computed as

$$\theta_{ij}^{g}(H) = \frac{\sigma_{jj} \sum_{h=0}^{H-1} \left(e_i' A_h \Sigma A_h' e_i\right)^2}{\sum_{h=0}^{H-1} \left(e_i' A_h \Sigma A_h' e_i\right)}, \tag{1}$$

where σ_{jj} is the standard deviation of the error for the j^{th} equation, and e_i is the selection vector, with one as the i^{th} element and zero otherwise. As the shocks in the GVAR framework are not orthogonal, one needs to normalize (1) in the following manner to obtain the generalized forecast error variance shares:

$$\theta_{ij}^{g}(H) = \frac{\theta_{ij}^{g}(H)}{\sum_{j=1}^{N} \theta_{ij}^{g}(H)}. \tag{2}$$

The essential idea of Diebold and Yilmaz (2009, 2012, 2014) is to construct a connectedness table, such as Table 1 (Zhang, 2017).

Table 1. Connectedness table based on variance decomposition

	x_1	x_2	$\cdots$	x_N	From others
x_1	$\tilde{\theta}_{11}^{g}(H)$	$\tilde{\theta}_{12}^{g}(H)$	$\cdots$	$\tilde{\theta}_{1N}^{g}(H)$	$\sum_{j=1}^{N} \tilde{\theta}_{1j}^{g}(H), j \neq 1$
x_2	$\tilde{\theta}_{21}^{g}(H)$	$\tilde{\theta}_{22}^{g}(H)$	$\cdots$	$\tilde{\theta}_{2N}^{g}(H)$	$\sum_{j=1}^{N} \tilde{\theta}_{2j}^{g}(H), j \neq 2$
$\vdots$	$\vdots$	$\vdots$	$\ddots$	$\vdots$	$\vdots$
x_N	$\tilde{\theta}_{N1}^{g}(H)$	$\tilde{\theta}_{N2}^{g}(H)$	$\cdots$	$\tilde{\theta}_{NN}^{g}(H)$	$\sum_{j=1}^{N} \tilde{\theta}_{Nj}^{g}(H), j \neq N$
To others	$\sum_{j=1}^{N} \tilde{\theta}_{j1}^{g}(H)$, $j \neq 1$	$\sum_{j=1}^{N} \tilde{\theta}_{j2}^{g}(H)$, $j \neq 2$	$\cdots$	$\sum_{j=1}^{N} \tilde{\theta}_{jN}^{g}(H)$, $j \neq N$	$\frac{1}{N}\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^{g}(H)$, $j \neq i$

From this table, we can develop some connectedness indices as follows. The total connectedness index is given by

$$S^{g}(H) = \frac{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^{g}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^{g}(H)} \cdot 100 = \frac{\sum_{\substack{i,j=1 \\ i \neq j}}^{N} \tilde{\theta}_{ij}^{g}(H)}{N} \cdot 100. \tag{3}$$

The directional connectedness from ("from") all other states to state is given by

$$S_{i\cdot}^{g}(H) = \frac{\sum_{\substack{j=1 \\ j \neq i}}^{N} \tilde{\theta}_{ij}^{g}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}^{g}(H)} \cdot 100 = \frac{\sum_{\substack{j=1 \\ j \neq i}}^{N} \tilde{\theta}_{ij}^{g}(H)}{N} \cdot 100. \tag{4}$$

[4]This approach makes the forecast error variance decomposition invariant to the ordering of variables in the VAR.

The directional connectedness to ("to") all other states from state is denoted by

$$S^g_{\cdot i} = \frac{\sum_{\substack{j=1 \\ j\neq i}}^{N} \tilde{\theta}^g_{ji}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}^g_{ij}(H)} \cdot 100 = \frac{\sum_{\substack{j=1 \\ j\neq i}}^{N} \tilde{\theta}^g_{ji}(H)}{N} \cdot 100. \tag{5}$$

The net ("net") directional connectedness from state to all other states is given by

$$S^g_{i}(H) = S^g_{\cdot i}(H) - S^g_{i\cdot}(H). \tag{6}$$

Finally, the net pairwise connectedness from state to state can be written as

$$S^g_{ij}(H) = \left(\frac{\tilde{\theta}^g_{ji}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}^g_{ij}(H)} - \frac{\tilde{\theta}^g_{ij}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}^g_{ij}(H)} \right) \cdot 100 = \left(\frac{\tilde{\theta}^g_{ji}(H) - \tilde{\theta}^g_{ij}(H)}{N} \right) \cdot 100. \tag{7}$$

Regarding parameters setting, we use $H = 6$ for horizon of underlying decomposition and $W = 48$ bimonths for size of overlapping window when computing rolling indices. Our choice for $H = 6$ makes economic sense, if we are to expect that one year's expenses will influence the following year. Anyway, we generated the sensitivity analysis results of total connectivity by changing the choice of H. The graph of total connectivity when using $H = 3, 6, 12$ bimesters suggests that the result holds robust to such changes, for of the Northeastern states, for instance. Finally, the lag structure parameter p was automatically selected by best fit, using the Akaike criterion and maximum lag 3. The selected lag was 1.

3. Empirical exercise

3.1 Data

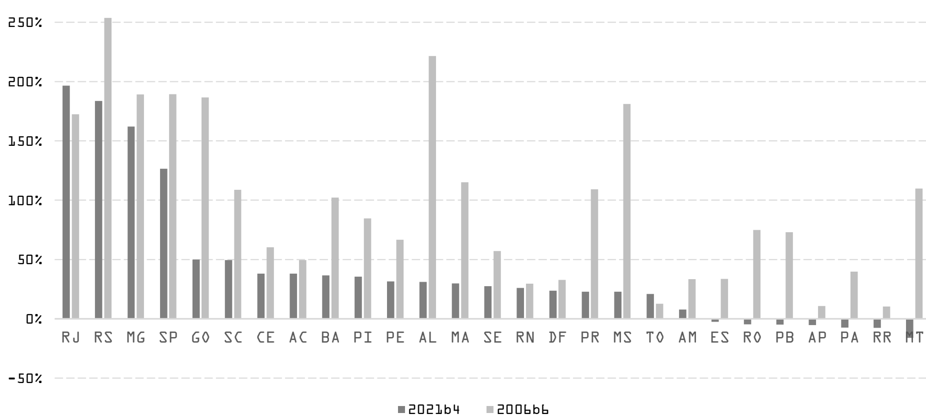
According to the Tax Statements Manual (MDF) of the National Treasury Secretariat (STN), the Consolidated Debt (DC) of a subnational federative entity, for tax purposes, corresponds to the total amount of financial obligations assumed, calculated without duplication (excluded obligations between bodies of direct administration and between these and entities of indirect administration). Regional governments cannot issue government bonds, and therefore they compose their debts as follows: a) contractual debt—carrying out credit operations under laws, contracts, agreements or treaties, for amortization within 12 months; b) judicial orders—issued from May 5, 2000 and not paid during the execution of the budget in which they were included; and c) credit operations with a term of less than 12 months, which have been included as revenue in the budget.

From DC, we calculate the Net Consolidated Debt (DCL), which is the most reported indebtedness indicator in the public finance literature, as it takes into account in its formula that the Consolidated Debt (DC) should be reduced from deductions, which consist of the relative balance between financial assets (availability of cash and other financial assets) and processed payables (except court orders). If the value of the financial assets is less than the value of the processed balances payable, there will be no deductions and both will be identical.

For the empirical exercise proposed here, we make use of the widest possible time series, with a bimonthly frequency, which comprises the period between the sixth bimester of 2006 (2006b6) and the fourth bimester of 2021 (2021b4). The source is the Brazilian Public Sector Accounting and Tax Information System (SICONFI) of the National Treasury Secretariat (STN). [5] In Figure 1 we report the first and last values for the debt to revenue ratio (DCL/RCL), while in Table 2, we report some summary statistics for its 1st difference.

The government states with the highest level of indebtedness in 2021b4 are among those with the highest GDP per capita: Rio de Janeiro (197%), Rio Grande do Sul (184%), Minas Gerais (162%), and São Paulo (127%). It is worrisome identifying the persistence of the high level of debt in RJ, which also leads the ranking of variation of the DCL/RCL ratio in the analyzed interstice, with an increase of more than 24%.

In addition to this state, only Tocantins showed an increase in indebtedness, so that all others had a reduction in the DCL/RCL value. It is important to highlight the significant reductions in indebtedness in the states of Alagoas, from 221% to 31%, Mato Grosso do Sul, from 181% to less than 31%, and Goiás, from 186% to



Source: SICONFI/STN/STN

Figure 1. Cross-state DCL/RCL (2006b6 and 2021b4)

[5] It is important to note that four states have isolated omitted data. We assumed that it would be reasonable to use interpolation in these cases, which were quite rare, typically an omitted data in 89 bimonths.

Table 2. Descriptive statistics of DCL/RCL (1st difference), from 2006b6 to 2021b4

State		Mean	S.D.	Asymmetry	Kurtosis	ADF
Acre	AC	−0.001	0.055	0.356	3.667	−9.207***
Alagoas	AL	−0.022	0.074	−2.088	14.049	−8.859***
Amazonas	AM	−0.003	0.076	2.022	19.636	−14.865***
Amapá	AP	−0.002	0.149	−0.886	11.306	−11.720***
Bahia	BA	−0.007	0.065	−1736	10.868	−11.457***
Ceará	CE	−0.003	0.054	−0.067	3.331	−8.860***
Distrito Federal	DF	−0.001	0.036	0.111	2.816	−11.732***
Espírito Santo	ES	−0.004	0.033	0.367	3.132	−10.940***
Goiás	GO	−0.016	0.053	0.051	6.523	−9.696***
Maranhão	MA	−0.010	0.070	0.486	4.007	−11.531***
Minas Gerais	MG	−0.003	0.072	0.478	3.891	−10.788***
Mato Grosso do Sul	MS	−0.018	0.038	0.445	3.557	−7.461***
Mato Grosso	MT	−0.014	0.048	0.644	3.410	−8.862***
Pará	PA	−0.005	0.034	0.413	3.190	−12.233***
Paraíba	PB	−0.009	0.044	0.239	3.586	−11.437***
Pernambuco	PE	−0.004	0.047	0.369	3.253	−11.581***
Piauí	PI	−0.006	0.083	−0.391	4.890	−12.532***
Paraná	PR	−0.010	0.070	2.410	15.792	−11.848***
Rio de Janeiro	RJ	0.003	0.110	−1.913	13.055	−5.843***
Rio Grande do Norte	RN	−0.000	0.070	1.596	18.020	−8.720***
Rondônia	RO	−0.009	0.143	0.238	22.323	−14.744***
Roraima	RR	−0.002	0.156	−0.257	5.310	−18.085***
Rio Grande do Sul	RS	−0.008	0.041	−0.842	4.809	−5.910***
Santa Catarina	SC	−0.007	0.065	3.550	24.883	−9.654***
Sergipe	SE	−0.003	0.040	−0.244	5.326	−9.492***
São Paulo	SP	−0.007	0.059	0.151	2.859	−9.995***
Tocantins	TO	0.001	0.078	−0.978	14.420	−13.160***

Source: SICONFI/STN

less than 50%. The time series of the DCL/RCL ratio for all states are reported in Figure 5 (Appendix).

According to the Table 2, it is possible to observe that 3 states in the North region (Roraima, Amapá and Rondônia) lead the ranking of oscillation of the variation of the DCL/RCL ratio. Equally important to mention the stability of the variation in Espírito Santo's DCL/RCL, combined with its low level of debt. We highlight that the Augmented Dickey–Fuller (ADF) test ensures stationarity of all series.

3.2 Preliminary analysis by region

The connectedness results between states by region are shown in Table 3. Given the limited amount of observations over time, it is not possible to perform an analysis with time sub periods separated by some threshold, for instance. There are several

Table 3. Connectedness of DCL/RCL (1st difference) for states by region, from 2006b6 to 2021b4

	Northeast Region									
	AL	BA	CE	MA	PB	PE	PI	RN	SE	From
AL	62.59	4.99	3.02	6.41	6.29	5.93	3.91	2.88	3.98	37.41
BA	3.33	35.47	8.63	9.65	8.16	18.59	6.07	3.95	6.14	64.53
CE	2.70	9.87	33.08	9.49	12.82	13.94	5.71	1.41	11.00	66.92
MA	2.60	6.87	9.25	35.25	11.44	14.56	9.59	3.75	6.69	64.75
PB	3.20	6.96	10.76	12.00	32.73	16.47	8.26	6.97	2.66	67.27
PE	2.61	11.98	11.23	12.14	13.99	29.25	9.58	3.67	5.55	70.75
PI	1.92	5.47	6.24	12.02	11.15	15.43	37.28	6.14	4.35	62.72
RN	2.58	3.73	2.23	4.21	12.59	6.88	5.96	56.39	5.43	43.61
SE	2.93	8.59	11.94	8.73	3.77	8.65	5.44	1.14	48.82	51.18
To	21.85	58.46	63.29	74.64	80.21	100.45	54.52	29.91	45.81	**58.79**
Net	−15.56	−6.07	−3.63	9.89	12.94	29.69	−8.19	−13.70	−5.37	–
	North Region									
	AC	AM	AP	PA	RO	RR	TO	From		
AC	45.46	12.79	3.10	17.57	6.20	5.37	9.50	54.54		
AM	8.98	61.13	6.04	8.65	9.35	1.66	4.20	38.87		
AP	2.74	5.44	72.86	5.49	2.76	4.98	5.73	27.14		
PA	13.69	7.29	4.23	49.46	6.96	5.45	12.92	50.54		
RO	7.15	3.69	1.72	8.62	70.51	4.38	3.93	29.49		
RR	5.52	3.52	15.08	11.08	0.90	62.30	1.60	37.70		
TO	10.76	5.00	7.06	14.97	3.91	2.13	56.18	43.82		
To	48.83	37.74	37.23	66.38	30.08	23.96	37.88	**40.30**		
Net	−5.70	−1.14	10.09	15.84	0.59	−13.74	−5.94	–		
	Midwest Region									
	DF	GO	MS	MT	From					
DF	57.61	2.91	12.27	27.20	42.39					
GO	3.66	77.44	4.20	14.71	22.56					
MS	14.17	3.93	63.53	18.37	36.47					
MT	24.05	9.53	14.32	52.09	47.91					
To	41.88	16.37	30.80	60.27	**37.33**					
Net	−0.51	−6.19	−5.67	12.37	–					
	Southwest Region									
	ES	MG	RJ	SP	From					
ES	58.41	12.31	9.58	19.71	41.59					
MG	13.10	66.82	12.24	7.84	33.18					
RJ	8.46	11.02	65.07	15.45	34.93					
SP	19.50	6.92	15.39	58.19	41.81					
To	41.06	30.25	37.20	43.00	**37.88**					
Net	−0.54	−2.94	2.27	1.20	–					
	South Region									
	PR	RS	SC	From						
PR	90.84	4.16	4.99	9.16						
RS	3.46	82.55	13.99	17.45						
SC	6.43	12.60	80.98	19.02						
To	9.89	16.76	18.98	**15.21**						
Net	0.74	−0.70	−0.04	–						

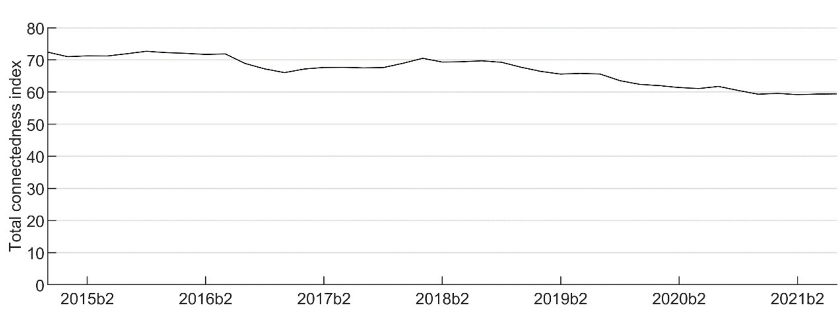
Note: The rolling estimation window width is 48 bimonths. The ij-th entry gives the ij-th pairwise directional connectedness, i.e., the percent of 6-bimonth-ahead forecast error of state i due to shocks from state j. The rightmost (FROM) column gives total directional connectedness (from), i.e., off diagonal row sums. The bottom (TO) row gives total directional connectedness (to), i.e., off diagonal column sums. The bottommost (NET) row gives the difference in total directional connectedness (to – from). The bottom-right element (in boldface) is the total connectedness.

points worth noting of which we highlight some. A first evidence suggests that the Northeast (South) region presents the highest (lowest) total connectedness, 58.8% (15.2%).

Another important analysis is to identify the states that stand out, sending (receiving) more spillovers to (from) the system, that is, with a higher connectedness "to" ("from"). In the Northeast region, the state with the highlight "to" and "from" connectedness is Pernambuco, which leads the entire country in terms of sending (receiving) regional spillovers, with a connectedness "to" ("from") of 100.5% (70.2%). In the North region, the state of Pará exerts the greatest influence in terms of connectedness to the system, with a connectedness "to" of 66.4%, being also one of the most influenced. In the Midwest, Mato Grosso has the greatest influence on the indebtedness of the others, with a connectedness "to" of 60.3%. Even with values of lesser order of magnitude, in the Southeast region, São Paulo exercises its leadership, with a connectedness "to" the system of 43.0%, closely followed by Espírito Santo, a state regarded as one of the most austere in the country, and a good example to be followed as indebtedness influencer. Finally, in the South region, where the lowest values of cross-connectedness are found, with Santa Catarina as the state with the greatest total influence over the others, with 19.0%.

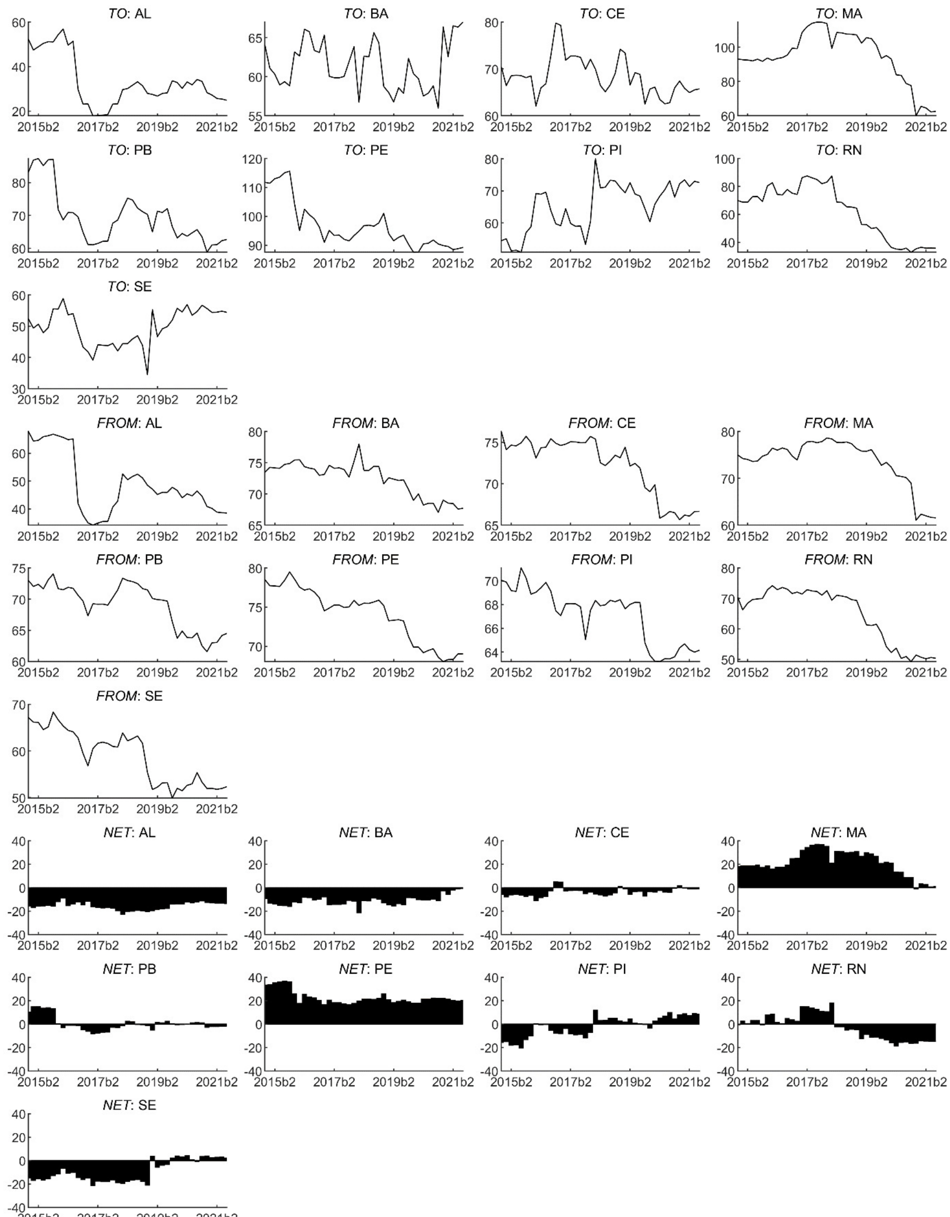
3.3 Main results: Connectedness for Northeast region states

In this subsection, we will deepen the study on connectedness only for the Northeast region, which had the highest total spillover (58.8%), as observed in Table 3. In Figure 2, we plot the rolling total connectedness of debt to revenue ratio for Northeast region states. Given that we need to use the window width of 48 bimonths, we have an output only from 2015. During the recent period, 2015 to 2021, connectedness was always higher than 59%, with peaks of this influence metric in the year 2015 and in the first half of 2016 (72% on average), the peak of the fiscal crisis recently experienced in Brazil. The spillover in this region has shown a consistent downward trend since 2018. In Figure 3, we plot the dynamic behavior of total directional



Note: The rolling estimation window width is 48 bimonths, and the predictive horizon for the decomposition is 6 bimonths.

Figure 2. Rolling total connectedness of debt to revenue ratio for Northeast region states



Note: The rolling estimation window width is 48 bimonths, and the predictive horizon for the decomposition is 6 bimonths. Total "to" ("from"/"net") connectedness is shown in the upper (middle/bottom) panel.

Figure 3. Rolling total directional connectedness of debt to revenue ratio for Northeast region states

connectedness for all Northeast region states.

According to Figure 3, we find that both directional "to" and "from" are very different from each other, and also quite volatile in the last 7 years, for all 9 state governments. In addition to this asymmetrical pattern, we also observe that the "from" connectedness of all states show comparable behavior over time, with a relatively clear downward trend, indicating most states have absorbed less spillovers from the remaining states, showing a greater independence in regional fiscal policies. As for the "to" connectedness, there are very different behaviors between states throughout the analyzed time interval. We also identified that, with the most obvious exception of PI and RN, the other states remain practically all the time with their status predominantly net receiver/sender of connectedness.

Finally, we also propose studying the pairwise net connectedness relationship of the variation of DCL/RCL to understand bilateral relationships. The results are reported in a network plot (Figure 4). The arrows are drawn from the state with positive pairwise net connectedness to its counterpart. Corroborating the precious finding reported in Table 3 and Figure 3, the state government of Pernambuco remains the most influential in the Northeast region, presenting positive pairwise connectedness with every other state, while the state government most influenced is that of Alagoas.

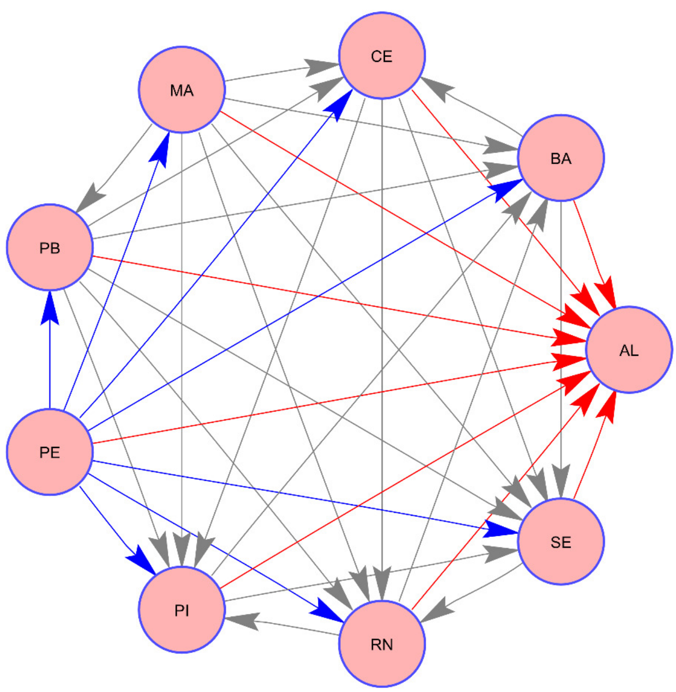


Figure 4. Pairwise net connectedness relationship of DCL/RCL for Northeast region states

4. Conclusion

Brazilian economy has a set of fiscal rules aiming to constrain government spending at the federal and subnational levels. A usual question to be addressed in public finance is whether those fiscal rules are to blame for the sharp public investment contraction rather reflected the lack of fiscal discipline and uncontrolled fiscal expansion. We add to this debate by identifying the pattern of cross-state connectedness by region, taking into account for the most used debt metric, DCL/RCL, during the last 15 years. Our findings on the highest level of connectedness to Northeast region, with the main leadership role played by Pernambuco, is worrying since this region has almost 57 million inhabitants and has historically had the lowest socio-economic indicators in Brazil. For more details on the growth drivers of this most vulnerable region of Brazil, see Matos, Bastos, Martins, and Vinana (2023).

On the other hand, it is comforting to show that the most economically and politically influential states, which are also the ones with the highest level of indebtedness in the country—Rio de Janeiro, Rio Grande do Sul, Minas Gerais, and São Paulo—do not have exerted a bad influence in their respective regions. Still on this issue of "bad influences", it is equally important to highlight that the state governments with increased indebtedness in the period, Rio de Janeiro and Tocantins, did not exert influence in their respective regions.

Our results call for an enhancement of cross-state fiscal policy coordination in Brazil. We claim that need to study and think about redesigning the fiscal framework with alternative fiscal rules able to support the necessary fiscal adjustment, encourage the use of current savings for investments, preserve strategic public investment, and control the level of indebtedness and its cross-state connectedness.

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Appendix.

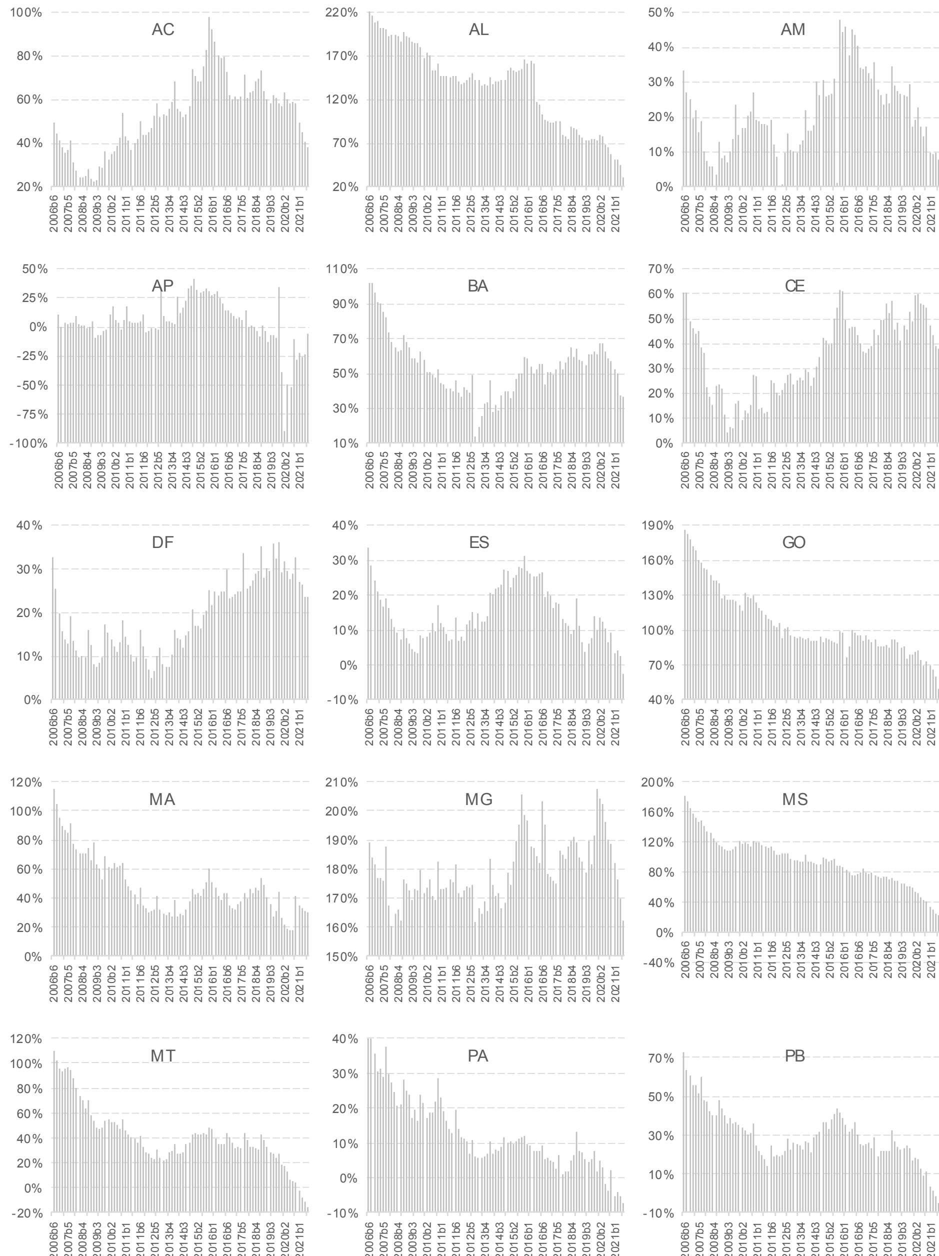

Figure 5. Cross-state DCL/RCL (from 2006b6 to 2021b4)

Source: SICONFI/STN

Figure 5. (Continued) Cross-state DCL/RCL (from 2006b6 to 2021b4)