Climate-related risks and firms' financial fragility in Brazil

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Abstract

In the present work, we assess the financial condition of a sample of Brazilian firms in different economic sectors in order to explore to what extent climate-related shocks can be a driver of real and financial instability in the largest Latin American economy, one of the major carbon-emitting countries in the area and highly exposed to extreme weather events. A comparative analysis of financial indicators and Minskyan analysis are conducted over the period 2017-2020 combining two different samples from Orbis and Economatica. When comparing the Brazilian sectors with all OECD countries the most financially fragile ones are Food, Wholesale and retail. When considering small, medium OECD firms to consider a similar productive structure among countries, differences are lower. The Minskyan analysis finds more fragile sectors where in the whole period analysed the majority of firms are in a speculative position with the only exception of year 2020, when the most frequent position was Ponzi. The assessment of the level of financial fragility of Brazilian firms is particularly relevant when considering the sectorial economic impact of climate change given that most of the clusters resulted in a speculative (e.g. Food, Water and Waste, Wood and machinery, Electrical equipment, Electricity, gas and steam supply) or Ponzi position (e.g. Mining-energy, Construction) are the same which can be directly impacted by climate-risks. In light of high degree of indebtedness, climate-risks may exacerbate their financial fragility and the risk of default, giving rise to contagion effects in the economy.

1 Introduction

Recent empirical studies on the drivers of corporate debt in Latin America and its macroeconomic implications have pointed to the worsening financial position of some corporate sectors. Caldentey et al. (2019) assessed the high level of indebtedness of the non-financial corporate sector in six large Latin American countries (Argentina, Brazil, Chile, Colombia, Mexico, and Peru) from 2009 to 2016,

distinguishing between bond-issuing and non bond-issuing firms in 34 sectors of economic activity. On the basis of liquidity, leverage, and profitability indicators, they show that bond-issuing firms are in a worse financial position and by applying the Minsky's taxonomy of cash flows (Minsky, 1975, 1986), which classifies firms in hedge, speculative, or Ponzi positions, they found that the majority of bond-issuing firms was in a speculative or Ponzi position. In particular, they found that the sectors most fragile were Retail, Automotive, Energy production and distribution, Construction, Food and Beverages. This evidence is also confirmed in Filho et al. (2018) who also applied the Minsky's taxonomy to analyze the financial soundness of electricity distribution companies in Brazil from 2007 to 2015, showing an increase in the financial fragility of the sector throughout the period and especially between 2008 and 2013.

Using a similar methodology, Rolim et al. (2021) analyzed the financial fragility of Brazilian publicly listed non-financial companies between 2010 and 2016, a period characterized by the reduction of commodities prices, currency depreciation, deceleration of economic growth at the global and domestic levels, and worsening access to finance. Despite specific sectoral patterns suggesting that certain sectors (e.g., Electronics, Software, and Data) were more resilient than others (e.g., Agriculture and Fishing, Construction, Steel and Metallurgy, and Telecommunications), their analysis supports the conclusion that, during the economic downturn, the overall financial fragility of publicly listed firms increased.

Furthermore, Caldentey et al. (2019) emphasize that Brazilian already fragile non-financial companies borrowing from international capital markets are particularly exposed to adverse fluctuations in external financial conditions, such as increased exchange rate volatility or changes in interest rates. However, these events may have pervasive effects on the domestic capital market. An increase in international interest rates, for example, may compel local monetary authorities to raise domestic interest rates so to prevent capital outflows and the depreciation of the currency, thereby increasing the cost borrowing also for firms that finance themselves on the domestic market[1]. On a similar ground, Caceres et al. (2016), who analyzed the potential risks and vulnerabilities to non-financial corporations in Latin America and Canada, found that country specific factors such as exchange rate depreciation as well as global conditions such as the state of expectations of investors on future assets volatility (e.g. as captured by the VIX index) are dominant drivers of corporate spreads[2]. A sustained reversal of global financial conditions would put significant pressure on corporate risk in Latin America.

In this specific financially fragile context of the Latin American corporate sector an additional source of risk may come from climate change. An increasing body of literature has been focusing on climate-related shocks as a potential cause of financial distress for firms, exploring their potential propagation through production and financial networks, affecting both the corporate sector and the broader economy[3].

[1]For a more comprehensive review on the financial integration of emerging economies and the impact of the international monetary system on capital flows and exchange rates, refer to Bonizzi et al. (2023)

[2]The authors argued that during periods where the VIX index is high, investors require a higher return in compensation of the higher perceived risk which then translates into higher corporate risk.

[3]For a more comprehensive review of this topic, refer to Battiston et al. (2020) and Campiglio and van der Ploeg (2022)

This literature has identified two broad categories of climate-related risks:

- Climate physical risks, which refer to climate-related weather events that have the potential to damage firms' physical assets and disrupt production capacity. These events may increase the risk of default within these firms, leading to cascading negative effects on other productive sectors, the banking system, the insurance sector, and ultimately impacting the public sector as well;

- Transition risks, arising from the need to decarbonise the economy. This category includes a broad range of causes ranging from the implementation of new regulatory frameworks, such as carbon pricing or new emission standards, to technological change, or to changes in consumer preferences. These factors may impact carbon intensive sectors by affecting the cost of doing business, by limiting the use of certain technologies, or by causing a premature devaluation of real and financial assets' value[4].

Lamperti et al. (2019) focused on physical impacts examining how climate-related damages impact the stability of the global banking system using an agent-based climate–macroeconomic model and Lamperti et al. (2021) employed a macro-financial agent-based model showing that financial constraints exacerbate the impact of climate shocks on the economy while, at the same time, climate damages to firms make the banking sector more prone to crises. They also found that credit provision can both increase firms' productivity and their financial fragility, with such a trade-off being exacerbated by the effects of climate change.
Still in reference to physical risks, Flori et al. (2021) explored empirically the interactions between commodity prices, climate-related variables (like rainfall and temperature) and an index that measures the degree of financial stress in capital markets using a combination of a multidimensional graph-theoretical approach with standard econometric techniques. Their results suggested that climate variables affect financial stability through the impact that they have on commodity prices.

Hebbink et al. (2019), Devulder and Lisack (2020), Cahen-Fourot et al. (2021) extended the analysis on transition risks, by looking at how a transition shock originally impacting some sectors, such as a carbon tax hitting the mining or the coal-gas-fueled electricity sectors, propagates through the production network on downstream sectors.
Still considering transition risks, Giuzio et al. (2019), Faiella and Lavecchia (2020), Delgado (2019), EIOPA (2020) assessed the direct exposure of different countries financial institutions to high-carbon sectors while Battiston et al. (2017), Stolbova and Battiston (2020) considered also the indirect exposure via financial networks.
Moreover, Jacques et al. (2023) studies the impacts of the introduction of carbon pricing in China on Indonesia (a major coal exporter to China) finding a trade-off between trade decarbonization and

[4]It is important to highlight that while physical risks can be more easily transferred to the insurance system, transition risks are more difficult to monitor and manage because the exact shape of the transition is difficult to predict, given that differently from physical damages the costs are not easily observable/traceable, and finally, because the risk for companies posed by the transition also depends on market, sector-specific, and institutional factors that may impact, for example, firms' ability to pass the additional costs implied by a new regulation on prices

sovereign financial stability for Indonesia.
Gourdel and Sydow (2022) considered both transition and physical climate risks to develop a framework for the short-term modeling of market risk and shock propagation in the investment funds sector, including bi-layer contagion effects through funds' cross-holdings and overlapping exposures.
Using stock-flow consistent modeling, Dafermos and Nikolaidi (2021) explored the impact on both physical and transition risks of the green supporting factor - a financial regulation policy that reduces capital requirements for "green" loans - and the dirty penalizing factor - a financial regulation policy that increase capital requirements for loans with a negative environmental impact.

However, except for Roncoroni et al. (2021) who explored the impacts of climate policy shocks on the Mexican financial system showing the role of financial contagion in threatening financial stability, little attention has been paid by the academic literature to connect climate change risks and firms' financial fragility in the context of Latin America, and in particular in Brazil which is one of the major carbon emitting countries in the area and one of the most exposed to extreme weather events such as floods, droughts and landslides.
These physical events have been shown to exert pervasive effects on several key sectors of the economy like Agriculture, Health, Infrastructure and Energy Production WB (2021), CMCC (2021) and international institutions have been paying increasing attention to the threats posed to financial stability by climate-related risks in Brazil BCB (2021a), FSB (2022a).

In the present work, we aim at filling this gap merging the above mentioned strands of the literature assessing the financial condition of two samples of Brazilian firms in different economic sectors in order to explore to what extent physical and transition shocks can be a further driver of real and financial instability in the largest Latin American economy. The rest of the article is organized as follows. Section 2 describes the methodology used for a comparative and a Minskyan analysis. Section 3 shows and discusses the relative results. Section 4 highlights the linkages between the assessment of firms' financial fragility and climate risks. Section 5 concludes.

2 Methodology

In order to perform a comprehensive assessment of Brazilian firms' financial fragility, leveraging all available data, we combine to approaches. First, we initiate the analysis by comparing two samples of Brazilian and foreign firms operating in different economic sectors obtained from Orbis, with a focus on the distribution of a selected set of financial indicators across these two populations. Then, as a further step, we assess Brazilian firms' ability to serve their debt and repay the principal by building upon the popular Minky's taxonomy. The data required for this second analysis were sampled from Economatica.

2.1 Comparative analysis

The comparative analysis builds on Orbis firm level data on the economic performance and balance sheet composition of different companies in Brazil and OECD countries in combination with the 2018 OECD input-output tables.

Starting with a broad perspective of the Brazilian corporate sector, our sample is composed of small, medium and large enterprises, both private and publicly listed, extracted from Orbis. We consider both active and inactive firms[5], Brazilian firms dealing with all legal forms except for foreign firms[6], and 2020 as last year of budget available.

The Brazilian sample covers 3,023 firms distributed over 41 two-digits NACE core code Rev. 2 sectors and 4 years (2020-2017).

Despite the richness of Orbis data, the sector coverage was heterogeneous and the sample size was not always sufficient to draw statistically relevant indications.

We hence tried to overcome this limitation by aggregating some sectors together. However, instead of choosing arbitrarily the sectors to be merged together, we decided to rely on the clustering properties of the 2018 Input-Output (IO, hereafter) tables for Brazil provided by the OECD. Therefore, we started by matching the 41 NACE-two digits sectors of our sample with the 30 sectors of the OECD IO tables. Next, we conducted a modular decomposition analysis to identify significant clusters of highly-connected sectors within the network. Subsequently, we aggregated the sectors belonging to the same community.

The rationale for this aggregation procedure can be appreciated keeping in mind the aim of the research, that is to study the direct and indirect impacts on Brazilian firms of climate adverse shocks, as they propagate through the production network depicted by IO tables, which allow to capture the strength of the inter-dependencies between economic sectors. Climate shocks to the economy will primarily and foremost be transmitted to sectors that are strongly interconnected with those originally affected. Hence, sectors belonging to a same densely-connected community will tend to display similar level of exposure to different types of climate shocks potentially hitting the economy.

Based on this argument, we proceeded to merge the sectors belonging to the same clusters, thereby shifting the focus of the analysis from individual sectors to communities of sectors. In addition, and quite interestingly as discussed later in the section, our cluster analysis retrospectively reveals communities of sectors that share a similar semiology, lending further support to our aggregation strategy.

Formally, we perform a modular decomposition analysis by employing the Leiden algorithm on a graph from the Z matrix of inter-industry flows.

The Leiden algorithm is a common hierarchical clustering algorithm that aims at finding the partitions of the network that maximize the modularity score for given values of the resolution parameter. The

[5]Inactive firms are firms which can be in the process of bankruptcy, liquidation, included in a merger or a demerger. Keeping these firms in the sample allows us to collect as much information as possible and it is in line with the comprehensive perspective adopted here.

[6]The exclusion of foreign firms is justified by tractability reasons starting with a simple analysis here. However, we are aware of the fact that foreign firms are part of the network of domestic firms, and in some sectors they may play an important role. For instance, they may be in a better position to provide trade credit to domestic firms with which they have business relationships. Future work may also consider the relation with foreign firms.

modularity is in fact a measure of the quality of a clustering, that compares the actual number of edges within communities to the expected number of edges and measures the quality of a given partition (Traag et al., 2019, p. 1).

Formally, modularity is defined as 1:

$$H = \frac{1}{2m} \sum_{c} \left(e_c - \gamma \frac{K_c^2}{2m} \right) \tag{1}$$

Where e_c is the actual number of edges in community c. The expected number of edges, based on the so-called configuration model, can be expressed as $\frac{K_c^2}{2m}$, where K_c is the sum of the degrees of the nodes in community c and m is the total number of edges in the network. γ>0 is the resolution parameter according to which communities should have a density of at least γ, while the density between communities should be lower than γ (Traag et al., 2019, pp. 1–2).

Lower values of the resolution lead to partitions characterized by fewer and larger communities. Increasing the resolution increases the segmentation of the network leading to smaller and more specific clusters of nodes.

The Leiden algorithm, introduced by Traag et al. (2019), stands out as a recent advancement in optimizing modularity more efficiently and with superior quality when compared to the widely used Louvain algorithm.

In particular, Traag et al. (2019) argue that the Leiden algorithm allows to solve a major limitation of the Louvain algorithm that is its tendency to find arbitrarily badly connected communities that are internally disconnected, meaning that one part of the community can reach another part of the same community only through a path outside the community. Moreover, thanks to the implementation of the fast local move procedure, the Leiden algorithm is more efficient. In fact, after having visited all nodes once, it continues visiting only those whose neighborhood has changed. On the contrary, the Louvain algorithm keeps visiting all nodes, even those that cannot be moved to another community. For more details on the specification of the algorithm and its advantages, see Traag et al. (2019).

During our analysis, we conducted tests using various values for the resolution parameter. Our goal was to identify a value that not only yielded high-quality clustering, as measured by the modularity score but also achieved an appropriate granularity for our procedure's objective. Specifically, we sought to identify communities of sectors sizable enough to ensure an adequate sample of firms (i.e., tackling the lack of observations for certain sectors) while maintaining sector homophily within each community, avoiding overly heterogeneous sectors.

We eventually settled on a value of resolution parameter γ=2.8 which identifies 23 clusters of economic activity and brings an acceptable sample size for most communities while preserving a reasonable degree of homophily within each of them.

As a matter of example, this clustering yields two separated clusters whose semiology is related to mining of energy-related and of non-energy-related activities, respectively. The former includes the following OECD sectors: Mining and Quarrying, Energy Producing Products (D05T06), Mining Support Service Activities (D09), Coke and Refined Petroleum Products (D19). Besides sharing a similar semiology, this grouping allows to aggregate the NACE sector 06 (Extraction of crude petroleum and natural gas), for which we only have financial data for 7 firms, with NACE sector 19 (Manufacture of

coke and refined petroleum products), for which we have data from Orbis for 17 firms.
The second non-energy-related mining cluster includes the OECD sectors Mining and Quarrying, Non-Energy Producing Products (D07T08), Basic Metals (D24), Fabricated Metals Products (D25). Also in this case, sectors display homophily and grouping them together allows to significantly increase the sample size, merging toghether the NACE sectors 07 and 08, including data for 6 and 8 Brazilian firms respectively, the Basic Metal sector (D24), including 22 firms, and the Fabricated Metal Product sector (D25), encompassing 22 firms. Similar considerations hold for other communities detected by the algorithm.
Figure1 displays the complete list of clusters, labeled according to their characterizing semiology, the OECD sectors within each community and the number of firms in each sector with available ORBIS data.
Given the stochastic nature of the algorithm employed and in order to check for the robustness of the

Cluster	OECD sectors	Number of firms with Orbis financial data
Food	D01T02 Agriculture, hunting, forestry	Nace code 01: 83 firms
		Nace code 02: 20 firms
	D10T12 Food products, beverages and tobacco	Nace code 10: 82 firms
	D03 Fishing and aquaculture	Nace code 03: no firms
Mining - energy	D05T06 Mining and quarrying, energy producing products	Nace code 06: 7 firms
	D09 Mining support service activities	Nace code 09: no firms
	D19 Coke and refined petroleum products	Nace code 19: 17 firms
Mining - no energy	D07T08 Mining and quarrying, non-energy producing products	Nace code 07: 6 firms. Nace code 08: 9 firms
	D24 Basic metals	Nace code 24: 22 firms
	D25 Fabricated metals products	Nace code 25: 22 firms
Textiles	D13T15 Textiles, textile products, leather and footwear	Nace code 13: 23 firms
Wood, Machinery	D16 Wood and products of wood and cork	Nace code 16: 8 firms
	D28 Machinery and equipment	Nace code 28: 34 firms
	D31T33 Manufacturing nec; repair and installation of machinery	Nace codes 31, 32, 33: no firms
Paper, Water	D17T18 Paper products and printing	Nace code 17: 21 firms
	D50 Water Transport	Nace code 50: no firms
Chemical, Plastic	D20 Chemical and chemical products	Nace code 20: 50 firms
	D22 Rubber and plastic products	Nace code 22: no firms
Human Health	D21 Pharmaceuticals, medicinal chemical and botanical products	Nace code 21: 26 firms
	D86T88 Human health and social work activities	Nace code 86: 55 firms
Construction, Non metal products	D41T43 Construction	Nace code 41: 152 firms. Nace code 42: 50 firms. Nace code 43: 22 firms
	D23 Other non-metallic mineral products,	Nace code 23: no firms
Computer, Electrical equipment	D26 Computer, electronic and optical equipment	Nace code 26: 22 firms
	D27 Electrical equipment	Nace code 27: 22 firms
Motor vehicles	D29 Motor vehicles, trailers and semi trailers	Nace code 29: 19 firms
Other transport equipment	D30 Other transport equipment	Nace code 30: no firms
Electricity, gas and steam	D35 Electricity, gas, steam and air conditioning supply (385)	Nace code 35: 385 firms
Water supply and waste	D36T39 Water supply, sewerage, waste management	Nace code 36: 30 firms. Nace code 38: 24 firms
Wholesale and retail	D45T47 Wholesale and retail trade, repair of motor vehicles	Nace code 45: 38 firms. Nace code 46: 208. Nace code 47: 80 firms
Land transport	D49 Land transport and transport via pipelines	Nace code 49: 60 firms
Accomodation	D55T56 Accommodation and food service activities	Nace code 55: 15 firms
	D51 Air Transport	Nace code 51: no firms
	D94D96 Other service	Nace code 94-96: no firms
Warehousing	D52 Warehousing and support act	Nace code 52: 114 firms
Postal sector	D53 Postal and courier activities	Nace code 53: no firms
Publishing, professional activities	D58T60 Publishing, audiovisual and broadcasting	Nace code 60: 15 firms
Telecommunication, Administration, Education	D61 Telecommunications	Nace code 61: 21 firms
	D77T82 Administrative and support service activities	Nace code 77: 36 firms. Nace code 82: 78 firms
	D85 Education	Nace code 85: 17 firms
Finance and insurande, IT, Public administration	D64T66 Financial and insurance activities	Nace code 64: 836. Nace code 65: 24 firms. Nace code 66: 43 firms
	D62T63 IT and other information	Nace code 62,63: no firms
	D84 Public administration and defence	Nace code 84: no firms
Real Estate, Entertainment	D68 Real estate activities	Nace code 68: 228 firms

Figure 1: Brazilian clusters, OECD sectors and available Orbis data.

emerging clusters over time, we performed two community stability checks. First, taking as a reference the partition of figure 1, obtained from the last available OECD IO table (2018), we calculated how many times all the sectors belonging to a given community were also in the same community over the previous 8 years, so to get a preliminary measure of the robustness of each community over time. Results displayed in figure 2 show a frequency of 1 or 0.77 in all the cases except for the communities

Computer and Electrical equipment (0.11); Paper products and printing, Water Transport (0.22); Chemical and Plastic (0.44).

Additionally, we evaluated the stability of the connections between each pair of sectors by determining the frequency of their co-occurrence within the same community over the 9-year period from 2010 to 2018. Results are displayed in table 1.

	Clusters/sectors	
1	Food	1
2	Mining - energy	1
3	Mining - non energy	0,7777777778
4	Textiles - sector	1
5	Wood, Machinery	0,7777777778
6	Paper, ~~Water~~	0,2222222222
7	Chemical, ~~Plastic~~	0,4444444444
8	Human Health	1
9	Construction,~~ Non met. product~~	1
10	Computer, Elect. equipment	0,1111111111
11	Motor vehicles - sector	1
12	~~Other Transport equipment - sector~~	1
13	Electricity, gas, steam - sector	1
14	Water supply and waste - sector	1
15	Wholesale and retail - sector	1
16	Land transport - sector	1
17	Accomodation, A~~ir transport~~, ~~Other service~~	1
18	Wharehousing - sector	1
19	~~Postal - sector~~	1
20	Publishing, ~~Professional activities~~	1
21	Telecommunication, Administration, Education	1
22	Finance and insurance, ~~IT~~, ~~Public admin~~.	1
23	Real Estate, ~~Entertainment~~	0,7777777778

Figure 2: Results of frequency by community check

Table 1: Results of frequency by sector check.

	Agriculture	Fishing	Mining-en	Mining	Mining serv	Food	Textiles	Wood	Paper	Coke	Chemical	Pharmaceuticals	Rubber	Other no-metals	Basic metals	Fabricated metals	Computer	Electrical equipment	Machinery	Motor	Other transport	Manufacturing nec	El gas	Water and Waste	Construction	Wholesale	Land transp	Water transp	Air transp	Warehousing	Postal	Accommodation	Publishing	Telecommunication	IT	Finance-Ins	Real estate	Profess	Administr act	Pub. administr	Education	Health	Arts	Other serv
Agriculture	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fishing	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mining-en	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mining	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.78	0.78	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mining serv	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Food	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Textiles	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wood	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paper	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Coke	0.00	0.00	1.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chemical	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pharmaceuticals	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
Rubber	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other no-metals	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Basic metals	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.67	0.22	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fabricated metals	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.67	0.22	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Computer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Electrical equipment	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.67	0.11	1.00	0.22	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Machinery	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.22	0.00	0.22	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Motor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other transport	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Manufacturing nec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.22	0.00	0.22	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
El gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water and Waste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wholesale	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Land transp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water transp	0.00	0.00	0.11	0.00	0.11	0.00	0.00	0.00	0.22	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Air transp	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Warehousing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Postal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.67	0.67	0.00	0.00	0.00	0.67	0.00	0.00	0.00
Accommodation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Publishing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.22	0.00
Telecommunication	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
IT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
Finance-Ins	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
Real estate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Profess	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00
Administr act	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pub. administr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Education	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Health	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other serv.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00

Note: Refer to Supplementary Materials for the code legend.

In the case of Computer and Electrical equipment, in light of the results obtained from these stability checks, we decided to keep the two sectors of the community separated, which leaves us with data for 22 firms in each of them, as from table 1. In the case of the Chemical and Plastic community, instead, the instability in the relationship between the two sectors composing the community does not have practical repercussions since one of the two (Rubber and Plastic Products, D22) displays no data at all. Similarly, considering the two sectors that make up the Paper products and printing and Water Transport communities, whose degree of homophily is indeed questionable, no data are available for the Water transport sector (D50), so that their aggregation would not produce any effect anyhow.
Finally, considering that two clusters, namely Other Transport Equipment and Postal and Courier Activities, coincide with individual sectors for which no data are available, the final number of communities eventually included in the analysis is 22.

To provide a broad assessment of the evolution of the economic performance and financial condition of the Brazilian communities of sectors over time, we first analyzed the distribution within each cluster of sectors of four synthetic indicators[7] over the timespan 2017 to 2020.

The four financial indicators chosen are:

1. The gearing ratio:

   Gearing = ((Non current liabilities + Loans) / Shareholders funds) * 100
   The gearing ratio is a financial metric of leverage measuring the the degree to which firm's operations rely on either firm's debt financing or the firm's equity.
   In particular, Non-current liabilities represent long-term financial debts to credit institutions (loans and credits) plus other long-term liabilities (not related to financial institutions but to taxes, group companies, pension loans, etc) and provisions that are not due within the next year.
   Loans refer to short-term financial debts to credit institutions (loans and credits) plus the part of long-term financial debts to be paid within the year.
   Shareholders' funds represents total equity (Issued Share capital plus all Shareholders funds not linked with the issued capital such as reserve capital, undistributed profit and minority interests if any).
   Generally, a high gearing ratio indicates a greater reliance on external debt financing and may be a signal of financial risk, as the company may face difficulties in meeting its debt obligations especially during economic downturn, while a low ratio may suggest a more conservative capital structure with a higher proportion of equity funding.
   However, the interpretation of the gearing ratio also depends on the economic sector and the specific circumstances of the company and should be analyzed in conjunction with the other financial metrics.

[7]For detailed definitions of each variable we refer to the Supplementary Materials.

2. The equity ratio:

   Equity ratio = (Shareholders funds / Total assets) * 100
   Total assets refer to the sum of all the assets owned by a company, including both current assets (such as cash, inventory, and accounts receivable, short-term financial securities) and non-current assets (such as buildings, intangible assets, treasury bill of five years).
   This ratio roughly indicates the proportion of the company's assets that has been generated/financed using the owner's equity: a high ratio suggests that the company has a larger cushion of equity to absorb unexpected losses and can hence be seen as a positive indicator of financial stability and solvency.
   Conversely, companies with a low equity ratio, possibly coupled with a high gearing, are more exposed to adverse shocks on credit markets and more prone to face potential difficulties in meeting their financial obligations if their earnings decline.

3. The liquidity ratio,

   Liquidity ratio = (Current assets - Stocks)/ Current liabilities

   The Liquidity ratio measures the ability of firms to pay bills and meet needs for cash. On the numerator, it subtracts Stocks which cannot be easily converted into cash in the short run (e.g. inventories) from total assets, thereby considering only more liquid assets like cash, cash equivalents, marketable securities, and accounts receivable.
   A high liquidity ratio thus tends to indicate a strong ability to meet short-term obligations with ready-available liquid assets.

4. the ROE,

   ROE = (Profit (Loss) for period / Shareholders funds) * 100

   The return on equity (ROE) is a broad profitability indicator measuring how efficiently a company generates profits by each unit of shareholders' equity. A high ROE generally signifies better performance and it can also indicate better growth potential.

After having analyzed the sectoral distributions of the indicators over time, we perform a second exercise by comparing Brazilian firms with their sectoral counterparts operating in OECD countries, testing for the existence of statistically significant differences between the two populations. To limit the sample size of the OECD population, only large and very large (both publicly listed and privately held) firms were considered for this latter, making up a population of 42,292 companies. Such a comparative analysis is meant to investigate whether, and in which direction, the financial conditions of Brazilian

firms within each sector deviate from those prevailing in the same sectors in the rest of the world. Such an international comparison also serves as a partial response to the challenges of defining an absolute measure of firms' financial fragility, especially considering the potential impact of sector-specific factors on firms' organizational setup and financial structure.
Finally, aware of the structural differences between OECD and Brazilian economies in terms of stage development as well as the potential bias in comparing the Brazilian sample with the OECD one, we complemented the analysis by comparing the Brazilian sample with a sample of 1,873 firms selected with the exact same criteria from five OECD countries, namely Mexico, Chile, South Africa, Indonesia and Turkey.
These countries were chosen according to the Harvard Growth Lab's Country Rankings which assess the current state of a country's productive knowledge through the Economic Complexity Index (ECI)[8]. Considering that the rank of these five countries was not such distant from Brazil[9] it was possible to match 20 out of the 22 Brazilian clusters with those of the 5-countries OECD sub-sample.

2.2 The Minskyan analysis

Besides comparing the financial situation of Brazialian firms to their foreign counterparts, we also seeked for an objective criterion to assess their ability to meet their financial obligations. For this purpose, we utilized the popoular cash-flow taxonomy introduced by Minsky (1975, 1986), which categorizes firms into hedge, speculative, or Ponzi positions based on a comparison between the cash inflow generated by firms in a specific period and their interest and principal payment obligations. Hedge firms are able to generate enough inflows of liquidity and do not need to rely on financial markets to meet their cash commitments. Conversely, firms whose cash flows are sufficient to cover interest payments, but not the repayment of the principal, are in a speculative position and need to roll over their debt or to undertake extraordinary measures such as selling their assets to repay the debt[10]. As such, speculative firms are inherently more fragile due to their susceptibility to adverse fluctuations in financial markets or the real economy. This vulnerability is further exacerbated for Ponzi firms, which find themselves unable to meet either their interest or principal repayments, forcing them to continually acquire additional debt merely to stay afloat.

While this taxonomy offers an objective criterion for evaluating a firm's solvency, its practical implementation necessitates highly detailed data on the structure of debt payments and cash flows, which are unavailable in Orbis. Therefore, for this second type of analysis we relied on the Economatica database which, however, covers a lower number of Brazilian firms.

[8]Conforming to this index countries are ranked according to how diversified and complex their export basket is. For the technical breakout refer to Hidalgo and Hausmann (2009)
[9]Mexico 20th, Turkey 41st, Brazil 60th, Indonesia 67th, South Africa 70th, Chile 76th
[10]Liquidating assets, however, may often prove insufficient and could potentially exacerbate a debt deflation/asset price deflation spiral, further jeopardizing the financial position of already-fragile firms.

2.2.1 Classification and indexes

Our methodology is primarily based on Davis et al. (2019). We define as hedge firms whose sources of funds (S) are enough to cover their interest (I) and principal payments (P). Speculative firms are those whose sources of funds are enough to cover their interest payments but insufficient to cover the sum of interest and principal payments. Finally, Ponzi firms are those whose sources of funds are insufficient to cover even their interest payments. Formally, this means that firms with $S - I - P > 0$ are hedge; otherwise they will be speculative if $S - I > 0$ and Ponzi if $S - I < 0$.

While Minsky's classification (1986) was theorized in terms of expected cash flows, its empirical application must rely, as noted by Davis et al. (2019), on realized cash flows. Relative to other investigations on the financial fragility of Brazilian firms, there are some differences between the methodology adopted by Davis et al. (2019) and that adopted, for example, by Bacic (1990) and Rolim et al. (2021) which are worth mentioning. Firstly, the former encompasses a broader concept of sources of funds, while the latter are more restricted to cash flow generated from profits obtained from operations. Another key difference is related to the definition of principal payments: Davis et al. (2019) base their analysis on the outstanding value of debt commitments as reported in the balance sheet from the previous period, whereas Rolim et al. (2021) focus on the actual debt repayments in the current period. These repayments may not necessarily align with the former as they can be influenced by liability management actions, such as debt restructuring and other renegotiations of previously agreed terms. Since Davis et al. (2019) methodology is able to capture more adequately the fragility of firms based on agreed terms of the contracts, we have adopted their methodology.

Our analysis first evaluates the number and percentage of firms that are categorized in each position within each one of the previously identified communities. Then, we enhanced the analysis by computing two aggregate indexes that facilitate the assessment of the overall solvency of each cluster: the SIP (sources minus interest and principal) and the SI (sources minus interest) indexes, as originally calculated by Davis et al. (2019). These measures indicate the amount of resources left after interest and possibly principal payments relative to the total assets of firms in the cluster. The mathematical formula for these indexes is reported below.

$$SIP_{c,t} = \frac{\sum_i^{N_{c,t}} (S_{i,t} - I_{i,t} - P_{i,t})}{\sum_i^{N_{c,t}} A_{i,t}} \tag{2}$$

$$SI_{c,t} = \frac{\sum_i^{N_{c,t}} (S_{i,t} - I_{i,t})}{\sum_i^{N_{c,t}} A_{i,t}} \tag{3}$$

When $SIP > 0$, there are positive resources left after deducing the cluster's total amount of interest and principal payments from the cluster's total funds available, although this might (and generally will) not hold for all the firms in the cluster. Conversely, when $SIP < 0$, these payments need to be covered by resorting to financial markets or asset sales, at least for some firms in the cluster. If still $SI > 0$, however, funds will at least be sufficient to cover interest payments. A $SI < 0$ instead implies that some firms in the cluster need to resort to financial markets or asset sales to cover both their principal payments and interest payments. The magnitude of the indexes provides a comparison with the total assets of the cluster.

There is some relation between the indexes and the Minskyan classification. Clusters with $SIP > 0$ and $SI > 0$ could be classified as hedge clusters; clusters with $SIP > 0$ and $SI < 0$ could be classified as speculative clusters; and clusters with $SIP < 0$ and $SI < 0$ could be classified as Ponzi clusters. However, these indexes are aggregate relations that may not reflect well the situation of firms in that cluster and are used solely as a source of additional information (in particular, to identify some heterogeneity in the clusters). Therefore, in our analysis, we define as hedge those clusters with a share of hedge firms larger or equal 50%, as speculative those clusters with a share of speculative firms larger or equal 50%, and as Ponzi those clusters with a share of Ponzi firms larger or equal 50%. Clusters that do not fall in any of these criteria are characterized as hedge-speculative clusters if their share of hedge plus speculative firms is larger or equal to 50% or as speculative-Ponzi clusters if their share of speculative plus Ponzi firms is larger or equal to 50%.

2.2.2 Data

To implement the Minskyan taxonomy we employed income statements, cash flows, and balance sheet data for Brazilian publicly listed firms taken from Economatica.

Our data are summarized in table 2. We consider as sources of funds the sum of "*Cash generated from operations", "Other operating cash flow items", "Total cash from investment activities", "Effect of exchange rate changes on cash and cash equivalents", "Other changes"* (cash flow), and *"Interest payments"*. The latter variable is added to sources of funds because it is deduced in firms' income statement to obtain *"Cash generated from operations"*. This means that we consider all resources generated by firms that can be used for interest and principal payments (after discounting cash commitments related to firms' operations that are listed in firms' income statements). The only source of funds that is not considered is the decrease in asset and liabilities and cash flow from financing activities. Thus, we obtain the total amount of funds available for interest and principal payments that have not been obtained from resorting to new debt, which is consistent with Minsky's definitions.[11]

Table 2: Description of Economatica variables

Description	Abbreviation	Missing obs. treatment
Sources of funds		
Cash generated from operations	CasGenOp	Removed
Other operation cash flow items	OtIOCF	Zero imputed
Total cash from investment activities	TotCashInvAct	Zero imputed
Effect of exchange rate changes on cash and cash equivalents	EffExchRate	Zero imputed
Other changes (cash flow)	OthChg	Zero imputed
Cash commitments		
Interest payments	FinancExp	Removed
Total short-term debt (current liabilities)	TotDebtST	Removed
Accounts payable current	STAccPayable	Zero imputed
Other obligations short-term	OtLbST	Zero imputed

[11] See also Davis et al. (2019) for more details on the variables selected.

With respect to cash commitments, we consider firms' interest payments and current liabilities. The latter is taken from the previous year, since it is a end-of-period stock, and is composed of firms' short-term debt, accounts payable, and other short-term liabilities. This means that our classification for a specific period requires data from that period as well as data from the previous period. When the latter data is not available, the firm is not considered in that specific period.

$$S_{i,t} = CasGenOp_{i,t} + OtIOCF_{i,t} + TotCashInvAct_{i,t} + EffExchRate_{i,t} + OthChg_{i,t} + Int_{i,t} \quad (4)$$

$$I_{i,t} = FinancExp_{i,t} \quad (5)$$

$$P_{i,t} = TotDebtST_{i,t-1} + STAccPayable_{i,t-1} + OtLbST_{i,t-1} \quad (6)$$

To clean the database, we follow Davis et al. (2019) and exclude firms with negative recorded sales (revenues) or negative interest payments, as well as firms with missing entries for these variables. Additionally, following Pedrosa (2019), we remove observations where *"cash generated from operations"* and *"total short-run debt"* were missing, with all other cases being imputed zero (as described in table 2).

The observation retrieved from Economatica were then classified into the same clusters introduced before, based on firms' industry classification. [12]

3 Results

3.1 Comparative analysis

Tables 10 to 13 display the p-values of the Kolmogorov-Smirnov tests to assess the existence of statistical significant differences (SSD) in the distribution of the four indicators from one year to the next one in the time span 2017-2020 in the Brazilian sample. Results show that over these four years analyzed there does not seem to be significant changes in the distribution of the four indicators for most Brazilian communities of sectors.

Given the absence of statistical differences in the distributions of Brazilian firms over the four years, we focus on 2020 to compare Brazilian firms with their OECD counterparts.

Tables 14 to 21 display the results of the bootstrapped Kolmogorov-Smirnov (KS) and Mann-Whitney U tests [13] for differences in the Brazilian and OECD (all countries) populations of each indicator for each community of sectors.

[12] This operation was straightforward for most firms as it simply asked to translate the NAICS index provided by Economatica into NACE. Yet, there were some two-digits NACE for which a cluster had not yet been assigned. For these cases, we manually assigned a cluster for each NACE based on their definition. In this process, we added new NACE to existing clusters and created additional clusters as long as the number of firms in the cluster would not be very small (less than three). Accordingly, we added the "Air transport", "Postal and courier", "Manufacture", "Culture and sports". All other firms with unmatched NACE were added to a new cluster named "Others".

[13] The Kolmogorov-Smirnov (KS) and the Mann-Whitney U tests are nonparametric statistical tests. The first one, compared the cumulative distribution function of the two samples and calculates a statistic based on the maximum difference between the two functions. The second one, ranked all the observations from both samples together, then it calculated a test statistic based on the difference between the sum of the ranks of one sample and the sum of the ranks of the other

When considering the entire OECD sample the results for both tests display statistically significant differences (significant threshold set to 0.05) in the two populations for 17 out of the 22 clusters of sectors (see table 3 and supplementary materials for each average indicator): Textiles for all indicators except for ROE, Paper only for ROE; Chemicals only for liquidity; Electrical equipment for all indicators except for ROE; Electricity, gas and steam supply for all indicators except for ROE; Land transport only for liquidity and ROE; Warehousing for all indicators except for gearing; Accommodation for all indicators except for liquidity; Real Estate for all indicators except for ROE; Food for all indicators but in case of liquidity and ROE only the bootstrapped KS finds SSD; Mining-en only for ROE; Mining only for gearing (KS) and equity ratio; Wood-Machinery but only for gearing and equity ratio; Construction for all indicators; Wholesale and retail for all indicators; Telecommunication, Administration and Education only for gearing (KS) and equity ratio; Finance and Insurance for all indicators.

Table 3: Results of bootstrapped Mann Whitney and KS tests. Brazil - OECD (all countries)

2020 Brazil-OECD (all countries)	**Gearing**	**Equity ratio**	**Liquidity ratio**	**ROE**
Textiles	yes	yes	yes	no
Paper	no	no	no	yes
Chemicals	no	no	yes	no
Computer	no	no	no	no
Electrical equipment	yes	yes	yes	no
Motor vehicles	no	no	no	no
ElGas	yes	yes	yes	no
Land transport	no	no	yes	yes
Warehousing	no	yes	yes	yes
Accommodation	yes	yes	no	yes
Publishing	no	no	no	no
Real estate	yes	yes	yes	no
Food	yes	yes	yes but only KS	yes but only KS
Mining-en	no	no	no	yes
Mining	yes but only KS	yes	no	no
Wood-Machinery	yes	yes	no	no
Health	no	no	no	no
Construction	yes	yes	yes	yes
Water and Waste	no	no	no	no
Wholesale	yes	yes	yes	yes
TelAdmEdu	yes but only KS	yes	no	no
Finance-Insurance	yes	yes	yes but only KS	yes

Among these 17 clusters, the analysis of the average indicators weighted according to firms' dimension, as proxied by their net sales [14], seems to reveal a more fragile situation for the Brazilian

sample. We opted for both bootstrapped tests to have more accurate p-value considering the difference in the size of the two samples.

[14] "Net sales consist of the gross proceeds from sales (gross sales) less sales returns and allowances and any discounts allowed" (Needles et al., 2010, p. 197).

Wholesale and retail, Food and Finance communities. For the other clusters where there are SSDs, the analysis of the average indicators shows a more robust Brazilian position given the markedly lower Brazilian average of gearing and higher Brazilian average of equity ratio, liquidity ratio and ROE.
For Wholesale and retail, the Brazilian community shows a higher gearing (142.63%) than the OECD one, with a difference between the samples of 42.15% , a lower equity ratio (28.01%) with a difference of 1.54%, a lower liquidity ratio (1.09) with a difference of 0,37 points and lower ROE (8.32%) with a difference of 7.90%. These results suggest, even if not markedly for all indicators, potential risks associated with debt leverage, limited equity financing, liquidity constraints, and lower profitability for Brazilian companies compared to large firms operating in OECD countries.
In the case of the Food cluster, results are more marked for some indicators showing a higher Brazilian gearing (237.47%) with difference of 144.52%, a lower equity ratio (19.85%) with difference of 22.46%, a lower liquidity ratio (1.00) with difference of 0.67 points but a higher ROE (24.84%) with difference of 10.54%. Overall, they still suggest the same potential financial challenges previously highlighted for the Wholesale and retail community.
Moreover, these findings can be relevant in assessing the economic impact of a shock hitting these clusters given that they contribute the most in total output of the economy (respectively for the 10% and 11% [15]) and the other proportions are highly disperse among the rest of the communities. In the case of Finance and insurance, results of the comparison show a higher Brazilian gearing (172.05%) with difference of 40.41%, a lower equity ratio (31.61%) with difference of 2.55%, a lower liquidity ratio (1.35) with difference of 0.72 points but a higher ROE (12.32%) with difference of 7.53%.
These facts suggest similar potential risks but, given the peculiarities of the financial sector, reliable conclusions should be complemented with other specific analysis that are out of the scope of this paper.
Regarding Electricity, gas and steam supply and Electrical equipment communities results of gearing, equity and liquidity ratios may overall potentially suggest financial challenges for Brazil but conclusions are ambiguous considering the absence of SSDs for ROE.
In particular, compared with all OECD countries the first community shows higher financial leverage (150.03%) with difference of 31.94%, a slightly higher equity ratio so that an almost equal ability to absorb financial shocks (36.08%) with difference of 1.58% and a slightly lower liquidity ratio (1.41), with difference of 0.64.
Almost similarly, the second community has lower financial leverage (gearing 90.95% with difference of 25.87%) but at the same time a lower potential ability to absorb shocks (equity ratio 32.29% with difference of 6.31%) and slightly higher liquidity constraints (1.03) with difference of 1.53.
To sum up, see table 4, results of this first comparison of Brazil with just large OECD firms show five Brazilian clusters potentially more financially fragile. Among them, Food represents the one with the highest differences in the averages weighted according with net sales between Brazil and OECD countries and it shows the worst performance in all the indicators except for ROE.

[15] Proportion calculated on the basis of the IO OECD tables (2018) for Brazil

Table 4: Results averages indicators (weight net sales) - Brazil vs OECD (all countries)

2020 Brazil vs OECD (all countries) Averages (Weight net sales)	Gearing Brazil (%)	Gearing all OECD (%)	Equity ratio Brazil (%)	Equity ratio all OECD (%)	Liquidity ratio Brazil	Liquidity ratio all OECD	ROE Brazil (%)	ROE all OECD (%)
Textiles	31.81	113.37 *	47.75	39.79 *	1.46	1.97 *	30.30	11.90
Paper	165.35	116.85	31.42	45.43	1.19	2.46	23.73	17.46 *
Chemicals	132.76	104.40	40.40	47.70	1.41	1.96 *	17.70	4.07
Computer	105.73	100.08	40.02	40.32	1.84	2.58	34.41	9.19
Electrical equipment	90.96	116.83 *	32.30	38.61 *	1.03	2.56 *	13.49	2.26
Motor vehicles	262.74	100.70	24.45	17.84	0.97	1.33	-21.77	-23.74
Electricity, gas and steam supply	150.03	118.09 *	36.08	34.49 *	1.41	2.06 *	22.97	18.23
Land transport	233.18	152.70	25.97	32.97	1.47	1.66 *	44.96	6.63 *
Warehousing	375.95	95.87	17.09	30.37 *	1.32	2.18 *	9.19	20.23 *
Accommodation	61.43	293.94 *	31.89	17.93 *	1.02	2.28	73.44	-33.10 *
Publishing	108.01	41.12	53.03	36.94	3.58	4.14	4.94	3.13
Real estate	69.79	155.44 *	61.21	33.04 *	5.97	1.97 *	44.88	8.77
Food	237.47	92.95 *	19.85	42.32 *	1.01	1.68 *	24.85	14.30 *
Mining energy	177.04	118.39	39.87	33.52	1.55	1.30	5.72	-95.69 *
Mining	54.90	100.68 *	51.92	38.90 *	1.13	1.96	11.44	-2.06
Wood, machinery	66.10	101.42 *	47.00	40.61 *	1.39	2.03	16.88	7.45
Health	141.15	95.62	36.81	41.57	1.16	2.02	5.87	12.43
Construction	65.80	128.68 *	47.33	37.13 *	2.36	2.06 *	3.05	24.63 *
Water and Waste	106.96	141.74	47.45	36.49	1.87	2.41	18.67	24.35
Wholesale and retail	142.64	100.48 *	28.01	29.56 *	1.10	1.48 *	8.32	16.23 *
Telecommunication, administration, education	139.25	114.06 *	35.56	38.88 *	1.10	2.05	15.88	11.84
Finance and insurance	171.06	130.64 *	31.61	34.17 *	1.35	2.07 *	12.33	4.79 *

Note: * highlights SSDs between Brazil and OECD populations

As discussed in section 2.1, we performed the same comparative exercise focusing just on a sub sample of five broadly similar OECD countries (Mexico, Chile, South Africa, Indonesia and Turkey). Tables 22 to 29 present the results for this second analysis of the bootstrapped Kolmogorov-Smirnov (KS) and Mann-Whitney U tests for differences in the Brazilian and OECD (five countries) populations of each indicator for each community of sectors.

As summarized below, see table 5, the results confirm the presence of SSDs in 15 of the 17 communities previously identified in the broader comparison with the entire OECD sample, whereas no SSDs are now found for Electrical Equipment and Mining.

Furthermore, upon closer examination of the individual indicators, it becomes evident that a reduced number of indicators exhibit statistically significant differences between the two samples. Among the sectors that were previously identified as potentially more fragile, Electricity, gas and steam supply now displays SSDs only for the equity ratio and only when using the KS test, while the Finance-Insurance cluster displays differences only for the gearing and equity ratio. Conversely, the Food and Wholesale, and the Retail communities still display significant differences for all the indicators.

Table 5: Results of bootstrapped Mann Whitney and KS tests. Brazil - OECD (5 countries)

2020 Brazil-OECD (5 countries)	**Gearing**	**Equity ratio**	**Liquidity ratio**	**ROE**
Textiles	yes	yes	**yes but only KS**	no
Paper	no	no	no	**no**
Chemicals	no	**yes**	**no**	**no**
Computer	no	no	no	**yes but only KS**
Electrical equipment	**no**	**no**	**no**	no
Motor vehicles	no	no	no	no
ElGas	**no**	**yes but only KS**	**no**	no
Land transport	no	no	**no**	**yes but only KS**
Warehousing	no	yes	**yes but only KS**	**yes but only KS**
Accommodation	yes	yes	**yes**	**no**
Real estate	**yes but only KS**	**no**	**no**	no
Food	yes	yes	**yes**	yes but only KS
Mining	**no**	**no**	no	no
Mining-en	**no**	yes	no	**no**
Wood-Machinery	yes	**yes but only KS**	no	no
Health	no	no	no	no
Construction	yes	yes	yes	yes
Wholesale	yes	yes	yes	yes
TelAdmEdu	**no**	**yes but only KS**	no	no
Finance-Insurance	yes	yes	**no**	**no**

Once again we compare the average of the indicators weighted for the firms' dimension for the two samples. However, given that there were no detailed data for net sales for the five OECD countries, we employed the broader measure of operating revenues, defined as *Net sales* + *Other operating revenues* + *Stock variations* as a proxy for firms' dimension.

Results confirm that firms operating within the Brazilian Food community tend to have a significantly

higher gearing (236.48%, using the new weights) than in other countries, although the difference with the 5-countries sub sample is now slightly lower (86.09%) compared to the difference with the entire OECD sample.[16].
Conversely, the equity ratio for firms in the Brazilian Food community it is almost equal to the OECD one when considering five countries (with a difference of 1.02%) while it was lower by 21.27% compared to the entire OECD sample.
Using the operating revenues as weights, the Brazilian liquidity ratio for the Food community becomes slightly higher (1.02%) than the counterparts for both the five countries (with an absolute difference of 0.26%) and full OECD (with an absolute difference of 0.67%) samples.
When considering the ROE, the Brazilian Food community continues to display a higher weighted average (24.92%) when compared with all OECD countries (difference of 12.03%) and more markedly when compared with the five countries (difference 26.62%)

Overall considered, these results suggest that despite being able to generate bigger returns in relation to their equity, Brazilian firms in the Food community tend to be under-capitalized compared to large firms in the full OECD sample and highly reliant on external debt, as testified by the considerably higher leverage compared to both the five-countries sub-sample and the OECD full sample. This seems to put firms in the Food community on a slippery slope, as it reveals a lower capacity to absorb shocks with internal sources of funds coupled with a bigger exposure to potential adverse swings in the credit market conditions.

With regard to the Wholesale and retail community, the Brazilian sample continues to display higher average of gearing which is more marked with respect of all OECD countries and lower averages of liquidity and ROE when compared with both OECD samples; at the same time results show slightly higher ability to absorb shock for the Brazilian community given the higher Brazilian equity ratio which is a bit more marked with respect of the five OECD countries.

See table 6 for a summary of these results.

[16]Recomputing the OECD average using operating revenues as weight delivers a difference of 136.58%

Table 6: Results averages indicators (weight operating revenues) - Brazil vs OECD (all and five countries)

2020 Brazil vs OECD (all and five countries) Averages (Weight operating revenues)	Gearing Brazil (%)	Gearing all OECD (%)	Gearing 5 OECD (%)	Equity ratio Brazil (%)	Equity ratio all OECD (%)	Equity ratio 5 OECD (%)	Liquidity ratio Brazil	Liquidity ratio all OECD	Liquidity ratio 5 OECD	ROE Brazil (%)	ROE all OECD (%)	ROE 5 OECD (%)
Textiles	32.20	130.66 *	181.79 *	47.54	38.33 *	33.06 *	1.47	2.04 *	1.61 *	30.62	14.65	11.99
Paper	167.40	143.80	172.05	31.27	37.87	37.63	1.18	1.70	1.54	23.38	7.89 *	14.79
Chemicals	132.84	99.25	119.44	40.41	46.25	41.82 *	1.41	1.89 *	1.84	17.65	5.04	29.62
Computer	105.59	112.17	88.45	44.19	39.40	61.43	3.57	2.52	4.88	36.39	11.50	53.23 *
Electrical equipment	90.33	110.76 *	72.69	32.45	40.10 *	44.29 *	1.04	2.37 *	1.58	13.68	0.83	22.52
Motor vehicles	266.49	105.99	89.60	24.04	19.76	33.11	0.96	1.35	1.34	-22.21	-25.42	-59.66
Electricity, gas and steam supply	152.23	127.55 *	94.45	35.93	30.23 *	34.43	1.41	1.96 *	1.63	23.31	7.10	27.95
Land transport	232.87	237.62	93.34	26.04	24.93	37.97	1.48	1.45 *	1.31	44.57	7.79 *	22.16 *
Warehousing	374.37	119.49	140.02	16.40	29.86 *	32.03 *	1.31	1.87 *	1.25 *	6.34	18.30 *	15.26 *
Accommodation	61.20	283.03 *	104.30 *	32.18	21.86 *	15.41 *	1.01	1.80	0.51 *	72.59	-20.25 *	-54.11
Real estate	72.50	136.19 *	391.80 *	61.73	36.31 *	45.46	6.08	1.94 *	1.63	39.01	7.98	36.50
Food	236.48	99.89 *	150.38 *	20.09	41.36 *	19.07 *	1.02	1.69 *	0.76 *	24.92	12.89 *	-1.70 *
Mining energy	177.48	169.47	147.52	39.91	34.44	20.69 *	1.56	1.75	1.65	5.83	-44.03 *	15.28
Mining	54.24	190.17 *	158.87	52.17	44.97 *	33.61	1.13	1.87	0.95	11.74	-1.32	33.61
Wood, machinery	64.75	98.16 *	78.77 *	47.79	42.35 *	37.46 *	1.41	1.99	1.70	17.72	8.01	23.07
Health	123.64	104.23	74.94	41.28	40.66	43.94	1.54	1.99	1.72	7.04	12.40	26.03
Construction	66.20	111.14 *	156.12 *	47.77	35.47 *	17.32 *	2.42	1.77 *	1.10 *	3.44	9.49 *	10.95 *
Wholesale and retail	140.95	112.09 *	119.59 *	28.36	27.95 *	26.34 *	1.11	1.36 *	1.46 *	8.39	13.14 *	11.88 *
Telecommunication, administration, education	133.37	115.65 *	108.73	35.68	36.52 *	23.44 *	1.10	1.94	1.39	16.12	11.97	76.01
Finance and insurance	159.39	146.07 *	402.67 *	34.17	29.00 *	14.33 *	1.50	2.00 *	1.66	12.44	1.08 *	-20.30

Note: * highlights SSDs between Brazil and OECD populations

3.2 The Minskyan analysis

In this section we report the results obtained from applying the methodology outlined in section 2.2. We analyze firms' classification from 2017 to 2020 for the whole sample. A more detailed analysis for the clusters is restricted to 2019 to show a recent picture pre-pandemic.

Considering the whole period, table 7 indicates that most firms in our sample are speculative firms, followed by hedge firms. The only exception was the year of 2020, when the most frequent position in our sample was Ponzi. This change was associated with a reduction in the percentage of speculative firms, while the percentage of hedge firms remained the same. While this does not mean that hedge firms in 2019 remained hedge in 2020 (for instance, some hedge firms in 2019 became Ponzi in 2020), the transition from speculative to Ponzi firms suggests that firms that were already in a fragile situation could not cope well with the financial stress caused by the pandemic and, therefore, suffered a worsening in their financial position. Despite of these differences, we can classify the Brazilian economy in the intermediate position of hedge-speculative in all four years analyzed because no position had a share above 50% and the sum of hedge and speculative was above 50%.

Table 7: Minskyan classification (all firms from 2017 to 2020)

Year	# Firms	Hedge	Speculative	Ponzi	Hedge (part.)	Speculative (part.)	Ponzi (part.)	Position	SIP	SI
2017	419	101	170	148	0.24	0.41	0.35	Hedge-speculative	-0.07	0.05
2018	457	96	200	161	0.21	0.44	0.35	Hedge-speculative	-0.07	0.07
2019	479	122	203	154	0.25	0.42	0.32	Hedge-speculative	-0.04	0.07
2020	517	131	180	206	0.25	0.35	0.40	Hedge-speculative	-0.03	0.07

Sources: Own calculation based on Economatica.

The SIP and SI indexes provide a more complex story. These indexes indicate the amount of resources left after discounting cash commitments relative to total assets. Consistent with the predominance of speculative firms, the SIP was negative and the SI was positive in all periods (including 2020). Interestingly, despite the increase in the percentage of Ponzi firms between 2019 and 2020, the SI and SIP remained basically the same, which is in line with the maintenance of the overall position as hedge-speculative. This suggests significant heterogeneity across firms: while many saw a worsening in their financial fragility position, some experienced an improvement that helped to keep stable values for the SIP and SI indexes. It also suggests that the macroeconomic effect of such increase in the percentage of Ponzi firms may have been smaller than that indicated by the percentage of agents in each position since it is likely that the more fragile firms are smaller firms, with less ability to cause systemic effects. Yet, one may also interpret this result as meaning that the macro effect is worse than that suggested by looking at the aggregate indexes since a closer look at individual firms reveals an increase in Ponzi firms that has the potential to default and create cascading effects on both the real and financial sectors. Thus, the possibility of interactions and systemic effects suggests the potential for more fragility, even if it has not yet materialized in the aggregate indexes.

This analysis indicates that there was some stability in firms' positions across the years, despite of the increase in the percentage of Ponzi firms in 2020. This is in line with the results obtained previously, justifying our focus on 2019 for the analysis of the clusters, which is reported in table 8.

Table 8: Minskyan classification (clusters in 2019)

Cluster	# Firms	Hedge	Spec.	Ponzi	Hedge (part.)	Spec. (part.)	Ponzi (part.)	Position	SIP	SI
Motor vehicles	3	2	0	1	0.67	0.00	0.33	Hedge	-0.09	0.00
Telecom., Admin. and education	20	8	4	8	0.40	0.20	0.40	Hedge-Speculative	0.01	0.15
Real estate	11	4	3	4	0.36	0.27	0.36	Hedge-Speculative	-0.02	0.03
Publishing	21	9	6	6	0.43	0.29	0.29	Hedge-Speculative	-0.16	0.06
Air transport	19	7	7	5	0.37	0.37	0.26	Hedge-Speculative	-0.02	0.08
Health	12	4	5	3	0.33	0.42	0.25	Hedge-Speculative	-0.10	-0.04
Mining non energy	30	7	14	9	0.23	0.47	0.30	Hedge-Speculative	-0.01	0.06
Warehousing	38	7	18	13	0.18	0.47	0.34	Hedge-Speculative	-0.08	0.05
Other	6	2	3	1	0.33	0.50	0.17	Speculative	-0.04	0.05
Water and waste	18	7	9	2	0.39	0.50	0.11	Speculative	0.00	0.06
Electricity, gas and steam supply	83	19	43	21	0.23	0.52	0.25	Speculative	-0.07	0.03
Wood and machinery	23	3	13	7	0.13	0.57	0.30	Speculative	-0.10	0.04
Paper	5	0	3	2	0.00	0.60	0.40	Speculative	-0.08	-0.01
Food	18	2	12	4	0.11	0.67	0.22	Speculative	-0.06	0.11
Postal and courier	3	1	2	0	0.33	0.67	0.00	Speculative	-0.01	0.07
Textiles	19	2	13	4	0.11	0.68	0.21	Speculative	-0.13	0.05
Wholesale and retail	35	7	24	4	0.20	0.69	0.11	Speculative	-0.11	0.07
Chemicals	8	1	6	1	0.12	0.75	0.12	Speculative	-0.51	0.03
Computer	2	0	2	0	0.00	1.00	0.00	Speculative	-0.33	0.06
Electrical equipment	2	0	2	0	0.00	1.00	0.00	Speculative	-0.09	0.27
Culture and sports	2	0	0	2	0.00	0.00	1.00	Ponzi	-0.10	-0.04
Mining energy	8	2	0	6	0.25	0.00	0.75	Ponzi	0.10	0.14
Finance	55	19	6	30	0.35	0.11	0.55	Ponzi	-0.01	0.04
Construction	32	9	6	17	0.28	0.19	0.53	Ponzi	-0.14	-0.00
Accommodation	3	0	1	2	0.00	0.33	0.67	Ponzi	-0.02	0.02
Manufacture	3	0	1	2	0.00	0.33	0.67	Ponzi	-0.16	0.02

Sources: Own calculation based on Economatica.

In 2019, five clusters presented hedge as the mode position among their firms. Only one of them was classified as a hedge cluster (with more than 50% of firms in this position), but it is a rather small cluster ("Motor vehicles"), which indicates that a large participation of hedge firms is not encountered in any relevant cluster. Moreover, the negative SIP of this cluster suggests that it is also financially fragile and confirms the heterogeneity between its firms.

There were seven clusters classified as hedge-speculative, which are clusters where the participation of hedge and speculative firms is larger than 50% of the firms. All of these clusters can be classified as relevant clusters in our sample, with more than ten firms. Interestingly, taking the SIP and SI indexes the "Telecommunication, Administration and education" cluster would have been classified as Hedge, since it is the only cluster among this group for which both indexes are positive. This cluster presents 40% of Ponzi firms, so positive SIP and SI values suggest that very robust firms compensated the fragility of the Ponzi firms in the cluster. We also find the "Real estate" and "Air transport" clusters in a similar situation, with an SIP very close to zero (albeit negative) and a positive SI. In terms of the participation of hedge firms, the cluster "Publishing" is the one with the largest percentage of hedge firms, and the "Telecommunication, Administration and education" is the cluster with the largest percentage of Ponzi firms. Interestingly, some of these clusters present a relatively small percentage of speculative firms (in most cases, smaller or equal to the percentage of Ponzi agents), suggesting a very heterogeneous setting: many firms are in a robust position, but many are also very fragile. However, there are also some clusters in which the mode position is speculative and the percentage of hedge and Ponzi firms is very similar.

We find 12 clusters classified as speculative clusters, with more than 50% of firms being classified as speculative. Taking the largest clusters among those, we find the "Wholesale and retail", "Water and waste", "Food", "Wood and machinery", "Textiles", "Warehousing", and "Electricity, gas and steam supply" clusters. All these clusters present speculative as the mode position among their firms and have a negative SIP, with the exception of the "Water and waste" cluster. The large presence of hedge firms in this cluster indicates that it is more robust than the other clusters in the group of speculative clusters. In addition, almost all clusters in this group present positive SI, which is consistent with their speculative position. The exception is the "Paper" cluster, indicating that they it is relatively more fragile. This also indicates some heterogeneity within this cluster: either the large firms are more fragile financially than the other firms or some small firms are extremely fragile.

Finally, we find six clusters presenting Ponzi as the mode position among their firms. Interestingly, these clusters do not necessarily present negative SIP and/or SI. For instance, the "Mining energy" cluster presents positive values for both indexes and the "Finance", "Accommodation", and "Manufacture" clusters present positive SI. Once again, this is an indicator of heterogeneity in each cluster's firms. It is worthwhile pointing out that finding the "Finance" cluster with a predominance of Ponzi firms was expected due to its own characteristics: as discussed by Davis et al. (2019), commercial banks cannot be hedge units. Therefore, the most important Ponzi cluster in term of representativeness is the "Construction" cluster, which presents negative SIP and SI, in addition to a large participation of Ponzi firms. As discussed by Rolim et al. (2021), this could be related to the negative effect on the construction sector of the corruption scandals and the reduction in public investments, which were still relevant in 2019.

Relative to the comparative analysis previously reported, the results discussed in this section add some new information. The most financially fragile clusters identified in the comparative analysis are "Food", "Wholesale and retail", "Electrical equipment", and "Electricity, gas and steam supply". These clusters are not among the most fragile sectors in the Minskyan classification, but they are not among the least fragile either: all of them present a predominance of speculative firms and negative SPI. Even if the Miskyan analysis finds more fragile clusters, it corroborates the evidence indicating fragility in these specific clusters. The contrast between the comparative and Miskyan analyses is most likely due to their different samples and methodologies. It is suggestive that among the most fragile clusters in the comparative analysis, the publicly listed firms are in a better position than the other firms.

4 Firms' financial fragility and climate risks

Several studies have been conducted to evaluate Brazil's exposure to the increase of both extreme and chronic natural adverse events related to climate change. In order to assess the vulnerability to flash flooding and landslide disasters, Debortoli et al. (2017) conducted simulations at high resolution using the Eta 20-km regional climate model nested within two global climate models (HadGEM2 ES and MIROC 5 IPCC AR5 models) and developed two indices showing increased vulnerability up to the end of the twenty-first century, using the representative concentration pathways (RCP) 4.5 and 8.5

from the IPCC AR5 RCP scenarios.

Tebaldi and Beaudin (2015) using dynamic panel data models examined the impact of rainfall variation (between the years 1970-2011) on GDP growth of Brazilian states showing that spring droughts as well as spring droughts combined with summer floods impact Northeastern Brazil most severely potentially exacerbating national inequalities given that historically the Northeast has been the most economically disadvantaged region in the country.

Similarly, Tomasella et al. (2018) estimated the level of land degradation in the case of the Northeast of Brazil during the years 2000-2016 using Normalized Difference Vegetation Index (NDVI) images. Results indicated that the degraded areas increased in the period of the study with an acceleration caused by the severe drought that affected the region since 2011.

de Assis Dias et al. (2018) estimated approximately 155.000 people exposed to the risk of landslides and/or floods in 1.357 risk areas in the state of Rio de Janeiro combining demographic census data with risk areas for landslides and floods.

Anderson et al. (2018) assessed the vulnerability of the Amazonian forests to recurrent droughts showing that 46% of the Brazilian Amazon biome was under severe risk to extreme drought in 2015/2016 as measured by the standardized precipitation index (SPI) compared with 16% and 8% for the 2009/2010 and 2004/2005 droughts, respectively. Moreover, the area showing a reduction in photosynthetic capacity (as measured by the enhanced vegetation index anomalies (AEVI)) reached more than 400.000 km2 of forests.

In this framework, the assessment of the level of financial fragility of Brazilian firms is particularly relevant when considering the sectoral economic impact of climate change given that most of the clusters resulted in a hedge-speculative (e.g. Health), speculative (e.g. Food, Water and Waste, Wood, Electrical equipment, Electricity, gas and steam suppy) or Ponzi position (e.g. Mining-energy and Construction), are the ones which can be directly impacted by climate-risks.

In particular, according to WB (2021) environmental degradation, changes in water resources and loss of biodiversity are an important source of economic losses for several Brazilian sectors such as agriculture, forestry, energy and health.

CMCC (2021) estimated that average economic damages to water supply, electricity generation, irrigation, federal highways and port infrastructure amount to 19 billion EUR in 2040 under a medium emissions scenario.

In particular, with regard to the impact of climate change on Agriculture, simulations conducted by CMCC (2021) suggest that climate change will reduce agriculture productivity by 18% between 2030 and 2049 and soybeans production, the most important Brazilian cash crop accounting for 31% of the world's production, would decrease by 36,5% resulting in a 34,3% decline in its exports under a high emissions scenario.

Giannini et al. (2017) estimated a loss of up to 11 million hectares of agricultural land by the 2030s as a result of cumulative climate change impacts and deforestation[17].

As highlighted by the final report by the Joint NGFS-INSPIRE Study Group on Biodiversity and Financial Stability (NGFS-INSPIRE, 2022), a recent research conducted by the University of Cambridge

[17]See also Assad et al. (2018)

Institute for Sustainability Leadership (CISL, 2022) showed that the exposure of listed companies in Brazil's food supply chain to degraded land can significantly impact their market value. The research found that healthy soil is a key differentiating factor between positive and negative market value. Using stress-test scenarios, the researchers observed a 13% decline in the market value of farmers operating on degrading land after extreme weather events, while those on healthy soils experienced a 6% increase. Among the affected companies, small-scale (local) businesses with exposure to degrading land were found to be the most vulnerable. For instance, small packaged-food companies connected to degrading land saw a negative impact on their valuation of up to 45% with repercussions of soil degradation extended throughout the supply chain, affecting companies like fertiliser suppliers.

Additionally, the study highlighted that increased purchasing costs, driven by the need to compensate for supply shortfalls through expensive spot markets, could not be passed on to consumers without risking a loss of market share to competitors not linked to degrading land. This situation could lead to increased capital costs, potentially pushing farmers to an economic tipping point which have been observed in the past, with large farming companies divesting from land in the Bahia and Piaui regions of Brazil due to harvest unpredictability (CISL, 2022).

Dealing with the impacts on the Water sector, droughts typically occur in the north-east and central regions of Brazil but since 2012 water crisis increased also in the southeast and center-west of the country. Moreover, adverse consequences of climate patterns like El Nino resulted in greater droughts in the northeast and floods in southern Brazil [18].

Considering the impact on Energy, the Brazilian energy supply is split between renewables (46% in 2019) and fossil fuels (52% in 2019). In particular, oil and biofuels account respectively for 36% and 32.1% of total energy supply(CMCC, 2021). Increased water scarcity as well as transition risks (such as carbon pricing, new emission standards, technological change or changes in consumer preferences) may be a source of shock implying higher costs or output forced reduction which can result into lower profitability and hence greater financial fragility.[19].

Moreover, Brazil may be considered vulnerable to the impacts of climate change on Human health: CMCC (2021) showed that rising temperature increases the risk of death from cardio-vascular diseases in major Brazilian cities by 50% and by 100% for respiratory diseases and it would also increase the risk of communicable diseases such as dengue (see also de Resende Londe et al. (2018).

In addition, reduced agricultural productivity and water accessibility and quality will have impacts for the country's food and water securities.[20]

The negative economic impacts caused by the growth in the recurrence of disasters and their magnitude in Brazil led the World Bank and the Global Facility for Disaster Reduction and Recovery (GFDRR) to develop several reports to estimate damages and losses for biggest disasters.

WB (2016) assessed that major disasters occurred between the years 1995 and 2014 accounted for total losses of BRL 182.7 billion, of which BRL 137.3 billion refer to public and private losses while

[18]See also Marengo et al. (2018)) and de Resende Londe et al. (2014)

[19]Refer to Schaeffer et al. (2018) for a more comprehensive review of the literature of the topic.

[20]See also de Souza Hacon et al. (2018)

BRL 45.4 billion refer to property damage[21]. The most relevant material damage reported is related to Infrastructure, representing 59% of the total. Those related to Housing represent approximately 36% of the total, while 5% refer to damages in Health, Teaching, Community Facilities, among others. Among the private losses, the ones in Agriculture are the most representative, with 70%, followed by those reported in Livestock, Service sector and Industry, with approximately 20%, 6% and 4%, respectively. WB (2014) estimated that costs of four major events (The 2011 floods and landslides in Rio de Janeiro, the 2010 floods in Pernambuco and Alagoas and the 2008 floods in Santa Catarina) accounted for total approximately R$ 15.3 billion of which R$ 9.4 billion in damages (direct costs) and R$ 5.9 billion in losses (indirect costs) and the sectors most affected were Housing, Transport, Agriculture, Health, Industry, Education.

Among the four disasters, the 2008 floods in Santa Caterina generated the highest total estimated costs (around R$5.32 billion) (WB, 2014) with a greater impact on the private sector as a consequence of the interruption of a series of activities economies that depend on important infrastructures that were affected (like the Port of Itajaí, the Bolivia-Brazil Gas Pipeline and several federal and national highways) (WB, 2012)[22].

The distribution of losses and total damage in the infrastructure (Transports, Telecommunications, Water, Energy) and productive sectors (Agriculture, Industry and Trade) was approximately BRL 1.5 billion while social sectors (Housing, Health, Education and Culture) amounted to R$ 1.7 billion.(WB, 2012) In the sectoral distribution, Transport (30%) and Housing (32%) were the sectors most severely affected (where costs exceeded BRL 1.3 billion) together with the productive sectors which had impacts of around BRL 1.4 billion (or 31% of the total disaster costs).(WB, 2012)

As highlighted by WB (2012), the disaster in Santa Caterina is an example of the importance of taking into account the interdependence of activities when infrastructure in critical areas are affected by natural disasters.

Following this perspective, Haddad and Teixeira (2015) evaluated the economic impacts of floods in the city of San Paulo in 2008 through the use of a Spatial Computable General Equilibrium (SCGE) model integrated with Geographic Information System (GIS) information related to the location of points of floods and firms [23].

In particular, they assessed the economic impacts associated to disruption of the production chains due to the temporary interruption of the activities of businesses located in the flooded areas[24]. In particular, direct impacts were mainly concentrated in tertiary activities (around 90%), especially services, commerce and transportation.

Thanks to the calibration of the SCGE model based on a fully specified inter-regional input output system considering 41 regions, 56 sectors and 110 products, they estimated that floods contributed

[21]The term “damage” refers to direct costs such as the loss of physical assets that have been partially or totally destroyed. The term “loss” refers to indirect losses caused by disasters such as the consequences deriving from interruption of business activity)

[22]For the other specific disaster case studies refer to WBb (2012), WBc (2012), WB (2016)

[23]In particular, the GIS database on firms is known in Brazil as RAIS (Annual Report of Social Information) that provides information on address, wages paid to workers, and the SIC code of its main activity for each single firm

[24]After having identified the firms directly affected by the flood events, they estimated the foregone wage and output losses in the periods of interrupted production and accordingly they created a shock vector that feeds the SCGE model to evaluate the total economic impacts of floods in San Paulo.

not only to reduce city growth and residents' welfare (due to lower real households consumption and reduction in tax revenues), but as well to decrease domestic and international competitiveness (considering a worsening of the interregional and international balances of trade).
In this framework, it is worth mentioning that increasing awareness about the need to monitor and identify potential vulnerabilities to the Brazilian financial stability originating from both physical and transition risks led the Brazilian Central Bank to develop a regulatory reporting for Social, Environmental and Climate risks (DRSAC) requiring information on the qualitative and quantitative exposure of the loan book and securities as well as data on economic sector, risk amplifiers and mitigators, geographical location of assets and net GHG emissions (BCB, 2021b) (FSB, 2022b).
In November 2022, the Financial Stability Report of the Brazilian Central Bank (BCB, 2022) presented the exposure of the National Financial System (FSN) to transition risks. Overall, around 8% of the SFN's credit portfolio refers to borrowers who may be affected by the transition risks. In particular, the largest sources of exposure to business credit are Road Transportation (R$100.2 billion), especially cargo (R$81.4 billion), Beef Cattle Breeding (R$28.6 billion) and Pig Iron and Steel industry (R$22.1 billion) while for personal credit, the sectors most exposed are beef cattle breeding (R$ 98.6 billion) and soybean production (R$75.6 billion).
Moreover, the Brazilian Central Bank started incorporating climate change scenarios into its existing stress tests frameworks (i.e the the stress test for extreme droughts (BCB, 2022) and the stress test for heavy rains (BCB, 2023)[25].
With regard to the results of the sensitivity analysis to extreme droughts risk, the Financial Stability report 2022 (BCB, 2022) showed that the percentage of loans in the credit book granted to debtors in municipalities with medium or high risk of severe drought would increase between 2030 and 2050 from 16% to 19%. Sectors which deserve bigger attention are Agriculture and Energy since they concentrate 48.5% of total medium or high risk exposures.
Concerning the results of the sensitivity analysis to heavy rains risk, the Financial Stability Report 2023 (BCB, 2023) showed that the share of the credit portfolio exposed to municipalities with high-risk of heavy rains would increase between 2030 to 2050 up to 32.9% and by the year 2050, approximately 281 banks, accounting for nearly 90% of the total financial system's credit, are projected to have 20% to 50% of their portfolios exposed to high-risk municipalities.
These results are confirmed by Assunção et al. (2023) who evaluated the impact of both physical and transition risks on the Brazilian banking sector showing on the one hand that climate projections of physical risks (floods and droughts) are expected to generate a sizable reduction of deposits and credit and an increase of non-performing loans; on the other hand, the analysis of transition risks showed that the exposure of banks concerning high impact sectors has a U-shape, growing since 2011.
In addition, it's important to highlight the increasing concern about the need to help central banks and financial supervisors to deal also with financial risks stemming from biodiversity losses (i.e nature-related financial risks) due to human activities (NGFS-INSPIRE, 2022). In fact, as showed by the final report from the Joint NGFS-INSPIRE Study Group on Biodiversity and Financial Stability (NGFS-INSPIRE, 2022) biodiversity loss due to human activities (e.g. land- and sea-use change,

[25]A stress test aims at assessing if a financial institution has enough capital to absorb losses.

overexploitation of organisms, climate change, pollution and invasive alien species (IPBES, 2019)) can be a threat to financial stability considering the interdependence between economic activities, financial assets and ecosystem services provided by biodiversity and the environment (such as food, raw materials, fresh water, climate, water and air quality regulation, pollination, pest and disease control, mental and physical health, spiritual and religious values) so that physical and transition risks generated by biodiversity loss could interact with each other to generate systemic risks.
The Brazilian Central Bank started actions to cope with nature-related financial risks making sure that financial institutions conduct evaluations for rural credit disbursement, preventing loans to projects that encroach upon protected or embargoed areas, as well as Indigenous territories. (NGFS-INSPIRE, 2022)
The first assessment of financial sector exposure to the loss of biodiversity in Brazil was carried out by the World Bank in 2021 (Calice et al., 2021).
With regard to the exposure to physical risks, the study showed that a collapse in ecosystem services could increase the cumulative long- term rate of corporate non-performing loans by 9 percentage points. With regard to the exposure to transition risk, results found that Brazilian banks have an outstanding loan exposure of BRL 254 billion (15% of their corporate portfolio) to firms potentially operating in protected areas. This exposure could increase to BRL 664 billion (38 per cent) if all priority areas become protected.
All this given, the results of this paper revealing the high degree of indebtedness of the sectors most exposed in Brazil is particularly relevant since climate and nature risks may exacerbate their financial fragility and the risk of default, giving rise to contagion effects in the economy.

5 Conclusions

In the specific financially fragile context of the Latin American corporate sector an additional source of risk may come from climate change. In order to connect it with firms' financial fragility in Brazil, in this work we assessed the financial condition of a sample Brazilian firms in different economic sectors combining a comparative and a Minskyan analysis using two samples from Orbis and Economatica. The main findings can be summarized as follows:

1. Results of the Kolmogorov-Smirnov tests to assess the existence of SSDs in the distribution of the four indicators from one year to the next one in the time span 2017-2020 in the Brazilian sample show that over these four years analyzed there does not seem to be significant changes in the distribution of the four indicators for most Brazilian communities of sectors.

2. Results of the bootstrapped Kolmogorov-Smirnov (KS) and Mann-Whitney U tests for differences in the Brazilian and OECD (all countries) populations of each indicator for each community of sectors for the year 2020 show statistically significant differences in 17 out 22 clusters of sectors.

3. When comparing the Brazilian clusters with all OECD countries (considering net sales as weight of the average indicators that excludes the five OECD countries for which there were no data on net sales), the most financially fragile ones in 2020 are Food, Wholesale and retail. In particular, Food represents the one with the highest differences in the averages between Brazil and OECD countries and it shows the worst performance in all the indicators except for ROE. Regarding the "Electricity, gas and steam supply" and "Electrical equipment" clusters, results are ambiguous.

4. When performing the two statistical tests for differences in the Brazilian and OECD sub-sample (five countries) populations for the year 2020 results show statistically significant differences in 15 out of 22 clusters of sectors. In particular, there are not SSDs in the "Electrical equipment" cluster, and a reduction of the indicators where there are SSDs in "Electricity, gas and steam supply" and "Finance".

5. When comparing the weighted average of the indicators (considering Operating revenues as weight) of Food and Wholesale and Retail clusters, results in 2020 show:

   (a) Brazilian Food worse performance when compared with both OECD samples but more marked differences when compared with all OECD countries than with the five OECD countries.

   (b) Brazilian Wholesale and retail worse performance but higher and more marked equity ratio weighted average when compared with all OECD countries.

6. Combining the results of the comparative analysis, it seems that large OECD firms are less fragile than small, medium and large Brazilian firms. These differences can be due both to dissimilar dimension and economic context in which they operate (such as the state of competition). When considering small, medium OECD firms taking also into account similar Economic Complexity Index rank among countries, differences are lower.

7. Results of the Minskyan analysis show that:

   (a) Along the whole period (2017-2020) the majority of firms are speculative with the only exception of year 2020, when the most frequent position was Ponzi. Nevertheless, taking the Brazilian economy as whole, it would be characterized as hedge-speculative in the entire period.

   (b) In the year 2019, Wholesale and retail and Food are not among the most fragile clusters but appear to be in a speculative position. Taking the largest clusters, which tend to be better represented by the Economatica data, we find that Telecommunication, Admnistration, and Education, Real estate Publishing, Air transport, Mining non-energy, Health, and Warehousing are in the hedge-speculative position. Water and Waste, Electricity, Gas and steam supply, Wood and Machinery, Food, Textiles, and Wholesale and retail are in the speculative position. Conversely, Finance and Construction clusters are in a Ponzi position.

8. It is suggestive that among the most fragile clusters in the comparative analysis, the Brazilian publicly listed firms are in better a position than the other firms. Since these clusters do not

appear in the Economatica sample as the most fragile clusters (in relation to all clusters), this can be due to the fact that the publicly listed firms are less fragile than the rest of the firms in that cluster, which helps that cluster to perform better when using Economatica data than when using Orbis data.

9. The clusters highlighted in the comparative analysis (Food, Wholesale and retail, Electrical equipment, and Electricity, gas and steam supply) are not among the most fragile sectors in the Minskyan classification, but they are not among the least fragile either: all of them present a predominance of speculative firms and negative SPI. These clusters present a predominance of speculative firms throughout the period between 2017 to 2020, indicating a structural financial fragility that is not related to the year selected for the analysis.

10. Even if the Miskyan analysis finds more fragile clusters, it corroborates the evidence indicating fragility in these specific clusters:

    (a) Among the largest clusters (more than ten firms), Wholesale and retail, Food, and Electricity, gas and steam supply are among the five clusters with the largest percentage of speculative firms (the "Electrical equipment" cluster has only two firms, so it is not considered in this comparison).

    (b) Also among the largest clusters, these three clusters are among the six clusters with the smallest percentage of hedge firms.

11. The assessment of the level of financial fragility of Brazilian firms is particularly relevant when considering the sectoral economic impact of climate change given that most of the clusters resulted in a hedge-speculative (e.g. Health), speculative (e.g. Food, Water and Waste, Wood, Electrical equipment, Electricity, gas and steam suppy) or Ponzi position (e.g. Mining-energy and Construction), are the same which can be directly impacted by climate-risks. In light of high degree of indebtedness, climate-risks may exacerbate their financial fragility and the risk of default, giving rise to contagion effects in the economy.

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Supplementary Materials

Table 9: Input-Output sectors code legend

OECD Input-Output tables code	Abbreviation
D01T02: Agriculture, hunting, forestry	Agriculture
D03: Fishing and aquaculture	Fishing
D05T06: Mining and quarrying, energy producing products	Mining-en
D07T08: Mining and quarrying, non-energy producing products	Mining
D09: Mining support service activities	Mining serv
D10T12: Food products, beverages and tobacco	Food
D13T15: Textiles, textile products, leather and footwear	Textiles
D16: Wood and products of wood and cork	Wood
D17T18: Paper products and printing	Paper
D19: Coke and refined petroleum products	Coke
D20: Chemical and chemical products	Chemical
D21: Pharmaceuticals, medicinal chemical and botanical products	Pharmaceuticals
D22: Rubber and plastics products	Rubber
D23: Other non-metallic mineral products	Other no-metals
D24: Basic metals	Basic metals
D25: Fabricated metal products	Fabricated metals
D26: Computer, electronic and optical equipment	Computer
D27: Electrical equipment	Electrical equipment
D28: Machinery and equipment, nec	Machinery
D29: Motor vehicles, trailers and semi-trailers	Motor
D30: Other transport equipment	Other Transport
D31T33: Manufacturing nec; repair and installation of machinery and equipment	Manufacturing nec
D35: Electricity, gas, steam and air conditioning supply	El gas
D36T39: Water supply; sewerage, waste management and remediation activities	Water and Waste
D41T43: Construction	Construction
D45T47: Wholesale and retail trade; repair of motor vehicles	Wholesale
D49: Land transport and transport via pipelines	Land transp
D50: Water transport	Water transp
D51: Air transport	Air transp
D52: Warehousing and support activities for transportation	Warehousing
D53: Postal and courier activities	Postal
D55T56: Accommodation and food service activities	Accommodation
D58T60: Publishing, audiovisual and broadcasting activities	Publishing
D61: Telecommunications	Telecommunication
D62T63: IT and other information services	IT
D64T66: Financial and insurance activities	Finance-Ins
D68: Real estate activities	Real estate
D69T75: Professional, scientific and technical activities	Profess
D77T82: Administrative and support services	Administr act
D84: Public administration and defence; compulsory social security	Pub administr
D85: Education	Education
D86T88: Human health and social work activities	Health
D90T93: Arts, entertainment and recreation	Arts
D94T96: Other service activities	Other serv

Variable definitions

From Orbis User Guide:

Non current liabilities = Long term financial debts to credit institutions (loans and credits) + other long term liabilities (not related to financial institutions but to taxes, group companies , pension loans, etc) and provisions that are not due within the next year.

Loans = short term financial debts to credit institutions (loans and credits)+ part of Long term financial debts payable within the year.

Shareholder funds = Total equity (Capital + Other shareholders funds).

Capital = Issued Share capital (Authorized capital).

Other shareholder funds = All Shareholders funds not linked with the Issued capital such as Reserve capital, Undistributed profit, include also Minority interests if any.

Total assets = Fixed assets + Current assets

Fixed assets = Total amount (after depreciation) of non current assets (Intangible assets+Tangible assets+Other fixed assets).

Intangible assets = All intangible assets such as formation expenses, research expenses, goodwill, development expenses and all other expenses with a long term effect.

Tangible assets = All tangible assets such as buildings, machinery, etc.

Other fixed assets = All other fixed assets such as long term investments, shares and participations, pension funds etc.

Current assets = Total amount of current assets (Stocks+Debtors+Other current assets).

Stocks = Total inventories (raw materials+in progress+finished goods)

Debtors = Trade receivables (from clients and customers only).

Other current assets = All other current assets such as receivables from other sources (taxes, group companies), short term investment of money and Cash at bank and in hand.

Current liabilities = Loans + Creditors + Other current liabilities.

Creditors = All debts to suppliers and contractors (trade creditors).

Other current liabilities = All current liabilities not payable to financial institutions nor trade debts such as pension, personnel costs, taxes, intragroup debts, etc.

Operating revenues = Total operating revenues (Net sales + Other operating revenues + Stock variations.

Table 10: Results of Bootstrapped KS test - each Brazilian sector with itself in the previous year - Gearing

	2020-2019	2019-2018	2018-2017
Textiles	1.00	0.87	0.98
Paper	0.97	0.97	0.99
Chemicals	0.85	0.99	0.93
Computer	0.88	0.85	0.81
Electr	0.78	0.84	0.98
Motor	0.50	1.00	0.36
ElGas	0.68	0.88	0.05
LandTransp	0.92	0.37	0.70
Warehouse	0.83	0.87	0.94
Accomm	0.93	0.90	0.60
Publishing	0.64	1.00	0.92
RealEstate	1.00	0.94	0.96
Food	0.74	0.95	1.00
Mining-en	0.84	0.33	0.75
Mining	0.99	0.96	0.85
Wood_mach	0.87	0.74	0.33
Health	0.90	0.27	0.62
Constr	0.91	0.55	0.98
Water	0.99	0.96	0.98
Wholesale	0.93	0.59	0.42
TAE	0.97	1.00	0.98
Finance_Ins	0.99	0.96	0.93

Table 11: Results of Bootstrapped KS test - each Brazilian sector with itself in the previous year - Equity ratio

	2020-2019	2019-2018	2018-2017
Textiles	0.99	0.88	0.99
Paper	0.99	0.97	0.88
Chemicals	0.52	1.00	0.95
Computer	0.65	0.99	0.99
Electr	0.99	0.87	0.99
Motor	0.98	0.98	0.98
ElGas	0.70	0.89	0.08
LandTransp	0.81	0.66	0.42
Warehouse	0.88	1.00	0.81
Accomm	1.00	0.92	0.68
Publishing	1.00	1.00	1.00
RealEstate	0.87	0.89	1.00
Food	0.99	1.00	1.00
Mining-en	0.99	0.69	0.99
Mining	0.80	1.00	0.99
Wood_mach	0.59	1.00	0.93
Health	0.31	0.85	0.81
Constr	0.53	0.95	1.00
Water	0.98	0.76	0.98
Wholesale	0.99	0.94	0.93
TAE	0.57	0.93	1.00
Finance_Ins	1.00	0.87	0.68

Table 12: Results of Bootstrapped KS test - each Brazilian sector with itself in the previous year - Liquidity ratio

	2020-2019	2019-2018	2018-2017
Textiles	1.00	0.86	0.63
Paper	0.60	0.85	0.99
Chemicals	1.00	0.97	0.97
Computer	0.36	1.00	0.39
Electr	0.99	0.63	0.87
Motor	0.80	0.98	0.98
ElGas	0.16	0.11	0.14
LandTransp	0.79	0.64	0.92
Warehouse	0.64	0.43	0.51
Accomm	0.91	0.94	0.66
Publishing	0.64	0.92	0.92
RealEstate	0.87	0.77	0.90
Food	0.90	0.73	1.00
Mining-en	0.68	0.26	0.69
Mining	0.91	0.98	0.63
Wood_mach	1.00	0.93	1.00
Health	0.82	0.98	0.80
Constr	0.52	0.81	0.55
Water	0.76	0.76	0.73
Wholesale	0.69	0.98	0.92
TAE	0.75	1.00	0.98
Finance_Ins	0.79	0.88	0.60

Table 13: Results of Bootstrapped KS test - each Brazilian sector with itself in the previous year - ROE

	2020-2019	2019-2018	2018-2017
Textiles	0.46	0.98	0.98
Paper	0.54	0.39	0.98
Chemicals	0.14	0.24	0.82
Computer	0.78	0.77	0.28
Electr	0.98	0.84	0.85
Motor	0.41	0.19	0.02
ElGas	0.85	0.10	0.31
LandTransp	0.56	0.79	0.96
Warehouse	0.95	0.70	1.00
Accomm	0.59	0.92	0.91
Publishing	0.59	0.90	0.90
RealEstate	0.98	0.50	0.99
Food	0.00	1.00	0.96
Mining-en	0.16	0.66	0.88
Mining	0.90	0.75	0.34
Wood_mach	0.71	0.25	0.95
Health	0.85	0.16	0.37
Constr	0.50	0.32	0.89
Water	0.82	0.65	0.66
Wholesale	0.02	0.25	0.46
TAE	0.48	0.24	0.70
Finance_Ins	0.26	0.24	0.95

Table 14: Results of Bootstrapped KS test - Brazil vs OECD all countries - Gearing

	2020	2019	2018	2017
Textiles	0.04	0.11	0.01	0.01
Paper	0.28	0.19	0.60	0.35
Chemicals	0.92	0.95	0.58	0.76
Computer	0.64	0.11	0.42	0.35
Electr	0.06	0.02	0.32	0.25
Motor	0.32	0.32	0.52	0.35
ElGas	0.00	0.00	0.00	0.00
LandTransp	0.30	0.20	0.49	0.58
Warehouse	0.54	0.15	0.64	0.69
Accomm	0.02	0.01	0.00	0.00
Publ	0.30	0.37	0.52	0.67
RealEstate	0.00	0.00	0.00	0.00
Food	0.00	0.00	0.02	0.00
Mining_en	0.13	0.05	0.40	0.18
Mining	0.05	0.06	0.04	0.11
Wood_mach	0.00	0.01	0.00	0.05
Health	0.68	0.17	0.01	0.04
Constr	0.00	0.00	0.00	0.00
WaterWast	0.72	0.99	0.70	0.71
Wholesale	0.00	0.00	0.00	0.00
TelAdmEduc	0.09	0.09	0.07	0.14
Finance_Ins	0.01	0.00	0.00	0.00

Table 15: Results of Bootstrapped Mann Whitney test - Brazil vs OECD all countries - Gearing. For each year the table displays how many times on 1000 boots there are SSD

	no diff 1	no diff 2	no diff 3	no diff 4	ss diff 1	ss diff 2	ss diff 3	ss diff 4
Textiles	545.00	649.00	249.00	191.00	455.00	351.00	751.00	809.00
Paper	669.00	689.00	832.00	844.00	331.00	311.00	168.00	156.00
Chemicals	948.00	902.00	889.00	931.00	52.00	98.00	111.00	69.00
Computer	826.00	587.00	850.00	747.00	174.00	413.00	150.00	253.00
Electr	458.00	462.00	704.00	849.00	542.00	538.00	296.00	151.00
Motor	695.00	860.00	886.00	930.00	305.00	140.00	114.00	70.00
ElGas	214.00	468.00	702.00	83.00	786.00	532.00	298.00	917.00
LandTransp	850.00	815.00	963.00	951.00	150.00	185.00	37.00	49.00
Warehouse	887.00	790.00	917.00	940.00	113.00	210.00	83.00	60.00
Accomm	77.00	73.00	19.00	1.00	923.00	927.00	981.00	999.00
Publ	754.00	923.00	925.00	940.00	246.00	77.00	75.00	60.00
RealEstate	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
Food	161.00	282.00	561.00	471.00	839.00	718.00	439.00	529.00
Mining_en	605.00	797.00	912.00	865.00	395.00	203.00	88.00	135.00
Mining	505.00	414.00	159.00	533.00	495.00	586.00	841.00	467.00
Wood_mach	16.00	142.00	25.00	585.00	984.00	858.00	975.00	415.00
Health	865.00	694.00	179.00	420.00	135.00	306.00	821.00	580.00
Constr	0.00	0.00	1.00	0.00	1000.00	1000.00	999.00	1000.00
WaterWast	870.00	950.00	922.00	874.00	130.00	50.00	78.00	126.00
Wholesale	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
TelAdmEduc	692.00	667.00	566.00	409.00	308.00	333.00	434.00	591.00
Finance_Ins	113.00	1.00	2.00	0.00	887.00	999.00	998.00	1000.00

Table 16: Results of Bootstrapped KS test - Brazil vs OECD all countries - Equity ratio

	2020	2019	2018	2017
Textiles	0.15	0.02	0.01	0.00
Paper	0.25	0.53	0.56	0.30
Chemicals	0.18	0.22	0.13	0.59
Computer	0.24	0.84	0.52	0.21
Electr	0.02	0.02	0.23	0.03
Motor	0.94	0.62	0.31	0.91
ElGas	0.00	0.00	0.00	0.00
LandTransp	0.24	0.01	0.01	0.00
Warehouse	0.01	0.03	0.00	0.00
Accomm	0.00	0.00	0.00	0.00
Publ	0.20	0.24	0.32	0.15
RealEstate	0.00	0.00	0.00	0.00
Food	0.00	0.00	0.00	0.00
Mining_en	0.49	0.33	0.28	0.41
Mining	0.06	0.03	0.01	0.00
Wood_mach	0.02	0.01	0.01	0.01
Health	0.44	0.18	0.02	0.18
Constr	0.00	0.00	0.00	0.00
WaterWast	0.30	0.75	0.65	0.27
Wholesale	0.00	0.00	0.00	0.00
TelAdmEduc	0.07	0.11	0.03	0.00
Finance_Ins	0.00	0.00	0.00	0.00

Table 17: Results of Bootstrapped Mann Whitney test - Brazil vs OECD all countries - Equity ratio. For each year the table displays how many times on 1000 boots there are SSD

	no diff 1	no diff 2	no diff 3	no diff 4	ss diff 1	ss diff 2	ss diff 3	ss diff 4
Textiles	553.00	424.00	279.00	218.00	447.00	576.00	721.00	782.00
Paper	726.00	883.00	878.00	844.00	274.00	117.00	122.00	156.00
Chemicals	979.00	912.00	864.00	938.00	21.00	88.00	136.00	62.00
Computer	625.00	859.00	809.00	669.00	375.00	141.00	191.00	331.00
Electr	242.00	261.00	632.00	465.00	758.00	739.00	368.00	535.00
Motor	946.00	875.00	803.00	931.00	54.00	125.00	197.00	69.00
ElGas	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
LandTransp	741.00	384.00	244.00	56.00	259.00	616.00	756.00	944.00
Warehouse	280.00	209.00	155.00	12.00	720.00	791.00	845.00	988.00
Accomm	64.00	57.00	2.00	13.00	936.00	943.00	998.00	987.00
Publ	670.00	708.00	725.00	804.00	330.00	292.00	275.00	196.00
RealEstate	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
Food	5.00	1.00	1.00	0.00	995.00	999.00	999.00	1000.00
Mining_en	966.00	928.00	932.00	933.00	34.00	72.00	68.00	67.00
Mining	452.00	205.00	215.00	45.00	548.00	795.00	785.00	955.00
Wood_mach	448.00	261.00	399.00	446.00	552.00	739.00	601.00	554.00
Health	934.00	718.00	327.00	650.00	66.00	282.00	673.00	350.00
Constr	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
WaterWast	864.00	916.00	930.00	935.00	136.00	84.00	70.00	65.00
Wholesale	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
TelAdmEduc	179.00	419.00	234.00	82.00	821.00	581.00	766.00	918.00
Finance_Ins	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00

Table 18: Results of Bootstrapped KS test - Brazil vs OECD all countries - Liquidity ratio

	2020	2019	2018	2017
Textiles	0.02	0.01	0.01	0.00
Paper	0.10	0.13	0.19	0.16
Chemicals	0.03	0.16	0.51	0.66
Computer	0.09	0.34	0.52	0.26
Electr	0.01	0.00	0.17	0.10
Motor	0.96	0.87	0.47	0.65
ElGas	0.03	0.04	0.00	0.00
LandTransp	0.00	0.00	0.03	0.00
Warehouse	0.00	0.00	0.00	0.00
Accomm	0.53	0.58	0.36	0.39
Publ	0.23	0.55	0.49	0.15
RealEstate	0.00	0.00	0.00	0.00
Food	0.01	0.01	0.01	0.01
Mining_en	0.95	0.46	0.53	0.32
Mining	0.37	0.62	0.34	0.83
Wood_mach	0.97	0.77	0.19	0.29
Health	0.37	0.12	0.02	0.08
Constr	0.00	0.00	0.00	0.00
WaterWast	0.27	0.21	0.48	0.45
Wholesale	0.00	0.00	0.00	0.00
TelAdmEduc	0.42	0.73	0.54	0.30
Finance_Ins	0.00	0.21	0.23	0.10

Table 19: Results of Bootstrapped Mann Whitney test - Brazil vs OECD all countries - Liquidity ratio. For each year the table displays how many times on 1000 boots there are SSD

	no diff 1	no diff 2	no diff 3	no diff 4	ss diff 1	ss diff 2	ss diff 3	ss diff 4
Textiles	492.00	218.00	233.00	25.00	508.00	782.00	767.00	975.00
Paper	529.00	554.00	584.00	461.00	471.00	446.00	416.00	539.00
Chemicals	616.00	818.00	787.00	908.00	384.00	182.00	213.00	92.00
Computer	814.00	979.00	987.00	932.00	186.00	21.00	13.00	68.00
Electr	140.00	217.00	774.00	466.00	860.00	783.00	226.00	534.00
Motor	947.00	932.00	924.00	883.00	53.00	68.00	76.00	117.00
ElGas	476.00	861.00	623.00	31.00	524.00	139.00	377.00	969.00
LandTransp	42.00	104.00	266.00	101.00	958.00	896.00	734.00	899.00
Warehouse	15.00	0.00	8.00	0.00	985.00	1000.00	992.00	1000.00
Accomm	850.00	903.00	847.00	861.00	150.00	97.00	153.00	139.00
Publ	960.00	963.00	978.00	978.00	40.00	37.00	22.00	22.00
RealEstate	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
Food	655.00	606.00	501.00	587.00	345.00	394.00	499.00	413.00
Mining_en	960.00	901.00	948.00	893.00	40.00	99.00	52.00	107.00
Mining	898.00	945.00	867.00	941.00	102.00	55.00	133.00	59.00
Wood_mach	942.00	885.00	824.00	912.00	58.00	115.00	176.00	88.00
Health	953.00	820.00	657.00	811.00	47.00	180.00	343.00	189.00
Constr	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
WaterWast	706.00	708.00	796.00	920.00	294.00	292.00	204.00	80.00
Wholesale	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
TelAdmEduc	878.00	909.00	914.00	692.00	122.00	91.00	86.00	308.00
Finance_Ins	610.00	884.00	900.00	848.00	390.00	116.00	100.00	152.00

Table 20: Results of Bootstrapped KS test - Brazil vs OECD all countries - ROE

	2020	2019	2018	2017
Textiles	0.81	0.30	0.21	0.18
Paper	0.01	0.22	0.50	0.32
Chemicals	0.08	0.37	0.19	0.31
Computer	0.42	0.60	0.10	0.52
Electr	0.09	0.25	0.39	0.03
Motor	0.69	0.85	0.48	0.01
ElGas	0.71	0.11	0.10	0.05
LandTransp	0.00	0.00	0.00	0.00
Warehouse	0.00	0.00	0.00	0.00
Accomm	0.02	0.02	0.00	0.05
Publ	0.30	0.04	0.39	0.06
RealEstate	0.23	0.52	0.06	0.08
Food	0.01	0.00	0.00	0.00
Mining_en	0.02	0.08	0.45	0.61
Mining	0.40	0.00	0.00	0.00
Wood_mach	0.13	0.97	0.03	0.01
Health	0.13	0.14	0.00	0.00
Constr	0.00	0.00	0.00	0.00
WaterWast	0.13	0.02	0.10	0.38
Wholesale	0.00	0.00	0.00	0.00
TelAdmEduc	0.24	0.01	0.38	0.22
Finance_Ins	0.00	0.00	0.00	0.00

Table 21: Results of Bootstrapped Mann Whitney test - Brazil vs OECD all countries - ROE.
For each year the table displays how many times on 1000 boots there are SSD

	no diff 1	no diff 2	no diff 3	no diff 4	ss diff 1	ss diff 2	ss diff 3	ss diff 4
Textiles	957.00	806.00	585.00	818.00	43.00	194.00	415.00	182.00
Paper	434.00	841.00	815.00	908.00	566.00	159.00	185.00	92.00
Chemicals	601.00	911.00	718.00	811.00	399.00	89.00	282.00	189.00
Computer	883.00	909.00	571.00	927.00	117.00	91.00	429.00	73.00
Electr	650.00	814.00	848.00	631.00	350.00	186.00	152.00	369.00
Motor	906.00	948.00	754.00	154.00	94.00	52.00	246.00	846.00
ElGas	930.00	830.00	789.00	784.00	70.00	170.00	211.00	216.00
LandTransp	295.00	494.00	90.00	138.00	705.00	506.00	910.00	862.00
Warehouse	224.00	182.00	134.00	95.00	776.00	818.00	866.00	905.00
Accomm	305.00	583.00	298.00	581.00	695.00	417.00	702.00	419.00
Publ	774.00	507.00	819.00	471.00	226.00	493.00	181.00	529.00
RealEstate	863.00	943.00	730.00	671.00	137.00	57.00	270.00	329.00
Food	681.00	21.00	6.00	13.00	319.00	979.00	994.00	987.00
Mining_en	129.00	826.00	923.00	791.00	871.00	174.00	77.00	209.00
Mining	764.00	334.00	116.00	0.00	236.00	666.00	884.00	1000.00
Wood_mach	535.00	950.00	596.00	280.00	465.00	50.00	404.00	720.00
Health	887.00	779.00	110.00	76.00	113.00	221.00	890.00	924.00
Constr	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
WaterWast	857.00	465.00	720.00	827.00	143.00	535.00	280.00	173.00
Wholesale	5.00	374.00	35.00	740.00	995.00	626.00	965.00	260.00
TelAdmEduc	867.00	497.00	912.00	842.00	133.00	503.00	88.00	158.00
Finance_Ins	399.00	653.00	876.00	948.00	601.00	347.00	124.00	52.00

Table 22: Results of Bootstrapped KS test - Brazil vs 5 OECD countries - Gearing

	2020	2019	2018	2017
Textiles	0.00	0.03	0.01	0.00
Paper	0.58	0.70	0.76	0.27
Chemicals	0.18	0.51	0.26	0.06
Computer	0.59	0.52	0.77	0.02
Electr	1.00	0.73	0.98	0.56
Motor	0.71	0.23	0.46	0.94
ElGas	0.30	0.66	0.22	0.72
LandTransp	0.27	0.07	0.51	0.25
Warehouse	0.57	0.78	0.55	0.33
Accomm	0.01	0.04	0.08	0.12
RealEstate	0.03	0.10	0.02	0.62
Food	0.00	0.00	0.00	0.00
Mining	0.25	0.14	0.23	0.45
Mining_en	0.13	0.24	0.13	0.06
Wood_mach	0.01	0.36	0.20	0.73
Health	0.34	0.09	0.61	0.71
Constr	0.00	0.00	0.00	0.00
Wholesale	0.00	0.00	0.00	0.00
TAE	0.57	0.73	0.50	0.77
Finance_Ins	0.01	0.11	0.10	0.08

Table 23: Results of Bootstrapped KS test - Brazil vs 5 OECD countries - Equity ratio

	2020	2019	2018	2017
Textiles	0.00	0.00	0.00	0.00
Paper	0.98	0.99	0.94	0.45
Chemicals	0.02	0.07	0.01	0.01
Computer	0.11	0.63	0.18	0.02
Electr	0.50	0.55	0.52	0.07
Motor	0.86	0.41	0.71	0.99
ElGas	0.00	0.00	0.00	0.01
LandTransp	0.20	0.24	0.21	0.25
Warehouse	0.01	0.01	0.02	0.00
Accomm	0.00	0.00	0.00	0.00
RealEstate	0.52	0.26	0.33	0.26
Food	0.00	0.00	0.00	0.00
Mining	0.29	0.16	0.02	0.04
Mining_en	0.01	0.00	0.00	0.00
Wood_mach	0.00	0.00	0.00	0.01
Health	0.44	0.18	0.10	0.34
Constr	0.00	0.00	0.00	0.00
Wholesale	0.00	0.00	0.00	0.00
TAE	0.04	0.14	0.03	0.03
Finance_Ins	0.00	0.00	0.00	0.00

Table 24: Results of Bootstrapped KS test - Brazil vs 5 OECD countries - Liquidity ratio

	2020	2019	2018	2017
Textiles	0.01	0.01	0.01	0.00
Paper	0.85	0.38	0.56	0.53
Chemicals	0.23	0.79	0.41	0.78
Computer	0.51	0.83	0.28	0.05
Electr	0.15	0.33	0.48	0.81
Motor	0.44	0.23	0.46	0.55
ElGas	0.57	0.50	0.22	0.17
LandTransp	0.09	0.12	0.99	0.24
Warehouse	0.01	0.00	0.35	0.01
Accomm	0.01	0.16	0.34	0.73
RealEstate	0.91	0.38	0.98	0.81
Food	0.00	0.01	0.00	0.00
Mining	0.44	0.49	0.33	0.68
Mining_en	0.12	0.02	0.01	0.02
Wood_mach	0.11	0.09	0.01	0.00
Health	0.88	0.33	0.90	0.91
Constr	0.00	0.00	0.00	0.00
Wholesale	0.00	0.00	0.00	0.00
TAE	0.52	0.58	0.22	0.21
Finance_Ins	0.20	0.44	0.07	0.03

Table 25: Results of Bootstrapped KS test - Brazil vs 5 OECD countries - ROE

	2020	2019	2018	2017
Textiles	0.12	0.74	0.43	0.73
Paper	0.80	0.12	0.26	0.02
Chemicals	0.43	0.50	0.19	0.46
Computer	0.01	0.11	0.31	0.18
Electr	0.43	0.72	0.62	0.02
Motor	0.13	0.02	0.78	0.01
ElGas	0.53	0.20	0.22	0.18
LandTransp	0.04	0.06	0.09	0.06
Warehouse	0.01	0.02	0.09	0.00
Accomm	0.47	0.03	0.07	0.56
RealEstate	0.15	0.78	0.98	0.15
Food	0.05	0.01	0.05	0.00
Mining	0.22	0.09	0.09	0.00
Mining_en	0.19	0.31	0.72	0.05
Wood_mach	0.64	0.78	0.07	0.00
Health	0.06	0.51	0.03	0.39
Constr	0.00	0.00	0.00	0.00
Wholesale	0.00	0.00	0.00	0.00
TAE	0.29	0.46	0.24	0.07
Finance_Ins	0.72	0.45	0.72	0.24

Table 26: Results of Bootstrapped Mann Whitney test - Brazil vs 5 OECD countries - Gearing. For each year the table displays how many times on 1000 boots there are SSD

	no diff 1	no diff 2	no diff 3	no diff 4	ss diff 1	ss diff 2	ss diff 3	ss diff 4
Textiles	254.00	590.00	585.00	364.00	746.00	410.00	415.00	636.00
Paper	987.00	982.00	993.00	997.00	13.00	18.00	7.00	3.00
Chemicals	914.00	958.00	891.00	675.00	86.00	42.00	109.00	325.00
Computer	1000.00	998.00	995.00	565.00	0.00	2.00	5.00	435.00
Electr	1000.00	995.00	999.00	991.00	0.00	5.00	1.00	9.00
Motor	979.00	976.00	979.00	999.00	21.00	24.00	21.00	1.00
ElGas	982.00	995.00	993.00	994.00	18.00	5.00	7.00	6.00
LandTransp	984.00	864.00	996.00	989.00	16.00	136.00	4.00	11.00
Warehouse	987.00	998.00	991.00	887.00	13.00	2.00	9.00	113.00
Accomm	252.00	467.00	843.00	970.00	748.00	533.00	157.00	30.00
RealEstate	1000.00	467.00	1000.00	991.00	0.00	533.00	0.00	9.00
Food	10.00	25.00	32.00	17.00	990.00	975.00	968.00	983.00
Mining	973.00	978.00	988.00	979.00	27.00	22.00	12.00	21.00
Mining_en	875.00	957.00	950.00	884.00	125.00	43.00	50.00	116.00
Wood_mach	504.00	975.00	909.00	998.00	496.00	25.00	91.00	2.00
Health	970.00	843.00	935.00	967.00	30.00	157.00	65.00	33.00
Constr	0.00	21.00	4.00	0.00	1000.00	979.00	996.00	1000.00
Wholesale	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
TAE	982.00	998.00	968.00	990.00	18.00	2.00	32.00	10.00
Finance_Ins	389.00	729.00	646.00	739.00	611.00	271.00	354.00	261.00

Table 27: Results of Bootstrapped Mann Whitney test - Brazil vs 5 OECD countries - Equity ratio. For each year the table displays how many times on 1000 boots there are SSD

	no diff 1	no diff 2	no diff 3	no diff 4	ss diff 1	ss diff 2	ss diff 3	ss diff 4
Textiles	247.00	337.00	192.00	75.00	753.00	663.00	808.00	925.00
Paper	996.00	999.00	996.00	993.00	4.00	1.00	4.00	7.00
Chemicals	838.00	743.00	423.00	350.00	162.00	257.00	577.00	650.00
Computer	943.00	987.00	911.00	577.00	57.00	13.00	89.00	423.00
Electr	1000.00	998.00	996.00	953.00	0.00	2.00	4.00	47.00
Motor	999.00	996.00	1000.00	999.00	1.00	4.00	0.00	1.00
ElGas	603.00	423.00	480.00	773.00	397.00	577.00	520.00	227.00
LandTransp	986.00	989.00	931.00	964.00	14.00	11.00	69.00	36.00
Warehouse	450.00	352.00	396.00	50.00	550.00	648.00	604.00	950.00
Accomm	0.00	174.00	48.00	309.00	1000.00	826.00	952.00	691.00
RealEstate	1000.00	1000.00	1000.00	1000.00	0.00	0.00	0.00	0.00
Food	0.00	1.00	0.00	0.00	1000.00	999.00	1000.00	1000.00
Mining	963.00	980.00	620.00	734.00	37.00	20.00	380.00	266.00
Mining_en	703.00	336.00	385.00	310.00	297.00	664.00	615.00	690.00
Wood_mach	355.00	469.00	514.00	672.00	645.00	531.00	486.00	328.00
Health	994.00	984.00	949.00	907.00	6.00	16.00	51.00	93.00
Constr	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
Wholesale	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
TAE	827.00	916.00	804.00	725.00	173.00	84.00	196.00	275.00
Finance_Ins	1.00	1.00	1.00	3.00	999.00	999.00	999.00	997.00

Table 28: Results of Bootstrapped Mann Whitney test - Brazil vs 5 OECD countries - Liquidity ratio. For each year the table displays how many times on 1000 boots there are SSD

	no diff 1	no diff 2	no diff 3	no diff 4	ss diff 1	ss diff 2	ss diff 3	ss diff 4
Textiles	513.00	427.00	558.00	109.00	487.00	573.00	442.00	891.00
Paper	992.00	937.00	977.00	967.00	8.00	63.00	23.00	33.00
Chemicals	994.00	998.00	999.00	999.00	6.00	2.00	1.00	1.00
Computer	998.00	999.00	924.00	886.00	2.00	1.00	76.00	114.00
Electr	971.00	984.00	989.00	1000.00	29.00	16.00	11.00	0.00
Motor	993.00	994.00	1000.00	1000.00	7.00	6.00	0.00	0.00
ElGas	982.00	973.00	954.00	946.00	18.00	27.00	46.00	54.00
LandTransp	928.00	927.00	998.00	946.00	72.00	73.00	2.00	54.00
Warehouse	885.00	750.00	967.00	601.00	115.00	250.00	33.00	399.00
Accomm	434.00	994.00	984.00	999.00	566.00	6.00	16.00	1.00
RealEstate	1000.00	994.00	1000.00	999.00	0.00	6.00	0.00	1.00
Food	254.00	462.00	192.00	251.00	746.00	538.00	808.00	749.00
Mining	998.00	989.00	958.00	996.00	2.00	11.00	42.00	4.00
Mining_en	908.00	833.00	724.00	847.00	92.00	167.00	276.00	153.00
Wood_mach	956.00	665.00	394.00	493.00	44.00	335.00	606.00	507.00
Health	992.00	973.00	986.00	998.00	8.00	27.00	14.00	2.00
Constr	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
Wholesale	0.00	0.00	0.00	0.00	1000.00	1000.00	1000.00	1000.00
TAE	952.00	972.00	926.00	858.00	48.00	28.00	74.00	142.00
Finance_Ins	920.00	992.00	750.00	650.00	80.00	8.00	250.00	350.00

Table 29: Results of Bootstrapped Mann Whitney test - Brazil vs 5 OECD countries - ROE.
For each year the table displays how many times on 1000 boots there are SSD

	no diff 1	no diff 2	no diff 3	no diff 4	ss diff 1	ss diff 2	ss diff 3	ss diff 4
Textiles	984.00	992.00	939.00	1000.00	16.00	8.00	61.00	0.00
Paper	1000.00	999.00	921.00	919.00	0.00	1.00	79.00	81.00
Chemicals	989.00	1000.00	1000.00	1000.00	11.00	0.00	0.00	0.00
Computer	747.00	735.00	974.00	987.00	253.00	265.00	26.00	13.00
Electr	1000.00	999.00	1000.00	946.00	0.00	1.00	0.00	54.00
Motor	784.00	750.00	1000.00	210.00	216.00	250.00	0.00	790.00
ElGas	990.00	909.00	950.00	971.00	10.00	91.00	50.00	29.00
LandTransp	940.00	949.00	963.00	804.00	60.00	51.00	37.00	196.00
Warehouse	967.00	970.00	995.00	864.00	33.00	30.00	5.00	136.00
Accomm	1000.00	595.00	901.00	999.00	0.00	405.00	99.00	1.00
RealEstate	1000.00	1000.00	1000.00	1000.00	0.00	0.00	0.00	0.00
Food	775.00	404.00	892.00	574.00	225.00	596.00	108.00	426.00
Mining	992.00	938.00	941.00	224.00	8.00	62.00	59.00	776.00
Mining_en	943.00	944.00	983.00	812.00	57.00	56.00	17.00	188.00
Wood_mach	997.00	995.00	992.00	514.00	3.00	5.00	8.00	486.00
Health	891.00	991.00	595.00	962.00	109.00	9.00	405.00	38.00
Constr	364.00	7.00	0.00	0.00	636.00	993.00	1000.00	1000.00
Wholesale	56.00	516.00	0.00	995.00	944.00	484.00	1000.00	5.00
TAE	916.00	932.00	915.00	745.00	84.00	68.00	85.00	255.00
Finance_Ins	991.00	987.00	982.00	889.00	9.00	13.00	18.00	111.00

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