Assessing the First Shocks of Covid-19 Pandemic on the Idiosyncratic Risk in the Brazilian and the Emerging Markets

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Abstract

The Covid-19 Pandemic affects social and economic relations in all national economies and the world economy, and their financial markets. Investment and production financing in economies takes place through these markets, in particular in the capital market. The idiosyncratic risk represents the risk associated only with a specific productive project, with an economic sector, or with a specific national economy. This work aims to estimate the idiosyncratic risk of the Brazilian economy, through heteroscedastic conditional models, to verify the initial impact of the Covid-19 Pandemic on the risk associated with productive projects developed in the Brazilian and emerging economies, and to their financing and investments. Daily data in US$, covers the period from June 30, 2017 to July 1, 2020, were used.

Keywords: Covid-19 Pandemic, Idiosyncratic Risk, Brazilian Economy, Emerging Economies.

1. Introduction

The sanitary crisis caused by the Covid-19 Pandemic is compared to the 1918 crisis caused by the H1N1 Influenza Pandemic. The sanitary crisis that triggered the Covid-19 Pandemic began with news of a public health problem that started in Wuhan, capital of Hubei province in China, caused by a virus identified as SARS-CoV-2, a new Coronavirus, which quickly spread over 180 countries causing high mortality. Compared to the 1918 crisis caused by the H1N1 Influenza Pandemic that haunt-ed the humanity in the beginning of the twentieth century, Covid-19 Pandemic has also triggered many studies and research in the most diverse areas of knowledge.

The great crises repercussions which spread throughout the world during the last centuries have been the object of studies and researches over time. Most of these researches were aimed to verify the immediate effects and the influence of these crises on the world population welfare and the economic and social behavior and relations in the world. Among these researches, Mackellar (2007) can be mentioned. In a broad study on the economic impacts of the Influenza Pandemic, Mackellar (2007) highlights that the loss is more human than material. The economic impacts of this Pandemic, according to Mackellar (2007), can be classified as direct and indirect. The study includes hospital costs, lost days of work, medicine costs, the decrease in tax revenue and the increase in health and economic aid expenditures to sectors in difficulty, followed by government fiscal deficits as direct impacts. Among the indirect economic impacts Mackellar (2007) includes the economic multiplier effects of direct costs and the behavior of consumers, affecting consumption relationships.

The crisis caused by the Covid-19 Pandemic had a direct impact on social and economic relations in all regions of the world affecting national economies and the world economy as well as world financial markets. These financial markets signal the expectations of national

economies and the world economy, through money, foreign exchange, credit and capital markets. While in the public health area, efforts are being made to minimize the serious problems in public health systems, economic agents seeks to verify the problems that the Covid-19 Pandemic has caused and should cause in the years to come, with the growing disorder in the costs and the production chains.

The financing and investment of production in economies happen, generally, through the financial market, in particular via the capital market. The productive projects that provide the necessary infrastructure for the development of economies and maintenance of jobs and the income growth have in the capital market the source of resources for investments and financing. In this way, one of the important advanced indicators of the economy is the performance of the capital market, whose first indicator is the stock market profitability index. This index reflects the expectations of economic agents regarding the economy, and allows estimates of the volatility or risk associated with productive projects, sectors of national economies, a national economy and the global economy. The volatility or the total risk has two components, the market risk and the idiosyncratic or unique risk. The market risk refers to the risk of exposure of productive projects, sectors of national economies, and a national economy, to the behavior of the respective market portfolios, respectively, the sector project portfolio associated to the productive project concerned, the portfolio that represents the national economy, and the portfolio that represents everything that is produced in all national economies. The idiosyncratic risk is the unique risk associated only with a specific productive project, or the project portfolio of a sector, or of a sector of a national economy, or of a national economy. Thus, each national economy has as an indicator that represents the portfolio that encompasses most of the productive projects of each of the national economies, that is, the indicator closest to a market portfolio which is the equity market profitability index of each national economy. These economies are part of the world economy, which has a profitability index of the global stock market as a proxy for the market portfolio. Some agencies or market institutions calculate and make available some profitability indexes of the nationals and global stock markets.

Many studies and researches started with the objective of verifying and mitigating the pressing public health and economic problems that present themselves during the Covid-19 Pandemic and the possible problems that will be originated. Among these studies it must be mentioned: Naidenova et al. (2019), which deals with idiosyncratic and systematic shocks caused by pandemics in financial markets; Gaurinchas (2020), who discusses the economic impact of the Covid-19 Pandemic; the study by Şenol and Zeren (2020), which deals with the influence of the Covid-19 Pandemic on the global economy through the capital market using the global market share profitability index to study the long term relationship between the markets of actions and the effects of the Covid-19 Pandemic; the research by Zeren and Hizarci (2020), which deals with the influence of the Covid-19 Pandemic in the capital mar-kets of selected countries; the work by Alam et al. (2020), which presents a study on the effect of the lockdown period on the Indian capital market through a sample of 31 companies listed on the Bombay Stock Exchange; and other researches related to this topic, such as Pata (2020), Khanthavit (2020), Atkeson (2020), Barro et al. (2020), Anderson et al. (2020) and Mckibbin and Roshen (2020).

With regards to the risk, based on the seminal work of Sharpe (1963), many re-searches have been carried out seeking, in an appropriate way, to determine the total risk and its components: systematic risk and idiosyncratic risk. The estimation of the market model, or the Single Index Model, suggested by Sharpe (1963) allows the determination of the main indicator of market risk, the beta coefficient, and the idiosyncratic risk, also called specific risk or unique risk. In a pioneering work Rosen-berg and McKibben (1973) seek to forecast the systematic risk and the specific risk of stocks and propose stochastic models for deter-mining the beta coefficient and the idiosyncratic risk using the Single Index Model. From this work, many researches were developed. Fu (2008) estimated the idiosyncratic risk and its relationship with the monthly stock returns using the three-factor model, suggested by Fama and French (1993).

Besides that Fu (2008) employed some of the ARCH family for volatility models derived from the Autoregressive Conditional Heteroscedasticity Models available in the finance literature developed from the seminal work of Engle (1982) and the work of Bollerslev (1986). In another relevant work Angelidis and Tessaromatis (2008) note that the idiosyncratic risk has been neglected to the detriment of a greater emphasis given to the systematic or market risk in determining the risk premium. In turn, Campbell et al. (2008) emphasized the importance of assessing specific or idiosyncratic risk. In general, market volatility increases in the periods leading up to these crises and during crises periods, as observed by Kalva (2008) in the recent period of the world economy with the subprime crisis. Among the most recent studies that attempt to estimate idiosyncratic risk, we can mention Blitz et al. (2018), which deals with this risk as an anomaly, Chang et al. (2018), with data from the Japanese economy, and Zhou and Shi (2019), that verify the idiosyncratic risk of the Chinese stock market.

This work aims to estimate the idiosyncratic risk or unique risk of the Brazilian economy and the emerging economies, using heteroscedastic conditional models of the ARCH family models in order to verify the impact of the Covid-19 Pandemic on the risk associated with productive projects developed in the Brazilian economy and the other emerging countries as well as on the risk associated with investments and financing.

Besides this introduction in Section 2 the methodological approach implemented in the research is presented. Section 3 presents the data or the sample used. The analysis of the results obtained in this research are reported in Section 4. Finally, Section 5 presents the conclusions and final comments of this work followed by the bibliographic references used.

2. Methodology

The concept and the determination of the total risk and its portions, systematic risk and idiosyncratic risk, were established from the Single Index Model, or the market model proposed by Sharpe (1963), which explain the risk asset portfolio returns through the returns of market portfolio. In the scope of this work, the risk asset portfolio is characterized by the Brazilian stock market profitability index represented by the MSCI Brazil index while the emerging stock market profitability index was represented by the MSCI Emerging index and the world stock market portfolio is characterized by the global equity market profitability index, represented by the MSCI ACWorld index. These indices are calculated by Morgan Stanley Financial Services (MSCI) and will be described in this work in the section dealing with the data used. The market model can be described as follows:

$$R_t = \alpha + \beta R_{Mt} + e_t \tag{1}$$

Where: R_t = the return of MSCI-Brazil index or MSCI-Emerging index in period t; R_{Mt} = the return of ACWorld index in period t. Thus, the conditional average and conditional variance of the financial asset returns can be determined as follows:

$$\textit{Mean}: \qquad E(R_t|R_{Mt}) = \alpha + \beta R_{Mt} \tag{2}$$

$$\textit{Variance}: \qquad V(R_t|R_{Mt}) = \beta^2 V(R_{Mt}) + V(e_t) \tag{3}$$

The estimation of the beta coefficient, the main indicator of market risk, takes place through linear regression models, as for example in the works elaborated by Scholes and Williams (1993), using corrections from a classic univariate model, and by Salles (2006), using a multivariate Bayesian model. The estimation of the idiosyncratic risk time series can be done through volatility models such as the ARCH family models, in particular, the GARCH model proposed by Bollerslev (1986). The GARCH model seeks to capture a common behavior in financial asset return time series, in which high values are also followed by high values in the following periods, not necessarily in the same direction, following a predictable process.

Therefore, a market model that allows obtaining estimates of the two components of the total risk can be built. Additionally to the GARCH model, some of the main models of the ARCH family were tested, such as ARCH, IGARCH, EGARCH and TGARCH, as described in Enders (2010). Using the model selection criterion suggested by Akaike, the AIC, which can be seen in detail in Gujarati and Porter (2011) or Wooldridge (2014), the market model to estimate the idiosyncratic risk was selected. With the alpha and betas parameters greater than zero, the volatility models estimated in this work have their general form given by the expressions shown below: the ARCH (q) model represented by the expression (4); the GARCH (p, q) model represented by expression (5); the IGARCH (p, q) model represented by expression (6); the EGARCH (p, q, r) model represented by the expression (7); and TGARCH (p, q, r) model represented by the expression (8).

$$\sigma_t^2 = \alpha_0 + \sum_{j=1}^{q} \alpha_j e_{t-j}^2 \tag{4}$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i e_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \tag{5}$$

$$\sigma_t^2 = \sum_{i=1}^{q} \alpha_i e_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 \tag{6}$$

$$ln\sigma_t^2 = \alpha_0 + \sum_{j=1}^{p} \beta_j \, ln\sigma_{t-j}^2 + \sum_{i=1}^{q} \alpha_i \left| \frac{e_{t-i}}{\sigma_{t-i}} - E\left(\frac{e_{t-i}}{\sigma_{t-i}}\right) \right| + \sum_{k=1}^{r} \gamma_k \frac{e_{t-i}}{\sigma_{t-i}} \tag{7}$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i e_{t-i}^2 + \sum_{j=1}^{p} \beta_j \sigma_{t-j}^2 + \sum_{k=1}^{r} \gamma_k \, d_{(e_{t-k} \leq 0)} |e_{t-k}|^2 \tag{8}$$

Thus, the model used in this work to estimate idiosyncratic risk was a heteroscedastic linear regression model, where the stochastic terms are distributed according to a Student's t distribution and the variance given by a GARCH (1, 1) model which can be described as follows:

$$R_t = \alpha + \beta \, R_{Mt} + e_t \;,\; e_t \sim Student\,(0; \sigma_t^2; \nu) \tag{9}$$

$$\sigma_t^2 = \alpha_0 + \alpha e_{t-1}^2 + \beta \sigma_{t-1}^2 \tag{10}$$

3. The Sample – Data Used

The primary data referring to the stock market indices that form the sample used in this work were collected on the Investing.com website. These indices are calculated and released by the financial services company Morgan Stanley Capital International (MSCI). These indicators were: the profitability index of the Brazilian stock market - MSCI Brazil; the profitability index of the stock market of emerging countries - MSCI Emerging Markets; and the worldwide stock market profitability index -- MSCI All-Country World Equity -- or simply the MSCI ACWI Index. The Brazilian stock market index is made up of 56 shares and represents 85% of the equities traded in the country and includes the main sectors of the Brazilian economy. The emerging markets index is composed of equities traded in China (33.00%), South Korea (13.02%), Taiwan (11.35%), India (9.16%), Brazil (7, 73%), South Africa (5.89%), Russia (3.77%), Mexico (2.55%), Thailand (2.34%) and others (11.59%). The global stock market index used is composed of equities from 11 sectors of the economy traded on the markets: from developed countries in the Americas, 2 countries, from Europe and the Middle East, 16 countries, and from the Pacific, 5 countries; and from emerging countries in the Americas, 6 countries, Africa, Europe and the Middle East, 11 countries, and Asia, 9 countries. Further details about the description of these index can be seen

https://www.msci.com. All information collected was daily data in US$, covering the period from June 30, 2017 to July 1, 2020.

Table 1 presents the time series statistical summary of interest to obtain this research results, that is, an estimate of the idiosyncratic risk time series using the market model. It can be seen that the time series location measures are disparate and do not have a symmetry. With regard to the volatility of the return time series it is high, as expected from market price returns or variations. As for the asymmetry and kurtosis coefficients: it can be seen that all the asymmetry coefficients shown in Table 1 differ from the asymmetry coefficient of a normal probability distribution, the same happens with regard to the kurtosis coefficients calculated for all series used. The Jarque-Bera test confirms the inferences made from observing the coefficients of asymmetry and kurtosis, that is, for every of the time series used, the normality hypothesis cannot be accepted. With regard to the stationarity hypothesis of the time series summarized in Table 1, the stationarity possibility of the time series of the quotes of the MSCI-ACWorld index according to the results of the ADF test cannot be rejected. However it should be noted that the extensions to the ADF test do not allow acceptance of the stationary hypothesis of the quotes of the global stock index MSCI-ACWorld.

Regarding the time series of the quotes of the MSCI-Brazil index, the hypothesis of stationarity for the ADF test and its variations cannot be accepted. Regards the MSCI-Emerging markets index, although stationarity is not rejected at the level of significance of 8%, for the ADF test the alternatives of the ADF test, without the constant or the trend component of the series, point to a contrary decision , that is, the stationarity hypothesis of the index corresponding to the portfolio of equities traded in emerging countries is not accepted.

Table 1- Statistical Summary of Time Series

Statistics	Quotes MSCI ACWorld	Quotes MSCI Brazil	Quotes MSCI Emerging	Return MSCI ACWorld	Return MSCI Brazil	Return MSCI Emerging
Mean	508.4525	1974.8900	1055.6170	0.0002	-0.0002	-0.0001
Median	510.7950	2051.7250	1054.8600	0.0007	0.0006	0.0006
Maximum	581.0200	2428.7100	1273.0700	0.0806	0.1516	0.0557
Minimum	384.0400	1036.3000	758.2000	-0.1000	-0.1943	-0.0694
Std Deviation	29.0043	299.2842	83.3356	0.0111	0.0238	0.0107
Skewness	-0.2542	-1.2263	-0.2568	-1.7250	-1.4790	-1.0731
Kurtosis	4.3565	3.9992	3.4671	26.5880	19.2500	11.5687
Jarque-Bera	68.5466	229.0998	15.7404	18564.320	8911.8340	2548.9370
(p value)	0.0000	0.0000	0.0004	0.0000	0.0000	0.0000
ADF test	-3.4276	-2.5858	-3.2140	-6.7032	-6.2662	-9.5897
(p value)	(0.0485)	(0.2870)	(0.0824)	(0.0000)	(0.0000)	(0.0000)

4. Results Obtained and Discussion

With regards the idiosyncratic risk of the Brazilian market, the time series was estimated using the market model for mean and an EGARCH model (p, q, r) for variance. In this market model, according to the descriptions in Section 3, the re-turns of the profitability index of the Brazilian stock markets, given by the stock profitability index MSCI-Brazil (MSCI-Br) as a response variable and the market portfolio given by the MSCI-ACWorld (ACW) index as a regressor. The market model selected was the model without intercept. Thus, the selected model was similar to that described by the expressions in (9), without the α parameter, with the EGARCH model (1,1,1) replacing the expression (10), since this model was selected using the criterion AIC. This model was selected among the 18 models with all the significant parameters among the 175 models estimated with different combinations, that is, varying: the estimation of the constant parameter in the average model; the probability distribution of stochastic terms, normal or Student's t; inclusion of dummy variables, in the average and or variance; and the volatility model. Additionally, as observed from the Pan American Health Organization (PAHO) information at https://www.paho.org/bra, these variable dummies considers the follow dates: January 23, the day of the first lockdown in Wuhan in China; January 30, the day of

outbreak declaration from the World Health Organization - WHO, that declares that the outbreak of the new corona-virus is a Public Health Emergency of International Importance (ESPII) and it is spreads for 19 countries; February 26, the day of the first case of Covid-19 in the São Paulo city -- Brazil, a patient coming from Italy; and March 11, the day of the characterization of the Covid-19 Pandemic by the World Health Organization - WHO. The variable dummies were added to the market model in the mean and / or variance, however none of these models were selected to estimate the idiosyncratic risk of the Brazilian economic activity.

Therefore the idiosyncratic risk used, hereafter IDR, was obtained for Brazil by estimating the market model without intercept term in the average, where the stochastic terms adjusted to a Student's t distribution with approximately 6 degrees of freedom and an EGARCH (1,1,1) model for the variance. The selected model is described in expressions (11) and (12), ahead, with the estimates and the necessary metrics to observe the performance of the estimates obtained listed in (13).

$$MSCI\text{-}Br_t = 1.2433\ ACW_t \tag{11}$$

se	(0.0592)
t	(20.9870)
p-value	(0.0000)

$$ln\sigma_t^2 = -0.2504 + 0.1294\ ln\sigma_{t-1}^2 - 0.0553\left|\frac{e_{t-1}}{\sigma_{t-1}}\right| + 0.9814\frac{e_{t-i}}{\sigma_{t-i}} \tag{12}$$

se	(0.0713)	(0.0327)	(0.0201)	(0.0072)
t	(-3.5121)	(3.9625)	(-2.7541)	(138.2680)
p-value	(0.0004)	(0.0001)	(0.0059)	(0.0000)

t Student distribution -- 6.48 *degree of freedom*			(13)
R^2 = 0.4636	----------	*Durbin-Watson* = 2.1010	
SE Regression = 0.0174	----------	*Sum Squared Resid* = 0.2379	
Akaike Criterion (AIC) = -5.5364			

The market model for emerging countries was estimated, to compare with the results obtained for the IDR Brazil time series. Thus, the same methodology was used to obtain the IDR Brazil using the MSCI-Emerging index (MSCI-Em), in that way obtain estimates for IDR-Emerging. From 18 estimated models, the results pointed to the selection of the market model whose results are shown forward. The model selected, using the AIC criterion, it is described in expressions (14) and (15), respectively, for the mean and for the variance, given by a GARCH model, and the performance metrics listed in (16) in the follow.

$$MSCI\text{-}Em_t = 0.8142\ ACW_t \tag{14}$$

se	(0.0232)
t	(35.1654)
p-value	(0.0000)

$$\sigma_t^2 = 1.84 \times 10^{-6} + 0.0864\ e_{t-1}^2 + 0.8764\ \sigma_{t-1}^2 \tag{15}$$

se	(7.45×10^{-7})	(0.0232)	(0.0305)
Stat t	(2.4652)	(3.7285)	(28.7151)
p-value	(0.0137)	(0.0002)	(0.0000)

t Student distribution -- 7.49 *degree of freedom*			(16)
R^2 = 0.5177	----------	*Durbin-Watson* = 2.4399	
SE Regression = 0.0074	----------	*Sum Squared Resid* = 0.0428	
Akaike Criterion (AIC) = -7.2559			

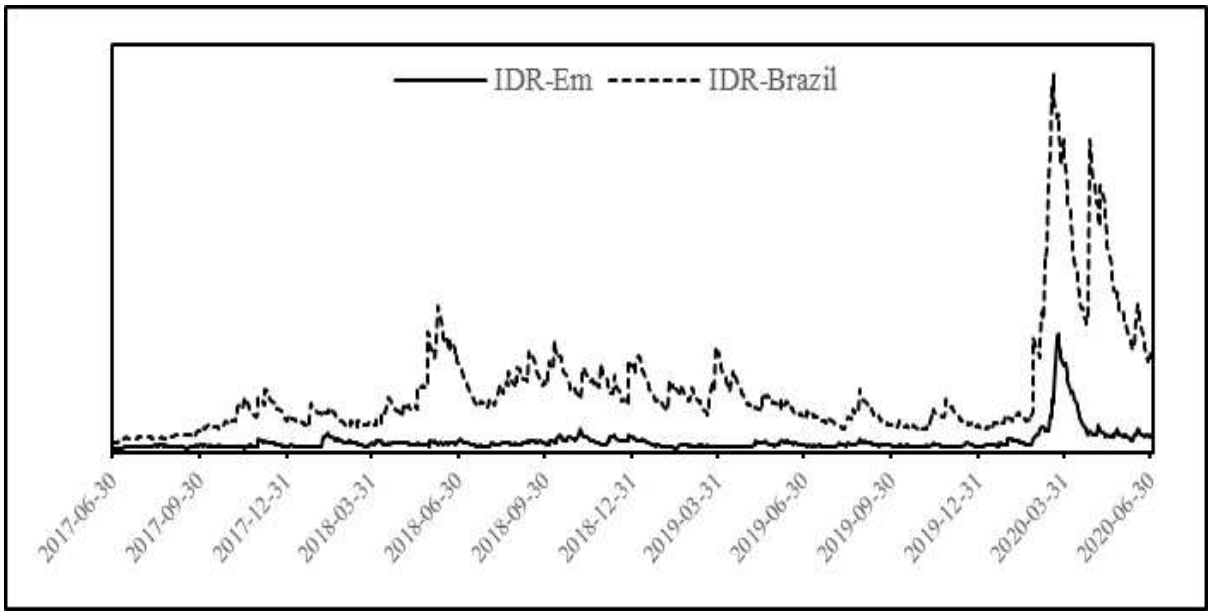

Figure 1 - The Idiosyncratic Risk of the Brazilian Market and the Emerging Markets (June 2017 / July 2020)

Thus, the IDR-Brazil and the IDR-Emerging were obtained from the market model, respectively, for the Brazil and for the emerging countries. The two plots in the Figure 1 illustrates the IDR-Brazil and the IDR-Emerging time series behavior. Regard to IDR-Brazil, it is can be to observe the risk associated with in-vestments and financing of economic activities in Brazil. In the period near the end of the first half of 2018 can be observes an increase with variations until the same period in 2019, maintaining a lower level with peaks close to the beginning of September and December 2019. At the end of February 2020, the IDR-Brazil plot shows an atypical behavior reaching a peak, the highest level in the period studied, on March 17, 2020 after March 11, when the Covid-19 epidemic was characterized as a Pandemic by WHO. At the end of April 2020, the IDR-Brazil decreased and then growing until the end of this month. From Figure 1, it can be inferred that the IDR-Brazil is always above the idiosyncratic risk of the group or the portfolio of emerging countries. Another relevant inference from the observation of IDR-Brazil behavior can be done at the end of the period studied, that is, on June 30, 2020 when the lowest level of risk in the period after the decree of the Covid-19 Pandemic by WHO was reached, which corresponds to the highest level the idiosyncratic risk of emerging countries that happened on March 23, 2020.

5. Conclusions and Final Remarks

This work aimed to carry out initial studies of the impacts of the Covid-19 Pandemic on national economies through idiosyncratic risk, associated with economic activity in Brazil and in emerging economies. The primary objective of this paper was to verify this impact on Brazilian economic activity. This work used a methodological approach based on the portfolio theory, a fundamental milestone of the finance theory, to obtain estimates of the idiosyncratic risk associated with the financing and investment of economic activity in Brazil, or the productive projects implemented in the Brazilian economy.

One of the two installments of the total risk of an asset portfolio, or of an economy, is the idiosyncratic risk, allowing to observe the part of the total risk that refers only to the asset portfolio or to a particular national economy. Thus, once the idiosyncratic risk can be estimated thought the market model, heteroscedastic market models were estimated for a portfolio of assets in the Brazilian economy and for a portfolio of assets traded in emerging countries. In

addition to heteroscedastic conditional models, Student's t distribution was used in these models as an alternative to the normal distribution for the stochastic terms.

The idiosyncratic risk time series estimated allowed to observe the impact or influence of the Covid-19 Pandemic on the risk of the Brazilian economic activities and the emerging economies over the studied period.

It should be emphasized that the allocation of resources in productive projects, or in national economies, occurs by observing the trade-off risk and return. This way, resource managers available for applications in the international market seek to invest in projects and in national economies that can offer returns compatible with the level of risk that is externalized in the international market. The level of specific or idiosyncratic risk associated with economic activity in Brazil demonstrated itself well above the risk of other emerging countries, in the entire period of the sample studied, which was accentuated by the Covid-19 Pandemic.

Future works can be done with other samples and methodologies that will provide more accurate results to allow for further subsidies that will contribute to minimize the Covid-19 Pandemic effects in the economic activities, particularly the financing and investment of production.

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