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# The Propagation Impulse-Response Effect of Macroeconomics Variables and your Impacts in the Accounting Information

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## Abstract

Objective: To analyze how the impulse-response effect of macroeconomic variables impacts on solvency indicators of regulated and unregulated publicly traded companies listed on Brazil, Stock Exchange, Over the Counter (B3).
Method: The Autoregressive Vectors with Error Correction (VEC) model was adopted for four lags, using the Cholesky ordering. The analysis period corresponded between the first quarter of 2005 and the third quarter of 2020. The sample data of 137 institutions were treated by 5% winsorization, aggregated based on the weighted average of the sectors.
Discussion: The regulated and unregulated segments presented different behavior, being unregulated institutions more impacted by the impulse-response effect compared to the regulated ones, with a tendency of the long-term economic effect in both segments. The model showed that macroeconomic variables have impacted since the first quarter after the observance of the shock, and the effect of the variable itself on the analyzed system does not always respond significantly to explain the long-term effect observed on solvency indicators, and the exchange rate (dollar) is more economically significant for the behavior of indebtedness.
Contributions: The research contributes to the definition of a model for the investigation of economic cycles at the institutional level and corroborates with the academy for understanding the macroeconomic effect on accounting information.

Keywords: Impulse-Response Function; Indebtedness; Business Cycle Theory; Autoregressive Vector. Accounting Information.

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# Introduction

The Economic Cycle Theory understands the economic process as a changing environment that can cause turbulence for its agents, especially for profit-oriented institutions (Pandini et al., 2018). Strictly speaking, an economic cycle is composed of a series of unique events, resulting from equally unique and preceding events (Mitchell, 1927). As individuals, companies are expected to react in different ways to economic phenomena, and promptly or not to circumstantial changes in the macro environment (Ross, 2016; Saltzman, 1967). Considering groups of individuals who share global characteristics inherent to their environmental qualities, such as regulated and unregulated companies, studying the sectoral set or segment allows for understanding the impact of macroeconomic phenomena at the level of accounting information (Burns & Mitchell, 1946; Mitchell, 1927; Pandini et al., 2018).

This theory does not only consider changes stemming from a single macroeconomic factor, as explained by Lima (2005) and Pandini et al. (2018). Macroeconomic variables tend to impact each other, causing systematic shocks to individuals, which in more severe cases can affect the structure of companies to the point of causing bankruptcies. Lima (2005) also emphasizes that, for economic cycle theorists, more important than understanding the initial shock (impulse) is to assess its propagation (response), its persistence, and the accumulation of this over time.

From a macroeconomic viewpoint, the impulse-response effect cannot be analyzed from a purely unidirectional perspective, as proposed by Sekunda et al. (2020), where the environment responds to the designs of individuals. This is because in the occurrence of imbalance conditions, there is no return to an initial level of individual economic conditions, but rather a search for a new equilibrium condition that is completely disparate from the original and adapted to the new reality (Burns & Mitchell, 1946).

Studies corroborate that the Macro structure has a greater impact on Micro conditions, to the point where the interference of an economic shock does not dissipate, instead creating an entirely new condition of existence, stemming from the propagation effect (Lima, 2005; Mitchell, 1927; Pandini et al., 2018; Schumpeter, 1939). Thus, the question arises: How does the impulse-response effect of macroeconomic variables impact the solvency indicators of regulated and unregulated companies in the Brazilian market? In this context, the objective is to analyze the impulse-response effect of macroeconomic variables and their impact on the solvency indicators of regulated and unregulated publicly traded companies listed on Brasil, Bolsa, Balcão (B3).

The analysis of economic and financial indicators allows for the investigation of the patrimonial, financial, and economic conditions of different institutions under various economic conditions (Brito & Assaf Neto, 2008). This study does not aim to analyze the decision-making process, but rather to understand the impact of economic conditions on key indicators for the state of solvency in the short and long term, since events of "default" do not occur suddenly (Brito & Assaf Neto, 2008; Stüpp, 2015). These are gradual circumstances arising from the accumulation of economic impacts that, consequently, degrade credit conditions.

# 2 Theoretical Reference

Economic cycles are regular macroeconomic structures stemming from market conditions that represent movements of expansion and contraction in aggregate production (Long & Plosser, 1983). These are observed by two distinct groups of studies: i) a process derived from exogenous circumstances and without a defined periodicity, or at least one that does not depend on oscillatory market movements; ii) an essentially oscillatory process where the general interpretation would be a life and death process of an economic state (Lima, 2005; Long & Plosser, 1983).

A third approach aims to interpret economic processes from a purely empirical perspective, adopting control indicators of market conditions through the Leading Indicator System (LIS) (Burns & Mitchell, 1946; Lima, 2005). Burns and Mitchell (1946) consider that economic indicators associated with aggregate production change with real economic conditions, serving as a thermometer of the phase of the economic cycle, divided into expansion, recession, contraction, and recovery (Schumpeter, 1939).

Classical economic theory did not take into account the occurrences of depressions and their effects, as the Economy adapts to favorable circumstances, such as low unemployment rates, where price fluctuations do not interfere with demand (Lima, 2005). On the other hand, Mitchell (1927) emphasizes that each economic cycle is independent of its predecessors and successors. Therefore, every cycle is a unique set of events with a unique cause.

This research follows this approach. Known as the propagation model, this line of thought identifies each cycle as resulting from an economic shock derived from exogenous causes, where the absorption of the shock is essential to explain the new trend. Carvalho (1988) points out that the regularity of economic cycles can be explained by this type of approach, however, the periodicity is not linked to this propagation process. Thus, both Carvalho (1988) and Lima (2005) agree that the propagation model requires an additional condition to explain the origin of the shock, as economically adverse scenarios are derived from both endogenous and exogenous events.

In conjunction with the theory of economic cycles, to

justify the adoption of aggregated accounting variables by market regulation, the disclosure theory was adopted, which designates two types of information: voluntary and non-voluntary, both being descriptive for institutions with particularities in the disclosure of their information. Regulated institutions are required to disclose critical information related to their business due to regulatory measures, while unregulated ones have less obligation for such disclosure (Bertomeu & Magee, 2015; Cianciaruso & Sridhar, 2018; Diamond & Verrecchia, 1991; Dontoh, 1989).

Medeiros et al. (2011) investigated the impact of macroeconomic variables on the main balance sheet and income statement accounts of Petrobras S.A. between 1990 and 2006. The authors adopted the Special System for Settlement and Custody (Selic) Interest Rate, Country Risk, Exchange Rate (US Dollar), Gross Domestic Product (GDP), and International Oil Price as exogenous variables to the system, in addition to the United States Producer Price Index (PPI) and Brazil's Wholesale Price Index - Domestic Availability (IPA-DI) as control variables. The research identified the need to use Vector Error Correction Models (VEC) due to the exposure of variables, both at the level and in first difference, when testing their cointegrations.

Konchitchki and Patatoukas (2014) investigated the correlation between corporate accounting earnings and the macro-scale economy. The authors found that an increase in aggregated accounting profits anticipates the economic situation in the USA, especially for forecasts one quarter ahead. Additionally, analysts do not fully absorb the information from accounting earnings when forecasting GDP growth, resulting in incorrect projections. This emphasizes the underestimated significance of accounting earnings in macroeconomic forecasting. The study adopted a cross-sectional weighted average of the quarters investigated (similar to the current research).

Pandini et al. (2018) investigated the impact of macroeconomic variables on 103 companies (64 cyclic consumption and 39 non-cyclic) listed on the BM&FBovespa (now B3) between 2008 and 2015. The premise was that the cyclic consumption sector is more affected by economically adverse scenarios, although both sectors are subject to the environmental conditions of the Brazilian economy.

Sekunda et al. (2020) investigated the impact of aggregated financial indicators on aggregated macroeconomic variables to identify whether financial performance indicators provide users with anticipations of economic events. For this purpose, the researchers adopted an impulse-response model, based on the Vector Autoregressive (VAR) methodology - at level and first difference - to simulate exogenous shocks. They used aggregated accounting variables such as operating cash flow, net profit, Earnings Before Interest and Taxes (EBIT), and equity, and macroeconomic variables such as GDP, interest rate (Selic), and unemployment. The data were obtained from Sidra-IBGE (unemployment) and Ipea-Data. The methodology adopted for the composition of the aggregated variables considered the average per variable of all companies listed on B3. The authors identified statistically insignificant effects, according to the unidirectional Granger-Cause composition adopted. The impact of variance decomposition was also insignificant, and no variable stood out in the adopted Impulse-Response model.

Abdalla and Carabias (2022) proposed a model for projecting GDP expectations based on what they called "Special Items" – extraordinary revenues and expenses. The authors compared the results of their model with those obtained by market professionals when projecting future GDP based on net income. The model used was the Vector Autoregression (VAR) with (q+1) and (q+2) lags, applied at the level. They found that professionals responsible for projecting future GDP, using models with net income as an independent vector, are accurate. However, models that consider "special items" after the reported profits demonstrated a better alignment with the actual behavior of the GDP.

Nasab et al. (2022) proposed a theoretical model for aggregating accounting information at the macroeconomic level to explore how the net income dispersed throughout the fiscal competence of Iranian companies impacts economic performance (GDP and job growth) between 2008 and 2018 through a univariate VAR model. Unlike the current research, which adopted a multivariate model, Nasab et al. (2022) projected the effect of accounting variables on the macroeconomic process, an approach similar to that of Sekunda et al. (2020). The authors identified that the model is more significant with the use of profits when the projection is made on Real GDP, although the Nominal GDP also showed good results. The projection is more significant the closer it is to the event of Real and Nominal GDP disclosure.

# 3 Methodological Procedure

When using mathematical modeling techniques to investigate the phenomenon, the research is quantitative in relation to the problem (Gil, 2019). By investigating an unexplored relationship between financial and macroeconomic variables concurrently with theoretical predictions, especially at the national level, it is exploratory in terms of objectives (Gil, 2019; Raupp & Beuren, 2006). As for the technical procedure, it is documentary (Gil, 2019), using public information derived from financial statements.

The population consists of 343 publicly traded companies listed on B3 (413 excluding 70 financial institutions as of August 2020). In this study, the sample was selected based on the following criteria: i) include companies listed between the first quarter of 2005 and the third quarter of 2020; ii) exclude companies that entered

and/or exited trading during this period, in order to maintain a homogeneous data scope, as we are not analyzing from the perspective of success or failure (Logit model), given that it is not within the scope to evaluate the cause of companies entering and exiting stock market trading (whether due to bankruptcy or a change in business strategy). After validations, 137 regulated and unregulated institutions were selected (Table 1). The period analyzed was limited to the third quarter of 2020 due to the consistency of the data being interfered with by the impact of the Covid-19 pandemic, which does not align with the objectives of the study.

Table 1: Total list of companies by sector and segment

| Segment/Sector | Total Companies | % |
|---|---|---|
| Unregulated | 237 | 69.10% |
| Industrial Goods | 73 | 21.28% |
| Cyclical Consumption | 78 | 22.74% |
| Non-Cyclical Consumption | 27 | 7.87% |
| Basic Materials | 32 | 9.33% |
| Others | 18 | 5.25% |
| Information Technology | 9 | 2.62% |
| Regulated | 106 | 30.90% |
| Communications | 7 | 2.04% |
| Oil, Gas, and Biofuels | 11 | 3.21% |
| Health | 20 | 5.83% |
| Public Utility | 68 | 19.83% |
| Total | 343 | 100% |

Source: Data from B3 as of August 2020.

The study data consists of: i) 3 (three) accounting variables related to the main solvency financial indicators (Table 2), collected for the analysis period from the Economática® database; and ii) 4 (four) macroeconomic variables (Table 3) obtained from the Ipeadata portal for the analysis period. This study sought in the literature the most recurrent financial indicators suitable for solvency analysis, allowing for the largest sample composition with the least loss of companies, by period, as shown in Table 2, used in this study for accounting vectors.

Table 2: Solvency financial variables

| Variable | Allocation | Authors |
|---|---|---|
| Total Debt | $Debt_{Tt}$ = (Current Liabilities + Non Current Liabilities /Total Assets) | Brito and Assaf Neto (2008), Sekunda et al., 2020), Stüpp (2015), and Stüpp, Flach and Mattos (2018). |
| Interest Coverage | Int Cov = (EBITDA / Finance Expenses) | |
| Operating Cash Flow | $Log_{OCF}$ = Logarithm of Operation Cash Flow | |

The choice of variables (Table 2) for accounting vectors is justified because, as highlighted by Brito and Assaf Neto (2008) and Stüpp (2015), there is no theory that allows for the exclusive listing of variables for solvency problem studies, as in other fields of economic study. For the purpose of this study, the main variables adopted for solvency analysis represent the Total Debt Capacity (DebTt) and Interest Coverage (Int Cov) capacity, which are determinants but not exclusive to solvency capacity (Brito & Assaf Neto, 2008). In addition to this, the research also adopts the Operating Cash Flow (OCF) because it represents the conditions of self-financing, which is important for economic performance in adverse scenarios (Sekunda et al., 2020). Unlike previous studies that investigated the topic by adopting more variables (Altman, 1968; Beaver, 1968; Brito & Assaf Neto, 2008; Medeiros et al., 2011; Stupp et al., 2018), this research contributes to the literature by verifying the need to maintain a small number of variables for a vector autoregressive model with error correction, as also adopted by Enders (1995) and Lima (2005), ensuring that the economic characteristics investigated in the variables are indeed related. The macroeconomic variables are presented in Table 3.

Table 3: Macroeconomic variables

| Variable | Allocation | Authors |
|---|---|---|
| Gross Domestic Product (GDP) | GDP | Lima (2005), Medeiros et al. (2011), Pandini et al. (2018), Sekunda et al. (2020) and Stüpp et al. (2018). |
| Interest Rate (Selic) | Selic | |
| Inflation Rate (IPCA) | IPCA | |
| Exchange Rate (U.S. Dollar) | ER | |

Note: GDP = Gross Domestic Product; IPCA_93 = Broad Consumer Price Index (Series started in 1993); ER_N = Nominal Exchange Rate; Selic = Special System for Settlement and Custody.

Burns and Mitchell (1946), Lima (2005), and Mitchell (1927) emphasize the importance of a system of aggregated macroeconomic variables for the study of economic cycles. The indicators (Table 3) allow for the analysis of economic scenarios, representing - among the literature - the main points of economic effect on Brazilian companies. These indicators are used in this study for macroeconomic vectors. GDP is recognized as the main indicator of economic activity. The Selic interest rate directly impacts receivables, accounts payable, loans, and financing of institutions. The IPCA inflation rate reflects the loss of economic capacity due to the devaluation of the purchasing power of the currency, and the ER exchange rate determines the devaluation of the local currency against other international currencies, directly impacting the capacity for import and export while affecting current assets and liabilities in foreign currencies. In this research, the exchange rate in relation to the US dollar was adopted.

The first data preprocessing step involved the exclusion of missing data, which reduced the observation period of the sample to the first quarter of 2005 through the

third quarter of 2020. The second step consisted of checking for outliers, or discrepant data (Sekunda et al., 2020). In this step, the winsorization method at 5% - of the natural logarithm of the vectors - was adopted, which allows for minimizing the impact of extreme values by bringing them within the defined confidence interval. The third step involved the creation of aggregated data divided into economic segments - regulated and unregulated. During this step, the data was consolidated through the value-weighted cross-sectional averages of each accounting variable vector per quarter, considering the sectoral proportions indicated in Table 1 (Konchitchki & Patatoukas, 2014; Sekunda et al., 2020).

### 3.1 Autoregressive Vector Model with Error Correction

The autoregressive model was developed based on the literature of economic cycles, aiming to understand the impact of the dynamics of multiple variables of macroeconomic framework on the activity of companies. The Vector Autoregressive (VAR) model provides the researcher with a system of simultaneous equations without the prior determination of endogenous and exogenous variables (Sims, 1980), as a VAR model, without restrictions, considers all variables as endogenous (Lima, 2005; Sims, 1980). This allows the variables to behave freely according to the economic dynamics being analyzed.

As Lima (2005) highlights, the VAR model only requires the selection of variables that will be included in the model. It essentially consists of a system in which variables are regressed as a function of lagged variables and other variables included in the analysis (Sims, 1980). The VAR model allows for the inclusion of exogenous variables, adding to the system without the need for prior verification, once the need for their inclusion is established by theoretical sources (Enders, 1995; Lima, 2005; Tsay, 2005). According to Enders (1995), Charemza and Deadman (1997), Lima (2005), and Tsay (2005), the unrestricted VAR model is represented by Equation 1.

$$Z_t = \sum_{i=1}^{\kappa} AiZ_{t-1} + \varepsilon_t \quad \text{Equation 1}$$

Where $Z_t$ represents all "n" variables estimated in the model and $\varepsilon_t$ the vector of random errors. The VAR model was developed in three steps (Sims, 1980):

1) definition of the most suitable number of lags for the observed event: the criteria of Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) by Schwarz, and Hannan-Quinn Criterion (HQC) were adopted, which identified that all variables performed better with four lags (Lag 4) (Lima, 2005; Sekunda et al., 2020);

2) evaluation of stationarity using the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests, which allow for the incorporation of additional lags. The ADF test is conducted regarding the unit root of the polynomial estimated using Ordinary Least Squares (OLS) for the AIC, BIC, and t-Statistic criteria. The analysis indicated that the model was suitable for the second difference, which was confirmed by the KPSS test (Baltagi, 2011; Libanio, 2005; Medeiros et al., 2011);

3) consideration of the cointegration process among the variables to determine the long-term relationship between one or more variables in the system. Once a vector did not show stationarity at levels or in first difference, the cointegration effect was tested using the Johansen test. This allows determining the use of an error correction vector corresponding to the number of cointegrated vectors (rank) (Enders, 1995; Lima, 2005; Medeiros et al., 2011; Tsay, 2005).

The use of error correction parameters in vector autoregressive models acknowledges the existence of a long-term relationship between variables, which becomes an indicative of the characteristics of a particular observed phenomenon (Lima, 2005). The Johansen test showed that all equations exhibited cointegration between the first and second order of lag, initially suggesting that an exogenous shock to the system affects the entire observed system. As highlighted by Lima (2005) and Tsay (2005), when cointegration effects are observed for variables at levels or in the first lag, the use of Vector Error Correction (VEC) is recommended to avoid distortions derived from long-term cointegration. Sekunda et al. (2020) did not consider this factor in their model.

Therefore, the autoregressive model (VAR) with error correction in four lags VEC (4) was estimated for the quarterly interval from 2005:1 to 2020:3, consisting of three economic and financial variables, avoiding interference in the accumulation of estimation errors (Lima, 2005). Thus, the systems of the adopted VEC model are represented in Equation 2.

$$Y = \sum_{j=i}^{p} \alpha_{1j} X1_{t-j} + \sum_{j=i}^{p} \beta_{1j} X2_{t-j} + \sum_{j=i}^{p} \gamma_{1j} X3_{t-j} + \sum_{j=i}^{p} \delta_{1j} X4_{t-j} + \mu_t$$

Equation 2

Where the variables are, respectively: Y = Solvency Indicator; X1 = GDP; X2 = Selic; X3 = IPCA; X4 = ER; $\mu$ = Estimation error for period t; t = Observation period; j = Lag adopted. Where $\alpha$, $\beta$, $\gamma$, and $\delta$ are the estimation parameters, p is the number of lags; and $\mu$ is the random error term in the systems.

When the variables are differenced, important properties of these variables are lost within the system (Lima, 2005; Tsay, 2005), since it is treated as $\hat{a}_t = y_{t-\hat{a}} - \beta x_t$ , being I(0), we assume that $y_t$ and $x_t$ are interrelated over time,

showing a long-term equilibrium relationship consistent with the study's objectives. The ordering of the variables depends on the results obtained through the Granger Causality F-test (Baltagi, 2011; Lima, 2005), and it may not necessarily be the one shown in Equation 2.

### 3.2 Granger Causality

The Granger Causality test allows identifying the best ordering of the VAR model specification based on the exogeneity effect, where the more exogenous variable precedes the less exogenous one (Lima, 2005). The test was applied to determine the exogeneity scale of the macroeconomic variables, exclusively adopted to determine the Cholesky ordering, even if there is no Granger-Causality effect between the variables – meaning that the null hypothesis is confirmed – the sole interest is in the exogeneity ordering. The adoption of the Cholesky ordering significantly impacts the results and their interpretations (Lima, 2005). Sekunda et al. (2020) did not consider the ordering, which had a significant impact on the results presented by the authors and the methodological differences with this research.

The VAR model does not need to identify in advance which variables are exogenous, as in other time series models, because the properties of this model already consider the integration of exogenous variables (Sims, 1980). At the same time, Costa (2020) suggests the use of the $\chi^2$ and F tests or Granger causality metrics with the aim of excluding variables that do not exhibit Granger causality. In the model, the $\chi^2$ obtained from the Doornik-Hansen test was used to determine the normality of the model (Bittencourt et al., 2016; Wooldridge, 2006), which is an exclusion condition for conducting the Granger causality F test (Doornik & Hansen, 2008; Pino, 2014). The variance decomposition and impulse-response function follow the Cholesky ordering obtained from the Granger causality test, without the need for variable exclusion (Baltagi, 2011; Lima, 2005; Medeiros et al., 2011).

Table 4 presents the Granger causality test (F-test) for each analyzed segment, with a significance level of 5%. To be considered a Granger causality relationship from X to Y, the p-value should be less than the adopted significance level.

The Cholesky ordering (Table 4) adopted for the VEC(4) models has a strong impact on the VAR models, especially in the variance decomposition and consequently in the impulse-response equations. An important consideration is the analysis of the economic cycle, following the parameters of Burns and Mitchell (1946), Lima (2005), and Mitchell (1927), which identify GDP as typically the primary aggregate indicator of the economic cycle. However, when observing the results of the F-test, it is evident that there are few occurrences of GDP as the most exogenous variable in the system.

## 4 Data Analysis

The analysis of descriptive statistics (Table 5) shows the sample quality, with all variables meeting the preliminary indications of normality, indicating that the initial data treatment was suitable for the research purpose. The

Table 4: Granger Causality Test

| Regulated | F Test | | p-value | Order | Unregulated | F Test | | p-value | Order |
|---|---|---|---|---|---|---|---|---|---|
| **Total Debt** | | | | | | | | | |
| GDP | F(4,38) | 0,1463 | [0,9635] | 4 | GDP | F(4,38) | 0,3147 | [0,8664] | 4 |
| IPCA | F(4,38) | 1,5900 | [0,1968] | 1 | IPCA | F(4,38) | 1,5588 | [0,2051] | 1 |
| ER | F(4,38) | 0,4309 | [0,7854] | 3 | ER | F(4,38) | 1,2432 | [0,3092] | 3 |
| Selic | F(4,38) | 0,4599 | [0,7646] | 2 | Selic | F(4,38) | 1,3050 | [0,2855] | 2 |
| **Interest Coverage** | | | | | | | | | |
| GDP | F(4,38) | 1,5715 | [0,2017] | 3 | GDP | F(4,38) | 0,1718 | [0,9515] | 4 |
| IPCA | F(4,38) | 1,7696 | [0,1551] | 2 | IPCA | F(4,38) | 0,4014 | [0,8064] | 2 |
| ER | F(4,38) | 0,7131 | [0,5882] | 4 | ER | F(4,38) | 1,7409 | [0,1612] | 1 |
| Selic | F(4,38) | 2,2059 | [0,0867] | 1 | Selic | F(4,38) | 0,306 | [0,8721] | 3 |
| **Operating Cash Flow** | | | | | | | | | |
| GDP | F(4,38) | 1,074 | [0,3828] | 3 | GDP | F(4,38) | 2,5767 | [0,0529] | 2 |
| IPCA | F(4,38) | 2,2574 | [0,0809] | 1 | IPCA | F(4,38) | 2,1778 | [0,0900] | 4 |
| ER | F(4,38) | 1,846 | [0,1401] | 2 | ER | F(4,38) | 4,0499 | [0,0078] | 1 |
| Selic | F(4,38) | 0,6215 | [0,6500] | 4 | Selic | F(4,38) | 0,4102 | [0,8002] | 3 |

Note: GDP = Gross Domestic Product; IPCA = Broad Consumer Price Index (Series started in 1993); ER_N = Nominal Exchange Rate; Selic = Special System for Settlement and Custody.

observations had a low range, and despite some skewness relative to the mean, the values were within the expected range and in line with kurtosis. These characteristics align with what was observed in the unit root and normality tests.

After evaluating the descriptive statistics and other model validation tests, data analysis was conducted based on the economic segment (regulated and non-regulated) and the accounting variables in response to macroeconomic shocks through the impulse-response function. Figure 1 shows the result of a shock in the proportion of one standard deviation of macroeconomic variables on total indebtedness for both analyzed segments. The shock led to a slight increase of just over 0.5% in the debt of the regulated segment in the first quarter, followed by a decline in the second quarter.

Among the observed effects is the increase for two successive quarters starting from the fourth quarter, indicating the presence of a short-term seasonal pattern while the long-term trend appears to show an increase, suggesting two economic cycles nested within each other. This is in line with the literature highlighted by Lima (2005), which identifies the occurrence of short-term cycles within a long-term economic cycle.

The most significant result in the regulated segment aligns with the work of Mitchell (1927), in which he emphasizes the importance of examining the long-term effect, given that the causes can be diverse, while, for the author, a shock creates a trend to which the market and its agents adapt. This trend can be observed in Figure 1 in relation to total debt, even though after 30 quarters, approximately seven years, there is a return to levels prior to the shock when compared to the GDP cycle.

The same can be observed in the unregulated segment, where GDP had the greatest impact in short time intervals, although its impact does not exceed a 4% change in debt. It is noteworthy that the debt tends to return to the initial level after more than thirty periods, that is, for a model with four lags ahead of the shock point, after seven and a half years, the effects of a GDP shock are still noticeable in the debt capacity of regulated institutions and with a smaller effect on non-regulated institutions.

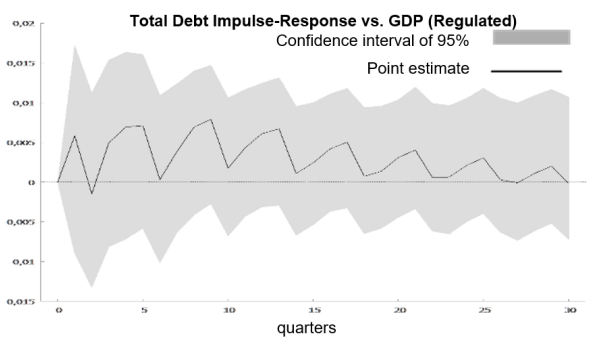
Another observed aspect (Figure 1) is that, after one year from the exchange rate shock, non-regulated institutions show a significant reduction (10%) in their debt. Economically, this suggests a reduction in obligations, corresponding to companies observing events to plan their next strategic steps, something not observed in regulated institutions, where the change in the total debt structure does not exceed 4%.

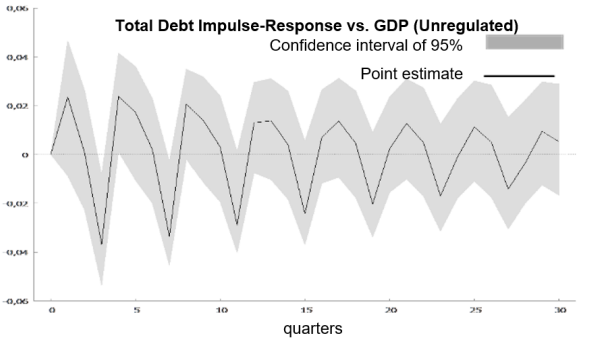
Medeiros et al. (2011) also identified these disruptions in the equilibrium state of variables, reflecting a new state of economic reality after macroeconomic shocks (Mitchell, 1927; Schumpeter, 1939). Supporting this observation, Sekunda et al. (2020) present a similar significance when dealing with the reverse relationship explored in this study. Among their findings, there is the dissipation of the long-term effect of the exogenous shock explored. The authors highlighted that accounting variables impact macroeconomic variables, but it is more likely that accounting variables are reacting to external shocks and perpetuating their impacts along the production chain, which feeds back into the system. Abdalla and Carabias (2022) identified in simulations that models considering special items after reported earnings demonstrated a better fit to the real behavior of GDP, adopting a VAR model with (q+1) and (q+2) lags. Figure 2 shows the impulse-response result of shocks to the interest coverage of regulated institutions. In the first, second, and third graphs, shocks for GDP, inflation, and exchange rate are presented, respectively. None of the three showed significance intervals (outside the shaded area) within the observed interval, considering a four-lag response. The interest rate graph was the only one that showed a significant response between the second and fourth subsequent quarters after the shock to interest coverage.

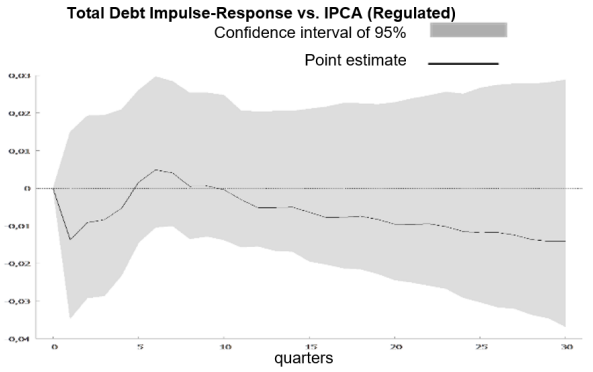
Table 5: Descriptive Statistics

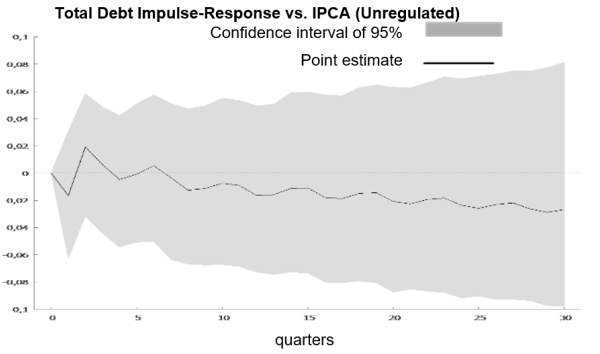
| Variables | Mean | Median | Minimum | Maximum | Standard Deviation |
|---|---|---|---|---|---|
| Total Debt (Regulated) | -0.47432 | -0.50251 | -0.7722 | -0.18833 | 0.16931 |
| Interest Coverage (Regulated) | 1.7128 | 1.6495 | 0.78357 | 3.1391 | 0.4709 |
| Operating Cash Flow (Regulated) | 12.747 | 12.654 | 10.684 | 15.378 | 0.974 |
| Total Debt (Unregulated) | -0.27857 | -0.339 | -0.68345 | 0.48957 | 0.31586 |
| Interest Coverage (Not Regulated) | 1.8837 | 1.7642 | 0.70908 | 3.4382 | 0.6166 |
| Operating Cash Flow (Unregulated) | 11.695 | 11.731 | 10.289 | 13.711 | 0.72619 |
| Gross Domestic Product (GDP) | 13.781 | 13.87 | 12.95 | 14.31 | 0.40853 |
| Broad National Consumer Price Index (IPCA) | 9.2983 | 9.2808 | 8.8931 | 9.6862 | 0.25775 |
| Exchange Rate (ER) | 5.9262 | 5.9533 | 5.5775 | 6.2929 | 0.18067 |
| Special Settlement and Custody System (Selic Rate) | 0.87479 | 0.9642 | -0.6717 | 1.5567 | 0.41042 |

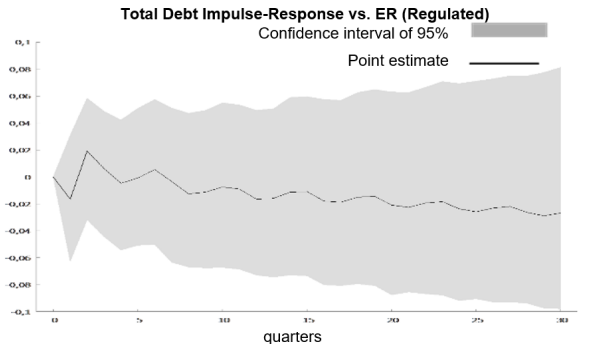
Figure 1: Total Debt Impulse-Response Graph

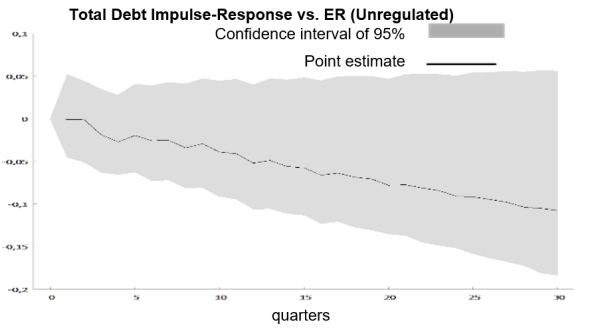


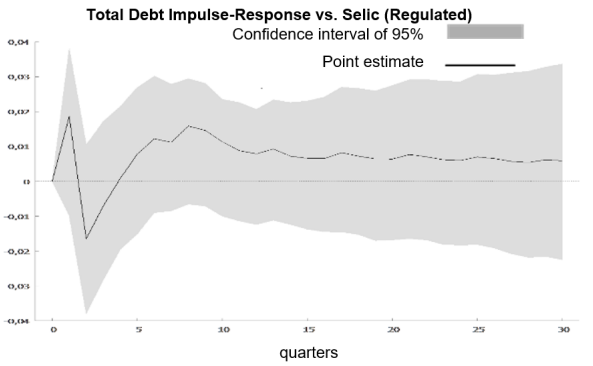



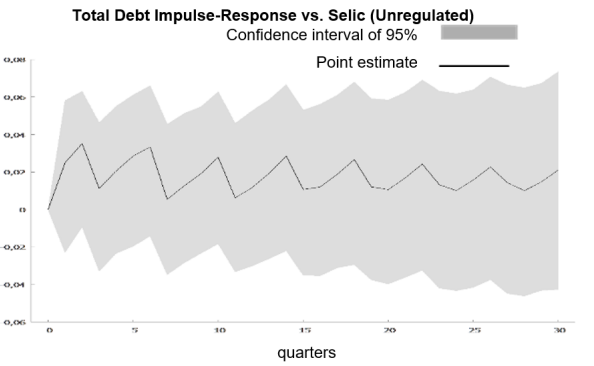




Note. GDP = Gross Domestic Product; IPCA = Broad Consumer Price Index (Series started in 1993); ER_N = Nominal Exchange Rate; Selic = Special System for Settlement and Custody.

Even though none of the graphs show statistical significance in interest coverage, economically, the responses to shocks suggest a long-term interference that changes the order of the original economic state. The graphs demonstrate that an exogenous shock results in a change of 10% or more in interest coverage capacity. In the case of Inflation and interest rates, this impact is mostly negative, with both showing a change without returning to the original equilibrium state. This is again in line with the theoretical predictions of Mitchell (1927) and Schumpeter (1939).

GDP is the only one that shows a negative result over the period after eight quarters. All shocks had a negative impact on interest coverage capacity, especially in the cumulative effect in the first quarter after the event. The highlights once again go to the inflation rate - represented by IPCA - which showed a reduction in interest coverage for non-regulated institutions of approximately 15%. With a significant recovery until the fifth quarter after the event, followed by a decrease, which again demonstrates that a macroeconomic shock creates a long-term effect that persists despite the capacity for recovery.

The second highlight was the exchange rate, which showed a decrease of 16% in the first subsequent quarter with a slight recovery between the second and sixth quarters, representing a year and a half after the shock event. Subsequently, a new, less abrupt but more persistent decline is observed until the end of the estimated series of 31 quarters.

Both inflation and the exchange rate showed a persistence of the effect far beyond the short term, significantly impacting over time, which is consistent with the research by Medeiros et al. (2011). This result aligns with Burns and Mitchell (1946) and Schumpeter (1939) since the impact of exogenous shocks from aggregate economic variables significantly reflects on aggregated financial accounting variables. The long-term impact on solvency indicators can be significant for decision-making (Brito & Assaf Neto, 2008) because, despite having demonstrated a negative impact in practically all conditions tested on the coverage of interest for non-regulated institutions, for a four-lag model, statistically, the impacts were not significant to affect the quality of accounting information; however, even in a stress scenario, the information was relevant and persistent.

Within the scope of the investigated variables, the operating cash flow showed the most significant behavior for the four-lag model (Figure 3). Starting with the shock observed in GDP, which showed significance over the first three periods following the shock, with a strong indication of a loss in operating cash flow capacity until the fourth period, followed by a retraction immediately after the point of maximum recovery observed in the fifth period. Significance is observed again between the sixth and eighth periods.

The significance can be observed in the impulse-response of the exchange rate from the moment of the shock until the second period in regulated institutions. However, the process does not repeat itself over the observations, indicating that GDP has a strong impact on the operational capacity of the regulated segment. Lima (2005) suggests GDP as the main indicator of the economic cycle, promoting impact on analyses starting from the existence of exogenous shocks to the economic cycle process. Such economic effects are observed in the short and long term in the present analysis.

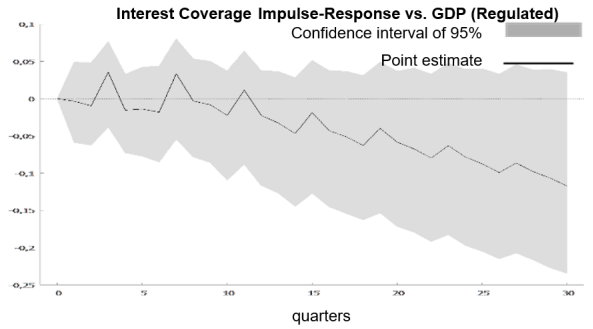
The operational cash flow of unregulated institutions exhibits a highly periodic behavior and is statistically significant. Both the exchange rate and inflation are economically significant, showing an increase of approximately 15% and a reduction of -15%, respectively, after 31 periods. The entire period is characterized by microcycles of about four periods each, with GDP and Selic being the variables with the most stable and closest to the original pre-shock conditions. After 20 periods from a GDP shock, the operational cash flow of unregulated institutions tends to return to the original level. This characteristic was only observed in other variables as well for GDP.

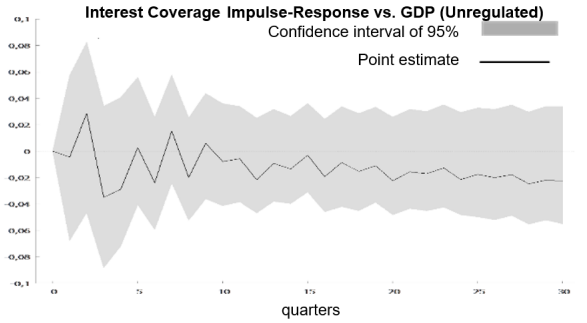
The shock in inflation showed opposite signs between the segments and is statistically significant. This characteristic was also observed in the interest coverage ratio. Economically, this demonstrates that inflation, by pushing prices upwards, leads to an increase in the operational cash flow of regulated institutions, which often have a monopolistic nature and, therefore, pricing with inelastic tendencies. However, the effect for unregulated institutions is the opposite, reflecting the expected supply and demand effect for adverse scenarios.

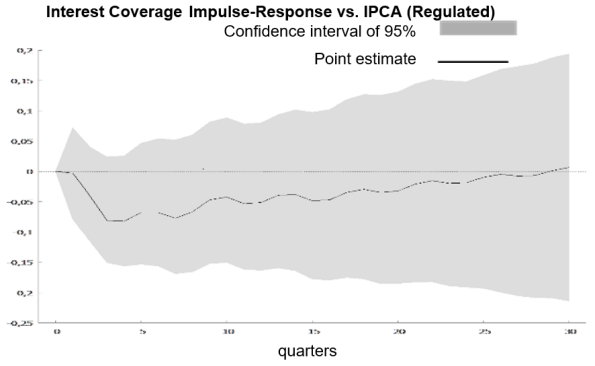
The exchange rate exhibited behavior with the same sign for both segments, with a similar magnitude. This implies that the exchange rate of the US dollar is strongly linked to the financing characteristics of the operation and the ability to pay both debts and associated interest, which are the subjects of this research. In line with the findings of Medeiros et al. (2011), the models identify a long-term effect persisting in accounting variables after an exogenous shock.

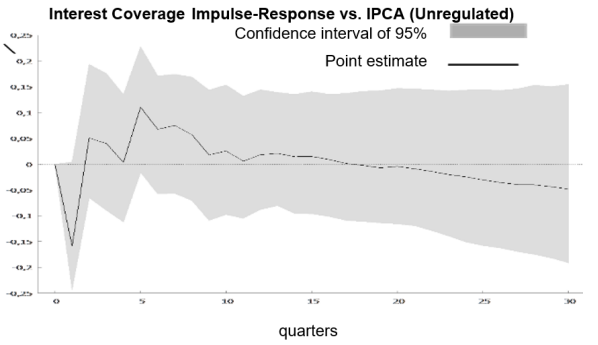
The decomposition of the variance of the cash flow from operations of regulated institutions (Table 6) clearly shows the effect that the exchange rate has on the operational financing condition of regulated institutions. The effect of the exchange rate surpasses the endogenous effect of cash flow from operations of regulated institutions from the 26th period onwards, at which point there is no possibility of returning to a previous level before the shock. The effect of accelerating propagation becomes even more evident when compared to the variance decomposition effect (Figure 3), in which the second shock - in the fourth period - becomes irreversible and grows at rates exceeding 25%. Compared to the other variables that do not exceed 7%, the exchange rate has a significant and consistent effect

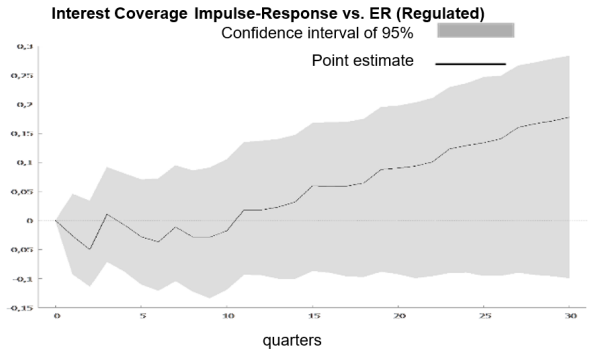
Figure 2: Interest Coverage Impulse-Response Graph

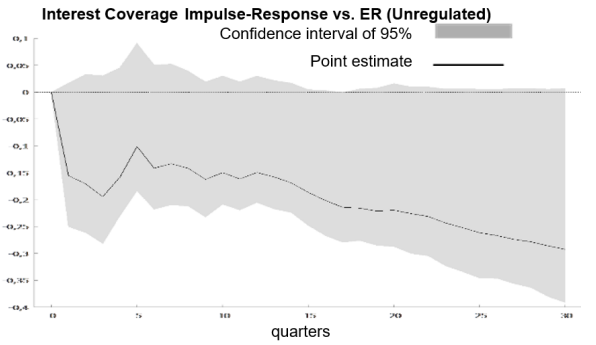


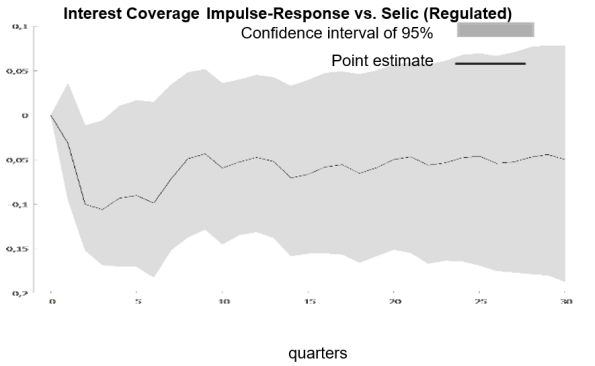



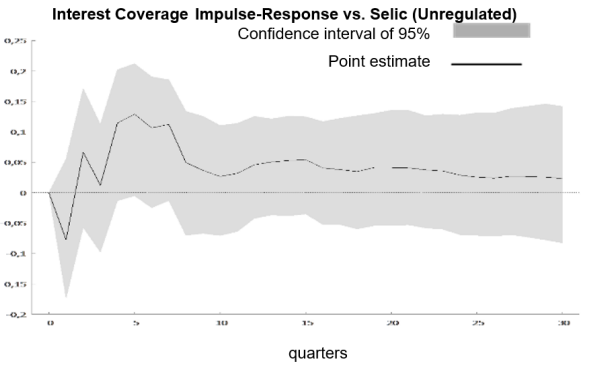



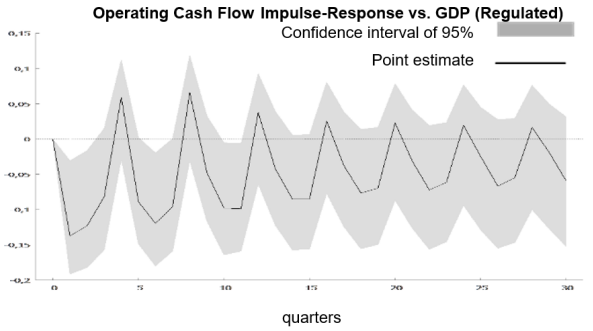



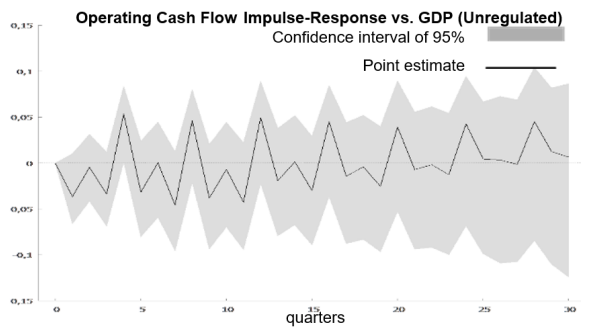



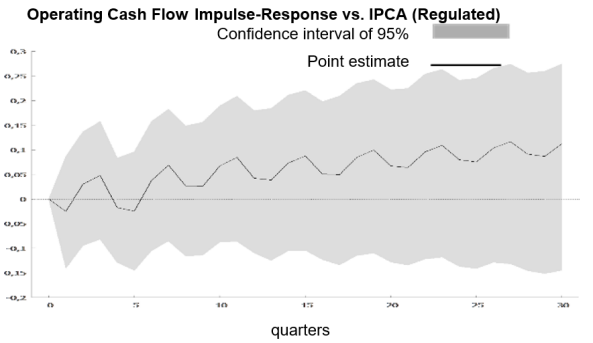



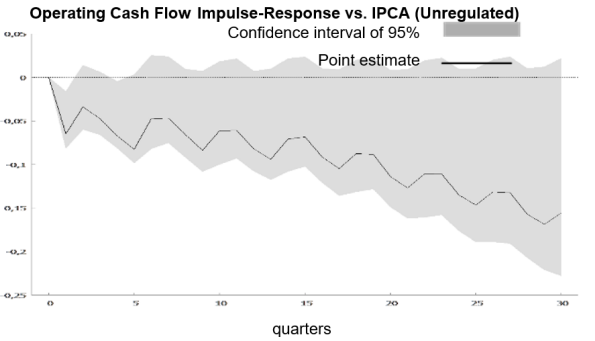

Note. GDP = Gross Domestic Product; IPCA = Broad Consumer Price Index (Series started in 1993); ER_N = Nominal Exchange Rate; Selic = Special System for Settlement and Custody.

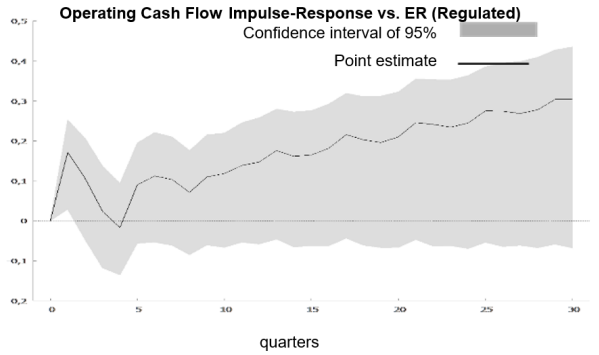
Figure 3: Operating Cash Flow Impulse-Response Graph

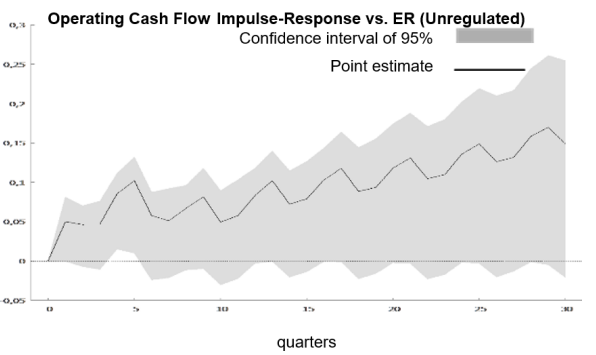


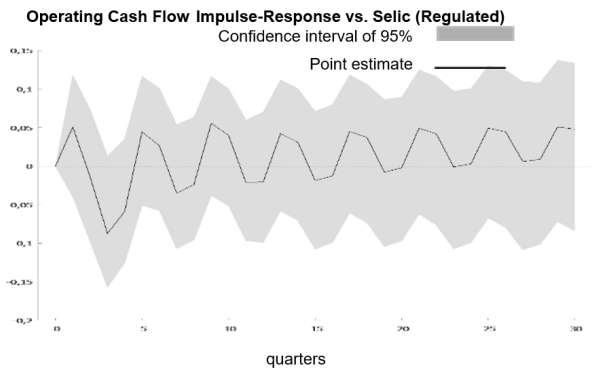



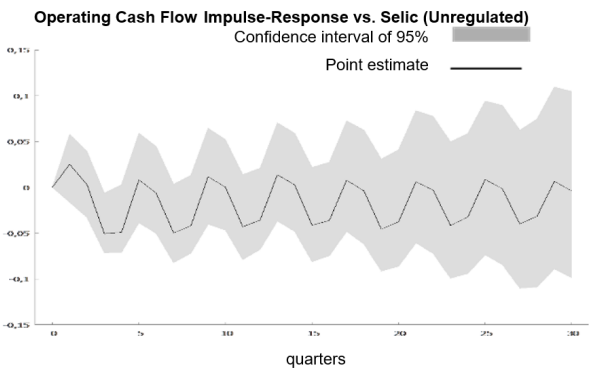




Note. GDP = Gross Domestic Product; IPCA = Broad Consumer Price Index (Series started in 1993); ER_N = Nominal Exchange Rate; Selic = Special System for Settlement and Custody.

with the propositions of Mitchell (1927) and Schumpeter (1939). Table 7 presents the variance decomposition of the cash flow variable for unregulated institutions.

When observing the effect of the variance decomposition in unregulated institutions (Table 7), the scenario changes considerably compared to regulated institutions (Table 6), highlighting another aspect that distinguishes the disclosure characteristic in both segments. The most significant fact is that, unlike the regulated segment, the unregulated segment suffers significant impacts from shocks originating from Inflation in cash flow, marking another characteristic of the Brazilian scenario. The exchange rate once again leads the long-term effect, surpassing the endogenous effect of cash flow from operations in the 15th period, but inflation is initially higher, indicating that even in the shock, it distorts the economic conditions of unregulated institutions. Pandini et al. (2018) demonstrates this effect in the cyclical and non-cyclical consumer sectors, which represent 18.88% and 6.35% of the explored sample, respectively. The analysis shows that the effect of the exchange rate surpasses the inflationary effect as early as the fifth period. This coincides with the graphical analyses (Figure 3), including the statistical significance observed in the graph of the effect of IPCA and the exchange rate. Once again, the long-term effect is observed in accordance with Mitchell (1927) and Schumpeter (1939) and goes in the opposite direction to the observations of Sekunda et al. (2020).

In summary, the nature of regulated and unregulated segments is distinct and adds multiple sectoral characteristics that were not deeply explored in this research but can be briefly understood in the work of Pandini et al. (2018), which explores the cyclical and non-cyclical consumer sectors. Undoubtedly, the data show that the exchange rate fixed in US dollars significantly impacts the models, as presented in the variance decomposition tables. The models focus on the impact of macroeconomic variables on short-term debt structures and debt-paying capacity. Brito and Assaf Neto (2008) highlight insolvency as a result of the accumulation of circumstances, the origin of which comes from the indebtedness of institutions.

The analysis identified that both the regulated and unregulated segments exhibit a strong dependence on the exchange rate associated with the US dollar, with the interest rate (Selic) being the second most impactful variable in the impulse-response models that aimed to "simulate" economically adverse conditions - representing an exogenous shock. All analyses revealed that sectors and segments respond differently to economic shocks (Mitchell, 1927; Schumpeter, 1939), while also verifying that GDP displays cyclical movements (Lima, 2005) much more noticeably than the other macroeconomic variables analyzed.

Table 6: Variance Decomposition of Operating Cash Flow from Regulated Institutions

| Period | Standard Error | OCF | IPCA | ER | GDP | Selic |
|---|---|---|---|---|---|---|
| 1 | 0.400023 | 100 | 0 | 0 | 0 | 0 |
| 2 | 0.486154 | 78.2671 | 0.268 | 12.3977 | 7.9732 | 1.0941 |
| 3 | 0.53041 | 71.9646 | 0.5545 | 14.4193 | 12.0765 | 0.985 |
| 4 | 0.555755 | 68.906 | 1.2448 | 13.3153 | 13.1704 | 3.3636 |
| 5 | 0.610676 | 72.2108 | 1.1116 | 11.1069 | 11.8656 | 3.7051 |
| 6 | 0.639776 | 70.1481 | 1.1611 | 12.092 | 12.7399 | 3.8588 |
| 7 | 0.67498 | 66.8125 | 1.3495 | 13.6317 | 14.5835 | 3.6228 |
| 8 | 0.710895 | 64.9733 | 2.1598 | 14.3926 | 14.9623 | 3.512 |
| 9 | 0.750567 | 66.6798 | 2.0649 | 13.8088 | 14.1968 | 3.2497 |
| 10 | 0.772664 | 65.5206 | 2.0621 | 15.0544 | 13.775 | 3.5879 |
| 11 | 0.800072 | 63.2144 | 2.6301 | 16.2173 | 14.3426 | 3.5956 |
| 12 | 0.839902 | 61.4347 | 3.4032 | 17.438 | 14.398 | 3.3261 |
| 13 | 0.881318 | 61.7301 | 3.323 | 18.6112 | 13.2608 | 3.0749 |
| 14 | 0.909415 | 59.7076 | 3.3017 | 21.2176 | 12.6691 | 3.104 |
| 15 | 0.935647 | 57.4081 | 3.7321 | 23.0211 | 12.7964 | 3.0423 |
| 16 | 0.970223 | 55.8801 | 4.2835 | 24.2995 | 12.6706 | 2.8663 |
| 17 | 1.00919 | 55.6502 | 4.2125 | 25.696 | 11.7762 | 2.665 |
| 18 | 1.04202 | 53.5747 | 4.1766 | 28.3865 | 11.1741 | 2.6882 |

Note: OCF = Operating Cash Flow; IPCA = Consumer Price Index; ER_N = Nominal Exchange Rate; GDP = Gross Domestic Product; Selic = Special System for Settlement and Custody.

Furthermore, contributing to the findings of this research, Medeiros et al. (2011) identified a similar long-term result derived from the propagation of shocks, which aligns with the assumptions of Mitchell (1927) and Schumpeter (1939) that every shock is distinct and unique, not comparable to the nature of other shocks before or after. At the same time, the propagation of shocks contributes to the change in the economic paradigm of any institution within the economic reality (Medeiros et al., 2011; Pandini et al., 2018).

A different Cholesky ordering was adopted in this study compared to other research, whose main focus was the impact of macroeconomic shocks on accounting variables. Sekunda et al. (2020) observed the effect of profitability indicators on macroeconomic conditions, which is distinct from the perspective of this study. The authors did not consider the Cholesky ordering, and Granger Causality tests were adopted to justify the observed propagation effect, even though the variance decomposition analyses demonstrated that this impact is endogenous to the macroeconomic variables themselves. Despite previous research analyzing perspectives from the same theoretical framework, this study indeed highlighted the economic scenario - represented by the impulse-response propagation effect - directly impacting the accounting reality of Brazilian institutions in both segments. The operational cash flow was statistically the accounting-financial variable most impacted by the shocks. At the same time, the study revealed a strong dependence on the US dollar in both segments, which was not observed in other studies. Additionally, inflation was found to be significant for the non-regulated segment but not for regulated institutions, consistent with the study by Pandini et al. (2018).

# 5 Final Considerations

The findings are consistent with those observed in related research. The effects of macroeconomic shocks on debt variables, interest coverage, and operational cash flow are not initially significant enough to cause a structural disruption at the institutional level. However, default scenarios occur after a buildup of market conditions that affect the institution at the operational level (Brito & Assaf Neto, 2008). This research observed this effect at the segment level, aggregating economic sectors and their institutions.

By aggregating accounting information, we are restricted to observations at the adopted scale. Therefore, the research cannot discern which companies may have been affected. However, the analysis revealed that both segments (regulated and non-regulated) have points of economic concomitance, as expected, while preserving the disclosure characteristics presented by the theory of disclosure (Bertomeu & Magee, 2015; Cianciaruso &

Table 7: Variance Decomposition of Operating Cash Flow from Unregulated Institutions

| Period | Standard Error | OCF | ER | GDP | Selic | IPCA |
|---|---|---|---|---|---|---|
| 1 | 0.140575 | 100 | 0 | 0 | 0 | 0 |
| 2 | 0.168963 | 69.5729 | 8.7742 | 4.6699 | 2.2315 | 14.7514 |
| 3 | 0.178633 | 62.3817 | 14.5609 | 4.2434 | 2.0296 | 16.7844 |
| 4 | 0.200518 | 49.9124 | 17.0006 | 6.2092 | 7.9681 | 18.9096 |
| 5 | 0.264109 | 46.6202 | 20.2755 | 7.7136 | 8.0281 | 17.3627 |
| 6 | 0.296734 | 36.9369 | 27.8888 | 7.2399 | 6.4362 | 21.4982 |
| 7 | 0.306103 | 34.7306 | 29.7654 | 6.8036 | 6.09 | 22.6103 |
| 8 | 0.32328 | 32.5351 | 29.1903 | 8.0928 | 7.8283 | 22.3534 |
| 9 | 0.364436 | 37.3385 | 26.3459 | 7.9812 | 7.4937 | 20.8407 |
| 10 | 0.385325 | 33.6718 | 28.0525 | 8.117 | 6.795 | 23.3637 |
| 11 | 0.393482 | 32.3586 | 28.4812 | 7.814 | 6.5162 | 24.83 |
| 12 | 0.409365 | 31.1342 | 28.2901 | 8.3031 | 7.1237 | 25.1489 |
| 13 | 0.445519 | 33.0867 | 27.3786 | 8.256 | 6.6597 | 24.6191 |
| 14 | 0.467784 | 30.2515 | 29.5944 | 7.6533 | 6.1279 | 26.3729 |
| 15 | 0.478745 | 28.9386 | 30.533 | 7.3077 | 5.8538 | 27.3669 |
| 16 | 0.495976 | 28.2923 | 30.9863 | 7.1744 | 6.149 | 27.398 |
| 17 | 0.532289 | 29.8518 | 30.6692 | 6.9498 | 5.798 | 26.7311 |
| 18 | 0.55692 | 27.8214 | 32.4893 | 6.4142 | 5.3164 | 27.9588 |

Note: OCF = Operating Cash Flow; ER_N = Nominal Exchange Rate; GDP = Gross Domestic Product; Selic = Special System for Settlement and Custody; IPCA = Consumer Price Index.

Sridhar, 2018; Dontoh, 1989). As future research, the intention is to demonstrate whether the same characteristics will also be observed among sectors. In this way, it will be coherent to deduce that the nature of the segments' tendencies will be reflected at the institutional level.

The results showed that non-regulated institutions are more susceptible to volatility from the propagation of exogenous shocks, even though they exhibited greater robustness in the information. Regulated institutions showed lower volatility and a return to equilibrium condition with a faster response compared to non-regulated ones, characteristics also found by Medeiros et al. (2011) and Pandini et al. (2018). This demonstrates that regulated and non-regulated institutions may have points of convergence, but in general, what allows both segments to have similar trends is not visible through the adopted variables, although it reflects on them, and this is an area for future study.

Unlike what was observed by Sekunda et al. (2020), this research did not identify a return to the point of origin prior to the shock. Simultaneously, it was evident that the non-regulated and regulated segments respond differently, but they aggregate relevant information from external economic events into the solvency structure of listed Brazilian companies (analyzed by total indebtedness), even though sometimes with opposite signs from the same macroeconomic variables. In these cases - as observed in the variable operational cash flow - the opposing sign reflects the prediction of microeconomic theory of supply and demand since this relationship will impact the inflows and outflows of resources. Inflation was the most relevant macroeconomic vector, reflecting well the effect on the cash flow of non-regulated entities, which mostly do not have the monopolistic characteristic observed in regulated entities. The interest rate (Selic) follows the same sequence of events as inflation, demonstrating the endogenous relationship between both.

The GDP presented statistically significant behavior in almost all analyses, with emphasis on the operational cash flow response; however, the same effect was not verified in the analysis of variance decomposition. Furthermore, it was evident that the accounting indicators do not return to the same conditions observed before the shock, as corroborated by the literature (Burns & Mitchell, 1946; Carvalho, 1988; Lima, 2005; Lucas, 1975; Medeiros et al., 2011; Mitchell, 1927; Pandini et al., 2018; Schumpeter, 1939), assuming that sectoral and segmental characteristics will contribute to the effect of exogenous impulse responses and that each one will be particular. In contrast to the evidence of Sekunda et al. (2020), this investigation considers that macroeconomic variables impact from the first quarter after the observation of the shock, and the effect of the variable itself on the analyzed system does not always respond significantly to explain the long-term effect observed on the solvency indicators analyzed. In this sense, the main contribution was the observation that indeed, as Burns and Mitchell (1946), Mitchell (1927), and Schumpeter (1939) highlighted almost a century ago, each shock is individual and explanatory for its own event, not relevant for predicting the existence of a new and isolated event from the first. To observe the relationship between distinct cycles, the impulse-response model is not suitable because the cycle is merely an effect of the exogenous event. However, the model allows us to infer the trend of movement of that specific cycle.

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