Value stocks and growth stocks: an econometric analysis of the effects of US monetary policy (2008-2021)

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Resumo: A presente pesquisa tem o objetivo de investigar os efeitos da política monetária sobre o mercado acionário estadunidense no período compreendido entre dezembro de 2008 e dezembro de 2021. Com efeito, o período apresenta larga vantagem no retorno absoluto das ações de crescimento sobre as ações de valor, em contradição às pesquisas que historicamente demonstraram vantagem destas sobre as primeiras. Por esse motivo, buscou-se examinar se a política monetária do período teria beneficiado as ações de crescimento, por intermédio da aplicação de um Modelo VAR com vetor de correção de erros (Modelo VEC), utilizando-se como variáveis quatro ETFs que seguem passivamente índices, sendo dois de valor e dois de crescimento. Para análise dos efeitos da política monetária do período, utilizou-se o total de ativos no balanço patrimonial do *Federal Reserve (FED)*. Os resultados apontaram, pelas funções generalizadas de impulso-resposta, maior elasticidade, no longo prazo, dos ETFs de crescimento aos choques no valor dos ativos do FED, confirmando a hipótese aventada de que os estímulos monetários influenciaram positivamente os retornos absolutos dos preços de ações de crescimento e de valor no período demarcado, com maior benefício às ações de crescimento.

Palavras-chave: Política monetária, mercado acionário, ações de crescimento, ações de valor.

Classificação JEL: E52, G00, C32.

Abstract: The present research aimed to investigate the effects of monetary policy on the US stock market in the period between December 2008 and December 2021. This period had a large advantage in the absolute return of growth stocks over stocks of value, in contrast to research that historically showed an advantage over the former. For this reason, we sought to examine whether the monetary policy of the period would have benefited growth stocks, through the application of a vector autoregressive (VAR) model with an error correction vector (VEC model), using as variables four exchange-traded funds (ETFs) that passively follow indices, two of which are value and two growth. To analyze the effects of monetary policy in this period, the total assets on the Federal Reserve (Fed) balance sheet were utilized. The results demonstrated, by the generalized impulse-response functions, the greater long-term elasticity of growth ETFs to shocks in the value of Fed assets, confirming the hypothesis that monetary stimuli positively influenced the absolute returns of stock price growth and value in the demarcated period, with greater benefits for growth stocks.

Keywords: Monetary policy, stock market, growth stock, value stock.

JEL Classification: E52, G00, C32.

Área Anpec: Área 8 - Microeconomia, Métodos Quantitativos e Finanças

1. Introduction

This research aims to investigate the effects of monetary policy on the North American stock market in the period between 2008 and 2021, examining whether monetary policy would have influenced the capitalization of companies, using *quantitative easing* during several occasions in the defined period. In this context, the absolute returns of growth and value stocks were considerable, but with a large advantage to the first group (growth stocks), in contrast to the financial literature that has traditionally indicated the prevalence of value stocks.

According to Bernanke (2002), through *quantitative easing*, the monetary authority causes the suppression of interest, especially on the long vertices, by buying assets that are incorporated into its balance sheet, as a measure to stimulate the US economy. Given this scenario, it is considered as a hypothesis whether the monetary policy of the period would have favored growth stocks, as opposed to value stocks, given the greater sensitivity of the first group to fluctuations in the interest rate of long-term bonds, used as a discount reference for estimated cash flows and as a component element of the *equity risk premium calculation*. These would have been introjected into investors' expectations for the formation of excess expected returns on the risk-free asset, with concomitant transmission effects on the calibration portfolio, in view of the suppression of risk-free asset returns, requiring investors to make a new allocation in view of the macroeconomic situation.

This effect of balancing portfolios has been felt in the last decade, so that the portfolios traditionally suggested in mature economies included an allocation of 50% in equity and 50% in fixed income, or 60% in equity and 40% in income. Fixed assets performed below portfolios that were more allocated to riskier assets, such as growth stocks and alternative investments such as *private equity* and *venture capital*. In view of the presented context, this research intends to evaluate the econometric results resulting from the influence of monetary policy on pricing and on outperforming the growth subgroup, compared to value stocks, through the impulse-response functions of the vector autoregressive (VAR) model with a vector of error correction (VEC model), based on data extracted from passive exchange-traded funds (ETFs) and a variable relative to total assets on the Fed's balance sheet.

To achieve these research objectives, this article is structured as follows: the theoretical framework, presented in the next section, refers to the theoretical aspects of monetary policy, as well as to the economic cycles according to the Austrian theory, the theory of rational expectations and the dichotomy between value stocks and growth. Then, in Section 3, the historical events of the great financial crisis of 2007/2008 and the Covid-19 pandemic are discussed. The fourth section includes the methodology with the presentation of the variables and the VAR model with error correction vector (VEC model), followed by further analysis of the research results in the fifth section.

2. Theoretical Framework

When discussing the theoretical notions related to monetary policy, one should begin with the quantitative theory, using the Fisher equation (1930), which considers the relationship between monetary policy and the price level, which was also examined by Gardiner (2006). This dogma of the quantity theory of money remained in force for decades without any solid attacks on its construction. However, with Keynesianism, the classical quantity theory of money was severely criticized, since the first economists of this branch attributed little relevance to the money supply. However, with the advent of monetarism, Milton Friedman, the main exponent of the current view, revitalized the quantitative theory, demonstrating, through an analysis of the 1930s depression, that its premises had been poorly shown. On the one hand, according to Froyen (2013), Keynesians indicated as a crucial problem for the crisis the fall of the components of aggregate demand, while Friedman and Schwartz (1965) understood, in convergence with the quantitative theory, that the problem was aggravated by the absence of an expansion of the monetary base.

Despite the fluctuations in monetary velocity after the 1980s, in sharp contrast to Friedman's alleged stability, much of what the Chicago economist had written became relegated. However, the influence of his thought on modern monetary theory is remarkable, since, according to Bernanke (2002), the studies of the former served as a definitive warning so that central bankers did not make the same mistakes as the 1930s.

The performance of the Federal Reserve (Fed), the North American central bank, provides several functions with macroeconomic relevance, which are considered in the expectations of agents in the market, according to the study of Blanchard et al. (2012). Pursuant to Section 2A of the Federal Reserve Act, it is incumbent upon the Federal Open Market Committee to promote the objectives of maximum employment, stable prices and moderate long-term interest rates, purposes which must be implemented through the monetary policy measures available to the authority, such as such as the posting of the *federal funds rate* (*FFR*), *forward guidance* and *quantitative easing* (or *tightening*). In this context, the importance of monetary policy appears, in terms of its consequences, in the so-called transmission effects. In short, these transmission effects have repercussions on financial markets through impacts on equities, the value of the US dollar against other currencies, credit spreads, credit granting standards and, finally, on the capital formation.

Thus, Rigobon and Sack (2002, 2003) were able to demonstrate the effects of an increase in short-term interest rates by the Fed on the US stock market, as well as the inverse causality, that is, the impact of a rise or a fall in the stock index on decision-making concerning monetary policy. Ehrmann and Fratzscher (2004) also observed that the effects of monetary policy on shares fluctuate depending on the business segment and the company's capital structure. Bernanke and Kuttner (2005) also reached similar conclusions, noting that the technology and telecommunications sectors respond about 50% more sensitively to the change in interest rates in the FFR. Finally, Joyce et al. (2011) observed that *quantitative easing* caused a reduction in the long vertices of the British yield curve, allowing, in short, a portfolio rebalancing as a transmission effect of monetary policy, with a greater exposure of stock portfolios.

Moving on to the Austrian theory of business cycles, according to Garrison (2001), macroeconomics based on capital structure is essential for understanding the intertemporal preferences of agents and to what extent they impact economic growth and the structure of economic production, in order to distinguish healthy growth from artificial growth, the latter being responsible for creating *boom and bust phenomena*, as a consequence of the actions taken by savers and the monetary authority. Thus, in the light of Hayek (1933), by intervening through the injection of money and the expansion of credit, the monetary authority distorts the healthy economic cycle, leading to a change in relative prices in the intertemporal structure. According to Huerta de Soto (2012), credit expansion implies the artificial and involuntary expansion of loanable *funds*, so that the production possibility frontier is distorted beyond equilibrium, by the increase in investments simultaneously with the increase in consumption. Furthermore, there is a drop in voluntary savings due to the fall in the interest rate, with the increase in investments, which, in the face of the artificial process, will be, in Hayek's terminology, *malinvestments*, distorting the triangle of the production structure until crisis, due to the unsustainability of the cycle, the cutting of production projects, rising unemployment, with repercussions on income and expenditure, and, finally, the fall in aggregate demand.

Furthermore, from the perspective of the theory of rational expectations, based on the work of Lucas and Prescott (1971), it is important to point out that agents incorporate in their forecasts not only past macroeconomic variables, but also future ones, based on the information available in the present, trying, according to King (2017), to conjecture the interactions between the variables for making allocative decisions. Therefore, the central bank's signals, even if only in words written in minutes, are also incorporated into economic agents' forecasts. In parallel with rational expectations, it is worth mentioning the efficient market hypothesis, according to Fama (1970), whose work aimed at demonstrating that capital markets would reflect in the price of assets all the information available to participants at that time, praising, therefore, the very precise ability of agents in the rapid pricing of any informational novelty that could have a direct impact on price formation.

Finally, in regard to the dichotomy between *value* and *growth stocks,* the literature, supported by Fama and French (1996), has historically indicated a return premium for value stocks overgrowth stocks. This finding, however, was overcome in the period selected for this research, between January 2009 and December 2021, in which *growth stocks* performed better than *value stocks.* The categorization of these two groups, according to Greenwald et al. (2001) and Penman and Reggiani (2018), started, in practice, to be carried out by the price/earnings multiples, in such a way that companies with a low price/earnings ratio, precisely because of the expectation of low earnings growth agents, would be considered value companies, while companies with high price/earnings multiples would imply, by projecting large earnings growth ahead, their labeling as growth companies. This dichotomy, moreover, is supported by *value investing,* which, according to Greenwald et al. (2001), methodologically assumes a cautious framework regarding the assumptions of large expected growth, which significantly impacts the valuation of companies in the estimation of cash flows.

3. Historical Evolution

The period selected for this research is demarcated by two crises. The first was the great financial crisis of 2008 and the second related to the Covid-19 pandemic. Much research has been devoted to understanding the causes of the 2008 financial crisis, triggered by the bursting of the *subprime mortgage bubble.* According to Leijonhufvud (2008) and Ravier and Lewin (2012), the best theoretical model to explain the crisis would be the Austrian theory of the business cycle, as, in the 1980s, the Fed started a process of decreasing the interest rate in the short term, still under the management of Paul Volcker, with price control according to the amount of money in circulation. Since then, the FFR has been on a constant downward trend, reaching zero during two crucial moments: the great financial crisis of 2008 and the Covid-19 pandemic in 2020.

Considering the current century, from the second half of 2004 onwards, the FFR started to rise gradually, finally reaching its peak in August 2006. Gradually, real assets and, especially in the case of *subprime mortgages,* real estate, began to have their prices corrected, impacting real estate financing due to the fall in the price of the collateral asset. Accompanying this upward movement, 30-year interest rates for mortgages also rose, significantly affecting the calculation of debtor payments. Faced with repressed interest rates, it would have been natural for economic agents to start looking for greater profitability in their investments, even if this presupposes the assumption of new risks. Thus, in view of the search for more returns, the *mortgage-backed securities market* began to offer securities that were based on real estate financing from categorized debtors with a lower ability to perform and, as a logical consequence, with a greater risk of default. However, the financial institutions categorized them into groups that would supposedly mitigate the risk, given the diversity of debtors, in which they were monitored by the risk agencies, which, despite the low performance capacity of those financed, maintained high *rating levels* for these titles.

In addition, as pointed out by Whalen (2008), the North American institutional model of encouraging *affordable housing,* through public-private partnerships, favored the use of innovative financial techniques to inflate the contributory capacity of debtors. Concurrently, the Securities and Exchange Commission (SEC) and the Fed itself were inert in regulating the expansion of over-the-counter derivatives and securities trading, with similar permissiveness from the SEC and Financial Accounting Standards Board for the accounting of the fair value. Thus, with the increase in mortgage interest rates and the deflation of real estate, the perfect scenario materialized for defaults to begin to rise, finally bursting the housing bubble. The problem was significantly amplified by the speculative behavior of financial institutions, such as AIG, many of whom sold in huge amounts derivatives (swaps*)* that guaranteed the contract holder protection against *subprime mortgage default,* as described by Lewis (2011). Supported by a false perception of security, these agents took disproportionate risks, which led to the failure of many institutions such as Lehmann Brothers, Bear Stearns, and AIG.

In addition, Bernanke's appointment as Fed president meant that there was then the leadership of a scholar of the 1929 crisis. Under Bernanke's direction, the Fed began to aggressively expand the monetary base and to finance the American treasury through the purchase of *treasuries*, which would discretionarily conduct an expansionary fiscal policy. Ravier and Lewin (2012) showed that the monetary base doubled immediately after the bubble burst, rising from slightly under US$900 billion to approximately US$1.8 trillion in less than six months between September 2008 and January 2009. Likewise, the *Fed's balance* in 2008 went from US$1 trillion to almost US$2.5 trillion in 2009, and continued to grow in subsequent years, driven by Bernanke's *quantitative easing.*

In terms of the Covid-19 pandemic, the strategy used after the 2008 financial crisis was recently repeated, when the Covid-19 pandemic broke out, with intense action by the Fed from March 2020, when announcing the implementation of a new *quantitative easing program,* with the purchase of *treasury bonds* and *mortgage backed securities* on March 15, 2015, in addition to the reduction of the FFR to zero and the reduction of banks' compulsory reserves. Days later, on March 23, 2020, the *Fed* announced that it would also buy corporate bonds, and finally, on April 9, 2020, it started to include in the purchase program ETFs from *high yield bonds* and from issuers that were downgraded to the BB rating/Ba before March 22nd.

The Fed's exceptional response resulted from severe impacts on the real economy, which subsequently had repercussions for the financial market – the opposite of what happened in the 2008 crisis, as noted by Nozawa and Qiu (2021). The work stoppages and lockdowns caused by the Covid-19 pandemic brought the US unemployment rate to 14.7%, according to data from the Bureau of Labor Statistics. Aside from the impacts on the real economy, the consequences on stocks were immediate. The Standard and Poor's (S&P) 500 between February and March 2020 – the period between the Italian lockdown and the announcement of *quantitative easing* of corporate bonds – underwent a correction of approximately 35% and only began to react after the Fed's announcements concerning the purchase of bonds and investment grade corporates. On the fixed income side, Nozawa and Qiu (2021) observed the *high yield and BBB credit spreads* widening after the lockdown in Italy, with the peak reaching the date of the announcement of quantitative easing aimed at *investment grade bonds* and the subsequent reduction of *spreads on high yield* bonds after the April 9, 2020 announcement.

In this context, Rebucci et al. (2022), when carrying out an analysis based on the main Fed announcements in March, concluded that the US central bank played a key role in stabilizing the fixed income market worldwide and, at the same time, addressing the global shortage of the dollar, caused by the immense demand for the US currency, common in times of flight to safety. At the same time, they also verified that the *quantitative easing* conducted by other central banks made it possible to stabilize the local bond market and exchange rates between currencies, in a reactive stage to the first steps taken by the Fed. In this research, it should be noted that the authors identified the importance of *quantitative easing* in reducing the yield premium demanded for *treasuries*, thus reducing long-term interest, something that can be explored in this work, given the repercussion on *valuations* of value and growth companies. In Cukierman's (2021) analysis, the use of fiscal expansion, in overcoming traditional austerity restrictions, together with central banks' actions in expanding the monetary base through *quantitative easing*, provided the safeguard of the real economy. For the economist, inflation would not be a concern, as the past decade had shown deflationary forces, similarly to that noted in Europe and Japan. On the other hand, and in line with what will be researched in this work, Cukierman (2021) observes that the wide use of *quantitative easing* caused a considerable increase in the value of financial assets, creating a distortion between the financial markets and the real economy, reinforcing, moreover, a growing trend of inequality and wealth distribution. In the author's view, seigniorage would be the best way to solve both problems, especially in a scenario of depressed levels of aggregate demand, with a low risk of inflation.

In view of the history briefly outlined, it is noted that, from 2008 onwards, *quantitative easing* became a reference measure for the Fed and other central banks of mature economies – and, according to Rebucci et al. (2021), despite inconclusive results, also used by emerging economies – to deal with severe economic crises, and it is the goal of this research to determine to what extent there is a correlation between the implementation and withdrawal of monetary stimuli and the evaluation of the shares of value and growth companies.

4. Method

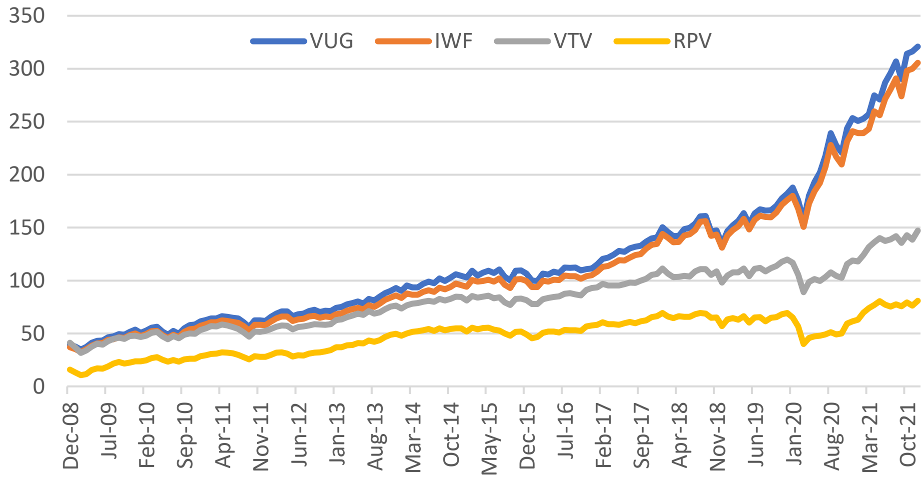
To achieve the research objectives, the methodology used consists of the application of an VAR model. In this context, this section is divided into two parts. In the first part, the data used in this research are presented and, in the second part, the econometric model is described in detail.

4.1 Data

For the econometric estimate, two ETFs from each group were selected (value stocks and growth stocks), which passively track indices monthly, with the value ETFs being the Vanguard Value ETF (ticker: VTV) and the Invesco S&P 500 Pure Value ETF (ticker: RPV). In terms of growth ETFs, the Vanguard Growth ETF (ticker: VUG) and the iShares Russell 1000 Growth ETF (ticker: IWF) were selected. Figure 1 shows the absolute return of these ETFs in the period between December 2008 and December 2021. As can be seen in Figure 1, there is a large advantage for growth ETFs, which in the analyzed period had a higher cumulative return than value ETFs.

Figure 1

Monthly Closing Prices of Selected Growth and Value ETFs for the Period 2008–2021

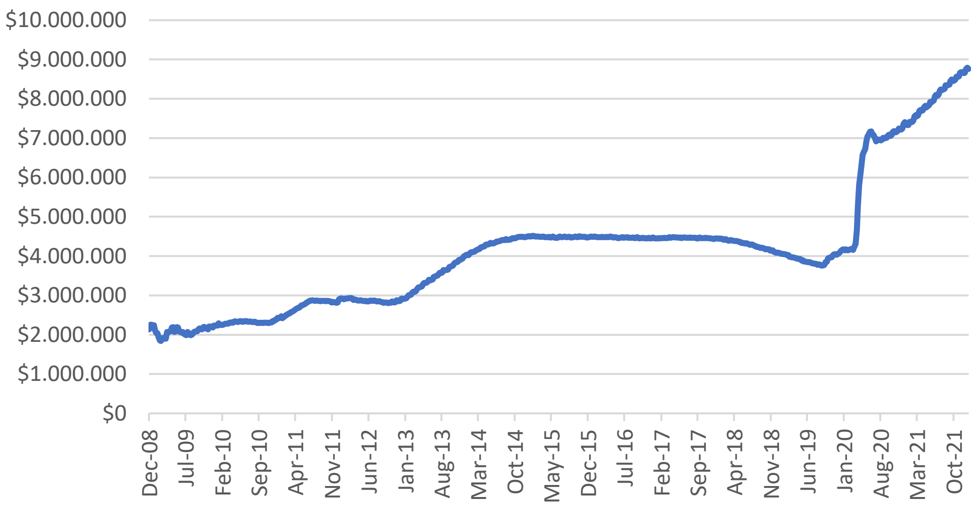


Source: Yahoo Finance. Available at: https://finance.yahoo.com. Accessed on March 26, 2022.

Regarding monetary policy, the total assets on the Fed balance sheet in the same demarcated period were used to assess its effects on the stock market, as shown in Figure 2. It is possible to perceive a growth trend in the total assets from 2008 to 2018, when total assets begin to fall, from approximately US$4.5 trillion to US$3.77 trillion at the end of 2019. In 2020, however, with the effects of the Covid-19 pandemic, there is a jump in the Fed's total assets, which rises to more than $7 trillion in June 2020 and $8.75 trillion in December 2021, which was the end of the analysis period for the present survey.

Figure 2

Total Assets (Minus Consolidation Eliminations), in Millions of US Dollars, on the Federal Reserve's Balance Sheet for the Period December 2008 to December 2021



Source: Federal Reserve Economic Data (FRED). St. Louis Fed. Data taken from the Board of Governors of the Federal Reserve System. Available at: https://fred.stlouisfed.org/series/WALCL. Accessed on August 24, 2022.

Table 1 presents the main descriptive statistics from the survey, bringing together Fed assets and the four selected ETFs. During the period between the end of 2008 and the end of 2021, 157 observations are noted, with the assets of the US central bank (assets) standing, on average, at US$4.14 trillion and at a median of US$4.15 trillion, although the high reached $8.75 trillion and the low reached $1.91 trillion.

Table 1

Descriptive Statistics with Monthly Variables from December 2008 to December 2021

	Assets (US$)	IWF (US$)	VUG (US$)	RPV (US$)	VTV (US$)
Average	4144842	112.97	119.65	47.67	82.41
Median	4159972	98.86	105.61	51.40	82.73
Maximum	8757460	305.59	320.90	80.83	147.11
Minimum	1916115	32.52	34.77	10.62	31.63
Standard Deviation	1640258	64.41	67.17	17.34	27.63
Asymmetry	1.10	1.21	1.23	-0.20	0.22
Kurtosis	3.86	3.89	4.00	2.04	2.23

Source: Yahoo Finance and FRED Economic Data – St. Louis Federal Reserve.

It is important to note that the values double in two crucial periods: the first after the great financial crisis and the second after the outbreak of the Covid-19 pandemic. On the growth ETFs side, the IWF had an average price of US$112.97, a median of US$98.86, a high of US$305.59 and a low of US$32.52, while the VUG had an average of $119.65, median of $105.61, high of $320.90 and low of $34.77. In the value spectrum, RPV had an average of US$ 47.67 per share, median of US$ 51.40, maximum of US$ 80.83 and minimum of US$ 10.62, while VTV had an average of US$ 82.40, median of $82.73, high of $147.11 and low of $31.63.

4.2 Econometric Model

Regarding the econometric model, it was initially intended to use a VAR model, pioneered by Sims (1980), which is shown as an alternative to multi-equation models, eliminating the need to impose restrictions a priori, with eventual damage to the analysis of information, as demonstrated by Sims (1986). In addition, according to Sims (1986), the VAR model would allow the analysis of the variables listed above simultaneously, to avoid the problems of identifying parameters in multi-equation models.

In this context, impulse-response functions were used as an instrument of analysis. The impulse-response functions allow the simulation of a shock in one of the model variables so that the behavior of the others can be observed, which is the fundamental point in the use of autoregressive vectors. Based on the estimates, it is possible to visualize the dynamic behavior of each of the ETFs in the face of a shock to the Fed's assets, thus capturing the change in the behavior of an ETF when another or the variable itself suffers a shock at instant *t*, replicating this impulse to the future, in periods *t+1*, *t+2* and so on.

Based on Gujarati and Porter (2011), the mathematical formula of the VAR model is represented by the following equation:

$$(1) \quad y_t = \mathrm{A}_1 y_{t-1} + . \ldots + A_N y_{t-N} + \mathrm{Bx_t} + \mathcal{E}_t$$

In which:

y_t = endogenous variable vector

$\mathrm{x_t}$ = exogenous variable vector

$\mathrm{A_1}+. \ldots + A_N\ e\ B$ = matrices of the coefficients to be estimated

$\mathcal{E}_t$= autocorrelated innovation vector.

As the VAR model is characterized by the explanation of the variables by the past of the variable itself and by the past of the other variables of the system, the main objective of the present research was to evaluate how the prices of the ETFs responded to impulses (shocks) on the assets present in the balance sheet of the Fed.

Furthermore, it is worth noting, based on Hill et al. (2011), that the VAR model requires stationary variables. In case of non-stationarity with cointegrated variables, a VEC model must be estimated, according to Vartanian et al. (2021), to compare the impacts of shocks on Fed assets on growth and value stocks. Based on the seminal study by Granger and Newbold (1974), it is known that non-stationary macroeconomic series can cause the problem of spurious regression. For these reasons, Maysami and Koh (2000) suggest the application of an error correction term, so that the behaviors of short-term variables are in line with long-term behaviors. In addition, the stability of the system must be analyzed, as well as the application of autocorrelation, the normality of the residues and the possible presence of heteroskedasticity.

One of the possible ways to treat the selected variables is through the formation of linear combinations of stationary variables (cointegrated). In this case, the cointegration of two series (for example, $\mathrm{X_t}\ \mathrm{Y_t}$) leads to the finding of an equal or common stochastic trend, by eliminating the difference $\mathrm{Y_t} - \theta \mathrm{X_t}$. Therefore, the cointegration of these two series makes it possible to model the respective first differences through VAR, with the addition of an additional regressor, the error correction term, equated by $\mathrm{Y_{t-1}} - \theta \mathrm{X_{t-1}}$. The combination of VAR with the error correction term enables the formation of the VEC model, through which predictions are made about future values of $\Delta \mathrm{Y_t}$and $\Delta X_\mathrm{t}$from past values of $\mathrm{Y_t} - \theta \mathrm{X_t}$.

In this sense, the Johansen cointegration test aims to identify the cointegration vectors, through the confrontation between the null hypothesis of no cointegration and the alternative hypothesis, thus making it possible to determine the application of a VAR or a VEC model. In this work, the results of the Johansen cointegration test imply the selection of the second one in the modeling, and this choice is also supported by Maysami and Koh (2000), whose research concluded for the greater efficiency of the cointegrated vector estimators provided by the VEC model, and in Mukherjee and Naka (1995), who, when applying the VEC model in a system of seven equations to evaluate the cointegration of the Japanese stock market with a group of six macroeconomic variables, concluded, in the same way, that the VEC model consistently outperforms the model VAR in predictive capacity. In addition, another benefit arising from the option for the VEC model results from the lack of *a priori assumptions*, which normally occur if the model's regressors are correlated with the error, to generate endogeneity problems.

Thus, in mathematical terms, a hypothetical system of two variables and a cointegration equation has the following algebraic formula:

(2) $y_{2,t} = By_{1,t}$

The resulting VEC model has the following equations:

(3) $\Delta y_{1,t} = \mathrm{a}_1\left(y_{2,t-1} - By_{1,t-1}\right) + e_{1,t}$
(4) $\Delta y_{2,t} = \mathrm{a}_2\left(y_{2,t-1} - By_{1,t-1}\right) + e_{2,t}$

Equations (3) and (4) present the error correction term, which is equivalent to zero in the long-term equilibrium, although, in the short-term, the variables $y_{1,}$e $y_2$may be suitable for the long-term equilibrium in line with the speed of adjustment of the endogenous variables, expressed by the coefficients $a_1$and a_2.

Thus, given the presence of originally non-stationary series that can be cointegrated, it is necessary to estimate the VEC model with the detection of a cointegration equation, in a model with two lags and a cointegration equation (as will be shown below), by applying the Johansen (1988) cointegration test. The choice of the appropriate number of lags follows the parameters of Akaike (1974) and Schwarz (1978) and is of fundamental relevance for the present investigation, since the higher the number of lags, the greater the number of parameters to be estimated, with consequent loss in the number of degrees of freedom.

Table 2

Augmented Dickey-Fuller (ADF)Unit Root Test

Variable	Lags	Constant	Trend	ADF	Critical Value 10%	Critical Value 5%	Critical Value 1%
Assets	5	yes	yes	-1.327519	-3.144346	-3.439857	-4.019975
VUG	5	yes	no	4.432831	-2.577008	-2.880591	-3.473967
VTV	0	yes	no	0.183626	-2.576674	-2.879966	-3.472534
RPV	0	yes	no	-0.957981	-2.576674	-2.879966	-3.472534
IWF	5	yes	no	4.627810	-2.577008	-2.880591	-3.473967

Source: Own elaboration.
Note. Number of lags selected according to Akaike's (1974) criteria.

Augmented Dickey-Fuller (ADF) unit root tests were applied. The test results are presented in Table 2. For the five variables, it was not possible to reject the null hypothesis of the presence of a unit root of the variables in level.

Table 3

Akaike (1974) and Schwarz (1978) Information Criteria

	Akaike Criterion	Schwarz Criterion
1 lag and 2 cointegration equations	-26.10*	-25.12*
2 lags and 1 cointegration equation	-26.05	-24.78
3 lags and 1 cointegration equation	-25.86	-24.08
4 lags and 1 cointegration equation	-25.96	-23.67

Source: Own elaboration.
Note. The asterisk represents the number of lags to use that minimize the criteria.

As previously mentioned, in non-stationary series it is necessary to identify the problem concerning spurious regressions, highlighted by Granger and Newbold (1974), with the adjustment of variables and correction of errors in the VAR model, requiring the Johansen test to identify the presence of vectors of cointegration. In Johansen's (1988) cointegration test, the null hypothesis implies recognizing that there is no cointegration vector, while the alternative hypothesis indicates that there is at least one cointegration vector.

Table 4

Results of the Johansen Cointegration Test (1-Lag Model)

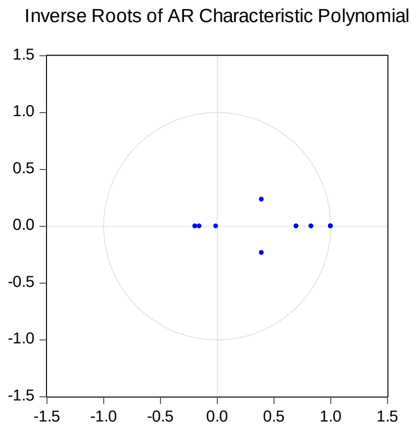
Number of Hypothesized Cointegration Equations	Eigenvalue	Trace Statistics	Critical Value 5%	Maximum Eigenvalue Statistic	Critical Value 5%
None	0.213793	92.81792*	69.82	37.28295*	33.87
up to 1	0.192048	55.53497*	47.86	33.05420*	27.58
up to 2	0.070533	22.48077	29.79	11.33739	21.13
up to 3	0.045474	11.14338	15.49	7.21380	14.26

Source: Own elaboration.
Note. * Indicates rejection of the hypothesis at a 5% significance level.

That said, four different models were estimated, as shown in Table 3. Given the fact that the series proved to be non-stationary, cointegration tests were performed with different lags to find the most appropriate model from the minimization of the values of the Akaike (1974) and Schwarz (1978) criteria. As the inclusion of different numbers of lags resulted in different numbers of cointegration equations according to the Johansen Test, four models were estimated and the Akaike (1974) and Schwarz (1978) information criteria were evaluated to select the most parsimonious model. The results of the Akaike and Schwarz criteria are presented in Table 3. As can be seen, the most appropriate VEC model must use a lag and, with a lag, two cointegration equations were identified, according to the results presented in Table 4.

Figure 3

Inverse roots of the Autoregressive Characteristic Polynomial



Source: Own elaboration.

Therefore, cointegration tests were performed on VEC models of one to four lags and, consequently, four models were estimated to identify the Akaike (1974) and Schwarz (1978) criteria to select the best model. As the model with one lag and two cointegration equations proved to be the most adequate, Table 4 presents the results of the Johansen cointegration test only for this model, which was the model used in the present research. As shown in Table 4, the Johansen cointegration test ensures the use of the VEC model with a lag and two cointegration equations, which was estimated with the five variables (assets plus the four ETFs) in logarithmic transformation. The stability of the estimated model was ensured by the analysis of the inverse roots of the autoregressive characteristic polynomial, which lie within the unit circle, as shown in Figure 3.

Table 5

Portmanteau's Autocorrelation Test

Lags	Q-Stat	Probability	Adjusted Q-Stat	Prob.	Degrees of Freedom
1	5.54	NA*	5.57	NA*	NA*
2	25.13	0.97	25.42	0.96	40
3	39.42	0.99	40.00	0.99	65
4	72.03	0.92	73.47	0.90	90
5	86.06	0.98	87.97	0.97	115
6	113.88	0.95	116.90	0.92	140
7	148.68	0.81	153.36	0.73	165
8	175.20	0.77	181.32	0.66	190
9	200.84	0.75	208.53	0.61	215
10	227.71	0.71	237.26	0.54	240
11	261.46	0.55	273.59	0.35	265
12	278.94	0.67	292.53	0.45	290

Source: Own elaboration.
Note. *The test is valid only for lags larger than the VAR/VEC lag order.

Subsequently, the portmanteau autocorrelation test was also performed, in which the null hypothesis is the absence of autocorrelation, highlighting that the test is valid only for lags greater than the lag order of the model. In this context, as shown in the results of Table 5, the absence of autocorrelation in the estimated model was identified, which was expected due to the treatment given by the cointegration and because the VEC model estimates the variables in difference.

Table 6

Tests (Set and Individual) of Residual Heteroskedasticity VEC

Individual Components					
Dependent	**R-Square**	**F (14.140)**	**Prob.**	**Chi-Square (14)**	**Prob.**
res1*res1	0.22	2.86	0.00	34.51	0.00
res2*res2	0.18	2.24	0.01	28.38	0.01
res3*res3	0.29	4.09	0.00	45.03	0.00
res4*res4	0.26	3.46	0.00	39.85	0.00
res5*res5	0.18	2.14	0.01	27.28	0.02
res2*res1	0.18	2.23	0.01	28.22	0.01
res3*res1	0.18	2.25	0.01	28.46	0.01
res3*res2	0.24	3.14	0.00	37.00	0.00
res4*res1	0.18	2.25	0.01	28.47	0.01
res4*res2	0.25	3.39	0.00	39.22	0.00
res4*res3	0.28	3.90	0.00	43.47	0.00
res5*res1	0.18	2.20	0.01	27.92	0.01
res5*res2	0.18	2.20	0.01	27.95	0.01
res5*res3	0.24	3.12	0.00	36.90	0.00
res5*res4	0.25	3.39	0.00	39.24	0.00

Joint Test		
Chi-Quad	**Lib Degrees**	**Prob.**
395.54	210	0.00

Source: Own elaboration according to econometric data.

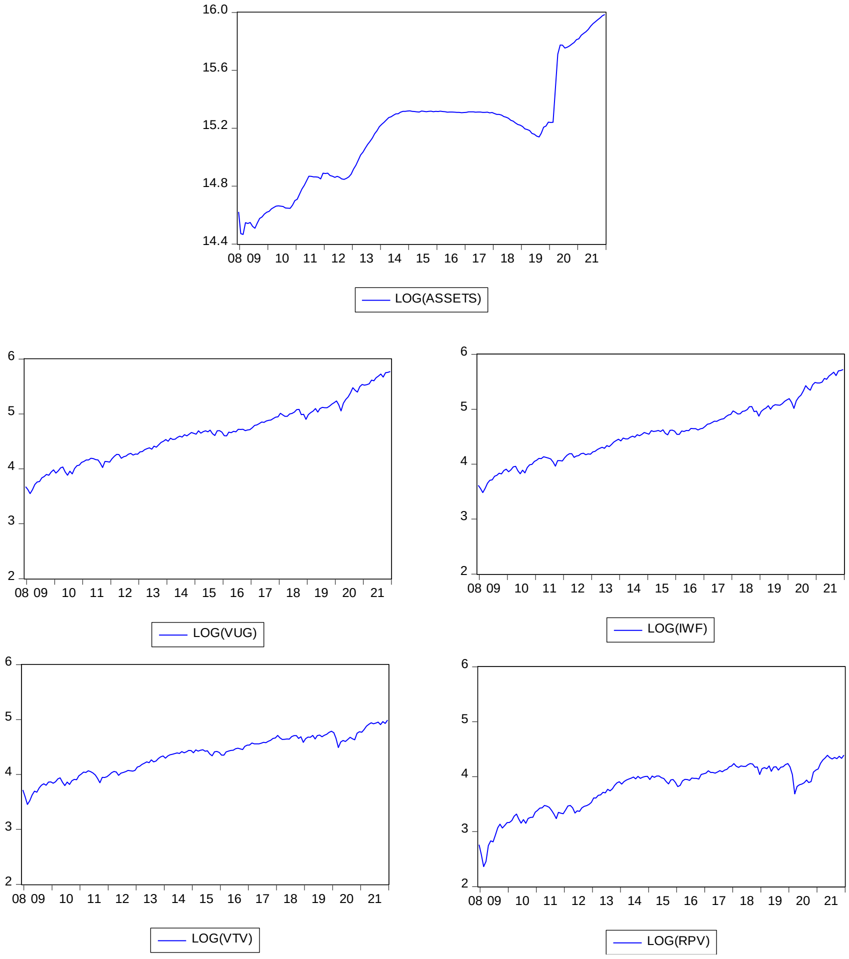
The last test performed concerned the heteroskedasticity of the residuals of the VEC model, presented in Table 6. As these are financial series, the presence of heteroskedasticity is common, which was confirmed by the test results, both in terms of individual components and in terms of the joint test case. One way to minimize heteroskedasticity was to estimate the model with the logarithmic transformation of the variables, which mitigates, although it does not eliminate, the issue of heteroskedasticity. As the purposes of the present research consist of the analysis of impulse response functions, the presence of heteroskedasticity does not affect the analysis of the results.

5. Results and Discussion

With the estimation of a VEC model due to the presence of a unit root of the series with the asset variables and the four ETFs (two of value and two of growth), complemented by the stability and autocorrelation tests, the response functions to impulses provide answers to the research problem. In this context, Figure 4 shows the behavior of the variables in the period defined in this research, with the vertical axis on a logarithmic scale and the horizontal axis pointing to the annual milestones. It is interesting to observe the clear upward trend of the US stock market, with the outstanding performance of growth stocks in the period, which outweighed value stocks. At the same time, and as mentioned above, assets on the Fed’s balance sheet continued to grow throughout the period, showing an exceptional decrease between 2018 and 2020, interrupted, however, by the announcement of the security purchase program (*quantitative easing)* in March of 2020.

Figure 4

Evolution of Variables in the Period 2008–2021



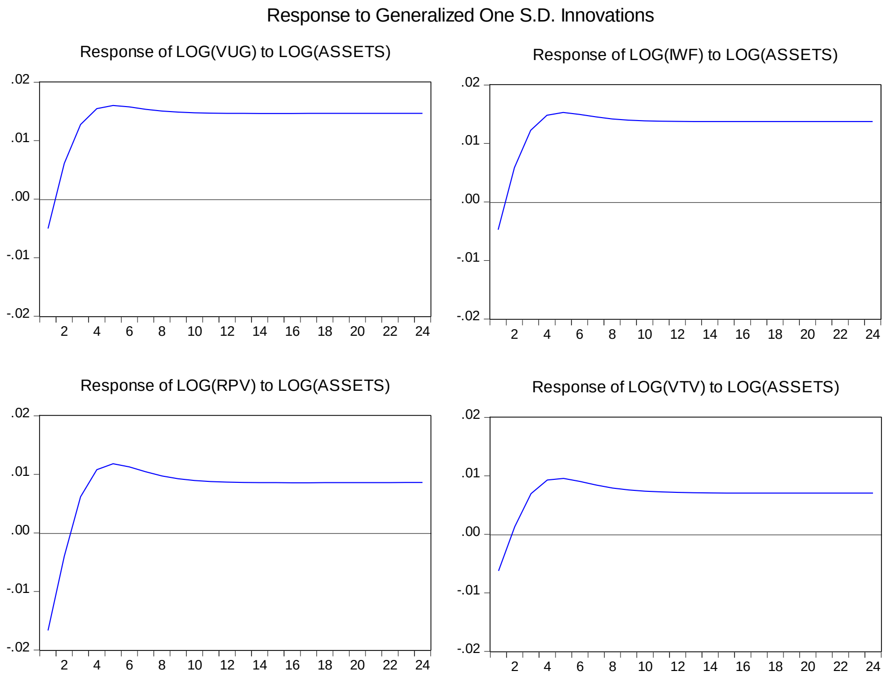
Source: Yahoo Finance and FRED Economic Data – St. Louis Federal Reserve.

Note. Logarithmic scale.

The estimation through the VEC model allowed for the generation of impulse-response functions, which demonstrated, by a hypothetical shock in the selected variable, the impact on another one gathered in the sample. Generalized impulse-response functions were used to solve the problem of different impacts on the results arising from the ordering of the model variables. Thus, Figure 5 presents the results from the shocks in the *assets variable* (assets on the Fed's balance sheet), with the reaction of the prices of the selected ETFs in the sequence. The graph scale on the vertical axis is in log and the horizontal axis has a time frame of 24 months.

Figure 5

Generalized Impulse-Response Functions with a Shock on Assets



Source: Own elaboration.

As shown in Figure 5, in terms of the shock on the variable referring to Fed assets, the four ETFs responded negatively in the first month after the shock, with greater sensitivity from the value ETFs. The exception, however, in the short term, was the behavior of the ETF RPV, which still maintained a negative correlation in the second month. However, after the second month, all ETFs reacted positively to the increase in assets on the Fed’s balance sheet. Of particular note, in this time frame of up to 24 months, is the finding that, in the long term, the price elasticity of growth ETFs was double that of value ETFs.

In this vein, to confirm the hypothesis launched at the beginning of this research, the size of the Fed’s balance sheet proves to be an important variable that can positively influence – or negatively in cases where there is a reduction of assets – the absolute performance of the prices of growth and value stocks in a cut-off period, in the long term (over two months), with an outstanding benefit – or loss, in the case of asset sales – to *growth stocks* in the comparison of the two subgroups.

However, it is necessary to note a reservation concerning the short-term period excepted above, of one month for VUG, IWF and VTV and of two months only for RPV. The question that naturally arises from this observation is: what would explain this negatively correlated movement in the lapse of weeks immediately following the event? Based on the results of Rigobon and Sack (2002, 2003), one could consider the surprise of market agents, in the face of an unanticipated movement by the monetary authority, with the result that, at first, they react positively to the decrease in the balance sheet, as if the central bank had signaled to them that the macroeconomic data would allow the withdrawal of monetary stimuli, with optimistic projections for the growth of profits of the companies. On the other hand, in the opposite situation, the unexpected move by the Fed would signal the need for more stimuli to maintain economic activity, implying negative projections for corporate profits, with the consequent sale of shares in the month immediately following the change.

This movement of investors, however, would be corrected in the medium and long term, with the perception of the agents that the stimuli of the monetary authority, due to the increase in assets, would lead to a benign macroeconomic scenario for the growth of corporate profits. On the other hand, according to a different hypothesis, the reduction of assets would cause an adverse macroeconomic scenario, harming the capital structure of companies and reducing aggregate demand, making it more difficult to continue growing projected profits. These findings are supported by the results achieved by Ribogon and Sack (2002), Ehrmann and Fratzscher (2004) and Bernanke and Kuttner (2005), who examined the effects of monetary policy, through the posting of the FFR on the US stock market. Similarly, there is also support in the work of Gilchrist and Zakrajsek (2013), Eksi and Tas (2017) and Swanson (2021), who identified the propensity of *quantitative easing* to persistently stimulate the stock market in the long term, due to the of portfolio balance transmission, with the expansion of the *equity position* and reduction of the allocation in *bonds.*

6. Final Considerations

This research aimed to evaluate the effects of US monetary policy, represented by assets on the Fed's balance sheet, on the market capitalization of value and growth companies in the period between December 2008 and December 2021. For the general objective outlined, it was necessary to collect data from two ETFs representative of each subgroup of stocks and, regarding monetary policy variables, the total assets on the Fed's balance sheet were selected. It was possible to observe, in the analysis period, a growth trend in all ETFs, with a large advantage for growth ETFs, concomitantly with a growth trend in Fed assets.

To conduct this research, the VEC model was used, given the presence of non-stationary series, which required the error correction vector applied to the VAR model. To measure the generalized impulse-response function, shocks were simulated on the asset variable *(assets* of the US central bank), analyzing the price reaction of the four selected ETFs. The results obtained showed that, except for the short term (one month for VUG, IWF and VTV and two months for RPV), the stock price represented here by the ETFs, both in terms of value and growth, are positively correlated with the increase or the decrease in Fed assets, which, finally, confirms the introductory hypothesis. Furthermore, attention is drawn to the greater sensitivity of growth stocks in relation to movements in the central monetary authority's balance sheet, which, in a period of 24 months, demonstrate twice as much elasticity as compared to value actions.

Regarding possible future investigations that this research gives rise to, it would be interesting to investigate the reasons why, in the short term, the correlation between assets and company capitalization is negative, as well as to examine in greater depth whether the long vertices of the curve interest rates would also be illustrative, in the long run, of the effects of monetary policy on stock pricing.

Finally, given the multiple and complex causal web and recognizing the difficulty of isolating a single factor as responsible for the effects on the stock market, it is also necessary to note the need to evaluate other factors that, during the selected period, may also have provided the absolute returns observed for both growth and value stocks, either through moderate inflation over the entire time span, or through relative innovative secular trends. For example, the spread of the smartphone and the infrastructure that it involves, the growth of cloud computing, the development of artificial intelligence and the advances in the field of biotechnology and robotics favor the outstanding performance of growth stocks. Due to the relevance of issues related to innovative and technological trends that may have influenced the behavior of stock prices, these topics are included as important issues for future research agendas.

References

Akaike, H. (1974). A new look at the statistical model identification. *IEEE Transactions on Automatic Control*, *19*(6), 716–723.

Bernanke, B. S. (2002, November). *Remarks at the Conference to Honor Milton Friedman* [Conference presentation]. University of Chicago, Chicago, IL, United States.

Bernanke, B. S., & Kuttner, K. N. (2005). What explains the stock market’s reaction to federal reserve policy? *The Journal of Finance*, *60*(3), 1221–1257.

Blanchard, O., Amighini, A., & Giavazzi, F. (2012). *Macroeconomics* (E. Rabasco Espáriz & L. Toharia Cortés, Rev. & Trans., 5th ed.). Pearson.

Cukierman, A. (2021). COVID-19, seignorage, quantitative easing and the fiscal-monetary nexus. *Comparative Economic Studies*, *63*, 181–199.

Ehrmann, M., & Fratzscher, M. (2004). Taking stock: Monetary policy transmission to equity markets. *Journal of Money, Credit and Banking*, *36*(4), 719–737.

Eksi, O., & Tas, B. K. O. (2017). Unconventional monetary policy and the stock market’s reaction to Federal Reserve policy actions. *The North American Journal of Economics and Finance*, (40), 136–147.

Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *The Journal of Finance*, *25*(2), 383–417.

Fama, E. F. & French, K. R. (1996). Multifactor explanations of asset pricing anomalies. *The Journal of Finance*, *51*(1), 55–84.

Fisher, I. (1930). *Theory of interest: As determined by impatience to spend income and opportunity to invest it*. Augustus M. Kelly.

Friedman, M., & Schwartz, A. J. (1965). Money and business cycles. In R. Fels & C. F. Christ (Eds.), *The state of monetary economics* (pp. 32–78). NBER.

Froyen, R. T. (2013). *Macroeconomics: Theories and policies* (10th ed.). Pearson.

Gardiner, G. W. (2006). Irving Fisher’s equation. In G. W. Gardiner (Ed.), *The evolution of creditary structures and controls* (pp. 142–158). Palgrave Macmillan.

Garrison, R. W. (2001). *Time and money: The macroeconomics of capital structure*. Routledge.

Gilchrist, S. & Zakrajsek, E. (2013). The impact of the Federal Reserve’s large-scale asset purchase programs on corporate credit risk. *Journal of Money, Credit and Banking*, *45*(2), 29–57.

Granger, C. W. J., & Newbold, P. (1974). Spurious regressions in econometrics. *Journal of Econometrics*, *2*(2), 111–120.

Greenwald, B. C. N., Kahn, J., Sonkin, P. D., & van Biema, M. (2001). *Value investing: From Graham to Buffett and beyond*. Wiley.

Gujarati, D. N., & Porter, D. C. (2011). *Basic econometrics* (D. Durante, M. Rosemberg, & M. L. G. L. Rosa, Trans., 5th ed.). AMGH.

Hayek, F. A. (1933). *Monetary theory and the trade cycle* (N. Kaldor & H. M. Crome, Trans.). Sentry,

Hill, R. C., Griffiths, W. E., & Lim, G. C. (2011). *Principles of econometrics* (4th ed.). Wiley.

Huerta de Soto, J. (2012). *Currency, bank credit and economic cycles* (M. X. de Brito, Trans.). Ludwig von Mises Institute.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, *12*(2–3), 231–254.

Joyce, M. A. S., Lasaosa, A., Stevens, I., & Tong, M. (2011). The financial market impact of quantitative easing in the United Kingdom. *International Journal of Central Banking*, (26), 113–161.

King, M. (2017). *The end of alchemy: Money, banking, and the future of the global economy*. WW Norton.

Leijonhufvud, A. (2008). Keynes and the crisis. *Center for Economic Policy Research: Policy Insights*, (23).

Lewis, M. (2011). *The big short: Inside the doomsday machine*. Penguin UK.

Lucas, R. E., Jr., & Prescott, E. C. (1971). Investment under uncertainty. *Econometrics*, *39*(5), 659–681.

Maysami, R. C., & Koh, T. S. (2000). A vector correction model of the Singapore stock market. *International Review of Economics & Finance*, *9*(1), 79–96.

Mukherjee, T. K., & Naka, A. (1995). Dynamic relations between macroeconomic variables and the Japanese stock market: An application of a vector error correction model. *Journal of Financial Research*, *18*(2), 223–237.

Nozawa, Y., & Qiu, Y. (2021). Corporate bond market reactions to quantitative easing during the COVID-19 pandemic. *Journal of Banking and Finance*, *133*.

Penman, S., & Reggiani, F. (2018). Fundamentals of value versus growth investing and an explanation for the value trap. *Financial Analysts Journal*, *74*(4), 103–119.

Ravier, A., & Lewin, P. (2012). The subprime crisis. *The Quarterly Journal of Austrian Economics*, *15*(1), 45–74.

Rebucci, A., Hartley, J. S., & Jimenez, D. (2022). An event study of Covid-19 central bank quantitative easing in advanced and emerging economies. In A. Chudik, C. Hsiao, & A. Timmermann (Eds.), *Essays in honor of M. Hashem Pesaran: Prediction and macro modeling*. Emerald.

Rigobon, R., & Sack, B. (2002). *The impact of monetary policy on asset prices* (NBER Working Paper Series No. 8794). National Bureau of Economic Research.

Rigobon, R., & Sack, B. (2003). Measuring the reaction of monetary policy to the stock market. *The Quarterly Journal of Economics*, *118*(2), 639–669.

Sims, C. A. (1980). Macroeconomics and reality. *Econometrics*, *48*(1), 1–48.

Sims, C. A. (1986). Are forecasting models usable for policy analysis? *Federal Reserve Bank of Minneapolis Quarterly Review*, *10*(1), 2–16.

Schwarz, G. (1978). Estimating the dimension of a model. *The annals of statistics, 6* (2), 461-464.

Swanson, E. T. (2021). Measuring the effects of federal reserve forward guidance and asset purchases on financial markets. *Journal of Monetary Economics*, *118*, 32–53.

Vartanian, P. R., Citro, S., & Scarano, P. R. (2021). Determinants of spot and forward interest rates in Brazil in an international liquidity scenario: An econometric analysis for the period 2007-2019. *International Journal of Applied Economics, Finance and Accounting*, *10*(1), 19–31.

Whalen, C. R. (2008). The subprime crisis: Causes, effect and consequences. *Journal of Affordable Housing & Community Development Law*, *17*(3), 219–235.