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Do Financial Markets Allow the Independence of Central Banks?

Abstract: The research work presented below addresses the possible concern of central bank independence through the development and application of econometric models. The complexity of the modelling has allowed a step further in corroborating that financial independence is not only linked to the appointments and pressures of the states regarding their economic policy but also the role that financial markets play by acting as a force that dictates and contaminates decisions of central banks. In this sense, the paper proposes a theoretical basis for recommendations on the application of the new monetary policy in a more complex environment, both due to the pandemic that was sweeping the world and the bulky debt that countries are carrying. The paper concludes with a series of measures and suggestions that could be addressed by monetary policymakers given the necessary but not easy normalization of monetary policy required at the global level.

Keywords: Central banks, financial markets, monetary policy, forecasting and simulation, financial econometrics, business cycles, cointegration, co-integrated vector error correction model (VEC).

JEL Code: E58, E54, E52, E47, E32, C58.

1. Introduction

One of the main arguments about the independence of central banks is that strategic decisions are detached from the political cycle, which normally has a more short-term view. In monetary policy, it is vital to lengthen the time horizon to

more distant levels and to establish contained and stable measures concerning inflation expectations. Another factor to consider is the credibility of the institution through the appointment of key people who stand out for their technical expertise in monetary policy, and the credibility of their messages so that they show unity in decision-making. In the current COVID-19 framework and after the collapse of Lehman Brothers, central banks have increased their role in providing essential support in the financial markets, keeping interest rates low until 2022, and ensuring liquidity in these markets. In this context, monetary policy managers must preserve their independence and autonomy by conducting an appropriate monetary policy. Therefore, the present research aims to study the degree of independence of central banks in the face of the actions of the financial markets.

Alan Greenspan, the former chairman of the US Federal Reserve during the period 1987-2006, was the precursor of the creation of expectations about interest rates. As early as 1988 he commented that "the difficulty in forecasting interest rates lies in the fact that the Federal Reserve, by its nature, is involved in and has considerable influence over them, which is why it is very difficult to make forecasts without creating market instabilities".

In addition, the growing process of economic globalization over the last two decades, mainly after the collapse of Lehman Brothers in 2008, marked a turning point in the relationship between central banks and financial markets. The contagion effect on the markets led to a rethinking of the market's systematic risk theory. Thus, several studies concluded that most international capital markets have increased their integration and, consequently, greater systematic risk. Specifically, as financial markets become more integrated, the long-run effects share common trends, regardless of where they are located (Kasa, 1992).

Over the past 40 years, the structure of financial markets has been refined through the development of increasingly complex financial engineering. Although during these 40 years, there have been crises such as the one that occurred in October 1987, the panics, and bubbles of the 1990s, and the dotcom crisis of 2000, it was not until the crisis of 2007-09, with the collapse of Lehman Brothers, that the relational change between central banks and financial markets occurred (Hortalà, 2020). Indeed, the last global financial crisis was an important milestone for central banks initiating rounds of non-conventional expansionary monetary policy operations to avoid contagious economic disruption (Demirbas and Can, 2022).

The global financial crisis of 2007-09, together with the impact of the panic and sovereign debt crisis in Europe, pushed the U.S. and world economies into a deep recession, far beyond what could be managed using traditional monetary poli-

cies. After reducing short-term rates close to zero, the Federal Reserve and other central banks around the world resorted to alternative policy tools to provide stimulus, including large-scale purchases of financial assets with so-called Quantitative Easing (QE) and Forward Guidance, this last one a tool that refers to a central bank's communication about the state of the economy and the likely future course of monetary policy (Sutherland, 2019).

Forward guidance attempts to influence the financial decisions of households, businesses, and investors by providing a guide to the expected path of interest rates. In turn, this method attempts to avoid surprises that could disrupt markets and cause significant fluctuations in asset prices. Consequently, communication is becoming more and more explicit about the central banks' monetary policy outlook and plans, becoming a guide to monetary policy orientation, which, in the case of Europe and Japan, has led to uncharted territories such as negative yields, as well as massive purchases of debt and equity assets.

The COVID-19 pandemic has further evidenced and accelerated the great dependence of the financial markets on the extraordinary measures of central banks. As expressed by the former Federal Reserve Chairman Ben Bernanke, who suggests that the use of monetary policy rules must change if monetary policy is to remain relevant, warning that if short-term rates are constrained, this will have serious consequences for the development of the real economy (Bernanke, 2020; Kiley, 2014, 2018, and 2019).

However, most research papers find that massive purchases have eased financial stress, as well as helped the above all to gain time in implementing and facilitating reforms in countries where the cost of financing in the past was higher (Mulaahmetović, 2022; Tanaka, 2020). In these cases, and when necessary, the ECB has even added new stimulus when short-term interest rates were already at their lower bound. However, despite this easing of financial tensions and the temporary help to facilitate reforms in countries where the cost of financing was higher in the past, failure to normalize the situation may be the dominant trend in the coming decades leading to major problems of inequality and imbalance in the future.

The pandemic has been a clear accelerator of unconventional policy with the largest monetary and fiscal stimulus intervention in history (Vallet, 2021). The actions taken by central banks and financial markets are mainly reflected in their record-high indices across all asset classes, while unconventional monetary policies follow a very narrow pattern of short-term change. Therefore, the authors of this paper, through various econometric models, have been able to demonstrate

that certain reciprocal links between central banks and financial markets could be evidenced. The present research attempts to show that financial markets induce a force at the time of dictating monetary policy, which would entail less room for manoeuvre on the part of central banks to face future crises, despite the unconventional monetary policy already implemented by them. Likewise, the work proposes an additional advance on how the future orientation (forward guidance) should be, given the exit from the unconventional monetary policy in which the central banks around the world currently are involved.

The second section of this paper continues with the existing academic literature and the motivation behind conducting the research. The third and fourth sections provide the methodology, data, and the main results, concluding with some final remarks in the fifth section.

2. Existing literature

2.1. Central bank independence

There is no doubt that the independence of central bank decisions is good for monetary policy management. Nowadays, most central banks enjoy substantially higher levels of legal independence than they did twenty years ago (Cukierman and Muscatelli, 2008). However, more recent and detailed work such as that of Garriga, where he analyses detailed data from 182 countries during the period between 1970 and 2012, shows detriments concerning central bank independence (Garriga, 2016). To reflect the dimension of central bank independence, it should be narrowed down to three main dimensions: personal, financial, and politically independent (Berger, De Haan, and Eijffinger, 2008). At the personal level, it reflects the limits of influence in the positions and their permanence. Financial independence restricts the government's ability to use central banks to finance expenditures avoiding the subordination of monetary policy to fiscal policy. Finally, policy independence reflects the central bank's powers to formulate and execute monetary policy by setting milestones and targets on key macroeconomic aggregates.

Since the Great Recession of the last decade, monetary policy has never been the same again, not only because interest rates have remained at extremely low levels, but also because of the new tools that central banks have been developing in response to the new financial landscape. The first is the forward guidance of their monetary policy. This is widely stated in some of the works cited above, which reaffirm the notion that long-term interest rates are key returns in aggregate

spending decisions and the proposition that indications of intentions regarding future short-term interest rate policy can also affect longer-term rates. Nevertheless, central banks are cautious about providing forward guidance on interest rates for fear that this could generate adverse market reactions (Lunsford, 2020). The second refers to the multiple lending programs and the different Quantitative Easing programs adopted by central banks. Such programs adopt the purchase of different asset classes, such as government bonds, or securities issued by supranational European institutions, corporate bonds, asset-backed securities, and covered bonds.

However, as demand for assets increases more generally, this portfolio rebalancing mechanism causes prices to rise and yields to fall, even for assets not directly included in the central banks' purchase program (Krishnamurthy and Vissing-Jorgensen, 2011). Asset purchases send signals to the markets that the central bank will keep policy rates low for an extended period. This signalling effect reduces volatility and uncertainty in the markets regarding the evolution of interest rates in the future. Beyond the interconnections between different assets, the perception of "safety" in the face of low volatility underestimates the probability of implosions in financial markets (Piffaut and Rey Miró, 2019).

2.2. From the virtuous to the vicious circle of monetary policy

In the face of the great recession that hit the financial markets in 2008, even today, fourteen years later, the aftermath is still dragging on in terms of both leverage and risk perception. In addition, the failure to implement a deleveraging process, especially in the public sector, with global leverage being further accentuated by the current pandemic, is causing greater pressures on monetary and fiscal policy.

Abundant access to credit has meant that companies with junk bond ratings continue to have credit and, irrational as it may seem, are obtaining it daily at a lower cost as new debt issuance incorporates less and less investor protection. In this regard, yields on US corporate junk bonds are trading at historic lows at the end of 2021, around 3.78%. (High yield Credit Suisse, ISIN CH0428194226) Such a magnitude reflects a high degree of distortion because yields on so-called "investment grade" corporate bonds in 2018 and 2019, before the pandemic, were trading at higher yields. Finally, the sharp increase in corporate borrowing among emerging economies also reflects the possibility of accessing low-cost funding in dollars or euros, causing greater reliance on the Fed and the ECB. Sri Lanka's bankruptcy is a clear symptom of the vulnerability of those dependent economies on external financing.

In this context, the volatilities of most assets continue to be low, showing a more tolerant risk perception environment, generating an excess of optimism which, as Minsky pointed out, will eventually create greater instability (Minsky, 1992). In this sense, previous works by the authors showed that changes in the volatility frontier reflect an illusion of calm that, once exceeded, volatility contagion occurs with greater virulence, as was proven in the Covid-19 crisis where the VIX reached its historical maximum of 82.69 on March 16, 2020 (Refinitiv Eikon, 2020). Other studies such as that by Danielsson, Valenzuela and Zer (2016), which analyzes around 60 countries with data from sixty-year averages, conclude that throughout history a persistent decrease in volatility has predicted episodes of financial instability, especially when it settles below its recent trend. Furthermore, the authors of this article assert with the current study that strong interventions by central banks in some financial assets are leading to notable contractions in trading volume. Kihara and Sakaguchi (2021) give an example of this in the Japanese bond market where trading volume is observed to have fallen to a two-decade low in May 2021, dashing the Japanese central bank's hopes that a clarification of its policy intentions in March 2021 would revitalize an inactive market, leading to further inefficiency in the transmission of monetary policy.

While central banks have learned how to communicate forward-looking expectations, it must also be considered that the management of communication is increasingly dependent on the magnitude and quality of messages, which also carries a greater impact in addition to the management of all assets purchased by central banks. Such dependence may lead to differences between the responses of rational expectations by leaders and adaptive learning by market participants, leading to episodes of financial friction. Moreover, these results are particularly important for policymakers, increasingly evidencing a situation of total dependence, a hypothesis that will be developed and tested in the results section of this research.

2.3. The theory of reflexivity in monetary policy

The theory of reflexivity in financial markets states that the prices of financial assets play an active role and are also capable of influencing the leaders of central banks, and vice versa (Soros, 2003). As can be intuited, this feedback and dependency loop plays an interesting role. George Soros demolishes with his theory, especially with its implementation, some of the fundamental hypotheses of economic and financial theory, such as those of rational expectations and market efficiency (Muth, 1961). Soros`s critique goes even further when he warns us that many political decisions are taken around the world based on these erroneous

theories. It is in these cases that reflexivity leads to the formation of bubbles. However, there always comes a time when expectations are so far from reality that any small exogenous or endogenous event can trigger the reversal of the movement or the "bursting of the bubble", something that usually occurs much more violently than its formation with a sharp increase in volatility.

The theory of reflexivity is somewhat reminiscent of Heisenberg's uncertainty principle, which states that the observation of reality produces interference in its measurement, especially in a changing world with more and more financial products, a greater volume managed, and more fragmented markets (Hortalà and Rey Miró, 2019). The fallibility of the vision of an increasingly interconnected world is a risk inherent to monetary policy. This partial view can lead to inappropriate actions or even a lack of credibility in the future conduct of monetary policy by participants (Dong, Miao, and Pengfei, 2020).

In other words, to decision-making in monetary policy, which already shows cognitive and national scope limitations, we must add the effect of our personal decisions and that of other economic agents, which will contribute to a greater misunderstanding of reality. The consequence of all the above is that central banks, as the size of their balance sheets increases, will become more dependent on the reactions of the financial market itself.

2.4. Taylor's theory, neutral rate, and new limits

The Taylor rule establishes that the short-term interest rate is set by the central bank to maintain an inflation rate by its potential growth rate, a value that should ideally fluctuate between 3 and 4 percent (Taylor, 1993). The nominal interest rate proposed by the rule depends on the equilibrium value of the real interest rate, the deviation of the annualized period's output from full employment output (potential GDP), and the deviation of the annual price inflation rate from target inflation.

The interest rate calculated by the Taylor rule is higher than the equilibrium value when inflation is above the target and is lower when inflation is below the target, or the level of output is below full employment. More recent studies, such as those by Fazzari et al., incorporate the monetary policy component and show that monetary policy contributes to the stabilization of the level of economic activity. Even though monetary policy is active, the interaction of the multiplier and accelerator effects reflects those fluctuations and shows that the fields of action of monetary policy are not infinite (Fazzari, Ferri and Greenberg, 2008).

Moreover, findings show that a generalized equation fits the empirical interest rate better and has a lower sum of squares compared with the Taylor rule (Wang and Hausken, 2023).

The consensus of research on the subject has found that monetary policy goes beyond inflation control. Bernanke himself adopted actions and targets that were fully transparent, and such transparency and discipline must be adopted towards a nominal anchor (Bernanke, 2020). In this regard, there are three frames of reference in monetary policy; the definition of an inflation range, the adoption of nominal interest rate changes aimed at reaching the inflation target, and the independence of the central bank (Sawyer, 2006).

Current monetary policy challenges these frameworks. The first is the adoption of the so-called monetary printing by adopting stimulus measures that reflect inflationary pressures outside the target range. A consensus has emerged that the risk of doing too little is far worse than doing too much. However, in the face of such a magnitude of monetary printing, inflationary pressures are observed in most countries, but most intensively in the United States.

Extensions of the Fazzari model presented by Oreiro showing simulations of the Taylor model with bubbles, wealth effect, and monetary policy, reflect that these modifications, despite dampening the fluctuations of the cycle, still show expansions and recessions (Fazzari et al., (2008); Oreiro, Stacanto de Souza, Vila Nova de Souza and Pereira Guedes, 2013). Additionally, the introduction of bubbles in asset prices, which affect aggregate demand through the wealth effect, causes the appearance of irregular and persistent cycles. All this urges one to reflect on the fact that distorting the Taylor rule, as has been happening throughout the past decade invites one to be aware that recessionary cycles could be more persistent than past cycles due in large part to the distortion caused by the central banks themselves.

3. Methodology and data

Having defined the theoretical foundations that motivate this research, the present study is developed based on two well-defined objectives. The first objective is to determine the different Granger causality-type interrelationships between the Fed's monetary policy rate, fixed income assets, equity assets, and the VIX volatility index, while the second consists of providing an assessment of the Federal Reserve strategy. Intuitively, it would seem logical that, given the evidence of financial contagion and interdependence between the different financial mar-

kets globally, these correlations should also exist between the different variables (Piffaut and Rey Miró, 2017 and 2019). For the fulfillment of this objective, we proceed to the estimation of vector autoregressive models (VAR) and the Granger test to determine the possible causality relationships and interrelationships between the different variables.

Consider a VAR model with p lags.

$$y_t = v + A_1 y_{t-1} + A_2 y_{t-2} + \square + A_p y_{t-p} + \varepsilon_t \quad (1)$$

Where y_t is a vector of Kx1 variables, v is a vector of Kx1 parameters, A1-Ap are KxK parameter matrices and ε_t is a vector of disturbances or errors with mean 0 and covariance matrix, being also an independent random variable and identically normally distributed in time (i.i.d).

A VAR (p) model can be rewritten as a Vector Error Correction (VEC) model of the form.

$$\Delta y_t = v + \prod y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \quad (2)$$

where

$$\prod = \sum_{j=1}^{j=p} A_j - I_k \; y \; \Gamma_i = -\sum_{j=i+1}^{j=p} A_j$$

In the model, the parameters v and t in (1) and (2) are identical.

Engle and Granger show that if the variables y_t are I (1), the matrix in (2) has rank $0 \leq r < K$, where r is the number of linearly independent cointegrated vectors. If the variables are cointegrated, then $0 < r < K$, and equation (2) shows that a VAR in first differences is misspecified because it omits the lagged term y_{t-1} (Engle and Granger, 1987).

Specifically, Engle and Granger pointed out that a linear combination of two or more nonstationary series can be stationary. If there exists a linear combination of series that is stationary, I (0), the nonstationary series, i.e., the series with a unit root that gives rise to that combination are said to be cointegrated. The stationary linear combination is called the cointegration equation and can be interpreted as the long-run equilibrium relationship between the different variables that make up the equation, which is why it is of great importance for the analysis of economic phenomena.

It is important to note that the VEC model in (2) also nests two important special cases; first, if the variables in y_t are I (1), i.e. integrated of order 1, but are not cointegrated, then it is a matrix of zeros and therefore has rank 0; second, if all the variables are I (0), i.e. integrated of order 0, then it has full rank K.

The second objective is more challenging and consists of determining whether the Fed, after fourteen years of pursuing unconventional monetary policy since the 2008 crisis, is being a prisoner of its own strategy, which would make it difficult to see interest rates like those before the 2008 crisis again. For this purpose, a double logarithmic model for the estimation of elasticities is implemented, complemented by a Markov-Switching model.

The characteristic of a Markov-Switching model is its ability to capture the dynamics of time series that are also state-dependent. Additionally, it is important to emphasize that the time series included in the model are stationary series, applying the unit root tests detailed at the end of this section.

Thus, a convenient and appropriate assumption about the unobserved state is that it follows a Markov chain, and it is for this reason that the regime-switching models are known as Markov-Switching models. Initially, these models were developed by Quandt (1972) and Goldfeld and Quandt (1973), being extended to autoregressive (AR) and nonlinear processes by Hamilton (Hamilton, 1989).

The variable of interest in this model is the Federal Reserve's monetary policy interest rate, whose coefficients to be estimated using a Markov-Switching model, are represented in the following general equation.

$$FedRate = \alpha(S_t) + \beta(S_t) + (\sigma_t)\mu_t, \quad for\ the\ states\ S_t = \{0,1,2\} \qquad (3)$$

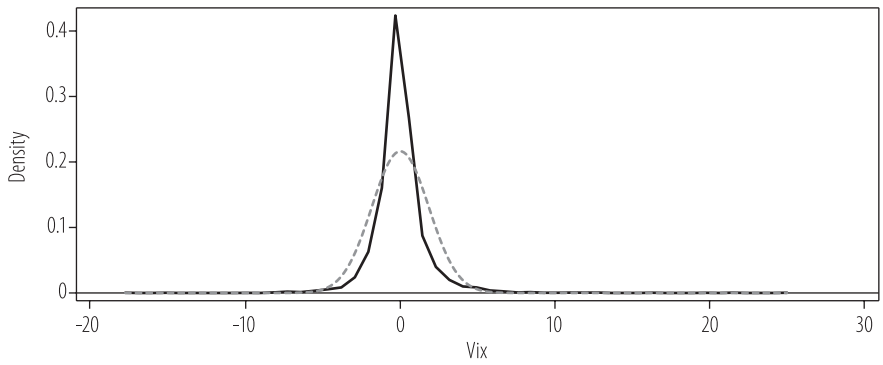
Equation (3) allows us to determine two important aspects of the Federal Reserve's monetary policy. The first is the estimation of parameters or average interest rates for the two periods defined by the monetary policy adopted by the Federal Reserve over the years: a period of "normal" monetary policy interest rates and a period of low interest rates. The second aspect is the determination of the dynamics established between both periods, such as the magnitude of persistence or probability of permanence in one or the other period or, as defined by the Markov-Switching model, the magnitude of persistence in States (S_t) 1 y 2.

Regarding the data, they correspond to the 2- and 10-year US Treasury bond returns, the S&P500 index that summarizes the movement of the equity markets, and the Fed's monetary policy rate. The series consists of 5,849 observations for the period January 4, 2000, to June 2, 2022. The data is also complemented by

the VIX series, which measures the volatility index, for the same period. In this regard, VIX is the ticker or abbreviation used to uniquely identify the Chicago Board Options Exchange Market Volatility Index.

The VIX is a number derived from the option prices contained in the S&P500 index and is a good indicator of expected market volatility and is a variable with a steeper or leptokurtic statistical distribution, outside the ranges of a normal distribution, like virtually all financial series and indices as shown in Figure 1.

Figure 1: VIX Index vs Normal Curve



Source: Authors' elaboration for the VIX in first differences.

The Figure highlights the normal curve in solid line indicating the leptokurtic distribution of the Volatility Index (VIX) in first differences. Table 1 summarizes the main statistics of the variables included in the models, with daily data series from January 2000 and June 2022. Data were obtained from Reuters, the Federal Reserve of St. Louis (FRED), and the Chicago Board Options Exchange Market (CBOE).

Table 1: Summary of Statistics

Index	N	Mean	St. Dev.	Min	Max.
BondT2Y (USA)	5849	1.96	1.69	0.11	6.91
BondT10Y (USA)	5849	3.20	1.34	0.49	6.78
S&P500 (USA)	5849	1820.61	919.25	676.53	4096.56
FedRate (USA)	5849	1.69	1.83	0.25	6.50
VIX (CBOE)	5849	20.03	8.72	9.14	82.69

Daily data for the period January 2000 - June 2022. Source: BSE, FRED, and CBOE.

The variables contained in the data are the 2-year US Treasury Bond (T2Y Bond), the 10-year US Treasury Bond (T10Y Bond), the Standard & Poor's 500 stock index (S&P500), the Federal Reserve interest rate (FedRate), and the volatility index (VIX). The variables reflect the equity markets, fixed income, the Federal Reserve (Fed) policy rate, and the VIX volatility index.

As usual, when analyzing time series data, one must consider the presence of unit roots in both the index series and the exchange rate data. In the case of financial series, returns are obtained from the logarithmic difference between the current value and its first lag, which makes the series naturally stationary. For the case of the VIX index and the Fed's interest rate change, the presence of unit roots is found, therefore, these series were included in the first differences in the respective econometric models.

The unit root tests applied are the traditional Dickey-Fuller ADF test (Dickey and Fuller, 1979), the PP test (Phillips and Perron, 1988), and the KPSS test which takes stationarity as the null hypothesis (Kwiatkowski, Phillips, Schmidt, and Shin, 1992). Additionally, the application of the ADF (Augmented Dickey-Fuller) test with an indication of the breakpoint in the series of Federal Reserve rates which estimated that there is a breakpoint on September 17, 2007, the date on which the financial crisis effectively began, and which marked its peak with the collapse of Lehman Brothers a year later, on September 15, 2008.

It is important to emphasize that of all these tests, the one proposed by Kwiatkowski et al. (1992) is perhaps the most consistent and rigorous when determining the presence of unit roots in the series, especially if the series does not represent an abundant number of observations, which is not the case in this study, but it is important to bear this in mind (Metes, 2005). For the case of the series used in this study that had to be used in first differences, all of them successfully pass the full set of unit root tests, so the series fully included in all models are stationary time series.

4. Results

4.1. Granger causality

Prior to the analysis, the optimal number of lags for the proposed VAR models is determined to be two lags based on the usual information criteria (AIC, BIC, and HQIC), indicating the high persistence present in volatility, spreading its effects on the markets over several weeks.

It is worth mentioning that Johansen's test was performed before implementing and using the VAR models. The main objective of this test is to rule out the possible presence of cointegration in the series. The main results based on the trace test and the maximum characteristic value test suggest the presence of at least two cointegrating equations at the 5% significance level. Due to the presence of cointegration, the equivalent vector error correction equation (VEC), derived from the corresponding cointegration test, was estimated for all the VAR equations. It is worth remembering that, in the presence of cointegration between variables, the VAR models are not adequate and must be replaced by their VEC equivalents. Only after this correction has been made, do the authors apply the Granger causality test to establish possible causal relationships between the different variables.

Based on the results of the VEC models, it is concluded that there is a Granger causality type relationship that goes from the Federal Reserve Rate and the VIX on the 2-year US Bond (T2Y Bond); similarly, there is a Granger causality type relationship from the Federal Reserve Rate to the S&P500; Finally, the Federal Reserve Rate and the 2-year US Treasury Bond have a Granger-type causal relationship with the VIX, most of these relationships with a statistical significance level of 1% and two of them with a statistical significance level of 10% (Table 3).

It is worth noting that there is also a Granger causal relationship from the variables of the model to the Federal Reserve Rate, i.e., according to the model two of the variables included would influence the Federal Reserve's decisions; the two-year US Treasury Bond and the VIX. Table 3 summarizes these relationships in which the only bidirectional Granger causal relationship occurs between the Federal Reserve and the two-year U.S. Treasury Bond (T2Y Bond). This implies that there is a two-way causal relationship between the behaviour of the two-year bond market (T2Y Bond) and the Federal Reserve (FedRate). In other words, the Fed's decisions affect the behaviour of the 2-year bond and vice versa.

Table 3: Granger Causality Relationships

BondT2Y (USA)	S&P500 (USA) *
	FedRate (USA) ***
VIX (CBOE)	BondT2Y (USA) ***
	FedRate (USA) ***
FedRate (USA)	BondT2Y (USA) ***
	S&P500 (USA) *
S&P500 (USA)	VIX (CBOE) **

Source: Authors' elaboration based on VEC results. *** p<0.01, ** p<0.05, * p<0.1

It is necessary to emphasize that for each estimated model the Durbin-Watson statistic for serial autocorrelation of a lag is close to its ideal value of 2.0, which validates the robustness of the VEC models estimated in this section (Durbin and Watson, 1951).

4.2. Estimation of elasticities and persistence test

One of the hypotheses put forward at the beginning of this research is that, given the implementation of extended periods of unconventional monetary policies, the Federal Reserve ended up being a prisoner of its own expansionary policy. In this regard, a double logarithmic model was estimated using the 10-year US Treasury bond (T10Y bond) as the dependent variable to determine the value of the elasticity of the Federal Reserve's interest rate in two different periods after the bankruptcy of Lehman Brothers. Indeed, the elasticity of the Fed variable is 1.74 times higher in the second half compared to its effect in the first half, i.e., we can assert that the persistence or the dependence of the Fed's monetary policy is 1.74 (0.0269/0.0154) times higher during the period between December 2014 and June 2022 than in the period between September 2008 and December 2014 (Table 4).

Table 4: Estimated Elasticities

VARIABLES	(1)	(2)
	Model (2008-2014)	Model (2014-2022)
FedRate	0.0154*	0.0269***
	(0.000)	(0.011)
VIX	-0.0227***	-0.0257***
	(0.002)	(0.002)
BondT2Y	0.3097***	0.4564***
	(0.000)	(0.000)
Constant	0.0522***	0.0584***
	(0.005)	(0.005)
Observations	1.345	2.226
R-squared	0.55	0.53

Standard error in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Even though the estimation of elasticities gives veracity to the hypothesis raised about the Federal Reserve's dependence on its expansionary monetary policy to keep the economy functioning at its current level, the previous results are complemented with a Markov-Switching model as a way of corroborating the previous result and to shed some evidence about the persistence of this behaviour of the Federal Reserve.

In effect, the model estimates two quite different periods; period 1 or State 1, characterized by a monetary policy on the part of the Federal Reserve in the most traditional sense, determined by movements in the interest rate to keep inflation contained between 2% and 3%. Thus, the average interest rate of State 1 is 3.35%. On the other hand, State 2 is characterized by an unconventional monetary policy with periods of maximum quantitative easing and an average interest rate of 0.65%, but with values close to 0.25% during long intervals of time.

It is important to emphasize that the Markov-Switching model allows us to clearly distinguish these two very dissimilar periods in the Federal Reserve's monetary policy. Tables 5 and 6 summarize the main findings and conclusions on this issue.

Table 5: Transition probabilities

State	Transition Prob.	St. Error.	[95% Conf.Interval.]	
P1	0.50	0.12	0.27	0.73
P2	0.50	0.12	0.27	0.73
P3	0.01	0.00	0.00	0.00
P4	0.99	0.00	0.99	0.99

Table 6: Expected Duration of Events

State	Expected Duration	Std. Error.	[95% Conf.Interval]	
State 1	2	0.27	1.59	2.68
State 2	207	39.01	143.02	299.46

Relevant information can be extracted from Tables 5 and 6. According to the transition probabilities in Table 5, which identifies two different states for the Fed's monetary policy, the P1 value of 0.50 indicates the probability of remaining in State 1, i.e., the state before the 2008 financial crisis. On the other hand, the P2 value of 0.50 indicates that the probability of moving from State 1 to State 2 is 50%. Finally, the P4 value indicates that once the Fed's policy reaches State 2, where it is currently, its probability of remaining in this State is high and very persistent with a probability of 0.99 or 99%. In other words, once the Fed transits from State 1 to State 2, a very deterministic fiscal, monetary, or macroeconomic policy is required so that the execution of that policy allows the Fed to transit from State 2 to the initial State 1. Simply put, the likelihood of the Fed's monetary policy returning to its pre-2008 conventional state is improbable, at least in the short and medium term, which translates into low-interest rates for a considerable period, but which is contradicted by the ongoing inflationary spiral.

In addition, Table 6 indicates that the estimated duration of stay in State 1, the period of a monetary policy closer to the conventional is only 2 days. In contrast, the average number of days of stay in State 2, the current state, reaches an average duration of 207 days. It should be noted that this average duration measured in days in no case represents the exact reaction time of the Federal Reserve but is a reference to the lack of flexibility that the Federal Reserve must act in the face of events in the stock market and the real economy, confirming all the above.

Regarding interest rates, the values reported for each State are average values because the period after Lehman's collapse shows minimum rates of 0.25% and maximum rates of 2.5%. This result was obtained after estimating different models and combinations of models. Econometric criteria determined that the model

reported here is the one that meets the criteria and econometric tests (multicollinearity, serial autocorrelation, heteroscedasticity, and omitted variables test, among others).

The results described above provide information about the current situation, or the crossroads at which the Federal Reserve (Fed) finds itself. On the one hand, the current global situation does not allow it to normalize its balance sheet, let alone reduce monetary stimulus through a low interest rate. In the current scenario, a sharp rise in interest rates would simply have a major impact on the real economy, consumption, investment, and employment. On the other hand, this long quantitative easing has been pushing prices upwards, although the CPI has improved its recording field, the estimation of the consumer price index is not accurate enough in the sense that it makes use of traditional methodologies, which do not include quality adjustments that better reflect the rises or falls of this indicator.

In this sense, both the Federal Reserve and recently the ECB have specified that the 2% target is a long-term measure for the current global macroeconomic environment. In other words, inflation is going to be well above 2% due to the compensation of several years below this mark. However, the CPI data show a false inflation containment, reporting increases in food and fuel of over 5%. Figures estimated by the U.S. Bureau of Labor Statistics and non-official agencies report increases in basic food and fuel prices that, on a transitory basis, border on increases between 15% and 17% during the first half of 2021 and even higher during 2022 (Moblus, 2021; U.S. Bureau of Labor Statistics, 2022).

Everything indicates that in the near rather than the distant horizon, the Federal Reserve will have to somehow normalize, step by step, its monetary policy. The worrying thing is that its room for manoeuvre has been getting smaller and smaller, aggravated by the current health situation and the possibility of stagflation that could affect the world in the near rather than distant future.

5. Conclusions

The central banks' ability to act has been forceful and effective in safeguarding the financial system over the last decade, but at the same time, it has led to an increasing dependence both in terms of the mechanisms implemented and the messages addressed by these institutions.

Given this scenario and observing the different econometric models proposed, new forward guidance should be addressed, which should describe more complete and accurate information regarding future expectations. The possibility of complementing complete guidance with different scenarios and policies, with a detailed description of the sequence as well as the pace of any plan to escape from the current stance, should be paramount for the best exit strategy from this unconventional monetary policy.

The paper raises a paradox about unconventional monetary policy, and that is that unorthodox interventions have reflected the omnipresence of central banks causing minimal trading volume in some markets. It is no coincidence that the world's largest bond market, the Japanese market, in May 2021 reflected the lowest bond trading since 2002 despite being the largest financial market for this instrument. Therefore, interventions, both in terms of size and long-time horizons, undermine and alter the allocative efficiency of the market itself. Further work could investigate whether such unconventional monetary policy causes a delay in monetary policy intervention and makes it increasingly dependent on financial markets.

Another conclusion we address is the future direction of central bank purchases. Communication on the flow, the composition of new purchases, and the reinvestment policy, which governs the destination of the asset portfolio, will be important to observe the respective behaviours. In practice, previous guidance in this area has been weak, and therefore, in the coming years, emphasis should be placed on the results and how they are to be addressed, to make monetary policy more credible for economic agents.

On the other hand, the establishment of monetary policy guidelines, both at the level of the economic cycle and inflation targets should be essential pillars for financial stability. Setting higher inflation targets and targeting price ranges, rather than a target inflation rate, are proposals for a new economic policy. Also, the expansion of both the size and coverage of asset programs should be approached in a gradual and well-coordinated manner among the major central banks. In a global financial system where the intensity of monetary policy is increasingly transmitted transnationally, a policy of gradual stimulus withdrawal will have to be addressed among the world's five major central banks. Still, it will also be subject to and contingent on the evolution, so far considered transitory, of the inflationary component in the world's major economies.

Given the dynamics of the financial markets, the authors, as evidenced in previous works, conclude that the transmission of the behaviour of yields and vola-

tility in the US market, exert a noteworthy influence on these in the rest of the global markets. Seventy percent of the world's central banks follow and emulate the strategies implemented by the US Federal Reserve. Diverging from the U.S. monetary policy could lead to sharp currency depreciations in the short term in countries with large external deficits.

The effectiveness of forwarding guidance may be compromised by a lack of credibility and by the limits of monetary policy itself. Concerning the first point, consideration should be given to the merits of conducting regular reviews of the strategy that provide obvious break points at which a central bank may default on any change in the reaction function. On the second point, the central bank could usefully supplement this guidance with an estimate of the fiscal stimulus required to stabilize the economy or prices, to incentivize the fiscal authority to coordinate both economic policies over the long run. However, total independence of monetary policy must be guaranteed, and the agency must not become politicized.

Finally, and as a collateral effect of the dynamics of the monetary policy implemented during the years following the 2008 financial crisis, central banks have discovered that not only can they control the cost of money in the short and long term through interest rate fluctuations and the so-called quantitative easing (QE), but they have also discovered something much more important and relevant, which is that they can also control the investor's perception of risk, which places us in a new paradigm of monetary policy yet to be resolved.

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