IFRS9: Using SAS/ETS® Software and SAS® Studio to Select Macro Economic Variables

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ABSTRACT

Published in 2014 by the International Accounting Standards Board (IASB), applying IFRS 9 (International Financial Reporting Standard) to financial instruments will be mandatory beginning January 1, 2021, in accordance with the Central Bank of Brazil. As the impairment model for IFRS 9 is forward-looking, banks in Brazil are required to consider future economic scenarios to calculate ECL, which brings new challenges to modeling teams. In particular, we have identified a set of conditions that make monetary and fiscal policy mutually influence each other in a perverse way. One of these conditions is what we call fiscal dominance: an increase in the interest rate makes public debt dynamics unsustainable, which leads to a rise in the inflation rate rather than a reduction.

If this hypothesis is confirmed, the entire IFRS 9 modeling structure should be based on these assumptions, since the forward-looking PDs or the expected credit loss (ECL) calculation would not only include macroeconomic variables related to the respective sector, but also asset prices that affect the whole system. In that case, there was a scenario in which the individual PDs suffer from systematic influence of a widespread increase of risk caused by an increased likelihood of default of sovereign debt in relation to the monetary policy tightness. We have developed a set of models, VAR/VECM, and related tests using SAS/ETS® and SAS Studio® to evaluate that theory.

INTRODUCTION

IFRS 9 Financial Instruments is the IASB's replacement of IAS 39 Financial Instruments, which brings important changes to the financial system, especially in the provisioning for losses of financial assets. The Central Bank of Brazil has discussed with the sector important issues for the adequacy of the Brazilian market. IFRS 9 establishes a new approach to the classification and measurement of financial assets that takes into account the business model in which the assets are managed and the characteristics of cash flow. Among other resolutions, it replaces the impairment model based on *losses incurred* from IAS 39 by a prospective model based on *expected credit losses* (ECL). The ECL model shall be applied to financial assets measured at "amortized cost" and the impact of changes in economic factors on loss estimates must be taken into account, which will be determined on the basis of weighted probabilities of default. Alongside monitoring changes in LGDs, exposure amounts, collateral values, migration of default probabilities and internal borrower credit risk grades, models used in the ECL calculation must consider current and historical forward-looking information, which includes macroeconomic variables that should be embedded in measures of PDs. Therefore, as IFRS 9's impairment model is forward-looking, banks in Brazil are required to consider future economic scenarios to calculate ECL, which brings new challenges to the modeling teams, compared to those of developed countries.

Among the problems facing the specialists in risk modeling is lack of reliable economic theory and data given the unawareness concerning the coordination of fiscal and monetary policies in Brazil, meaning that the decision of choosing the macro variables to IFRS 9's impairment model may be taken on the basis of wrong information. It may occur due to misunderstanding of the real macroeconomic structure in Brazil. Non-conventional patterns of fiscal and monetary coordination may arise due to the macroeconomic uncertainty, as the country's new economic agenda is in full swing under a weak economic environment –

still struggling to overcome the fiscal crisis generated during the period of the New Macroeconomic Matrix, introduced by President Dilma Rousseff in mid-2011 - 2015. An economic turnaround is slow coming, though economic agents are still wondering if this is the best time to invest in Brazilian assets – which will depend of the political ability of the new government to pass legislation and implement other needed reforms.

In particular, we have identified a set of conditions that make monetary and fiscal policy mutually influence each other in a perverse way. One of these conditions is what we call fiscal dominance. Roughly speaking, a country is in fiscal dominance when an increase in the interest rate makes public debt dynamics unsustainable, which leads to a rise in the inflation rate rather than a reduction. Rising interest rates would increase the perception of debt default risk, inhibiting capital inflows and depreciating the currency. This effect, in addition to raising inflation, worsens debt dynamics and causes further rises in risk premiums and further currency depreciation.

THEORY

The first monetarist assumptions of fiscal dominance undertake that monetary policy can not permanently influence levels of output and employment. However, monetary policy can exercise significant control over inflation in the long run, implicitly inferring some coordination between the two parties. However, nothing permits us to infer that there can be no cases in which the fiscal and monetary authorities, each in possession of their policy instruments, have different preferences, and in this way, uses them in a non-cooperative manner, which likely to imply unwanted outcomes for society. It would therefore be necessary to consider the circumstances in which this difference of objectives predominates, especially in a special case: when discretionary actions of the fiscal authority threatens the credibility and commitment of the monetary authority with price stability.

In this context, there are studies that consider the possibility of perverse effects of fiscal policy on monetary policy, which is commonly referred to in the literature as fiscal dominance, and which will be a condition in which the monetary authority may become unable to control inflation. One of the first approaches was proposed by Sargent & Wallace (1981) according to which, in a context of an economy that satisfies monetarist assumptions - namely: (1) the monetary base is closely related to the level of prices; (2) the monetary authority is able to increase the tax revenues from the base expansion, termed seigniorage - in some cases, the power of control of this authority over the price level can actually be limited if the tax authority imposes dominance over the monetary one, in the sense that the latter will come up against the restrictions imposed by the actions of this first one and the demand for government bonds.

Implicit in Sargent & Wallace's (1981) approach is the conception that government must respect its intertemporal budget constraint, so that the value of public debt should equal the discounted present value of the flow of budget surpluses, which can be generated by the two sources described above. An alternative approach was developed by Woodford (1995, 2001) and other authors, called Price Level Tax Theory.

Distinct from Sargent and Wallace's (1981) view, the intertemporal budget constraint of the government is a condition of equilibrium and, therefore, will be, together with fiscal policy, the factors that determine the equilibrium price, while for the former this restriction worth for any price level. In addition, there is one more important distinction between approaches: in the monetarist conception, the fiscal authority may be impelled to take a balanced stance on fiscal deficits and the trajectory of debt if the monetary authority maintains a credible commitment to stability of prices. This could be achieved through an independent central bank. But on the other hand, according to the TFNP approach, this is not a sufficient condition for guaranteeing price stability, because the Central Bank can not be indifferent to the way fiscal policy is determined. In other words, the mere commitment of the Central Bank to a monetary policy governed by a Taylor rule is insufficient to ensure a low and stable rate of equilibrium inflation if there is no coordination established between the two authorities (WOODFORD, 2000).

According to this theory, there may be a non-Ricardian fiscal regime in which the government's primary surpluses are stipulated independently, and it is not necessarily required that the trajectory of the public debt remain controlled. In this case, to meet the present value of the budget constraint, it will be the price level that should adjust, and we will be in the condition where there is fiscal dominance. Conversely, under a Ricardian fiscal regime, fiscal policy passively adjusts the primary surplus to ensure government solvency for any trajectory of the price level, and thus the traditional conception will remain in which the price level will depend on the performance of the authority monetary policy. In the latter case, fiscal performance does not prevent the Central Bank from pursuing an inflation target.

Analyzing Brazilian economic history since the implementation of the Real Plan, monetary policy in Brazil has operated in a high real interest rate regime, under threats of external insolvency on many occasions, with largely unpredictable fiscal outcomes. Therefore, there is evidence and theoretical reasons to consider that Brazilian economy is a candidate for fiscal dominance. In that case, regarding the application of these concepts to the Brazilian case, the standard reference is Blanchard (2004), entitled "Fiscal Dominance and Inflation Targeting: Lessons from Brazil".

> "A standard proposition in open-economy macroeconomics is that a central-bank-engineered increase in the real interest rate makes domestic government debt more attractive and leads to a real appreciation. If, however, the increase in the real interest rate also increases the probability of default on the debt, the effect may be instead to make domestic government debt less attractive, and to lead to a real depreciation. That outcome is more likely the higher the initial level of debt, the higher the proportion of foreign-currency-denominated debt, and the higher the price of risk. Under that outcome, inflation targeting can clearly have perverse effects: An increase in the real interest in response to higher inflation leads to a real depreciation. The real depreciation leads in turn to a further increase in inflation. In this case, fiscal policy, not monetary policy, is the right instrument to decrease inflation". (BLANCHARD, 2004).

This was a topic of debate for the Brazilian case in 2015. Economists were divided into two groups: the first group argued that the COPOM should not resume the cycle of tightening interest rates, even in the face of rising inflation expectations, once that this would lead to a worsening in the dynamics of inflation. The second should resume the tightening of monetary policy so as not to demonstrate to the market that it had lost the ability to push inflation to its goal.

However, we believe that even this hypothesis is currently too extreme to create a consensus. However, we consider it extremely plausible to have an intermediate situation in which the conduct of monetary policy does not necessarily lead to the explosion of public debt. But it is enough to impose a strong constraint on fiscal adjustment, which, in turn, creates uncertainty about meeting the central bank's goals. This is a condition that would affect the whole system, which would have a strong impact on the ability of companies to honor their debts, that is, it has a direct impact on the probability of default. If this hypothesis is confirmed, the entire IFRS 9 modeling structure should be based on these assumptions, since the forward looking PDs for the ECL calculation would not only include macroeconomic variables related to the respective sector, but also asset prices that affect whole system, as we shall see below.

We believe that this intermediate situation is possible because of the combination of the following factors: weak GDP growth, growth of government revenue that depends on nominal GDP, and its expenditures are indexed to past inflation, or are largely rigid. Thus, under these conditions, tight monetary policy results in a contraction of GDP. And the contraction of GDP makes the fiscal adjustment more time consuming and uncertain, which in turn, causes impact on asset prices and inflation expectations, jeopardizing the potency of monetary policy. In other words, a worsening of the primary result signals to the market the difficulty of stabilizing public debt. Even though the debt dynamics have not gotten out of control, uncertainty causes the market to react with increased country risk, currency depreciation and worsening inflation expectations.

MODELS AND DATA

The nominal interest rate is the overnight rate (the interest that the Government pays to banks that lent him money), in percentage, which we call SELIC. This is the basic interest rate of the economy and serves as a benchmark for other interest rates in the country and is the instrument of Central Bank's monetary policy. The exchange rate EXR is the nominal rate of currency BRL versus US$. SWAP is a derivative that reflects market expectations with regard to interest rates. EMBI is the country risk index calculated by JP Morgan and CDS is the corresponding derivative of 5 years that protects investors against default on sovereign debt (which can also be considered a measure of risk). From econometric models of time series we can test the assumptions described above. The condition of fiscal dominance in your weak version can be established if there is evidence that the interest rate controlled by the central bank because of systematic risk impacts country (EMBI and CDS), directly or indirectly through the worsening of surplus primary. We use SAS/ETS® tool to run the vector autoregressive models and cointegrated models VAR/VECM, as well as to perform the tests, validation of the models and analyses of the residuals. SAS/ETS® provides excellent flexibility to perform these functions.

ECONOMETRICS

Unit Root Test

The VAR approach as well as other methodologies that involve time series, requires that the variables referred to be stationary to prevent the problem of spurious relation (on regression). A spurious regression features high R2 and significant statistics t but do not have any economic significance. To check the stationarity of the series were used the traditional unitary root, ADF (augmented Dickey-Fuller), presented at Dickey-Fuller (1979.1981) and the Phillips-Perron (PP) presented in Phillips-Perron (1988). Additionally, we will apply the modified test of Dickey-Fuller ADF-GLS proposed by Elliott, Rothenberg & Stock (1996), which is an alternative approach to the tests above, since they allow you to circumvent some of the problems of conventional tests such as, test size distortions and low statistical power.

The simplest models of the Dickey-Fuller test considered three types of regressions that can be used to test the stationarity:

$$\Delta y_t = \beta y_{t-1} + \epsilon_t \tag{1}$$
$$\Delta y_t = \alpha_0 + \beta y_{t-1} + \epsilon_t \tag{2}$$
$$\Delta y_t = \alpha_0 + \alpha_1 t + \beta y_{t-1} + \epsilon_t \tag{3}$$

The difference between these are due to the presence or not of the deterministic elements of intercept α_0 and trend $\alpha_1 t$. The parameter of interest is β, if β = 0, and the series y_t contains unit root and, therefore, do not reject the null hypothesis that the series will be non-stationary level (against the alternative hypothesis that 0 β < series is stationary). The estimation of this parameter is done by ordinary least squares (OLS), and compare the statistic t with appropriate values computed by Dickey-Fuller to reject or not the null hypothesis of unit root, that is, if β = 0. Therefore, it is common to designate this statistic, not like t, but as τ **statistic**, once your distribution is not the same as the statistic t common, even asymptotically. (DAVIDSON & MACKINNON, 2004). This is due to the Monte Carlo studies of Dickey-Fuller, which found that the values for β = 0 would depend on the size of the sample and of the functional form of the regression. Therefore, there will be statistics suitable for each case – if there is no intercept either the deterministic trend, only intercept, or if the two terms are present – the statistics τ, τ_μ e τ_τ. The choice among the three types of models can be based on other three F statistics calculated in Dickey-Fuller (1981) to test the hypothesis of coefficients, that is, once again, suitable for each case presented above.

However, as not all stochastic processes can be represented by a first-order detect process using commonly the ADF test Dickey-Fuller is necessary. This is due to the fact that the unit root tests assume that the errors are independent and have constant variance, but the omission of relevant variables in the model may violate the condition of no autocorrelation in the residuals. The proposed use of an ADF is to include regressors in differences in the same length is the order of the process of the error term. Therefore, the test takes the following specification, and we can test the existence of unitary root exactly according to the above procedure.

$$\Delta y_t = \alpha_0 + \alpha_1 t + \beta y_{t-1} + \sum_{i=2}^{p} \beta_i \Delta y_{t-1+i} + \epsilon_t \qquad (4)$$

Therefore, as the true order of the detect process is generally unknown, so the challenge is to find the number of lags. Including lags in excess reduces the power of the test to reject the null hypothesis of unit root, since the estimation of these additional parameters implies loss of degrees of freedom. On the other hand, few lags do not capture appropriately the process the error term, which will mean that β and the errors will not be standards well estimated. A valid procedure would start with an arbitrarily large number of lags and the removal of these from the higher, based on statistical significance t and/or F, repeating the process until the largest gap is significant. We can use the Akaike criteria and/or Schwarz to support that procedure. In this paper, we use the second, which tends to be more thrifty about the lags (DAVIDSON & MACKINNON, 2004).

In practice, if the serial correlation of the error term of the model is well adjusted to an AR (p) low-order, in moderately sized samples the ADF test shows a good performance. However, if the error term follow a pattern more complicated as an MA or even GUN, so, the ADF can present problems. (DAVIDSON & MACKINNON, 2004). Therefore, with regard to the problem of determining the lags explained above to avoid waste, an autocorrelation test alternative Phillips-Perron (PP) presented in Phillips-Perron (1988). In short, your test is to use modified statistics of Dickey-Fuller statistic τ to retain degrees of freedom in the model, since this method would include additional lagged variables anymore (to make the white noise error term), as is done in the ADF, which lessen the problem of excessive lags, above. In addition, the critical values tabulated for the PP test are exactly the same data by DF tests.

However, this does not solve the problem, the problem of appropriate selection for the lag order of the term increased. In addition, the extraction of time series trend using OLS is inefficient. Therefore, an alternate procedure proposed by Elliott, Rothenberg & Stock (1996), designated as ADF-GLS is to use generalized least squares (GLS) to remove the stochastic trend series, and subsequently, applying the standard procedure to calculate the statistics ADF-GLS by regression for OLS, to test if β = 0, in the series $\tilde{y}_t$ contains a unit root and, therefore, do not reject the null hypothesis that the series will be non-stationary level, against the alternative hypothesis that 0 β < series is stationary. $\tilde{y}_t$ will be the series with trend removed by GLS, and e_t will be autocorrelated and not as a homoscedastic residual, in the model:

$$\Delta \tilde{y}_t = \beta' \tilde{y}_{t-1} + \sum_{i=1}^{p} \beta_i \Delta \tilde{y}_{t-i} + e_t \qquad (5)$$

Regarding to the problem of proper choice of lags, Ng and Perron (2001) show that when you have a negative polynomial root moving averages in the series, Akaike information criteria and Schwarz tend to select low values for the lag p, distorting the results of the tests. Soon, in order to minimize distortions caused by improper selection of lag in the equation using the Akaike information criterion is modified for the selection of the autoregressive lag. The combined application of this criterion modified with the ADF-GLS, according to these authors, produce more robust results compared to traditional tests, since it gets test with greater power in addition to smaller statistical size distortion.

Multivariate Causality

The analysis of causality in this work is given by a vector model detect estimation (VAR) that brings together all the variables mentioned above. The concept of causality in the sense of Granger is associated with the idea of temporal precedence between variables, such that, if a variable A_t contains information that helps in predicting another variable B_t (and if this information is not contained in other

series used in the model), then A_t Granger cause B_t (GRANGER 1969). The VAR approach proves to be useful if the goal of the empirical analysis is uniquely determine interdependencies among a set of variables statistics, what does this methodology, a complete specification of the economic structure in question . The VAR in reduced form of size p can be written as:

$$x_t = \boldsymbol{\phi}_0 + \boldsymbol{\Phi}_1 x_{t-1} + \boldsymbol{\Phi}_2 x_{t-2} + \cdots + \boldsymbol{\Phi}_p x_{t-p} + \boldsymbol{e}_t \tag{6}$$

x_t is a vector ($n \times 1$) containing each of the n variables included in the VAR standing, $\boldsymbol{\phi}_0$ is a vector ($n \times 1$) intercept terms, $\boldsymbol{\Phi}_i$ is the matrix ($n \times n$) coefficients, e_t is a vector ($n \times 1$) white noise error term, with zero mean [E(e_t) = 0], contemporary nonzero covariances [E($e_t e_t'$) = Σ] and covariances contemporary not equal to zero [E($e_t e_s'$) = 0, $t \neq s$], p is lag number.

The above equation, one can see that, in the VAR, there are no contemporary relations between variables of the system, but between your shocks. This type of VAR is named unrestricted, which differs from structural VAR, in which some kind of structure is imposed on the VAR for the same show a contemporary relationship between variables of the system. The biggest criticism of VAR models with respect to your little theoretical foundation, which makes the role of the researcher to simply choose the most appropriate variables to be included in the system in question, a condition that can contribute to the generation of results that do not possess significant economic content. However, the use of VAR is relevant in cases where the structure of the relationship between the variables of interest is not defined, given the complexity of the underlying theory. More than that, according to Sims, Stock and Watson (1990), one of the goals of the VAR analysis is to determine the interrelationship between variables and not only estimation. i.e., in macroeconomic models can work with a VAR unrestricted even if the result we reveal "over-parametrization", in the sense that many of the estimated coefficients remain insignificant. This is because we can prioritize the identification of this interrelation between the variables, and does not attempt to perform short-term forecasts. ENDERS (2003) VAR unrestricted formulation begins with the choice of variables that will be part of the system to be reviewed, to later set the order of the VAR (i), i.e. the number lags to be included in the model. One of the methods to select the order is the decision based on Akaike information criteria (AIC), Schwarz (BIC), Hannan-Quinn (HQ) whose expressions are respectively listed below:

$$AIC(i) = \ln\left(\left|\widetilde{\Sigma}_i\right|\right) + \frac{2k^2 i}{T} \tag{7}$$

$$BIC(i) = \ln\left(\left|\widetilde{\Sigma}_i\right|\right) + \frac{k^2 i \ln(T)}{T} \tag{8}$$

$$HQ(i) = \ln\left(\left|\widetilde{\Sigma}_i\right|\right) + \frac{2k^2 i \ln(\ln(T))}{T} \tag{9}$$

Where T is the number of observations in the sample used, being k for the coefficients of the matrix dimension VAR and $\left|\widetilde{\Sigma}_i\right|$ the determinant of the matrix of variance-covariance of the error. We have, therefore, that the selection of the order of gap can be made according to criteria of information above.

As the right side of the equation VAR above contains only predetermined variables and if the term is autocorrelated and not have constant variance, each system equation can be estimated by OLS, in process that will result in indicators consistent and asymptotically efficient. Then, the analysis of causality does not require the estimation of structural parameters, and there is no need to adopt any strategy of ID in the above system. The maximum likelihood method may also be used, both being asymptotically equivalent, except that the estimates are asymptotically normal under regular conditions. (TSAY, 2005). After estimation we should perform tests to check the model, checking your fitness. First, we must check the condition of stability of VAR. Precisely, rewriting the equation above using difference operators, obtaining VAR(p),

$$(I - \Phi_2 B - \cdots - \Phi_p B^p)x_t = \boldsymbol{\phi}_0 + \boldsymbol{e}_t \tag{10}$$

Must also be carried out tests to verify the autocorrelation (LM test and/or Portmanteau test); normality test (Jarque-Bera) and homoscedasticity of the residues of the VAR. The presence of autocorrelation in the residuals can indicate poor model specification used, while the absence of normality can be a clue to the presence of outliers in the sample, which must be controlled in order to obtain more results satisfactory. After these tests can show the impulse response functions, which is a convenient way to represent the behavior of the variables of the model in response to various possible shocks. Similarly to the univaried case, a VAR (p) can be described as a linear function of past innovations, i.e.

$$x_t = \mu + e_t + \Psi_1 e_{t-1} + \Psi_2 e_{t-2} + \cdots, \tag{11}$$

$\mu = [\Phi(1)]^{-1}\phi_0$ provides that the process is invertible and the coefficients of the matrices can be obtained by equating the above expression with the expression of the VAR in previous difference operators, which reveals,

$$(I - \Phi_1 B - \cdots - \Phi_p B^p)(I + \Psi_1 B + \Psi_2 B^2 + \cdots) = I \tag{12}$$

I is the identity matrix, and the expression above the moving average representation of x_t, with coefficient matrix Ψ_i and past innovations e_{t-i} in x_t, as well, Ψ_i is the effect e_t on future observation x_{t+1}. So, Ψ_i is impulse response of x_t. Finally, the causality of Granger of the variable to the variable B is evaluated, the equation in which B is the dependent variable, testing the null hypothesis that the coefficients of the variable in all its lags are statistically equal to zero. If the null hypothesis is rejected, it is concluded that the variable Granger cause the variable B. However, in the case where the vector variables x_t are stationary should not test and Cointegration, if so we should proceed through analysis of a vector model detect with error correction (VECM), which uses the co-integrantion to obtain a linear relationship between the stationary variables. Whereas the specification of the VAR above in (6), we can rewrite it in the form

$$\Delta x_t = \phi_0 + H_1 \Delta x_{t-1} + H_2 \Delta x_{t-2} + \cdots + H_{p-1}\Delta x_{t-p+1} - \Pi x_{t-1} + e_t \tag{13}$$

where $\quad H_i = -\sum_{k=i+1}^{p} \Phi_k$ and $\quad i = 1, \dots, p-1$ and $\quad \Pi = I - \Phi_1 - \cdots - \Phi_p$.

The Cointegration can be tested by following the procedure proposed by Johansen consisting of specifying models to test if the rank of the matrix Π is reduced and equal to r (the number of cointegrated vectors), calculate the maximum estimates likelihood of cointegranted vector error correction model with multivariate gaussians errors. Johansen proposes test statistics *Max eingenvalue* λ_{max} e trace, $\lambda_{trace} = \sum_{i=1}^{r} ln(1 - \lambda_i)$ to test how many cointegranted vectors there are in (13), testing of recursive manner, in that the null hypothesis is that there is the maximum r cointegrated vectors. As well as in VAR, we must check the validity of the VECM model specification for testing of non-serial autocorrelation, normality and homoscedastity.

Unit root tests results the results of the unit root tests ADF (augmented Dickey-Fuller), the Phillips-Perron (PP) and the modified test of Dickey-Fuller ADF-GLS proposed by Elliott, Rothenberg & Stock (1996) are presented in table 1, whose lags were established at the discretion of Schwarz for both first and second modified criteria of Akaike for testing ADF-GLS. In all cases, with the exception of the SELIC, the tests have shown that we can reject the null hypothesis if existence of unit root level variables to a significance level of 5%. For the SELIC, the first two tests showed values that could reject the null hypothesis, indicating stationarity. However, if using the graphical analysis of the series, we see that the result was due to the presence of structural breaks, which distorted the test statistic, since it clearly note that the series cannot be stationary level. This can be corroborated by the ADF-GLS test result. However, all series were stationary in first differences, where we conclude that all are integrated of order one, or I (1).

VECTOR AUTO REGRESSIVE MODELS

VAR / VECM

Given the determination of the degree of integration of the variables to be included in the model, the correct specification of a model VAR/VECM will depend on the determination of the dimension of the space of Cointegration, according to the discussion on item above. For the application of the test of Johansen, model was not well defined what better specification that should be used in the test. We decided to start with a usual specification in literature to the Johansen test, whose result was the rejection of the null hypothesis that there is no cointegrated vector, for both the test of how to test the maximum eigenvalue. In this case, we should consider the existence of Cointegration vector and a VECM estimation by imposing the Cointegration space has dimension one.

However, the results are sensitive to test specification (by removing the VAR or constant terms the deterministic trend in the Cointegration vector) and in this way, you get ambiguous results: the trace test rejects the null hypothesis that there is no any cointegrante vector (in which consider the existence of Cointegration vector), while the maximum eigenvalue test tends not to reject this hypothesis. So, if you consider the possibility of no Cointegration vector, we could evaluate the representation of a VAR (p-1) in first difference. So, are these the two models to be estimated, and the results will be compared in the light of the theory exposed in this work. The number of lags for the VAR was based on the criteria of Akaike, Schwarz and Hannan-Quinn, who revealed to us as the best VAR (level) of order 3, what is reasonable,especially in cases of autoregressives vectors, which extension of the lags tend to consume many degrees of freedom.

The constant was not significant, and your withdrawal has allowed an improvement of indexes, as well as the autocorrelation of the residuals. Later, for both models VAR in first difference and the VECM, apply the Portmanteau test for autocorrelation of the residuals (in that the null hypothesis is that the waste does not exhibit autocorrelation of i-th order), and the test to check your normal (where the null hypothesis is normality of waste). The test results indicate good signs that we cannot reject the null hypothesis of no autocorrelation, which presence is somewhat corroborated by graphical analysis and correlograms obtained by analysis of VAR. However, the normality test of waste and homoscedascity presents less satisfactory results.

To assess the relationship of interest, as the theory proposed in this work, the impulse response function analysis which was obtained for estimation of VAR. The function impulse response reveals how each variable in the system responds to a shock in a single period in one of the white noise vector elements that present no autocorrelation. Soon after, we present the results of the tests of Granger causality based on estimation of VAR and in the VECM, with the two lags, as another way to obtain information about these relationships of interest. First, we performed the VAR between SELIC and SWAP. The flexibility of the SAS/ETS® codes allows us to observe the tests necessary to evaluate the model: the unit root test, the test of Granger-causality, cointegration tests and test impulse-response functions. All these can be ordered by PROC VARMAX.

```
ods graphics on;
proc varmax data = mrisk.&base_macro plot(unpack)=(residual model forecasts impulse);
        model SELIC SWAP / p=2 noint lagmax=2000
        dftest  cointtest=(johansen)
        print=(impulse=(all) estimates diagnose)
        printform=univariate;
        output out = result(KEEP=_ALL_)
        lead=30;
    causal group1=(SELIC) group2=(SWAP);
    causal group1=(SWAP) group2=(SELIC);
run;
```

Figure 1. SAS/ETS® VARMAX PROCEDURE

The VARMAX Procedure

Number of Observations	942
Number of Pairwise Missing	0

Simple Summary Statistics							
Variable	Type	N	Mean	Standard Deviation	Min	Max	Label
SELIC	Dependent	942	11.29496	3.09566	6.40000	14.15000	SELIC
SWAP	Dependent	942	11.04980	3.09256	6.29000	16.23000	SWAP

Dickey-Fuller Unit Root Tests					
Variable	Type	Rho	Pr < Rho	Tau	Pr < Tau
SELIC	Zero Mean	-0.37	0.5984	-1.60	0.1030
	Single Mean	0.87	0.9865	0.99	0.9966
	Trend	-4.25	0.8709	-2.69	0.2394
SWAP	Zero Mean	-0.44	0.5838	-1.52	0.1213
	Single Mean	-0.20	0.9467	-0.19	0.9375
	Trend	-4.97	0.8226	-1.99	0.6056

Granger-Causality Wald Test			
Test	DF	Chi-Square	Pr > ChiSq
1	2	20.80	<.0001
2	2	2.81	0.2459

Test 1: Group 1 Variables:	SELIC
Group 2 Variables:	SWAP

Test 2: Group 1 Variables:	SWAP
Group 2 Variables:	SELIC

Cointegration Rank Test Using Trace						
H0: Rank=r	H1: Rank>r	Eigenvalue	Trace	Pr > Trace	Drift in ECM	Drift in Process
0	0	0.0271	26.9056	0.0001	NOINT	Constant
1	1	0.0011	1.0389	0.3576		

Long-Run Parameter Beta Estimates		
Variable	1	2
SELIC	0.79033	-0.25385
SWAP	-0.77525	0.34062

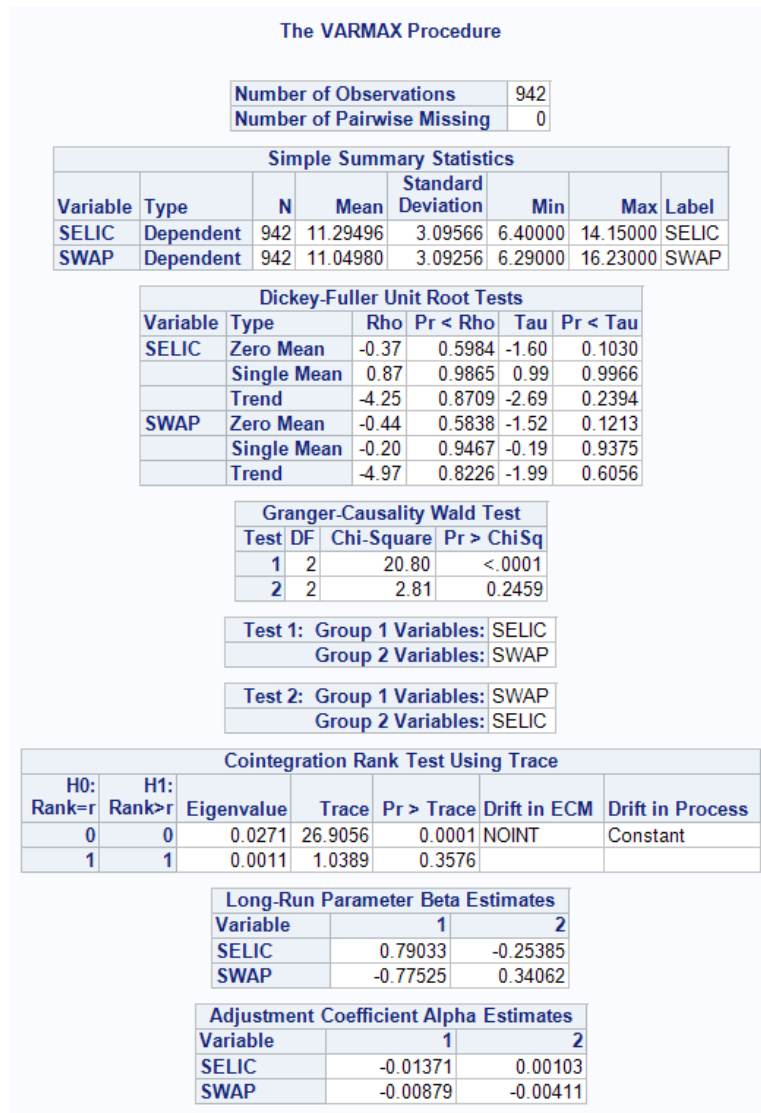| Adjustment Coefficient Alpha Estimates		
Variable	1	2
SELIC	-0.01371	0.00103
SWAP	-0.00879	-0.00411

Figure 2. SAS/ETS® VARMAX PROCEDURE RESULTS

Once the test has shown us that there is at least one vector of Cointegration, we can run the VECM model adding the code the syntax:

```
ecm=(rank=1 normalize=SELIC)
```

The impulse response functions are shown below, by continuous curves, being dashed curves representing the limits by two standard deviations, and each column below shows the responses of each of the different variables in relation to an innovation.
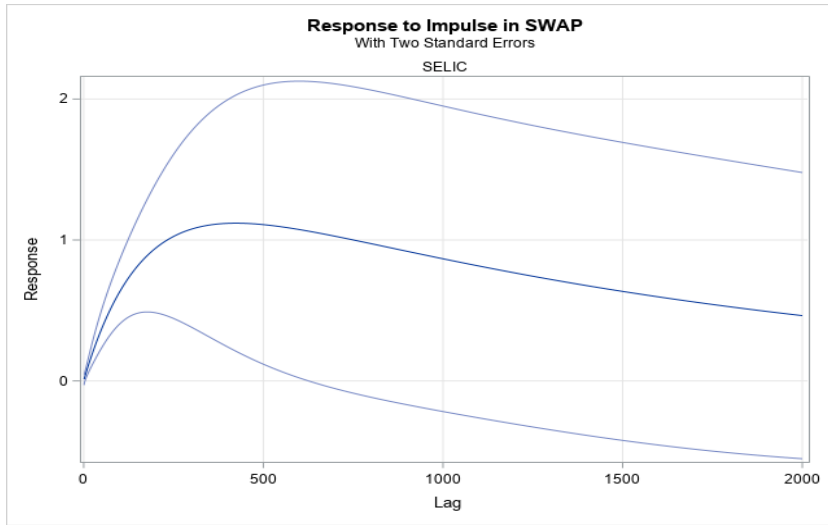
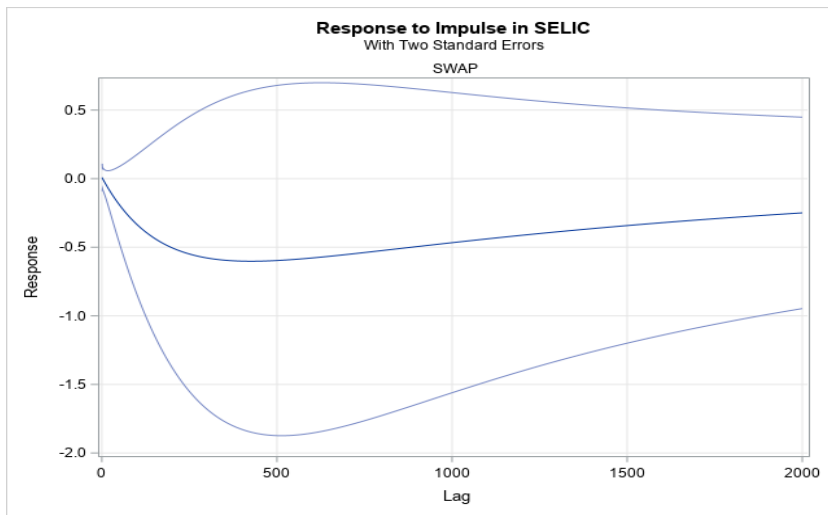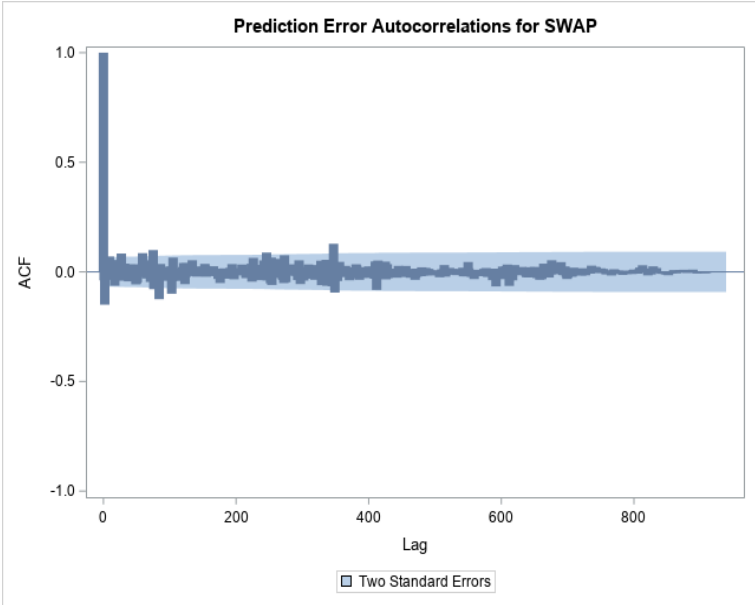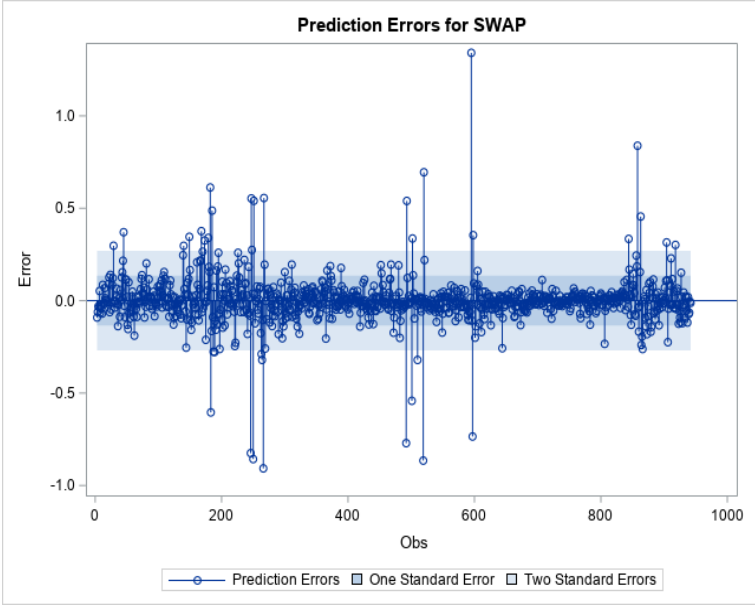Figure 3. IMPULSE RESPONSE: SWAP

Figure 4. IMPULSE RESPONSE: SELIC

The prediction errors, prediction Autocorrelations and prediction error partial autocorrelations for SWAP are shown below:

Figure 5. PREDICTION ERRORS: SWAP

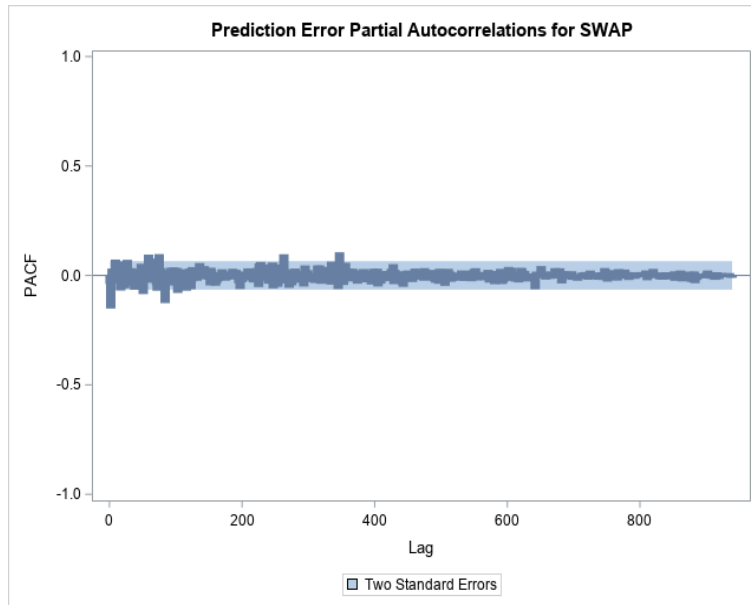Figure 6. PREDICTION ERRORS AUTO CORRELATION: SWAP

Figure 7. PREDICTION ERROR PARTIAL AUTO CORRELATION: SWAP

Further, we can plot the impulse-response functions: just as in the PROC VARMAX® can create the corresponding code for analysis of residuals separately, we can use PROC AUTOREG®, to test stationarity of residuals (Augmented Dickey Fuller, Phillips Perron, KPSS), in addition to the tests of autocorrelation of the residuals Durbin-Watson and ARCH test for heteroscedasticity.

```
proc autoreg data = resid;
    model RES1 = /   stationarity =(adf =3, PHILLIPS, KPSS)
                     archtest = (qlm, wl, lk)
                     dw=4 dwprob;
run;
```

Figure 8. AUTOREG PROCEDURE

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The AUTOREG Procedure

Dependent Variable	RES1
	Residuals for SELIC

Ordinary Least Squares Estimates			
SSE	7.23456034	DFE	939
MSE	0.00770	Root MSE	0.08778
SBC	-1900.5393	AIC	-1905.3852
MAE	0.02224473	AICC	-1905.381
MAPE	144.301601	HQC	-1903.5379
		Total R-Square	0.0000

Durbin-Watson Statistics			
Order	DW	Pr < DW	Pr > DW
1	2.0010	0.5063	0.4937
2	2.0287	0.6820	0.3180
3	2.0294	0.6972	0.3028
4	2.0307	0.7153	0.2847

NOTE: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrelation.

Phillips-Perron Unit Root Test					
Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau
Zero Mean	6	-909.6629	<.0001	-30.6487	<.0001
Single Mean	6	-909.3166	0.0018	-30.6430	<.0001
Trend	6	-902.3009	0.0008	-30.8283	<.0001

Augmented Dickey-Fuller Unit Root Tests							
Type	Lags	Rho	Pr < Rho	Tau	Pr < Tau	F	Pr > F
Zero Mean	3	-1073.8225	<.0001	-15.7781	<.0001		
Single Mean	3	-1077.5928	<.0001	-15.7826	<.0001	124.5452	<.0010
Trend	3	-1151.2992	<.0001	-16.0186	<.0001	128.2984	<.0010

KPSS Stationarity Test			
Type	Lags	Eta	Pr > Eta
Single Mean	21	0.8633	0.0048
Trend	21	0.1051	0.1416

KERNEL=NW, SCHW=12

Figure 9. AUTOREG PROCEDURE RESULTS

Tests for ARCH Disturbances Based on OLS Residuals							
Order	Q	Pr > Q	LM	Pr > LM	LK	Pr > |LK|	WL	Pr > WL
1	0.1119	0.7380	0.1113	0.7387	-2.1770	0.0295	743.2830	<.0001
2	0.2191	0.8962	0.2200	0.8959	-3.0607	0.0022	1453.8613	<.0001
3	0.3270	0.9549	0.3313	0.9540	-3.7564	0.0002	2143.6925	<.0001
4	0.4355	0.9795	0.4453	0.9786	-4.3553	<.0001	2819.3616	<.0001
5	0.5444	0.9904	0.5619	0.9897	-4.8928	<.0001	3476.2388	<.0001
6	0.6538	0.9954	0.6812	0.9949	-5.3877	<.0001	4113.4918	<.0001
7	0.7622	0.9978	0.8020	0.9974	-5.8461	<.0001	4738.6837	<.0001
8	0.8718	0.9989	0.9263	0.9987	-6.2834	<.0001	5346.4161	<.0001
9	0.9838	0.9995	1.0556	0.9993	-6.7086	<.0001	5939.7785	<.0001
10	1.0916	0.9997	1.1831	0.9996	-7.1029	<.0001	6523.1898	<.0001
11	1.2013	0.9999	1.3153	0.9998	-7.4905	<.0001	7090.3672	<.0001
12	1.3114	0.9999	1.4506	0.9999	-7.8677	<.0001	7644.5686	<.0001

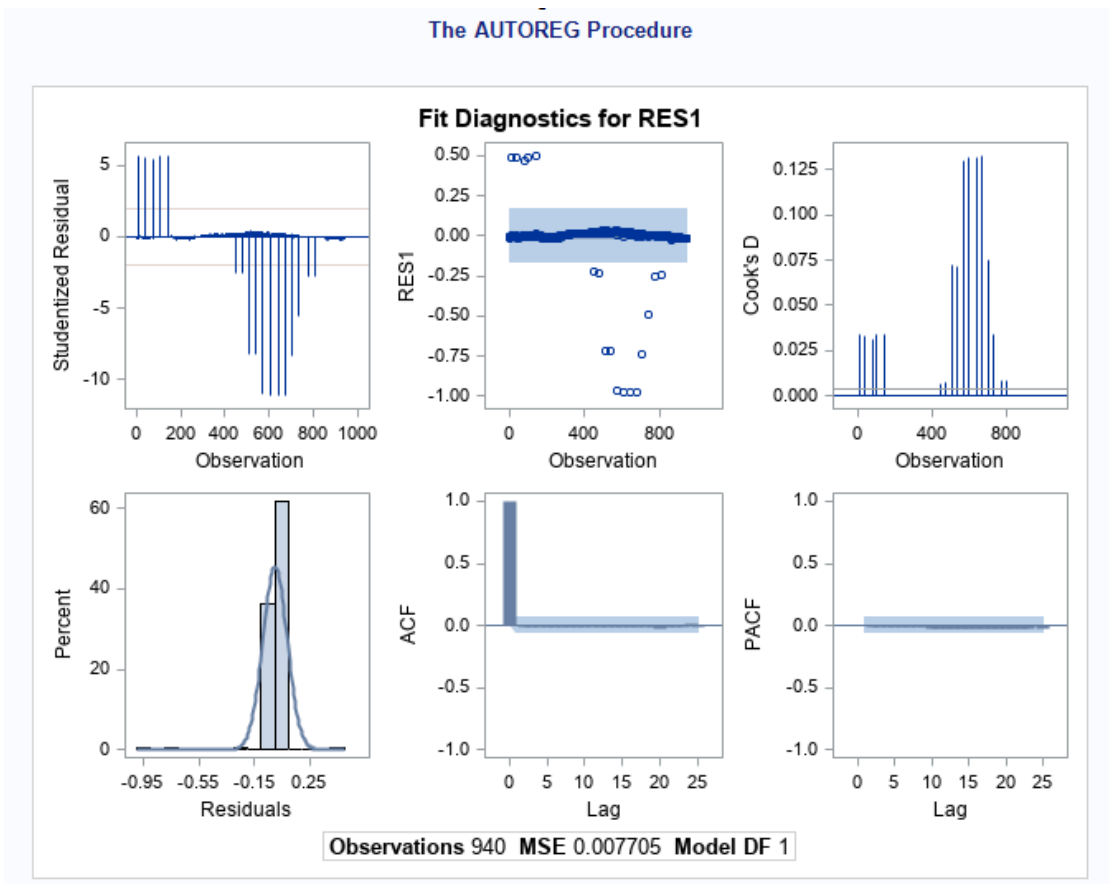| Parameter Estimates					
Variable	DF	Estimate	Standard Error	t Value	Approx Pr > |t|
Intercept	1	-0.001607	0.002863	-0.56	0.5748

Figure 10. TEST FOR ARCH DISTURBANCES

Figure 11. FIT DIAGNOSTICS

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Testing the hypothesis of weak version of fiscal dominance The results show that increase in market interest rates causes an elevation of the SELIC rate and an increase in SELIC rate leads to the opposite movement. This indicates a lack of fiscal dominance, since the Monetary Authority responds to increased inflation expectations (SWAP), as well as these decay after the reaction of the Monetary Authority. In a scenario of fiscal dominance the SWAP should be exactly opposite. To obtain more evidence of absence of fiscal dominance in your weaker version, we need to perform interactions between the interest rate and the variables that indicate increased risk perception which would imply the influence of this dynamic for the inflation scenario. These variables are EMBI, 5 CDS and real exchange rate EXR.
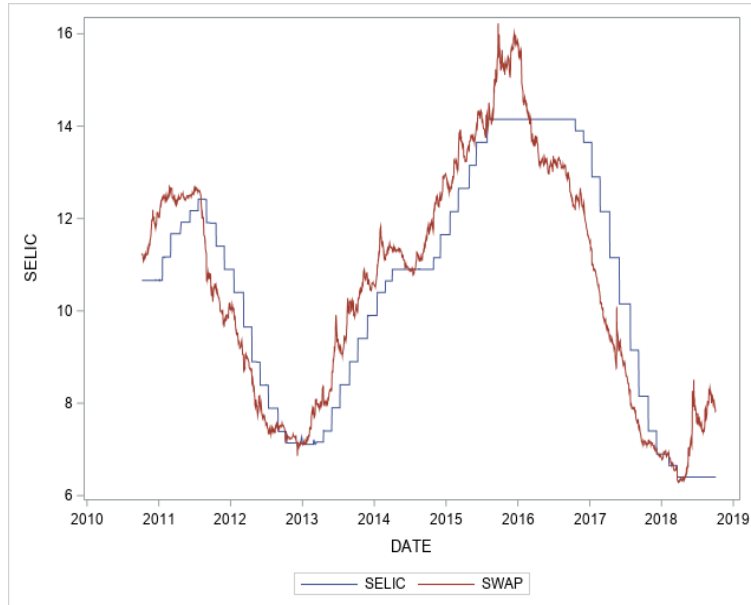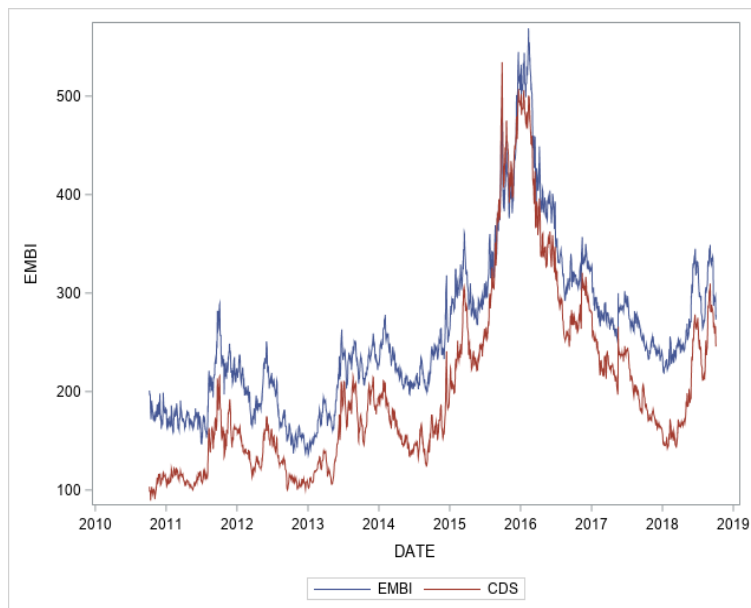

Figure 12. SELIC AND SWAP TIME SERIES

Figure 13. EMBI AND CDS TIME SERIES

Granger-Causality Wald Test			
Test	DF	Chi-Square	Pr > ChiSq
1	2	1.22	0.5432
2	2	3.33	0.1895

Test 1:	Group 1 Variables:	SELIC
	Group 2 Variables:	CDS

Test 2:	Group 1 Variables:	CDS
	Group 2 Variables:	SELIC

Figure 14. GRANGER CAUSALITY WALD TEST 1: SELIC - CDS

Granger-Causality Wald Test			
Test	DF	Chi-Square	Pr > ChiSq
1	2	0.10	0.9534
2	2	3.35	0.1870

Test 1:	Group 1 Variables:	SELIC
	Group 2 Variables:	EMBI

Test 2:	Group 1 Variables:	EMBI
	Group 2 Variables:	SELIC

Figure 15. GRANGER CAUSALITY WALD TEST 1: SELIC - EMBI

Granger-Causality Wald Test			
Test	DF	Chi-Square	Pr > ChiSq
1	2	1.47	0.4794
2	2	0.03	0.9870

Test 1:	Group 1 Variables:	SELIC
	Group 2 Variables:	EXR

Test 2:	Group 1 Variables:	EXR
	Group 2 Variables:	SELIC

Figure 16. GRANGER CAUSALITY WALD TEST 1: SELIC – EXR

CONCLUSION

We examined data relating to the macroeconomic scenario with daily data to verify the existence of a possible causal relationship between the performance of the Monetary Authority and asset prices. If asset prices may change with a more restrictive monetary policy (devaluation of the exchange rate and increased risk country) would be strong evidence that the Monetary Authority is weak enough that we can consider the prevalence of fiscal dominance. Given the data available we can evaluate this hypothesis by two channels: the relationship between market interest rates and the interest rate controlled by the central bank and the relationship of interest rate controlled by the central bank and the prices that indicate the variation of country risk. For this first relationship, the data indicate that there is a relationship of unilateral causality market interest rate to the Monetary Authority. That means the central bank is reactive enough to meet the market expectations as regards increased inflationary pressure. This can be evidenced by the Granger causality test and the format of the impulse response functions. It may be noted that the extent to which the central bank reacts to inflationary pressure by increasing interest rates, there is a reaction in the opposite direction of the SWAP rates, indicating that the next interest rate cycle must be monetary loosening since the Bank Central was successful in combating inflation. This whole scenario is consistent with the absence of fiscal dominance.

However, there is a possibility of existence of a weak version of monetary dominance. In the most extreme scenario, a restrictive monetary policy systematically worsening the primary surplus, by pressing the Government debt, which necessarily must be reflected in the assets that reflect the risk country. In this context, the debt out of control, resulting in an adverse scenario. A more restrictive monetary policy may be unable to control inflation due to the fiscal situation of the Government very weak. In the intermediate scenario, loose monetary policy doesn't necessarily lead to inability to control inflation, but can perfectly coexist with a loss of power of the monetary policy, by the increase of assets reflect the risk country.

However, the data show that this is not the current case in the brazilian economy. VAR models/VECM of SELIC with the country risk assets and (separately), we note that, in none of the models realize one-way causality relationships of interest rate controlled by the central bank and country risk. If there was this relationship, this should occur through the worsening of the primary result profile. Therefore, we reject the hypothesis of the absence of fiscal dominance, based on the estimated models. In the context of modeling of PD Forward Looking, according to IFRS 9 resolution, in which we must establish the set of macroeconomic variables for calculation of the ECL, this paper provides evidence that there is no reason to believe any abnormal scenario in which the PDs individual suffering from systematic influence of a widespread increase of risk increased likelihood of default of sovereign debt in relation to the monetary policy tightness. If that were the case, variables that indicate a worsening of this global scenario ought to belong to the set of variables to be included in models of of PD FL. However, despite the recurring crises that the brazilian economy has been suffering, there is no evidence to support this hypothesis.

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