A FCVAR MODEL FOR THE CENTRAL AMERICAN ECONOMY

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(preliminary draft)

ABSTRACT

In this article we propose the use of univariate and multivariate fractionally integrated techniques in the analysis of the Central American economy by means of investigating three series (prices, interest rates and monetary base) in a group of the six countries that form the CMCA (i.e., Costa Rica, Honduras, El Salvador, Guatemala, Nicaragua and Dominican Republic). The univariate results indicate that the series are highly persistent with orders of integration close to 1 in the majority of the cases. The main exceptionsare found for the cases of Guatemala, El Salvador and Nicaragua, especially for the monetary base and the interest rate, where mean reversion is found in some cases. The multivariate results show evidence of one long run equilibrium relationship between broad money, interest rates and inflation for Costa Rica, Honduras, El Salvador and Dominican Republic, and two equilibrium relationships for the remaining countries, i.e., Guatemala and Nicaragua. ETC

Keywords: FCVAR; Central America; inflation; monetary base; interest rate

JEL Classification: C22

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[*]: Prof. Luis A. Gil-Alana gratefully acknowledges financial support from the Ministerio de Economia y Competitividad (ECO2014-55236).

1. Introduction

While not working towards an imminent transition to a monetary or currency union, the Central American Monetary Council (or CMCA, from Spanish *Consejo Monetario Centroamericano*) serves as an institution promoting economic and financial stability among five Central American countries (Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua) and the Dominican Republic. Econometric studies conducted by researchers from CMCA have traditionally focused on studying inflation levels of these countries, making use of econometric tools such as unit roots, VECM and cointegration methods. It is our will with this work to introduce some new techniques in time series analysis, extending the above methodology to the fractional case in the analysis of the Central American region, hoping this may benefit policy makers and regulators in the area. With the implementation of the FCVAR model, we want to show how forecasting results can be obtained for key economic variables in the Central-American region, with the hope that this may enable policy makers and researchers in the region to come up with sound policy recommendations.

2. Contextual setting

The CMCAattempts to provide economic and financial stability to five Central American countries (Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua) and the Dominican Republic. Measuring and controlling inflation levels constitutes a very important task for SECMCA (from the Spanish *Secretaría Ejecutiva del Consejo Monetario Centroamericano*), which acts as the research branch of the CMCA. The history of the Central American Monetary Council can be summarized as an outstanding integrationist effort made by the Central Banks of its member countries (Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras and Nicaragua).

Between 1951 and 1957 several bilateral agreements among these Central American countries were signed, constituting thus the basis for the creation of a new system of Central Banks in Central America with the initial goal of achieving monetary integration. The first step was to create a mechanism of multilateral payment compensations, which was established under the Central American Compensation Chamber Agreement, signed in July 1961. This was followed by the Central American Monetary Union Establishment agreement in February 1964, which lead to the formation of the Central American Monetary Council. Later on the Central American Monetary Establishment Fund was established in 1969 with the aim of establishing an equilibrium in the balance of payments between the member countries that could affect their corresponding exchange rates stability.

These agreements were united in 1974 under the Central American Monetary Agreement, which was modified in 1999 in order to include some of the integrationist achievements that took place during the 1990s. Among these we shall point out the Tegucigalpa Protocol in December 1991, which lead to the foundation of the Central American Integration System; and the Guatemala Protocol in October 1993, which substituted the Central American Economic Integration General Treaty that had originally been signed in 1960. The Central American Monetary Agreement constitutes the main pillar of the monetary and financial integration in Central America. During its 50 years of existence the Central American Monetary Council has held multiple meetings, all of them with the aim of improving and fostering economic integration among its country members. Despite not having as ultimate goal the adoption of a new common currency, the CMCA attempts to achieve economic and financial stability in the region, in order to promote the integration and mutual collaboration of its member countries.

In this paper we look at the relationship between CPI, the interest rates and the monetary base among the six countries that form the CMCA, using updated techniques in time series analysis. The following section briefly describes the methodology used in the paper. Section 4 presents the data and the main empirical results, while Section 5 concludes the paper.

3. Methodology

The methodology used in this paper is based on the concepts of fractional integration and cointegration. Fractional integration is a natural generalization of the concepts of unit roots or I(1) behavior to the fractional case. In particular it basically means that the number of differences required in a time series to get a short memory or I(0) process does not necessarily be an integer value (usually 1) but any real value, including thus values constrained between 0 and 1 or even above 1.

Using L as the backshift operator (i.e., $Lx_t = x_{t-1}$), we say that a process $\{x_t, t = 0, \pm 1, \ldots\}$ is integrated of order d, and denoted as I(d) if it can be represented as

$$(1 - L)^d x_t = u_t, \quad t = 0, \pm 1, \ldots, \tag{1}$$

with $x_t = 0$ for $t \leq 0$, and where u_t is an $I(0)$ process, defined, for the purpose of the present work, as a covariance stationary process with spectral density function that is positive and finite. Note that the fractional polynomial in the left hand side of equation (1) can be expressed as

$$(1 - L)^d = \sum_{j=0}^{\infty} \psi_j L^j = \sum_{j=0}^{\infty} \binom{d}{j} (-1)^j L^j = 1 - d\,L + \frac{d(d-1)}{2} L^2 - \ldots,$$

and thus equation (1) becomes

$$(1 - L)^d x_t = x_t - d\,x_{t-1} + \frac{d(d-1)}{2} x_{t-2} - \ldots = u_t. .$$

In this context, d plays a crucial role as an indicator of the degree of dependence in the series. Thus, the higher the value of d, the higher the level of association is between the observations. If d = 0, the series is short memory or integrated of order 0 and denoted as I(0); if 0 < d < 0.5, the series exhibits long memory and it is still covariance stationarity; if 0.5≤ d < 1, the series is then nonstationary though still mean reverting with shocks disappearing in the long run; if d = 1 the series is integrated of order 1 or I(1) and in general, if d ≥ 1 there is no mean reversion with shocks persisting forever.

The I(d) literature was introduced in the 80s by Granger (1980), Granger and Joyeux (1980) and Hosking (1981) and was later extended in the context of economic and financial time series by authors such as Baillie (1996), Gil-Alana and Robinson (1997), Mayoral (2006) and others.

On the other hand, the natural extension of the concept of fractional integration to the multivariate case is throughout the idea of fractional cointegration. This concept appears in the original description by Engle and Granger (1987) though most of the applications following this paper focused on the cases where the orders of integration of the variables are integer values (1 for the parent series and 0 for the equilibrium relationship). The first theoretical papers on fractional cointegration were developed by Peter Robinson and his coauthors (Robinson and Hualde, 2003, 2007; Robinson and Marinucci, 2001; Robinson and Yajima, 2002) and later on, more general multivariate approaches have been presented by Johansen and Nielsen (2010, 2012) throughout the Fractional Cointegration VAR (FCVAR) approach, extending the classical CVAR of Johansen (1991, 1996).

The Fractionally Cointegrated Vector AutoRegressive (FCVAR) model was introduced by Johansen (2008) and further explained by Johansen and Nielsen (2010, 2012). The model is a generalization of Johansen´s (1995) Cointegrated Vector

AutoRegressive (CVAR) model, which enabled for fractional processes of order d that cointegrate with order d-b. The CVAR model is:

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \sum_{i=1}^{k} \Gamma_i \Delta Y_{t-i} + \varepsilon_t = \alpha\beta' L Y_t + \sum_{i=1}^{k} \Gamma_i \Delta L^i Y_t + \varepsilon_t \qquad (2)$$

Then the easiest way to derive the FCVAR model is to replace the difference and lag operators Δ and L in (2) by their fractional counterparts, Δ^b and $L_b = 1 - \Delta^b$, respectively. We then obtain:

$$\Delta^b Y_t = \alpha\beta' L_b Y_t + \sum_{i=1}^{k} \Gamma_i \Delta^b L_b{}^i Y_t + \varepsilon_t, \qquad (3)$$

which is applied to $Y_t = \Delta^{d-b} X_t$ such that:

$$\Delta^d X_t = \alpha\beta' L_b \Delta^{d-b} X_t + \sum_{i=1}^{k} \Gamma_i \Delta^b L_b{}^i Y_t + \varepsilon_t, \qquad (4)$$

where ε_t is p-dimensional independent and identically distributed with mean zero and covariance matrix Ω.

The parameters have the usual interpretations known from the CVAR model. In particular, αand β are $p \times r$ matrices, where $0 \le r \le p$. The columns of βare the cointegrating relationships in the system, that is to say the long-run equilibria. The parameters Γ_i govern the short-run behaviour of the variables and the coefficients in α represent the speed of adjustment towards equilibrium for each of the variables. Thus, the FCVAR model allows simultaneous modelling of the long-run equilibria, the adjustment responses to deviations from the equilibria and the short-run dynamics of the system. In Johansen and Nielsen (2012) and Nielsen and Popiel (2016) one can find estimation and inference for the model, and the latter provides Matlab computer programs for the calculation of estimators and test statistics.

4. Data and empirical results

We use monthly data from January 2001 up to December 2016 corresponding to CPI, monetary base and interest rate levels of the six countries that belong to the CMCA, having thus series of 180 data values of each series. We obtained them from the official CMCA statistical database called SIMAFIR (http://www.secmca.org/simafir.html).

Performing standard unit root tests (Phillips and Perron, 1988; Elliot et al, 1996) the results support in the majority of the cases the unit root hypothesis. However, it is well known that the results may be biased if the data follow fractionally integrated specifications.[1] Because of that we use across this work I(d) models which include the unit root case as a particular case when d is equal to 1.

We start with the univariate analysis by considering the following regression model,

$$y_t = \beta_0 + \beta_1 t + x_t, \quad t = 1, 2, \ldots \tag{5}$$

$$(1 - L)^d x_t = u_t, \quad t = 1, 2, \ldots, \tag{6}$$

where y_t is the observed time series; β_0 and β_1 are the coefficients corresponding respectively to the intercept and a linear time trend, and x_t is supposed to be I(d) and thus, u_t in (6) is I(0) adopting the forms of a white noise process (in Table 1) and autocorrelated throughout the model of Bloomfield (1973) (in Table 2)

Across these tables we display the estimates of d along with their confidence intervals for the three cases corresponding to the three models usually employed in the literature, that is, the one with no deterministic terms, one with an intercept, and another one with an intercept and a linear time trend. The values reported in the tables are those corresponding to the lowest statistic using the Lagrange Multiplier (LM) test of Robinson (1994). This method tests the null hypothesis

[1]Hassler and Wolters (1994), Lee and Schmidt (1996).

$$H_o : d = d_o , \qquad (7)$$

in (5) and (6) for any real value d_o, including stationary ($d_o < 0.5$) and nonstationary ($d_o \geq 0.5$) cases. Thus, it does not require preliminary differencing in nonstationary contexts and its limiting distribution is standard normal independently of the potential autocorrelation of the error term and the inclusion of deterministic terms, unlike what happens with other more standard unit roots (and fractional integration) methods (Schmidt and Phillips, 1992).

Focussing first on the case of white noise errors (Table 1) we notice that the time trend is required in all the cases for monetary aggregate; in all except one country (Dominican Republic) for prices, while there are only two countries (Guatemala and Nicaragua) with a time trend in the case the of interest rates. Dealing with the orders of integration we observe substantial differences across the series. Thus, for example, for prices, the estimates of d are significantly higher than 1 in all cases, with the values ranging from 1.14 (El Salvador) to 1.51 (Dominican Republic). for Money, the values are substantially smaller, and mean reversion (i.e., d < 1) takes place in the cases of Guatemala, El Salvador and Dominican Republic, while the unit root null hypothesis (i.e., d = 1) cannot be rejected in the other three countries. Finally, for the interest rates, mean reversion occurs for El Salvador and Nicaragua, while values of d significantly higher than 1 are obtained in the remaining four series.

[Insert Tables 1 and 2 about here]

Table 2 displays the results based on autocorrelated disturbances. We observe that the time trend is required in all cases for prices and in all countries except for El Salvador in the case of money. For the interest rates, the intercept is sufficient to describe the deterministic components. Looking at the estimates of d and starting with prices, the values are found above 1 in all cases except for El Salvador where the unit root null hypothesis cannot be rejected; for money the I(1) hypothesis cannot be rejected in any series with the exception of Guatemala, where the value of d is significantly below 1; finally, for the interest rates, mean reversion occurs for Nicaragua, the I(1) hypothesis cannot be rejected for El Salvador and Dominican Republic, and the estimated value of d is smaller than 1 in the remaining countries.

Table 3 summarizes the results in Tables 1 and 2. We observe that for Money the I(1) is the most plausible model, while the order of integration is higher than 1 for prices, and mixed evidence (depending on the country) is obtained in case of the Interest rates.

[Insert Tables 3 and 4 about here]

Table 4 displays the estimates of d using a semiparametric method where no functional form is imposed on the error term. We display the results for a selected group of bandwidth numbers. We notice that evidence of unit roots in a number of cases, of the numbers values which are statistically below and above 1 .

[Insert Tables 5 - 7 about here]

Next we move to the multivariate case and present the results of the FCVAR approach of Johansen and Nielsen (2012) in Tables 5 and 6. When verifying with a likelihood ratio test, as suggested by Nielsen and Popiel (2016), in all the cases the FCVAR model beats the CVAR model, meaning that results of cointegrating relationships between the series under study shall be performed in the fractional scenario, that is to say by making use of the Fractional CVAR (FCVAR) model. Results for all the different Central American economies can be found in Table 6, and corresponding forecasts of the three variables under study are provided in Table 7. Relatively small Mean Square Values of the out of sample forecasts reveal that the FCVAR model can be used as an useful tool to determine inflation forecasts.

5. Concluding comments

In this article we have introduced the FCVAR model as an interesting additional tool for central bankers and practitioners in the Central American region. After univariate analysis leading providing grounds for the utilization of the generalization of the more traditional CVAR model in the fractional scenario, we have obtained results for all the economies that belong to the Consejo Monetario Centroamericano. In particular we have provided FCVAR models employing inflation, monetary base and interest rates, which can be used as useful forecasting tools of such variables. Such models can be used by policy makers in order to assess inflation forecast measures within the region

References

Baillie, R.T., 1996, Long memory processes and fractional integration in econometrics. Journal of Econometrics 73, 5-59.

Bloomfield,P., 1973, An exponential model in the spectrum of a scalar time series. Biometrika, 60, 217-226.

Engle, R.F. and C.W.J. Granger (1987) Cointegration and error correction model.Representation, estimation and testing, *Econometrica* 55, 251-276.

Gil-Alana, L.A. and P.M. Robinson, 1997, Testing of unit roots and othernonstationary hypotheses in macroeconomic time series. Journal of Econometrics80, 241-268.

Granger, C.W.J. (1980) Long Memory Relationships and the Aggregation of Dynamic Models, *Journal of Econometrics*, 14, 227-238.

Granger, C.W.J. and R. Joyeux, (1980), An introduction to long memory time series models and fractional differencing, *Journal of Time Series Analysis* 1, 15-39.

Hassler, U. and J. Wolters (1994) On the power of unit root tests against fractional alternatives, *Economics Letters* 45, 1-5.

Hosking, J.R.M. (1981), Fractional differencing, *Biometrika* 68, 165-176.

Johansen, S. (1991) Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models, *Econometrics* 59, 1551-1580.

Johansen, S. (1995) Identifying restrictions of linear equations with applications to simultaneous equations and cointegration, *Journal of Econometrics* 69(1), 111-132.

Johansen, S. (1996) Likelihood based inference in cointegrated vector autoregressive models, Oxford University Press.

Johansen, S. (2008) A representation theory for a class of Vector Autoregressive Models for fractional models, *Econometric Theory* 24(3), 651-676.

Johansen, S. and M.Ø. Nielsen (2010) Likelihood inference for a nonstationary fractional autoregressive model, *Journal of Econometrics* 158, 51-66.

Johansen, S. and M.Ø. Nielsen (2012) Likelihood inference for a Fractionally Cointegrated Vector Autoregressive Model, *Econometrica* 80(6), 2667-2732.

Lee, D. and P. Schmidt (1996) On the power of the KPSS test of stationarity against fractionally integrated alternatives, *Journal of Econometrics* 73, 285-302.

Nielsen, M.Ø. and M.K. Popiel (2016) FCVARmmodel.m: a Matlab software package for estimation and testing in the fractionally cointegrated VAR model, *QED Working Paper* 1273, Queens University.

Mayoral, L., (2006), Further Evidence on the Statistical Properties of Real GNP, Oxford Bulletin of Economics and Statistics 68, 901-920.

Robinson, P.M. (1994) Efficient tests of nonstationary hypotheses, *Journal of the American Statistical Association* 89, 1420-1437.

Robinson, P.M. and J. Hualde (2003) Cointegration in fractional systems with unknown integrationorders.Econometrica 71, 1727-1766.

Robinson, P.M. and J. Hualde, (2007) Root-n-consistent estimation of weak fractional cointegration. Journal of Econometrics 140, 450-484.

Robinson, P.M. and D. Marinucci, (2001) Semiparametric fractional cointegration analysis, *Journal of Econometrics* 105, 225-247.

Robinson, P.M. andYajima Y. (2002) Determination of cointegrating rank in fractional systems, *Journal of Econometrics* 106, 217-241.

Schmidt, P. and P.C.B. Phillips (1992) LM tests for a unit root in the presence of deterministic trend, Oxford Bulletin of Economics and Statistics 54, 3, 257-287.

Table 1: Estimates of d and 95% intervals under white noise disturbances

PRICES			
	No regressors	Anintercept	A linear time trend
COSTA RICA	0.98 (0.88, 1.10)	1.41 (1.33, 1.51)	1.35 (1.28, 1.48)
HONDURAS	0.98 (0.89, 1.10)	1.36 (1.26, 1.49)	1.29 (1.20, 1.43)
EL SALVADOR	0.98 (0.89, 1.10)	1.15 (1.06, 1.28)	1.14 (1.05, 1.26)
GUATEMALA	0.98 (0.89, 1.10)	1.38 (1.28, 1.52)	1.34 (1.24, 1.48)
NICARAGUA	0.98 (0.88, 1.10)	1.38 (1.28, 1.53)	1.37 (1.26, 1.52)
DOMINICAN	0.98 (0.89, 1.10)	1.51 (1.40, 1.65)	1.49 (1.38, 1.63)
MONEY			
	No regressors	Anintercept	A linear time trend
COSTA RICA	0.97(0.88, 1.09)	1.02(0.93, 1.12)	1.01 (0.94, 1.10)
HONDURAS	0.99(0.90, 1.11)	0.91(0.79, 1.06)	0.93 (0.83, 1.06)
EL SALVADOR	0.97(0.88, 1.09)	0.77(0.72, 0.84)	0.76 (0.70, 0.84)
GUATEMALA	0.98(0.89, 1.11)	0.75(0.70, 0.85)	0.71 (0.60, 0.86)
NICARAGUA	0.98(0.89, 1.10)	0.88 (0.83, 0.95)	0.86 (0.78, 0.93)
DOMINICAN	0.98 (0.89, 1.09)	1.01 (0.92, 1.13)	1.01 (0.93, 1.12)
INTEREST RATES			
	No regressors	Anintercept	A linear time trend
COSTA RICA	0.99(0.90, 1.11)	1.35 (1.24, 1.48)	1.35(1.24, 1.47)
HONDURAS	0.97(0.88, 1.10)	1.25 (1.17, 1.35)	1.25(1.17, 1.35)
EL SALVADOR	0.95(0.86, 1.06)	0.91 (0.84, 0.99)	0.91(0.84, 0.99)
GUATEMALA	0.97(0.88, 1.09)	1.13(1.08, 1.20)	1.12 (1.07, 1.18)
NICARAGUA	0.92(0.83, 1.04)	0.52(0.44, 0.61)	0.54 (0.47, 0.63)
DOMINICAN	1.01 (0.93, 1.12)	1.13 (1.03, 1.25)	1.13 (1.03, 1.25)

Table 2: Estimates of d and 95% intervals under autocorrelated disturbances

PRICES			
	No regressors	Anintercept	A linear time trend
COSTA RICA	0.94 (0.80, 1.14)	1.38 (1.26, 1.51)	1.30 (1.21, 1.43)
HONDURAS	0.95 (0.79, 1.15)	1.23 (1.04, 1.43)	1.14 (1.02, 1.32)
EL SALVADOR	0.95 (0.79, 1.15)	1.08(0.95, 1.27)	1.08 (0.96, 1.25)
GUATEMALA	0.96 (0.79, 1.16)	1.29 (1.10, 1.52)	1.21 (1.07, 1.44)
NICARAGUA	0.94 (0.80, 1.14)	1.19 (1.03, 1.37)	1.16 (1.03, 1.35)
DOMINICAN	0.96 (0.82, 1.15)	1.31 (1.16, 1.51)	1.27 (1.13, 1.46)
MONEY			
	No regressors	Anintercept	A linear time trend
COSTA RICA	0.96 (0.80, 1.15)	1.13 (0.98, 1.31)	1.10 (0.99, 1.27)
HONDURAS	0.96 (0.79, 1.16)	0.85 (0.69, 1.34)	0.91 (0.71, 1.26)
EL SALVADOR	0.94 (0.80, 1.15)	1.01 (0.87, 1.18)	1.01 (0.86, 1.18)
GUATEMALA	0.93 (0.79, 1.15)	0.76 (0.70, 0.88)	0.60 (0.45, 0.86)
NICARAGUA	0.95 (0.79, 1.15)	0.98 (0.90, 1.12)	0.97 (0.86, 1.14)
DOMINICAN	0.96 (0.80, 1.15)	1.00 (0.84, 1.18)	1.00 (0.89, 1.17)
INTEREST RATES			
	No regressors	Anintercept	A linear time trend
COSTA RICA	0.97 (0.81, 1.17)	1.30 (1.07, 1.61)	1.30 (1.07, 1.62)
HONDURAS	0.93 (0.79, 1.15)	1.39 (1.23, 1.61)	1.38 (1.23, 1.60)
EL SALVADOR	0.97 (0.81, 1.16)	1.11 (0.98, 1.30)	1.12(0.98, 1.31)
GUATEMALA	0.93 (0.79, 1.15)	1.54 (1.40, 1.74)	1.47 (1.35, 1.67)
NICARAGUA	0.92 (0.77, 1.14)	0.64 (0.47, 0.84)	0.69(0.56, 0.85)
DOMINICAN	1.00 (0.85, 1.19)	1.04 (0.85, 1.28)	1.04(0.85, 1.28)

Table 3: Summary of the parametric resutls

i) No autocorrelation			
	PRICES	MONEY	INTEREST
COSTA RICA	1.35 (1.28, 1.48)	1.01 (0.94, 1.10)	1.35 (1.24, 1.48)
HONDURAS	1.29 (1.20, 1.43)	0.93 (0.83, 1.06)	1.25 (1.17, 1.35)
EL SALVADOR	1.14 (1.05, 1.26)	0.76 (0.70, 0.84)	0.91 (0.84, 0.99)
GUATEMALA	1.34 (1.24, 1.48)	0.71 (0.60, 0.86)	1.12 (1.07, 1.18)
NICARAGUA	1.37 (1.26, 1.52)	0.86 (0.78, 0.93)	0.54 (0.47, 0.63)
DOMINICAN	1.51 (1.40, 1.65)	1.01 (0.93, 1.12)	1.13 (1.03, 1.25)
ii) Autocorrelation			
	PRICES	MONEY	INTEREST
COSTA RICA	1.30 (1.21, 1.43)	1.10 (0.99, 1.27)	1.30 (1.07, 1.61)
HONDURAS	1.14 (1.02, 1.32)	0.91 (0.71, 1.26)	1.39 (1.23, 1.61)
EL SALVADOR	1.08 (0.96, 1.25)	1.01 (0.87, 1.18)	1.11 (0.98, 1.30)
GUATEMALA	1.21 (1.07, 1.44)	0.60 (0.45, 0.86)	1.54 (1.40, 1.74)
NICARAGUA	1.16 (1.03, 1.35)	0.97 (0.86, 1.14)	0.64 (0.47, 0.84)
DOMINICAN	1.27 (1.13, 1.46)	1.00 (0.89, 1.17)	1.04 (0.85, 1.28)

In bold, evidence of unit roots at the 5% level.

Table 4: Estimates of d based on a semiparametric method

PRICES					
	11	12	13	14	15
COSTA RICA	1.457	1.466	1.479	1.500	1.500
HONDURAS	1.226*	1.225*	1.210*	1.208*	1.111*
EL SALVADOR	1.219*	1.209*	1.212*	1.152*	1.169*
GUATEMALA	1.181*	1.219*	1.281	1.318	1.212*
NICARAGUA	1.375	1.444	1.467	1.330	1.314
DOMINICAN REP.	1.340	1.415	1.460	1.497	1.500
MONEY					
	11	12	13	14	15
COSTA RICA	1.411	1.437	1.467	1.443	1.202*
HONDURAS	1.270	1.173*	1.220*	1.071*	0.799
EL SALVADOR	1.170*	1.162**	1.202*	1.155*	1.143*
GUATEMALA	0.619	0.686	0.624	0.686	0.697
NICARAGUA	1.307	1.355	1.191*	1.123**	0.962*
DOMINICAN REP.	1.133*	1.198*	1.225*	1.210*	1.209*
INTEREST RATES					
	11	12	13	14	15
COSTA RICA	0.833	0.939*	1.019*	1.028*	1.097*
HONDURAS	1.203*	1.355	1.410	1.421	1.396
EL SALVADOR	1.350	1.230*	1.208*	1.249	1.205*
GUATEMALA	1.500	1.500	1.500	1.500	1.500
NICARAGUA	1.168*	1.178*	1.202*	1.115*	1.154*
DOMINICAN REP.	1.074*	1.022*	1.104*	1.137*	1.126*
Lower 95% I(1)	0.752	0.762	0.771	0.780	0.787
Upper 95% I(1)	1.247	1.237	1.228	1.219	1.2125

*: Evidence of unit roots at the 5% level.

Table 5: Cointegrating Rank Test with Lag length

Rank	Log-Likelihood	LR statistic
COSTA RICA		
0	1457.686	41.914
1	**1473.913**	**9.460**
2	1478.370	0.545
HONDURAS		
0	1518.160	59.160
1	1533.548	29.308
2	**1547.721**	**0.962**
EL SALVADOR		
0	1317.560	33.643
1	**1330.438**	**7.889**
2	1333.178	2.408
GUATEMALA		
0	1597.933	84.160
1	1621.310	37.525
2	**1639.941**	**0.264**
NICARAGUA		
0	1103.425	93.232
1	**1142.264**	**15.561**
2	1149.895	0.301
DOMINICAN REPUBLIC		
0	1067.009	38.984
1	**1081.310**	**10.381**
2	1086.475	0.052

Table 6: FVECMmodels

COSTA RICA
$\Delta^{1.164}\left(\begin{pmatrix}\log\_M\\ \log\_R\\ \log\_P\end{pmatrix} - \begin{pmatrix}13.553\\ 3.228\\ 3.581\end{pmatrix}\right) = L_{1.164}\begin{pmatrix}0.021\\ -0.028\\ 0.016\end{pmatrix}\begin{pmatrix}1.000\\ 0.889\\ -1.514\end{pmatrix}(X_t - \mu) + \Gamma\Delta^{1.164}L_{1.164}(X_t - \mu) + \varepsilon_t$
HONDURAS
$\Delta^{1.076}\left(\begin{pmatrix}\log\_M\\ \log\_R\\ \log\_P\end{pmatrix} - \begin{pmatrix}9.678\\ 3.145\\ 4.792\end{pmatrix}\right) = L_{1.076}\begin{pmatrix}-0.083 & -0.087\\ -0.041 & -0.030\\ 0.010 & -0.012\end{pmatrix}\begin{pmatrix}1.000 & 0.000\\ 0.000 & 1.000\\ -1.905 & 0.064\end{pmatrix}(X_t - \mu) + \Gamma\Delta^{1.076}L_{1.076}(X_t - \mu) + \varepsilon_t$
EL SALVADOR
$\Delta^{0.937}\left(\begin{pmatrix}\log\_M\\ \log\_R\\ \log\_P\end{pmatrix} - \begin{pmatrix}7.443\\ 2.050\\ 4.319\end{pmatrix}\right) = L_{0.937}\begin{pmatrix}-0.078\\ -0.012\\ -0.019\end{pmatrix}\begin{pmatrix}1.000\\ -0.352\\ -1.733\end{pmatrix}(X_t - \mu) + \Gamma\Delta^{0.937}L_{0.937}(X_t - \mu) + \varepsilon_t$
GUATEMALA
$\Delta^{0.889}\left(\begin{pmatrix}\log\_M\\ \log\_R\\ \log\_P\end{pmatrix} - \begin{pmatrix}9.931\\ 2.876\\ 4.055\end{pmatrix}\right) = L_{0.889}\begin{pmatrix}-0.105 & 0.015\\ -0.061 & 0.051\\ 0.003 & -0.042\end{pmatrix}\begin{pmatrix}1.000 & 0.000\\ 0.000 & 1.000\\ -1.567 & 0.192\end{pmatrix} + \Gamma\Delta^{0.889}L_{0.889}(X_t - \mu) + \varepsilon_t$
NICARAGUA
$\Delta^{0.886}\left(\begin{pmatrix}\log\_M\\ \log\_R\\ \log\_P\end{pmatrix} - \begin{pmatrix}9.596\\ 3.084\\ 4.228\end{pmatrix}\right) = L_{0.886}\begin{pmatrix}-0.024\\ -0.004\\ -0.020\end{pmatrix}\begin{pmatrix}1.000\\ 0.664\\ -1.225\end{pmatrix} + \Gamma_i\,\Delta^{0.886}L_{0.886}(X_t - \mu) + \varepsilon_t$
DOMINICAN REPUBLIC
$\Delta^{0.664}\left(\begin{pmatrix}\log\_M\\ \log\_R\\ \log\_P\end{pmatrix} - \begin{pmatrix}10.547\\ 2.980\\ 3.529\end{pmatrix}\right) = L_{0.664}\begin{pmatrix}-0.027\\ 0.023\\ 0.004\end{pmatrix}\begin{pmatrix}1.000\\ -2.799\\ -3.210\end{pmatrix} + \Gamma_i\,\Delta^{0.664}L^{i}_{0.664}(X_t - \mu) + \varepsilon_t$

Table 7: FVECM Forecast Mean Square Errors:

Country	Prices	Money	Interest rate
COSTA RICA	0,0006621	0,0002114	0,0002018
HONDURAS	0,0048973	0,0224752	0,0000149
EL SALVADOR	0,0031961	0,0012310	0,0001276
GUATEMALA	0,0002791	0,0007938	0,0000298
NICARAGUA	0,0001617	0,0447095	0,0002884
DOMINICAN REP.	0,0013325	0,0935417	0,0004660