Exchange Rates Contagion in Latin America

Por: Rubén Albeiro Loaiza Maya,
José Eduardo Gómez-González,
Luis Fernando Melo Velandia

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Exchange Rates Contagion in Latin America[1]

Rubén Albeiro Loaiza Maya[2]
José Eduardo Gómez-González[3]
Luis Fernando Melo Velandia[4]

ABSTRACT. A regular vine copula approach is implemented for testing for contagion among the exchange rates of the six largest Latin American countries. Using daily data from June 2005 through April 2012, we find evidence of contagion among the Brazilian, Chilean, Colombian and Mexican exchange rates. However, there are interesting differences in contagion during periods of large exchange rate depreciation and appreciation. Our results have important implications for the response of Latin American countries to currency crises originated abroad.

Keywords: Exchange Rates, Contagion, Copula, Regular Vine, Local correlation.

JEL Codes: C32, C51, E421.

Introduction

Empirical studies on exchange rates have focused on testing the efficient markets' hypothesis. Relatively little attention has been given to assessing exchange rate co-movements. However, as shown in some recent literature[5], exchange rates dependence is a relevant topic. It is crucial for the risk hedging decisions of investors taking positions in international financial markets, and also for economic policy assessment and international economic policy coordination.

The recent international financial turmoil, which began in the United States subprime mortgage market and rapidly spread all over the world, highlights the relevance of studying financial linkages and contagion among international financial markets. Different definitions of contagion co-exist in the literature.[6] In this study we follow the definition of Forbes and Rigobon (2002). They define contagion as a significant increase in cross-market linkages after the occurrence of a shock in one country. They show that the mechanism of transmission of crises arises from high interdependence among markets. Defining contagion this way allows distinguishing between temporal and permanent mechanisms for the transmission of crises. This differentiation is crucial for designing economic policy actions that may be useful for preventing or diminishing the

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[2] Department of Economics, University of Melbourne. E-mail: rloaizma@gmail.com
[3] Research Unit, Banco de la República (Central Bank of Colombia). E-mail: jgomezgo@banrep.gov.co
[4] Econometrics Unit, Banco de la República (Central Bank of Colombia). E-mail: lmelovel@banrep.gov.co
[5] See, Kang et al. (2002), Chadwick et al. (2002), Patton (2006), Fernandez (2007), Kuhl (2008), Orlov (2009), and Benediktsdottir and Scotti (2009).
[6] See, for instance, Loaiza et al (2014).

negative effects caused by external shocks.

Particularly, whenever contagion is identified between any two pairs of exchange rates, short-run isolation policies such as capital controls or central bank interventions in foreign currency markets may be effective for isolating a country from a currency crisis originated abroad. However, whenever the transmission of crises is due to permanent channels (no contagion) these policies may be ineffective and costly. Capital controls, for example, may delay the effects of an external crisis in a particular country, but will not be able to permanently avoid such effects.

The aim of this paper is to disentangle the level of contagion in Latin American exchange rate markets using a methodology that goes beyond a simple analysis of correlation breakdowns. We use daily data on exchange rates for the six largest Latin American countries[7] from June 2005 through April 2012. Under our approach, contagion is defined as a situation in which significantly different values of dependence coefficients are encountered during times of crises and during normal times. As in Bradley and Taqqu (2004) and Durante and Jaworski (2010) we measure middle and tail dependencies using local correlation coefficients. We implement a regular vine copula approach for modeling the multivariate dependence among exchange rates. The regular vine structure is computed following the methodology proposed by Dissmann et al. (2012).

Pair-Copula construction, initially proposed in the seminal work of Joe (1996) and extended by Bedford and Cooke (2001, 2002), is a method that allows computing a d-variate distribution as the product of $\mathrm{d}(\mathrm{d}-1)/2$ bivariate copulas. Various studies have implemented C-Vine and D-Vine pair-copulas.[8] However, these methods are particular cases of regular vines. In this sense, our approach is more comprehensive than those frequently used in the literature.

Studying the dependence among Latin American countries exchange rates is crucial both for local policy makers and for investors worldwide. From the standpoint of local policymakers, the nominal exchange rate is a key macroeconomic variable in a small open economy. For instance, it is a very important determinant of the price level. This importance is greater for small open economies with an inflationary past, like many Latin American countries.

From the point of view of global investors, the international financial crisis of 2007-2009 revealed the need to study in detail the performance of emerging markets, as these have become an important destiny for investments. Several Latin American countries, such as Colombia and Peru have recently acquired investment grades from the three major rating agencies, and hence investors around the world are interested in learning more about the economic conditions in these countries for making investment decisions. A key issue for investment decisions in Latin America deals with the interdependence between local markets.

Our results indicate that contagion exists among the Brazilian, Chilean, Colombian and Mexican exchange rates. For the cases of Argentina and Peru, the evidence exchange rate contagion with other countries in the region is much weaker. This result is consistent with interesting peculiarities of these two countries. Argentina's exchange rate behavior is

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[7] Argentina, Brazil, Chile, Colombia, Mexico and Peru.
[8] Example given, Korowicka and Cooke (2006) and Aas et al (2009).

quite independent from the behavior of other economies in the region given particular issues relating with the recent financial history of this country, as the process of debt restructuring that began in January 2005. Meanwhile, in contrast to the other large economies in the region, Peru is financially dollarized.

There are also interesting differences in contagion during periods of large exchange rate depreciation and appreciation. Particularly, while the exchange rates of Brazil, Chile, Colombia and Mexico exhibit contagion among each other during periods of appreciation, during devaluations contagion is only encountered in pairs of countries that include either Chile or Mexico.

The rest of the paper is organized as follows. Section 2 presents a brief overview of exchange rate regimes in Latin America in the 1990s and 2000s. Section 3 explains the regular vine copula methodology implemented in this study. An empirical application for Latin American exchange rates is shown in section four, and Section 5 concludes.

2. Exchange Rate Regimes in Latin America in the 1990s and 2000s

During the 1980s many Latin American countries suffered of international credit rationing due to the banking crises that took place during that decade. However, the international financial context favorably changed for Latin America in the early 1990s. In an environment of high liquidity and low interest rates, the United States launched the Brady plan. This plan's objective was to aid highly indebted countries in alleviating their debt burden with international banks. Several Latin American countries were benefited by this plan, and started a deregulation process of financial markets.

These changes in the international conditions pushed capital from the developed world to developing economies, including several Latin American countries. Argentina, Brazil, Chile and Mexico were the main recipients of these capital flows, but Colombia and Peru followed them closely.

As a consequence, macroeconomic policies in these countries, including exchange rate policies, were adapted to face these new economic conditions. Many countries that struggled to fight inflation[9] during the 1980s decided to carry on stabilization programs using the exchange rate as a nominal anchor. Hence, many countries in the region established pegs or almost fixed exchange rate regimes. Chile and Colombia were two notable exceptions. These two countries did not suffer from high inflation during the 1980s. Hence, their main concern was that of establishing an exchange rate regime flexible enough for maintaining a relatively competitive real exchange rate. With that objective in mind, during the 1990s both countries used crawling band regimes.

The Mexican crisis of 1994 and the Russian and Asian crises of the late 1990s had important effects over economic policy implementation in Latin America. Many countries in the region suffered sudden stops and capital reversals, leading to speculative attacks and banking crises in several countries. These phenomena imposed important challenges for maintaining macroeconomic stability and for the design of exchange rate policies.

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[9] Particularly Argentina, Brazil, Mexico and Peru.

Those countries which have implemented crawling pegs, and also those that were under crawling band regimes, had to migrate to more flexible exchange rate arrangements. Brazil let the Real float in January 1999. Shortly after most Latin American countries decided to implement floating exchange rate regimes. This policy change allowed many countries to implement inflation targeting schemes in the early 2000s.

Even though all the six main Latin American countries moved to more flexible exchange rate regimes, some economists have argued that none of them has fully implemented pure floating (e.g., Chang, 2008, and Frenkel and Rapetti, 2010). Central banks in Latin American countries have intervened frequently exchange rate markets, especially in moments of exchange rate appreciation. This stylized fact has been called “fear of appreciation”, following Levy-Yeyati et al. (2013).

3. Methodology

In this section we briefly present the R-Vine copula methodology used in our empirical analysis.

3.1. Copulas

A d-variate copula $C(F(x_1), \dots, F(x_d))$, is a cumulative distribution function whose marginals, $F(x_1), \dots, F(x_d)$, are uniformly distributed on the unit interval.[10]

Following Sklar (1959), if $F_1(x_1), \dots, F_d(x_d)$ are cumulative distribution functions of the continuous random variables $x_1, \dots, x_d$, then $C(F(x_1), \dots, F(x_d))$ is a copula function that represents the d-variate cumulative distribution function of $x_1, \dots, x_d$.

$$F(x_1, \dots, x_d) = C\big(F(x_1), \dots, F(x_d)\big) \tag{1}$$

The corresponding density function is given by

$$c(F(x_1), \dots, F(x_d)) = \frac{\partial^d C(F(x_1), \dots, F(x_d))}{\partial F(x_1), \dots, \partial F(x_d)} \tag{2}$$

If $F(x_1), \dots, F(x_d)$ are continuous functions, then $C(F(x_1), \dots, F(x_d))$ exists and is unique. Equation (1) shows that a multivariate distribution function has information on dependence and information about its marginals. The copula function C models the dependence structure.

3.2. Regular Vine Copulas

The Regular Vine Copula, initially proposed in the seminal work of Joe (1996) and extended by Bedford and Cooke (2001, 2002), is a method for computing c as the product of $d(d-1)/2$ bivariate copulas.

[10]A detailed revision of copulas can be found in Nelsen (2006), Joe (1997), Becerra and Melo (2008), among others.

This method is useful for modeling dependence structures allowing for asymmetry and flexible lower and upper tail dependence. Dissman et al. (2012) show in detail the theoretical definitions about regular vines and automated selection and estimation methods. They write the density of a regular vine copula as follows:

$$f_{1,\dots,d}(x) = \prod_{j=1}^{d} j_j(x_j) \prod_{k=d-1}^{1} \prod_{i=d}^{k+1} c_{m_{k,k},m_{i,k}|m_{i+1,k},\dots,m_{d,k}} \left(F_{m_{k,k}|m_{i+1,k},\dots,m_{d,k}}(z_1(k,i)), F_{m_{i,k}|m_{i+1,k},\dots,m_{d,k}}(z_2(k,i))\right)$$

$$z_1(k,i) = x_{m_{k,k}|m_{i+1,k},\dots,m_{d,k}}$$

$$z_2(k,i) = x_{m_{i,k}|m_{i+1,k},\dots,m_{d,k}}$$

where $m_{i,k}$ correspond to the elements of the m matrix that represent a regular vine structure.

Regular vine structures are easily represented in terms of graphs. A regular vine satisfies two conditions. First, its graphs are cyclical at each level. Second, each pair of edges in level l have $l-1$ common elements. Other conditions are given in Bedford and Cooke (2001, 2002). Two particular examples of regular vines, a C-vine and a D-vine with 5 variables and 4 trees, are depicted in Figures 1 and 2.

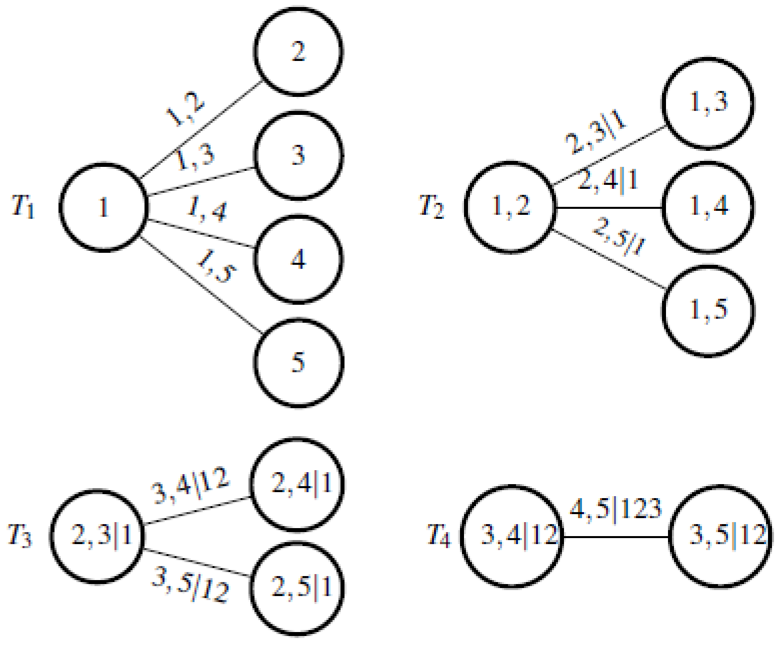

Figure 1. C-Vine with 5 variables.

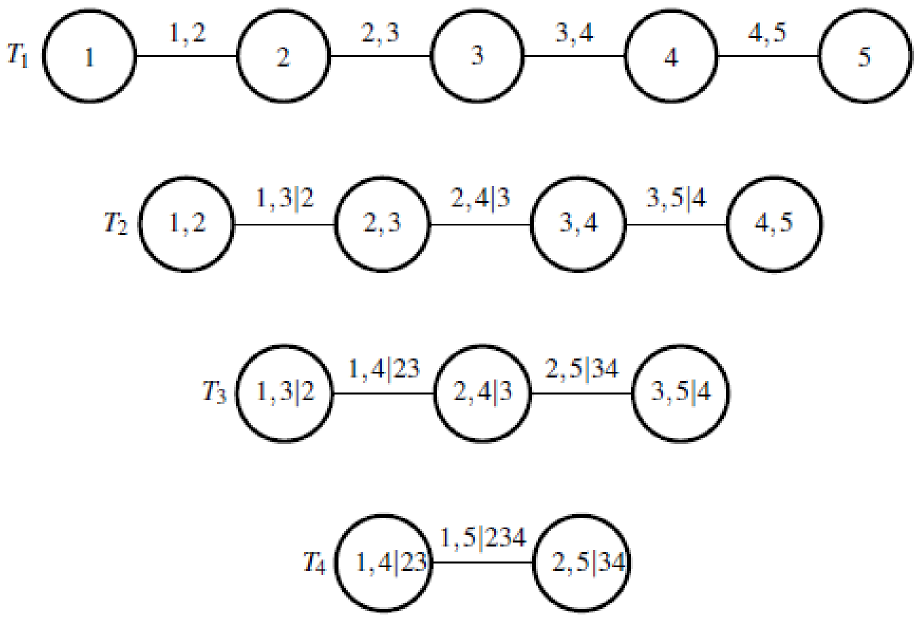

Figure 2. D-Vine with 5 variables

The edges in Figures 1 and 2 indicate the bivariate copulas in the C-Vine and D-Vine densities for five variables, as shown in the equations below.

C-Vine

$$
\begin{aligned}
f(x_1,x_2,x_3,x_4) = {} & f(x_1),f(x_2),f(x_3),f(x_4)f(x_5) \\
& c_{12}\big(F(x_1),F(x_2)\big)c_{13}\big(F(x_1),F(x_3)\big)c_{14}\big(F(x_1),F(x_4)\big)c_{15}\big(F(x_1),F(x_5)\big) \\
& c_{23|1}(F(x_2|x_1),F(x_3|x_1))\ c_{24|1}(F(x_2|x_1),F(x_4|x_1))c_{25|1}(F(x_2|x_1),F(x_5|x_1)) \\
& c_{34|12}(F(x_3|x_1,x_2),F(x_4|x_2,x_3))c_{35|12}(F(x_3|x_1,x_2),F(x_5|x_1,x_2)) \\
& c_{45|123}(F(x_4|x_1,x_2,x_3),F(x_5|x_1,x_2,x_3))
\end{aligned}
$$

D-Vine

$$
\begin{aligned}
f(x_1,x_2,x_3,x_4) = {} & f(x_1),f(x_2),f(x_3),f(x_4)f(x_5) \\
& c_{12}\big(F(x_1),F(x_2)\big)c_{23}\big(F(x_2),F(x_3)\big)c_{34}\big(F(x_3),F(x_4)\big)c_{45}\big(F(x_4),F(x_5)\big) \\
& c_{13|2}(F(x_1|x_2),F(x_3|x_2))\ c_{24|3}(F(x_2|x_3),F(x_4|x_3))c_{35|4}(F(x_3|x_4),F(x_5|x_4)) \\
& c_{14|23}(F(x_1|x_2,x_3),F(x_4|x_2,x_3))c_{25|34}(F(x_2|x_3,x_4),F(x_5|x_3,x_4)) \\
& c_{15|234}(F(x_1|x_2,x_3,x_4),F(x_5|x_2,x_3,x_4))
\end{aligned}
$$

Nevertheless, more complex structures can be also modeled. See Figure 3.

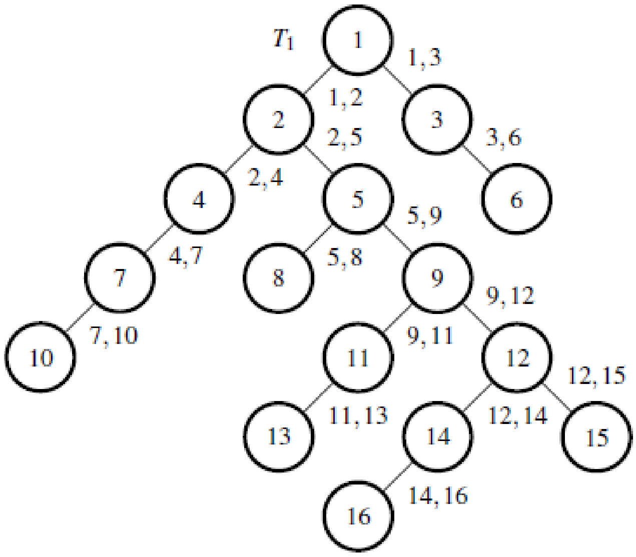

Figure 3. First tree of an R-Vine with 16 variables

3.3. The R-Vine Specification

Morales-Napoles (2010) show there are $\frac{d!}{2}2^{\binom{d-2}{2}}$ R-Vine structures for a d-dimensional problem. Therefore, it is important to select a suitable vine structure. Dissmann et al. (2012) suggest the following sequential procedure to identify and estimate an R-Vine structure:

- (i) The tree structure is selected by maximizing the sum of the absolute empirical Kendall correlation coefficients using the algorithm proposed in Prim (1957).
- (ii) The copula families associated with the tree specified in the previous step are chosen by minimizing the AIC.
- (iii) The parameters of the selected copulas are estimated by maximum likelihood methods.
- (iv) The transformed observations that will be used in the next tree are calculated.
- (v) Steps (i) to (iv) are repeated using the transformed observations for all of the remaining trees of the regular vine.

3.4. Local Correlations

Given that contagion is defined as significant increases in cross-market linkages, it is necessary to define a measure of dependence in crises and calmer periods. Following Bradley and Taqqu (2004) and Durante and Jaworski (2010), the dependence in any region of a bivariate distribution can be measured using local correlations. In the contagion case, the regions of interest are the tails and the central part of the distribution that are defined in terms of the percentiles of the distribution as follows:

$$\tau_L(\lambda) = [0,\lambda) \times [0,\lambda)$$

$$\tau_U(\lambda) = (1-\lambda, 1] \times (1-\lambda, 1]$$
$$\mu(\lambda) = [\lambda, 1-\lambda] \times [\lambda, 1-\lambda]$$

where τ_L, τ_u are the lower and upper tail region, respectively; μ is the central part of the distribution and λ indicates the threshold that divides these regions. It is important to notice that the local correlations are calculated over a pseudo-sample that has marginal uniform distribution in the unit interval. Durante and Jaworski (2010) propose testing for contagion using the following hypothesis in terms of these regions:

$$H_0: \rho_s(C_\tau) \leq \rho_s(C_\mu) \text{ No contagion}$$
$$H_a: \rho_s(C_\tau) > \rho_s(C_\mu)$$

Where $\rho_s(C_r)$ represents the Spearman's rank correlation calculated for the copula C over the region r, with $r = \tau, \mu$. This hypothesis can be applied to appreciations periods $(\tau = \tau_L)$ and depreciation periods $(\tau = \tau_U)$.

We implement the testing procedure in the following way:

(i) Given the estimated regular vine, N simulations of a d-dimensional vector are obtained using the algorithms proposed in Dissmann et al. (2012). This exercise is replicated S times.

(ii) The lower tail, upper tail and middle local correlation coefficients are computed for the threshold λ. This procedure is performed for each of the S replications.

(iii) The difference between the tail correlation coefficients and the middle correlation coefficient is computed for the S replications.

(iv) The $(1-\alpha/2)100\%$ confidence intervals for the previous difference are computed as the corresponding quantiles of their empirical distribution.

4. Empirical Application

The empirical analysis is based on the exchange rates of the six largest Latin American economies: Argentina, Brazil, Chile, Colombia, Mexico and Peru, over the period comprised between June 2005 and April 2012.

The first differences of the logarithms of exchange rates are graphed in Figure 5 of Appendix A.

Our method has three steps. In the first step the marginal distributions are modeled. In the second step, the R-Vine copula is estimated using the pseudo-sample associated with the standardized residuals of the models of the first step. Finally, local correlation coefficients are computed.

4.1. Models for the Marginal Distributions

In the first step, the first and second moments of the variables are modeled using an ARX(p)-GARCH(1,1) specification as follows:

$$r.ER_{c,t} = \alpha_{c,0} + \sum_{i=1}^{p_c} \alpha_{c,i}\, r.ER_{c,t-i} + \sum_{j=1}^{q_c} \boldsymbol{\beta}'_{c,j} \boldsymbol{X}_{c,t-j} + \sum_{j=1}^{q_c} \boldsymbol{\gamma}'_{c,j} \boldsymbol{Z}_{t-j} + \varepsilon_{c,t} \tag{3}$$

$$\eta_{c,t} = \varepsilon_{c,t}/\sqrt{h_{c,t}} \tag{4}$$

$$h_{c,t} = \omega_{c,0} + \omega_{c,1} h_{c,t-1} + \omega_{c,2} \varepsilon^2_{c,t-1} \tag{5}$$

in which $r.ER_{c,t} = log\left(ER_{c,t}/ER_{c,t-1}\right)$, $\boldsymbol{X}_{c,t} = (i.Diff_{c,t}, r.Equity_{c,t}, d.CDS_{c,t})'$, $Z_t = (r.S\%P500_t, r.VIX_t)'$, $ER_{c,t}$ is the exchange rate level of country c in period t, $i.Diff_c$ is the interest rate differential, $r.Equity_c$ is the stock index return, $d.CDS_c$ is the first difference of the credit default swaps, $r.S\&P500$ is the U.S. stock index return, $r.VIX$ is the VIX return, $c = \{ARG, BRA, CHI, COL, MEX, PER\}$, and $\eta_{c,t} \overset{iid}{\sim} (0,1)$.

We use an ARX(p)-GARCH(1,1) specification instead of an AR(p)-GARCH(1,1) specification due to our definition of contagion. We are looking for non-fundamental contagion. Therefore, we use different variables in the mean equation in order to factor-out the effect of fundamentals from the standardized residuals.

Some specification tests are presented in Tables 3 and 4 of Appendix B. The results of these tests show no evidence of misspecification. Finally, the estimated pseudo-sample $(u_{c,t} \equiv F_c(\eta_{c,t})$ was obtained as the empirical distribution of the standardized residuals. The estimated pseudo-sample is used as an argument of the regular vine copula.

4.2. Specification of the regular vine copula

The R-Vine copula structure was identified according to the methodologies described in section 3.3. The selected R-Vine structure is shown in Figure 4.

Thirty one families of copulas were considered: Gaussian, t, Clayton, Gumbel, Frank, Joe, Clayton-Gumbel, Joe-Gumbel, Joe-Clayton, Joe-Frank, Survival Clayton, Survival Gumbel, Survival Joe, Survival Clayton-Gumbel, Survival Joe-Gumbel, Survival Joe-Clayton, Survival Joe-Frank, Rotated Clayton 90 and 270 degrees, Rotated Gumbel 90 and 270 degrees, Rotated Joe 90 and 270 degrees, Rotated Clayton-Gumbel 90 and 270 degrees, Rotated Joe-Gumbel 90 and 270 degrees, Rotated Joe-Clayton 90 and 270 degrees and Rotated Joe-Frank 90 and 270 degrees.

The estimated parameters of the bivariate copulas of the R-Vine described in Figure 4 are displayed in Table 1. Most of the parameters of the conditional and unconditional copulas are significant. Those parameters that are non-significant are restricted to some copulas that include either Argentina or Peru.

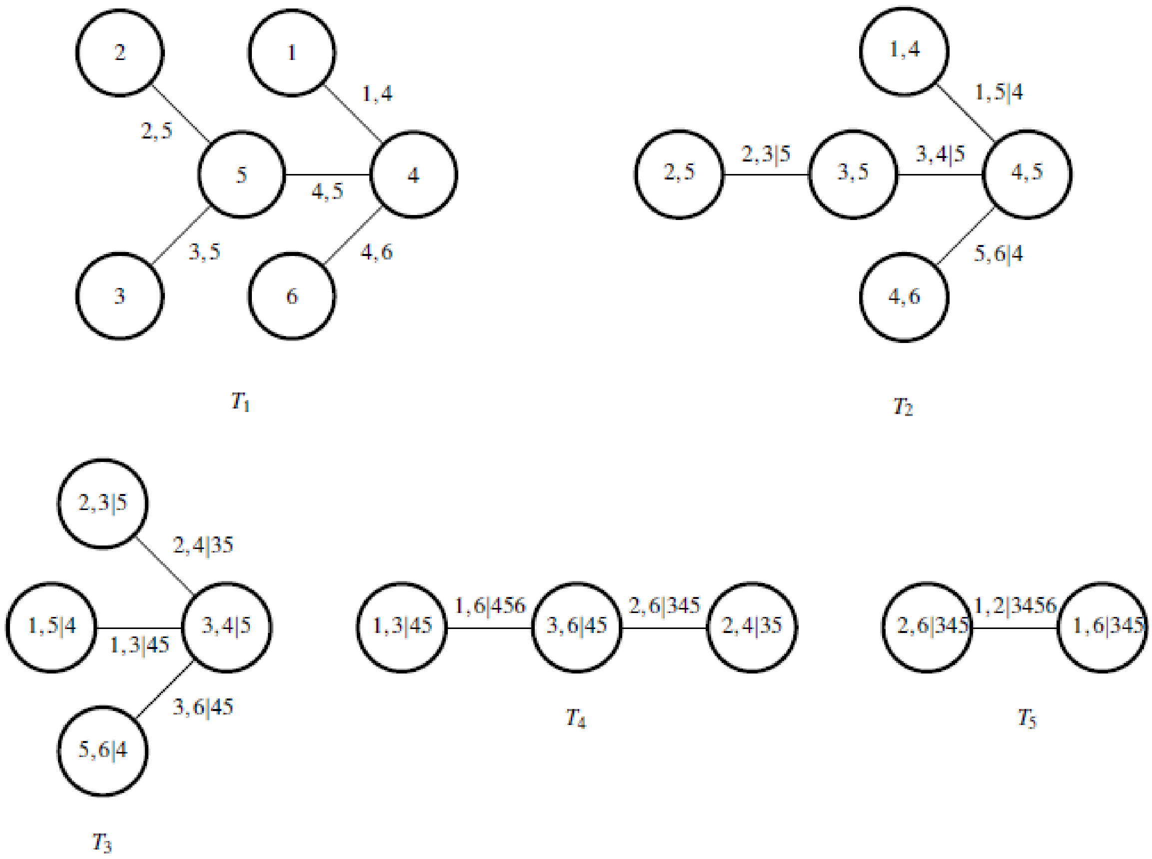

Figure 4. Estimated regular vine. The numbers indicate the exchange rates of the 6 Latin American countries as follows: 1=ARG, 2=BRA, 3=CHI, 4=COL, 5=MEX, 6=PER

	Copula	Parameter 1	Parameter 2	Std 1	Std 2
ARG_BRA	Gaussian	0.020	-	0.033	-
ARG_CHI	t	-0.031	10.103	0.037	3.745
ARG_COL	t	0.091	9.430	0.037	3.271
ARG_MEX	t	0.044	6.891	0.038	1.978
ARG_PER	Rotated Joe 270 degrees	-1.041	-	0.028	-
BRA_CHI	Survival Gumbel	1.103	-	0.025	-
BRA_COL	Survival Gumbel	1.108	-	0.025	-
BRA_MEX	t	0.394	6.802	0.030	1.714
BRA_PER	Clayton	0.043	-	0.037	-
CHI_COL	t	0.160	5.940	0.037	1.376
CHI_MEX	t	0.355	3.864	0.034	0.608
CHI_PER	t	-0.076	9.617	0.037	3.520
COL_MEX	t	0.282	4.346	0.036	0.771
COL_PER	t	0.182	7.823	0.036	2.323
MEX_PER	t	0.094	11.259	0.036	4.048

Table 1. Regular vine copula estimation results.

Based on the estimated regular vine copula, the local correlation coefficients were obtained using the simulation procedure explained in section 3.4. This exercise includes

$S = 500$ simulations of $N = 10000$ observations of a $6-$dimensional vector. The local correlation coefficients were calculated for different thresholds.

	ARG	BRA	CHI	COL	MEX	PER
ARG		No contagion	0.17	No contagion	0.16	No contagion
BRA	No contagion		No contagion	No contagion	0.19	No contagion
CHI	No contagion	0.13		0.14	0.13	0.19
COL	No contagion	0.11	0.14		0.14	No contagion
MEX	0.17	0.20	0.13	0.13		No contagion
PER	No contagion	No contagion	No contagion	No contagion	No contagion	

Table 2. Minimum local correlation threshold where contagion was found at the 1% level of significance

The results of the test for contagion are displayed in Table 2. The procedure is performed for different thresholds in increasing order from 0.05 to 0.20, considering increments of 0.01.

Table 2 shows the value of the first threshold for which contagion is detected. For example, the coefficient 0.17 for Argentina and Chile means that this is the minimum local correlation threshold (between 0.05 and 0.20) for which the null hypothesis of contagion is not rejected. Note that if the null hypothesis is rejected for all thresholds, the label "No contagion" is displayed. The implication of this label is that currency crises between the pair of countries under consideration can only be transmitted through permanent transmission channels.

The upper diagonal of this table shows the contagion results for the upper tail region of the bivariate distributions. The lower tail contagion tests associated with large appreciations are shown in the bottom diagonal of the same Table.

Our results indicate that contagion exists among the Brazilian, Chilean, Colombian and Mexican exchange rates. For the cases of Argentina and Peru, the evidence of exchange rate contagion with other countries in the region is much weaker. This result is consistent with interesting peculiarities of these two countries. Argentina's exchange rate behavior is quite independent from the behavior of other economies in the region given particular issues relating with the recent financial history of this country, as the process of debt restructuring that began in January 2005. Meanwhile, in contrast to the other large economies in the region, Peru is financially dollarized.

There are also interesting differences in contagion during periods of large exchange rate depreciation and appreciation. Particularly, while the exchange rates of Brazil, Chile, Colombia and Mexico exhibit contagion among each other during periods of appreciation, during devaluations contagion is only encountered in pairs of countries that include either Chile or Mexico.

It is noteworthy that the Chilean and Mexican exchange rates exhibit contagion with those of the other Latin American countries both during large appreciations and depreciations. This implies that currency crises originated in either of these two countries are transmitted to the rest of countries in our sample through temporary channels. Similarly, currency crises originated in any Latin American economy are transmitted to Chile and Mexico through temporary channels.

This fact indicates that short-run isolation strategies may be a feasible response of Chile and Mexico to currency crises originated in other Latin American countries. Similarly, the rest of Latin America may follow these strategies to overcome a currency crisis in Chile or Mexico. Short-run isolation strategies include, for example, capital controls and foreign exchange interventions by central banks.

In the case of currency appreciations, evidence of contagion is encountered for all possible pairs of exchange rates among Brazil, Chile, Colombia and Mexico. Hence, short-run isolation strategies may be valid. However, in the case of currency depreciations these are only valid for particular cases.

In cases in which no evidence of contagion is encountered, crises are transmitted mainly through permanent channels that exist in all states of the world. In these cases, following short-run isolation strategies may not be effective. These strategies will only delay a country's adjustment to a shock. However, they will not prevent it from being affected by the crisis, and may result extremely costly.

5. Concluding Remarks

In this study, we follow the definition of contagion in Forbes and Rigobon (2002). According to this definition, contagion is identified by the existence of a significant difference between dependence coefficients during crises and calmer periods. The identification of contagion between the markets of any two countries implies that crises are spread through temporary channels. In contrast, if no contagion is identified under this view, crises only spread through permanent channels. This last case is characterized by a constant level of interdependence in any region of the joint distribution of the markets.

This study implements a regular vine copula methodology useful for evaluating the level of contagion among the exchange rates of the six major Latin American countries (Argentina, Brazil, Chile, Colombia, Mexico and Peru). We use data spanning from June 2005 through April 2012. Based on our definition of contagion and following Durante and Jaworski (2010), and Bradley and Taqqu (2004), we measure contagion in terms of local correlations.

Our results indicate that contagion exists among the Brazilian, Chilean, Colombian and Mexican exchange rates. For the cases of Argentina and Peru, the evidence of exchange rate contagion with other countries in the region is much weaker. This result is consistent with interesting peculiarities of these two countries. Argentina’s exchange rate behavior is quite independent from the behavior of other economies in the region given particular issues relating with the recent financial history of this country, as the process of debt restructuring that began in January 2005. Meanwhile, in contrast to the other large economies in the region, Peru is financially dollarized.

There are also interesting differences in contagion during periods of large exchange rate depreciation and appreciation. Particularly, while the exchange rates of Brazil, Chile, Colombia and Mexico exhibit contagion among each other during periods of appreciation, during devaluations contagion is only encountered in pairs of countries that include either Chile or Mexico.

Our results suggest that the implementation of asymmetric exchange rate policies may be appropriate for Latin American countries different from Chile and Mexico. Particularly, these policies can be characterized by short-run isolation strategies during periods of large currency appreciations, and long-run policy strategies during periods of large depreciations. In the cases of Chile and Mexico, the evidence suggests that these two countries should always implement short-run isolation policies, such as capital controls, whenever a currency crisis develops in another country of the region.

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Appendix A. Exchange rates graphs

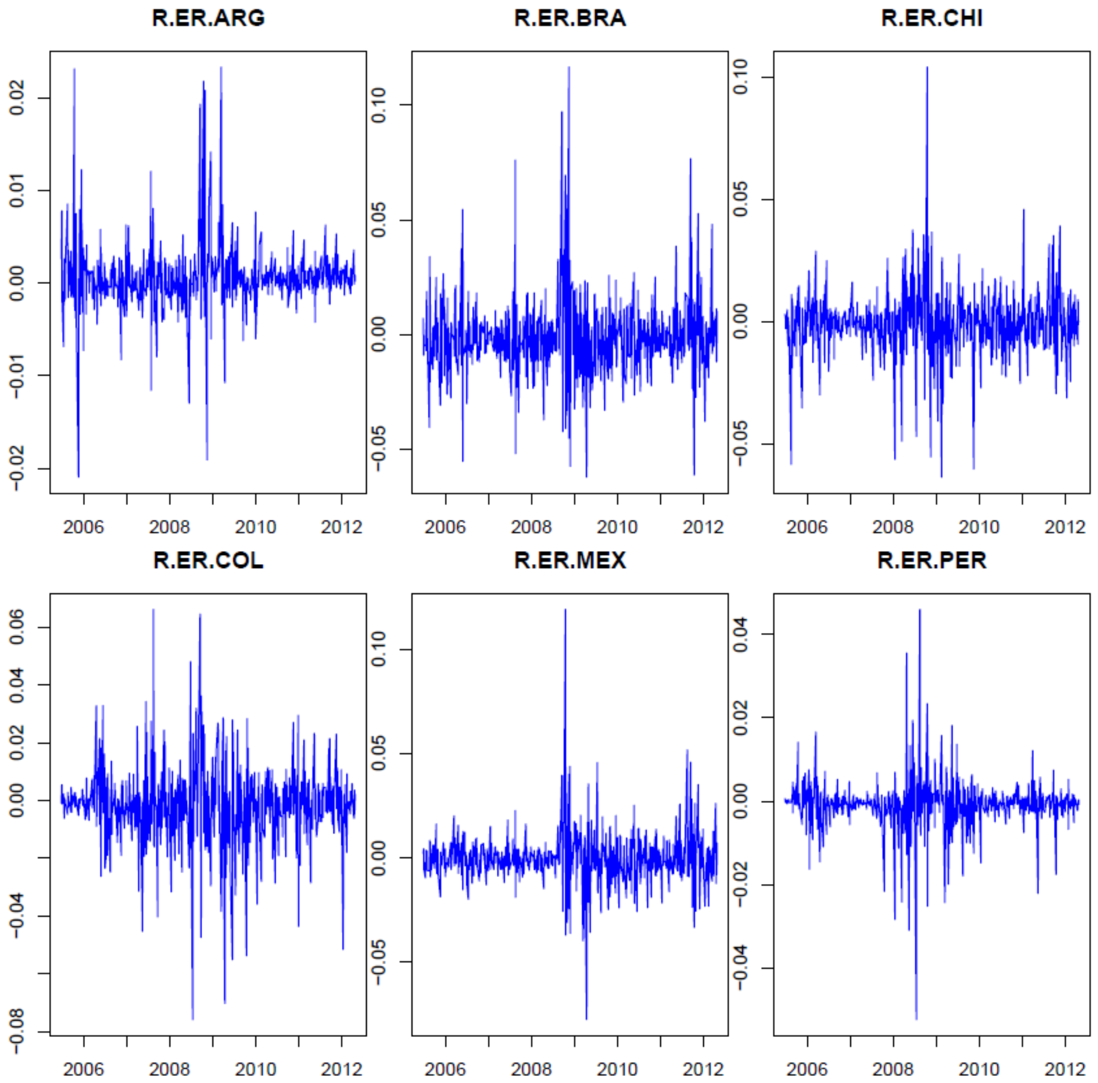

Figure 5. First difference of the logarithm of exchanges rates of Argentina, Brazil, Chile, Colombia, Mexico and Peru

Appendix B. Specification tests

	ARCH (LM) (lags = 12)	Portmanteau (lags = 100)
ARG	0.888	0.564
BRA	0.942	0.610
CHI	0.475	0.799
COL	0.378	0.215
MEX	0.258	0.284
PER	0.019	0.739

Table 3. Univariate specification tests for the standardized residuals (P-Values)

	Null Hypothesis	Lags	Statistic	P-Value
Breusch and Godfrey (LM)	No autocorrelation	4	163.169	0.131
Portmanteau	No autocorrelation	100	3533.780	0.522
LM (squared residuals)	No MGARCH effect	12	445.358	0.318

Table 4. Multivariate specification tests for the standardized residuals