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Commodity-Price Volatility, Exchange Market Pressure, and Macroeconomic Linkages: Evidence from Latin America

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Abstract

As a major source of commodity exports, Latin America has long been susceptible to external shocks, that continue to this day. With prices falling for oil, copper, and other key products, it is important to study the effects of commodity-price volatility on the region's macroeconomies. Using Principal Components Analysis, this study creates an index of Latin American commodity prices. This index's volatility is then entered into a VAR that includes exchange market pressure (EMP), U.S. stock prices, and other macroeconomic variables. Granger causality and impulse-response functions show that variables such as growth are more affected by commodity-price volatility than is EMP. One key finding is that commodity-price risk reduces economic growth in Mexico, Chile, and Peru, but appears to increase Brazil's growth rate. Further exploration might help reveal possible differences in Brazil's economic structure that might drive this result.

JEL classification numbers:F31
Keywords: Commodity Prices, Volatility, Exchange Market Pressure, Latin America, Vector Autoregression

1 Introduction

As oil prices continue their downward slide, following years of record highs, commodity exporters have felt their revenues and budgets squeezed as a result. Manufacturers, on the other hand, might benefit from reduced input prices, but as a general rule, macroeconomic volatility of any kind increases risk and might reduce economic activity.
Having been a major exporter of many different commodities over its history, Latin America has long been vulnerable to commodity-price swings. Even today, with Mexico and Brazil continuing to diversify their economies through manufacturing, these risks remain. In particular, both these large economies are oil exporters as well as manufacturers. Fluctuations in the oil price, therefore, might have an impact on the

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region's currencies and on growth. The literature exploring the linkages between commodity prices and the overall economy is vast. Much of the literature on interlinkages deals with oil prices and other commodity prices, particularly metals. Others focus on oil prices and exchange rates. For example, Hammoudeh and Yuan (2008) apply Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models and find that oil-price shocks have differing effects on gold, silver, and copper prices. Sari et al. (2010) find evidence of some connections among metals prices, the dollar/Euro exchange rate, and oil prices. While Zhang et al. (2008) and Reboredo(2012) test for comovements between oil prices and exchange rates, Papadamou and Markopoulos (2014) examine connections between precious-metal prices and the Euro, Pound, and Yen. One study that considers the broader macroeconomy is that of Farzanegan and Markwardt (2009), who use Vector Autoregression (VAR) methods to examine the effects of oil price shocks on Iranian output, inflation, Government expenditure, and the exchange rate.

This study examines the linkages among commodity-price volatility, external shocks, growth in domestic credit and government debt, and inflation on four Latin American countries' exchange markets. Cashin et al. (2002) performed a seminal study of "commodity currencies," which rise and fall in tandem with the value of a major export. Tanner (2000) first explored the main drivers of EMP in Latin America, but did not focus on commodity prices. Connections between price changes (but not volatility) have been previously explored by Hegerty (2010, 2014), but volatility was not included in the analysis. This study, therefore, provides an important extension to this branch of the literature.

We do this in three steps. First, we calculate indices of Exchange Market Pressure (EMP), which capture depreciations vis-a-vis the U.S. dollar, as well as central bank action to maintain a currency's value. Then, we calculate volatility measures of changes in commodity prices and the countries' real effective exchange rates. Using basic Vector Autoregressive (VAR) methods, we find evidence of spillovers not only between terms-of-trade volatility and EMP, but also with the other macroeconomic variables in the model.

2 Data and Methodology

Using monthly data from the International Financial Statistics (IF) of the International Monetary Fund, we conduct our empirical analysis for Brazil, Mexico, Chile and Peru. Our period of analysis differs slightly from country to country, and is listed below in Figure 3. Following Eichengreen et al. (1996), we calculate a monthly, continuous measure of EMP that captures currency depreciations (increases in units per U.S. dollar), as well as reserve losses (deflated by the lagged monetary base) and changes in the interest-rate differential (money market rate) vis-à-vis the United States. These latter two components represent interventions that can be used to prevent a depreciation. Each of the three components is scaled by its own standard deviation:

$$EMP_t = \frac{1}{\sigma_{\Delta e}}\left(\ln E_t - \ln E_{t-1}\right) - \frac{1}{\sigma_{\Delta RES}}\frac{\Delta RES_t}{MB_{t-1}} + \frac{1}{\sigma_{\Delta r}}\Delta\left(r_t - r_t^{US}\right) \quad (1)$$

Next, following Hegerty (2014), we use Principal Components Analysis (PCA) to create a single „commodity price index" that comines log price changes in oil (West Texas Intermediate), coffee, and copper. We then calculate the volatility of this measure by running a rolling first-order autoregressive, or AR(1), estimation over 12-month windows and recording the standard errors. As is noted by Bahmani-Oskooee and Hegerty (2012), this method is often used in studies of exchange-rate volatility. We construct similar measures for each country's real effective exchange rate (REER), except Peru, for which IFS data were unavailable. We then enter EMP and our volatility measure into a VAR that also includes the growth rate of real domestic credit (all year-over–year), the growth rate of government borrowing (scaled by domestic M2), the growth rate of industrial production, the CPI inflation rate, and log changes in U.S. stock prices:

$$\left[EMP_t, CRG_t, GOVG_t, GROWTH_t, INF_t, \Delta\ln\left(P_S^{US}\right)_t, VOL_t\right] \quad (2)$$

We first perform Granger Causality/Block exogeneity tests to see whether the addition of each variable adds significant explanatory power to regressions of the other variables. Significant results are therefore evidence of spillovers. Our main tool in this study, however, is the Impulse Response Function (IRF), which plots the time path of a variable's response following a shock to another. This will allow us not only to address significance (with the addition of ±2 standard error bands), but also sign as responses move above or below the zero line. In order to avoid issues with the proper ordering of the variables, which is necessary for "orthogonalized" VARs, we apply the Generalized VAR approach of Pesaran and Shin (1998). Our findings are presented below.

3 Main Results

Our indices of commodity prices (in log changes), as well as our resulting volatility series, are presented in Table 1. We see that oil and copper prices plunged during the 2008 recession; this contributes to a volatility spike during this same period. The underlying PCA results are provided in Table 1 as well. There is one principal component with an eigenvalue above 1; this is used as the volatility index. As mentioned above, the standard error of a rolling AR(1) estimation, with 12-month horizons, is used as the volatility measure.

The three countries' REER volatility series are depicted in Figure 2. We see that each country's experience is different, with Mexico's more closely approximating the volatility of the oil price. Brazil's REER volatility is high in the late 1990s and early 2000s, while Chile's series experiences variance throughout the sample. We examine connections with the macro economy with an additional VAR specification that replaces commodity-price volatility with REER volatility for these three economies.

For each VAR, the variables will be differenced as necessary to achieve stationary. Table 2 presents the results of the Phillips-Perron test, performed on the level variables. The following VARs reflect these results, which are provided in Table 3.

After selecting lag lengths for each VAR by minimizing the Hannan-Quinn goodness-offit criterion, we next conduct Granger Causality/Block exogeneity tests. Overall, we find that commodity-price and REER volatility have limited effects on EMP; only the Mexican currency market is affected, and only by REER volatility. Growth, particularly in Mexico and Brazil, is the variable that is most influenced by the other variables. In particular, EMP has a significant impact on both countries' industrial production, as does commodity price volatility. REER volatility, however, does not have a similar effect.

Turning to the Generalized IRFs, which are depicted in Figure 3, we see a number of interesting results—particularly with regard to the macroeconomic variables. EMP tends to reduce growth, while increases in U.S. stock prices reduce EMP. This suggests that both potential currency crises have detrimental effects on Latin America's real economy, and that events in global currency markets can affect the region's currency markets.

Our main focus of this study is the impact of commodity-price and REER volatility on EMP and other macroeconomic variables. Here, we find two interesting results. First, commodity-price volatility reduces growth in Peru, Mexico, and Chile. This spillover from commodity markets to the real economy is important: It shows how important this sector is in the region and demonstrates the continued susceptibility of Latin America to this risk. REER volatility reduces industrial production growth only in Mexico. Chile is more susceptible to commodity prices in a way that its more industrialized neighbor is not. At the same time, REER volatility might reduce credit growth in Mexico over time, while commodity-price volatility increases it. This suggests that while commodity-price and REER volatility both measure terms-of-trade and external risk, they behave very differently.

Secondly, Brazil responds differently from its three neighbors in its response to external shocks. Commodity-price volatility leads to increased growth and reduced EMP in Brazil. Perhaps the country has been able to diversify out of commodities into manufacturing in a way that the rest of the region has not. Nonetheless, this finding is worthy of further exploration.

4 Figures and tables

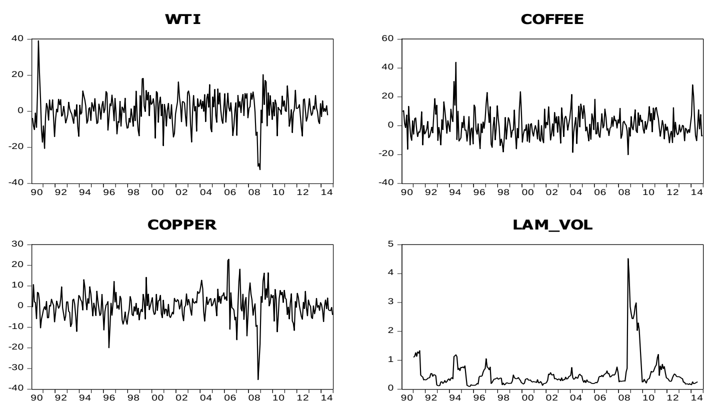


Figure 1: Commodity prices (log changes) and index volatility, 1990-2014

Table 1:Principal components analysis results

PC	Eigenvalue	Proportion	Variable	Loading	Correlations	Coffee	Copper
1	1.469	0.490	Coffee	0.335	Coffee	1	
2	0.958	0.319	Copper	0.687	Copper	0.173	1
3	0.574	0.191	Oil	0.644	Oil	0.060	0.410

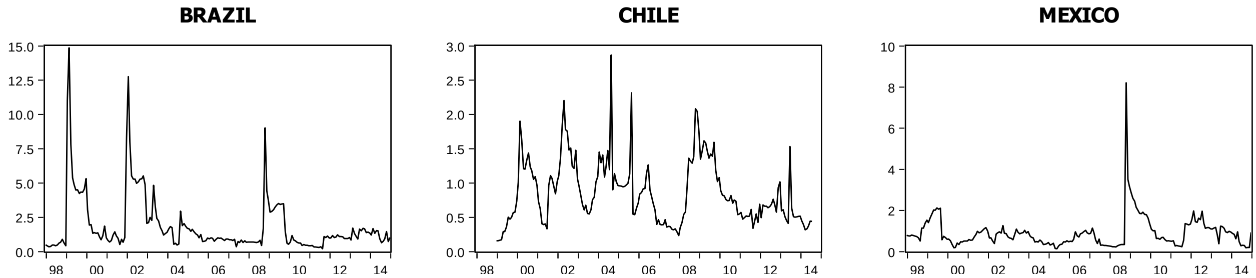


Figure 2: Real effective exchange volatility

Table 2: Phillips-Perron stationarity test results (p-values in parentheses).

	Brazil	Chile	Mexico	Peru
EMP	-7.936 (0.000)	-10.061 (0.000)	-7.936 (0.000)	-11.781 (0.000)
CRG	-4.469 (0.000)	-13.512 (0.000)	-4.469 (0.000)	-3.384 (0.012)
GOVG	-3.016 (0.033)	-6.169 (0.000)	-3.016 (0.033)	-17.338 (0.000)
GROWTH	-4.719 (0.000)	-7.314 (0.000)	-4.719 (0.000)	-6.779 (0.000)
INF	-2.447 (0.129)	-13.485 (0.000)	-2.447 (0.129)	-13.228 (0.000)
DLNUSPS	-13.566 (0.000)	-11.258 (0.000)	-13.566 (0.000)	-13.492 (0.000)
LAMPCVOL	-4.403 (0.000)	-3.557 (0.007)	-4.403 (0.000)	-4.286 (0.001)
REERVOL	-5.953 (0.000)	-4.861 (0.000)	-5.953 (0.000)	

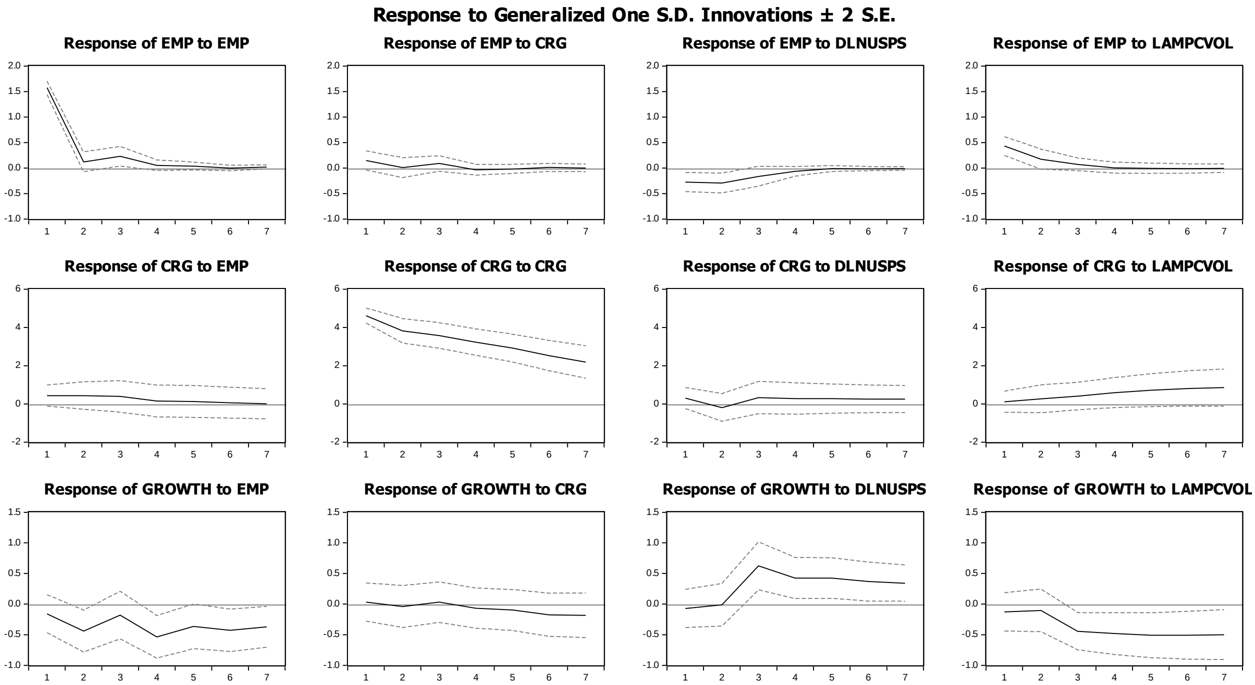
Table 3. Granger causality/block exogeneity test results (p-values in parentheses)

Brazil	EMP	CRG	GROWTH	DINF	Brazil	EMP	CRG	GROWTH	DINF
EMP		0.661 (0.416)	**5.460 (0.020)**	0.101 (0.750)	EMP		0.571 (0.450)	**9.019 (0.003)**	0.213 (0.645)
CRG	0.198 (0.656)		0.082 (0.775)	0.502 (0.479)	CRG	0.228 (0.633)		0.099 (0.753)	0.475 (0.491)
GROWTH	0.052 (0.820)	0.081 (0.776)		1.950 (0.163)	GROWTH	0.157 (0.692)	0.264 (0.607)		0.025 (0.875)
DINF	0.005 (0.942)	0.376 (0.540)	**3.913 (0.048)**		DINF	0.008 (0.929)	0.272 (0.602)	**5.403 (0.020)**	
DGOVG	2.732 (0.098)	0.172 (0.678)	3.311 (0.069)	0.097 (0.755)	DGOVG	2.700 (0.100)	0.144 (0.704)	3.687 (0.055)	0.167 (0.682)
DLNUSPS	**4.285 (0.039)**	0.053 (0.818)	0.906 (0.341)	0.072 (0.788)	DLNUSPS	4.878 (0.027)	0.059 (0.808)	0.977 (0.323)	0.020 (0.888)
LAMPCVOL	0.204 (0.652)	0.273 (0.602)	**4.188 (0.041)**	**5.496 (0.019)**	REERVOL	2.030 (0.154)	0.347 (0.556)	1.115 (0.291)	0.034 (0.854)
All	8.052 (0.234)	1.430 (0.964)	**24.168 (0.001)**	6.46 (0.374)	All	9.933 (0.128)	1.504 (0.959)	**20.863 (0.002)**	0.978 (0.986)
Mexico	EMP	CRG	GROWTH	DINF	Mexico	EMP	CRG	GROWTH	DINF
EMP		0.079 (0.961)	**10.642 (0.005)**	**6.72 (0.035)**	EMP		2.046 (0.563)	**23.934 (0.000)**	**24.331 (0.000)**
CRG	1.013 (0.603)		0.126 (0.939)	**17.454 (0.000)**	CRG	1.266 (0.737)		**12.004 (0.007)**	**23.297 (0.000)**
GROWTH	1.981 (0.371)	**5.224 (0.073)**		2.466 (0.292)	GROWTH	3.856 (0.278)	**9.642 (0.022)**		3.248 (0.355)
DINF	**7.849 (0.020)**	**6.288 (0.043)**	**24.462 (0.000)**		DINF	3.270 (0.352)	3.237 (0.357)	**30.911 (0.000)**	
DGOVG	1.496 (0.473)	0.805 (0.669)	2.598 (0.273)	**7.501 (0.024)**	DGOVG	1.761 (0.623)	0.405 (0.939)	4.814 (0.186)	7.489 (0.058)
DLNUSPS	**8.384 (0.015)**	**6.637 (0.036)**	**13.042 (0.002)**	1.142 (0.565)	DLNUSPS	**10.07 (0.018)**	3.274 (0.351)	**12.305 (0.006)**	1.181 (0.758)
LAMPCVOL	1.564 (0.458)	5.515 (0.064)	**8.807 (0.012)**	1.595 (0.451)	REERVOL	**17.045 (0.001)**	7.456 (0.059)	0.892 (0.827)	**24.56 (0.000)**
All	**21.783 (0.040)**	**30.012 (0.003)**	**62.271 (0.000)**	**44.669 (0.000)**	All	**49.794 (0.000)**	**45.05 (0.000)**	**85.124 (0.000)**	**92.469 (0.000)**
Chile	EMP	CRG	GROWTH	INF	Chile	EMP	CRG	GROWTH	INF
EMP		0.089 (0.765)	1.959 (0.162)	0.020 (0.888)	EMP		0.004 (0.947)	2.619 (0.106)	0.012 (0.912)
CRG	0.383 (0.536)		0.763 (0.382)	0.000 (0.992)	CRG	0.443 (0.506)		0.569 (0.451)	0.002 (0.967)
GROWTH	2.425 (0.119)	0.743 (0.389)		0.064 (0.800)	GROWTH	1.518 (0.218)	0.932 (0.334)		0.125 (0.723)
INF	0.001 (0.981)	0.000 (0.986)	0.092 (0.761)		INF	0.003 (0.953)	0.005 (0.942)	0.057 (0.811)	
GOVG	3.615 (0.057)	0.025 (0.875)	0.083 (0.773)	0.095 (0.758)	GOVG	2.905 (0.088)	0.051 (0.821)	0.000 (0.995)	0.101 (0.750)
DLNUSPS	**5.408 (0.020)**	0.776 (0.378)	0.491 (0.484)	0.168 (0.682)	DLNUSPS	**5.869 (0.015)**	1.575 (0.210)	1.191 (0.275)	0.078 (0.780)
LAMPCVOL	2.512 (0.113)	0.075 (0.784)	**6.932 (0.009)**	0.025 (0.874)	REERVOL	2.341 (0.126)	2.375 (0.123)	0.014 (0.907)	0.105 (0.746)
All	10.957 (0.090)	1.726 (0.943)	**13.506 (0.036)**	0.475 (0.998)	All	10.779 (0.096)	4.047 (0.670)	6.343 (0.386)	0.556 (0.997)
Peru	EMP	DCRG	GROWTH	INF					
EMP		0.922 (0.337)	1.624 (0.203)	0.487 (0.485)					
DCRG	3.542 (0.060)		0.676 (0.411)	2.217 (0.137)					
GROWTH	**6.199 (0.013)**	0.000 (0.985)		**5.373 (0.020)**					
INF	**4.384 (0.036)**	0.133 (0.715)	1.967 (0.161)						
GOVG	0.052 (0.820)	2.245 (0.134)	0.387 (0.534)	1.384 (0.239)					
DLNUSPS	2.079 (0.149)	0.019 (0.890)	0.504 (0.478)	0.022 (0.883)					
LAMPCVOL	0.108 (0.743)	1.677 (0.195)	3.444 (0.064)	1.436 (0.231)					
All	**16.293 (0.012)**	5.002 (0.544)	8.119 (0.230)	**12.977 (0.043)**					

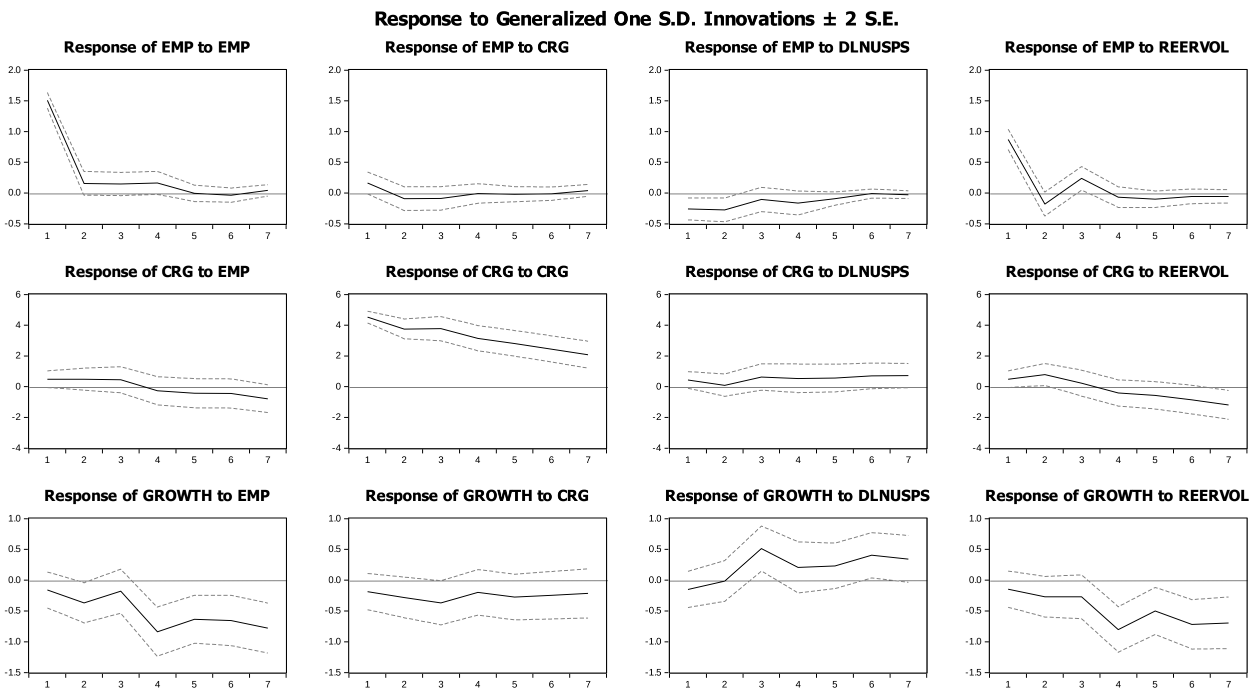
Bold = Significant at 5 percent.

Figure 3: Generalized impulse-response functions (with ±2 error bands)

Mexico (1991m01-2014m07)
PCVOL



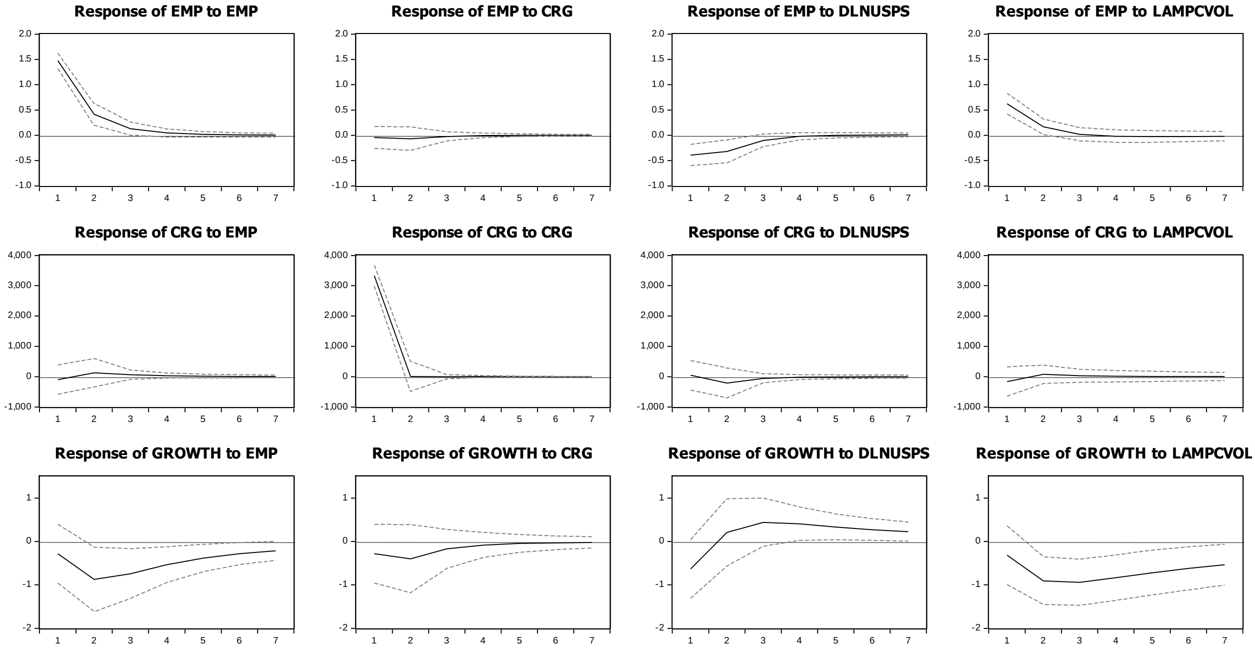
REERVOL



Chile (1998m12-2014m07)

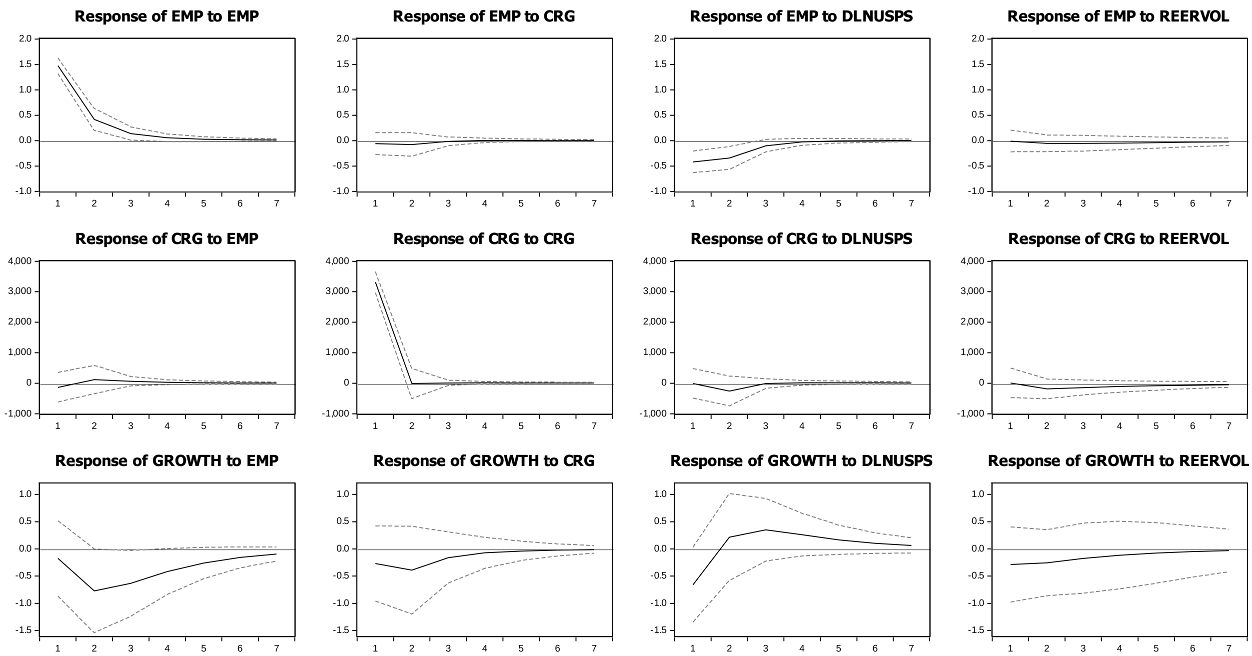
PCVOL

Response to Generalized One S.D. Innovations ± 2 S.E.



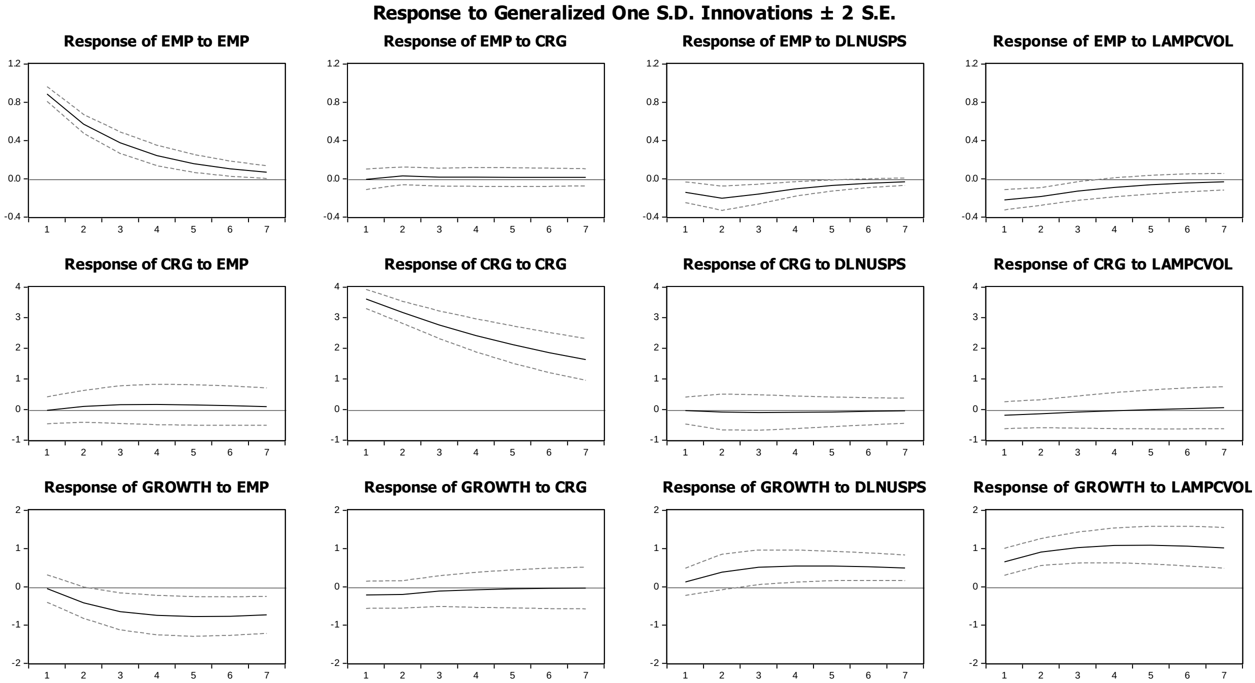
REERVOL

Response to Generalized One S.D. Innovations ± 2 S.E.

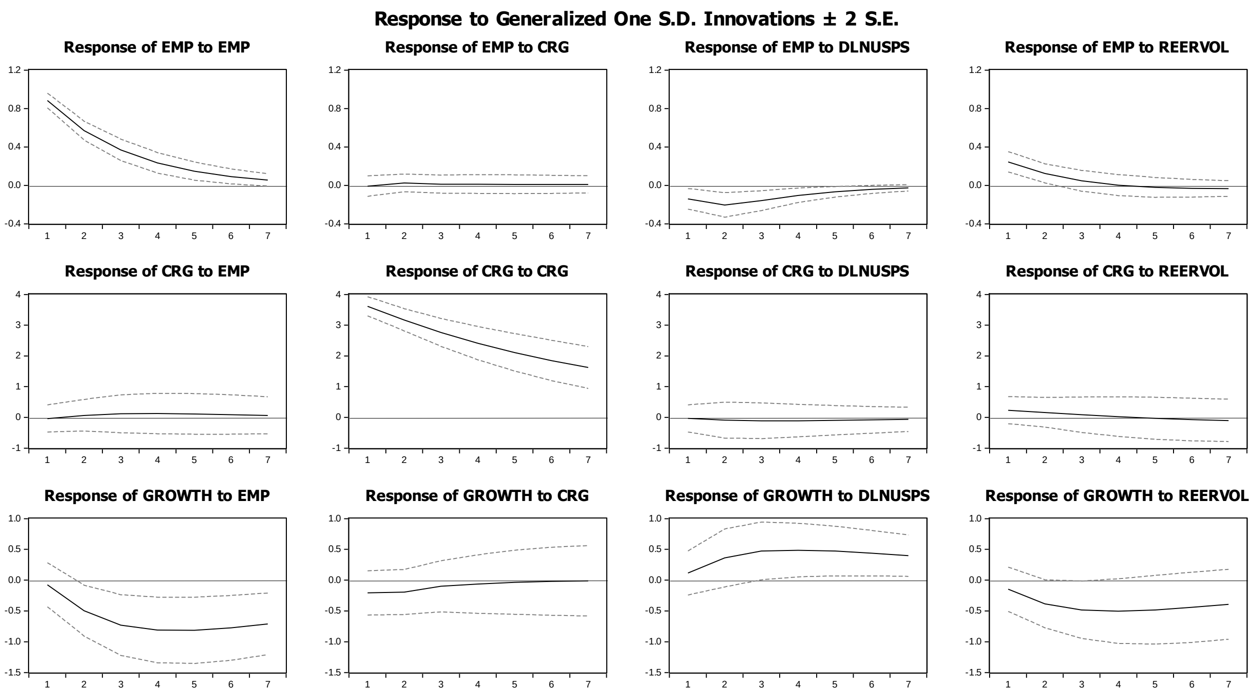


Brazil (1992m01-2014m07)

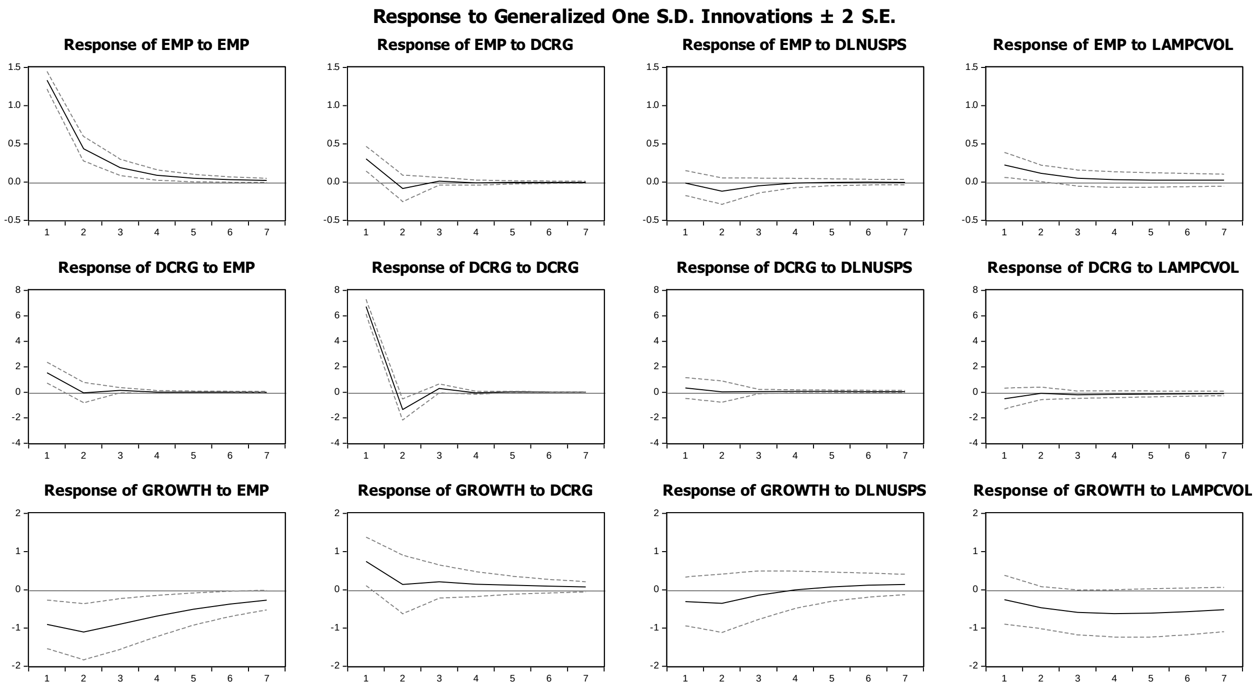
PCVOL



REERVOL



Peru (1992m01-2014m04)
PCVOL



5 Conclusion

With its long history of commodity exports that have left the region susceptible to external shocks, Latin America now faces declines in the prices of oil, copper and other key products. This study creates an index of Latin American commodity prices and calculates its volatility, before entering it into a VAR that includes exchange market pressure (EMP), U.S. stock prices, and other macroeconomic variables. Granger causality and impulse-response functions show that commodity-price and REER volatility have less of an effect on EMP than they do on other variables. In particular, commodity-price risk reduces economic growth in Mexico, Chile, and Peru. On the other hand, this risk appears to boost Brazil's growth rate. This finding is worthy of further exploration, particularly regarding possible differences in Brazil's economic structure that might drive this result.

Drawing on these results, policymakers would be wise to consider orienting policy toward growth rather than the exchange rate. While regulating swings in global markets would be difficult, it is possible to help mitigate the effects of these fluctuations. In particular, Mexico, Chile, and Peru should consider some sort of countercyclical policy to counter the reduced growth brought about by commodity-price variability.

References

Bahmani-Oskooee, M. &Hegerty, S.W. (2012).Measures of uncertainty in economics, in: Simmons, P.E. Jordan, S.T. (Eds.) *Economics of Innovation, Incentives and Uncertainty*, Nova Science Publishers, pp. 141-153.

Cashin, P., Céspedes, L.,& Sahay, R. (2002). Keynes, cocoa and copper: In search of commodity currencies, IMF *Working Paper Series* WP/02/223.

Eichengreen, B., Rose, A., & Wyplosz, C. (1996). Contagious currency crises: First tests. *Scandinavian Journal of Economics,98*(4), 463-484.

Farzanegan, M., & Markwardt, G. (2009). The effects of oil price on the Iranian economy. *Energy Economics*, *31*, 134–151.

Hammoudeh, S., & Yuan, Y. (2008). Metal volatility in presence of oil and interest rate shocks. *Energy Economics*, *30*, 606–620.

Hegerty, S.W. (2010).Exchange-Market pressure and currency crises in Latin America: Empirical Tests of Their Macroeconomic Determinants. *Economics Bulletin, 30*(3): 2210-2219.

Hegerty, S.W. (2013).Exchange market pressure, output drops, and domestic credit: Do *Emerging Markets Behave Differently*? *Economics Bulletin,33*(4), 2583-2595.

Hegerty, S.W. (2014). Exchange market pressure, commodity prices, and contagion in Latin America. *Journal of International Trade & Economic Development23*(1), 56-77.

Papadamou, S., & Markopoulos, T. (2014). Investigating intraday interdependence between gold, silver and three major currencies: the Euro, British Pound and Japanese Yen. *International Advances in Economic Research*, 20(4), 399-410.

Pesaran, M.H., & Shin, Y. (1998). Generalised impulse response analysis in linear multivariate models, *Economics Letters,58*, 17-29.

Reboredo, J. (2012). Modelling oil price and exchange rate co-movements. *Journal of Policy Modeling*, *34*(3), 419-440.

Sari, R., Hammoudeh, S., &Soytas, U. (2010). Dynamics of oil price, precious metal prices, and exchange rate. *Energy Economics*, 32, 351–362.

Sims, C.A. (1980). Macroeconomics and reality. *Econometrica*, *48*, 1-48.

Tanner, E. (2000). Exchange market pressure and monetary policy: Asia and Latin America in the 1990s. *IMF Staff Papers,47*, 311-333.

Zhang, Y. J., Fan, Y., Tsai, H. T., & Wei, Y. M. (2008).Spillover effect of US dollar exchange rate on oil prices. *Journal of Policy Modeling*, 30, 973–991.