Spillover effects of the US economic policy uncertainty in Latin America*

Efectos indirectos de la incertidumbre de la política económica de EE.UU.en América Latina

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Abstract

This paper is aimed at assessing the spillover effects of the US Economic Policy Uncertainty (EPU) in macroeconomic variables of major Latin American Countries (LAC): Mexico, Colombia, Brazil, and Chile. To do that, we estimate a set of two-country Structural Vector Autoregressive (SVAR) models for 1997-2019; each model includes the US and one of the LAC. We use the following variables: EPU indexes, exchange rates, consumer price indexes, industrial production (IP), and interest rates (IR) of the US and the studied LAC. The main finding is that positive shocks in the US EPU index lead to currency depreciation for all four LAC; the largest effect is for Mexico. Other statistically significant results are a brief and small positive impact on Colombia's IP and a positive impact on Mexico's IR. The remaining LAC's estimates are statistically insignificant. For this reason, we applied Rossi and Wang's (2019) robust Granger causality tests that considers structural breaks. Finally, the estimates before and after the 2008 financial crisis suggest that LAC became slightly more responsive to US EPU shocks after the crisis.

Key words: *Economic policy uncertainty, structural vector autoregressive, impulse response function, robust Granger-causality tests.*

JEL Classification: *F62, N16.*

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Resumen

Esta investigación tiene como objetivo evaluar los efectos indirectos de la incertidumbre de la política económica de EE.UU. en las variables macroeconómicas de los principales países de América Latina: México, Colombia, Brasil y Chile. Para ello, estimamos un conjunto de modelos de vectores autorregresivos estructurales de dos países para 1997-2019; cada modelo incluye a EE.UU. y un país de América Latina. Utilizamos las siguientes variables: índices la incertidumbre de la política económica, tipos de cambio, índices de precios al consumidor, producción industrial y tasas de interés de los Estados Unidos y países de América Latina estudiados. El principal hallazgo es que los choques positivos en el índice incertidumbre de la política económica de EE.UU. conducen a la depreciación de la moneda local en los cuatro países de ALC; el mayor efecto es para México. Otros resultados estadísticamente significativos son un impacto positivo breve y pequeño en la producción industrial de Colombia y un impacto positivo en la tasa de interés de México. Las estimaciones restantes para América Latina son estadísticamente no significantes. Por esta razón, aplicamos las pruebas robustas de causalidad de Granger propuestas por Rossi y Wang (2019) que consideran cambios estructurales. Por último, las estimaciones antes y después de la crisis financiera de 2008 sugieren que América Latina se tornó un poco más sensible a los choques de incertidumbre de la política económica estadounidense después de la crisis.

Palabras clave: *Incertidumbre de la política económica, vectores autorregresivo estructurales, función impulso respuesta, pruebas robustas de causalidad de Granger.*

Clasificación JEL: *F62, N16.*

1. Introduction

The influence of the US economy policy on advanced and emerging countries has been widely studied in the specialized literature. In particular, there are several papers dealing with the impact of the uncertainty of the US economic policy on economic and financial variables on several countries and regions. In this regard, Gupta, Olasehinde-Williams and Wohar (2020) assess the impact of Economic Policy Uncertainty (EPU) shocks on a panel of 50 advanced and emerging market economies These authors find that for advanced economies the exchange rate regime and financial vulnerability account for a large portion of the contraction in activity. In emerging economies the responses do not depend on the exchange rate regime, but the responses become larger when trade openness is high and weakness in the financial system. Also, Kido (2016) analyzes spillover effects of shocks the US economic policy uncertainty on real effective exchange rates of several countries duing the period 2000-2014 by using a Dynamic Conditional Correlation Generalized Autoregressive Conditional Heteroskedasticity (DCC-GARCH) model.

the other hand, Zouhair, Lanouar, and Ajmi, (2013) examine the volatility spillovers in stock markets, securitized real estate, bond markets, currency markets, and economic policy uncertainty spillovers across 7 countries. The authors' empirical findings are that spillovers are important and account for, respectively, about 72% and 50% of the dynamics of financial market stress and economic policy uncertainty, respectively, across the 7 economies examined. Also, Liow, Liao, and Huang (2018) find empirical evidence that policy uncertainty spillovers lead financial market stress spillovers in a multi-country context. In other words, changes in international economic policy uncertainty spillovers may be a predictor of changes in international financial market risk spillovers in the short run. Finally, Colombo's (2013), and Bernal, Gnabo, and Guilmin (2016) assess the impact of economic policy uncertainty on risk spillovers within the Eurozone.

Regarding the impact of the US economic policy uncertainty in the country itself, Baker, Bloom, and Davis (2016) find that the US EPU is associated with greater stock price volatility and reduced investment and employment in policy-sensitive sectors like defense, health care, finance, and infrastructure construction. Also, Bloom (2009) simulate the impact of a large EPU shock in the US and find that it generates a rapid drop, rebound, and overshoot in employment, output, and productivity growth. Hiring and investment rates fall dramatically in the 4 months after the shock because higher uncertainty increases the real-option value to waiting, so firms scale back their plans. Finally, Istiak and Serletis (2020) find that commercial bank leverage rises when geopolitical risk and macroeconomic, policy, and equity uncertainty increase. Moreover, the authors find that the leverage of broker-dealers and shadow banks declines when Chicago risk and macroeconomic, policy, financial, and equity uncertainty increase.

Concerning the convergence of uncertainties across the World, Christou, Gozgor, Gupta, Keung, and Lau (2019) analyze the convergence of a news-based measure of uncertainty across 143 countries in the period of 1996-2018. The authors use a panel data-based unit root test to the ratio of the uncertainty of individual countries relative to that of global uncertainty. These authors find empirical evidence of convergence and hence, the spillover of uncertainty across the economies of the world. Moreover, Gabauer and Gupta (2018) focuss on the transmission mechanism of country-specific and international economic uncertainty spillovers by using a Time-Varying Parameter Vector Autoregressions (TVP-VAR) approach.

For Latin American Countries (LAC), the US influence tends to be significant due to both financial and trade ties in the region. In this regard, Alam and Istiak (2020) examine the impact of US policy uncertainty on Mexico by using a Structural Vector Autoregressive (SVAR) model with linear and nonlinear tests. These authors show that an increase in the US economic policy uncertainty leads to a fall in Mexican output (industrial production), price level and interest rate. It is worth mentioning here that there is a lack of research into the possible effects on uncertainty of the US economic policy on macroeconomic aggregates in broader regions of Latin America.

This research examines the spillover effects of US economic policy uncertainty on macroeconomic aggregates in Latin American Countries by estimating a SVAR model during the period 1997-2019. Most of the empirical analysis is mainly based on Impulse Response Function (IRF) estimations from two-country SVAR[1] by using information of the EPU indexes and macroeconomic variables for the US, Mexico, Colombia, Brazil, and Chile. The IRF will be used to quantify the magnitude and persistence of a US economic policy uncertainty shock on LAC for the entire period, 1997-2019, and for specific periods before and after the 2008 financial crisis.

The rest of this paper is organized as follows: section 2 describes the nature of data and presents a summary of the descriptive statistics; section 3 depicts the SVAR specification and shows the obtained empirical results; section 4 presents the findings about Granger-causality tests from the EPU index of the US toward the currency depreciation for all four LAC; finally Section 5 concludes.

2. Nature of Data and Summary Statistics

Our dataset consists of monthly time series of EPU indexes and macroeconomic data for the US and the following LAC: Mexico, Colombia, Brazil, and Chile. The entire period of study is from January 1997 to December 2019. All series are expressed in growth rates.

EPU indexes data for all the countries were collected from the webpage of Economic Policy Uncertainty Index.[2] We also include the following macroeconomic fundamentals for all the countries: inflation (CPI), growth rate of industrial production (IP), short interest rate (IR), and the rate of depreciation of the exchange rates (ER). Macroeconomic data comes from different sources; some of them come from the Organization for Economic Cooperation and Development (OECD) webpage, other from the Federal Reserve Economic Data (FRED) database, and other more from National Central Banks of the corresponding LAC. See Appendix A for a full description of the data sources.

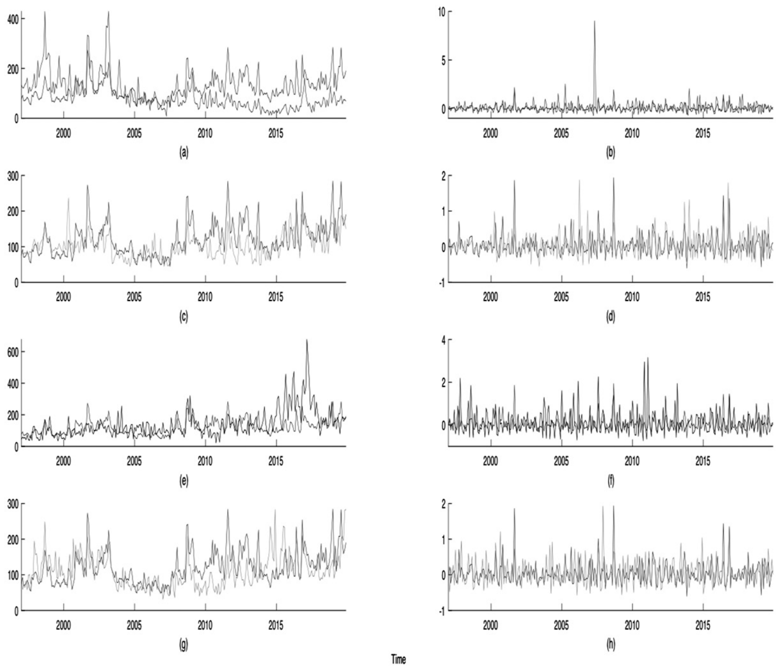
Figure 1 shows the EPU indexes for the US and each one of the four LAC. The left-hand side presents the EPU indexes in levels and the right-hand side presents the EPU indexes in growth rates. The right-hand graphs suggest the EPU indexes in growth rates are indeed stationary for the US and each of the four LAC. In terms of the levels, Figure 1 also shows that Mexico and the US tend to follow each other closely before the 2008 crisis, but not so much after the crisis. In fact, Mexico's index tends to be below that of the US and with

1 For measuring uncertainty see Jurado, Ludvigson, and Ng (2015) and Mumtaz and Theodoridis (2018).

2 Available in http://www.policyuncertainty.com/

lower volatility after the 2008 crisis. The rest of LAC tend to follow the US more closely.

FIGURE 1
EPU INDEXES TIME SERIES PLOT IN LEVELS (LEFT) AND GROWTH RATES (RIGHT). THE EPU INDEX FOR THE US PLOTTED AGAINST MEXICO IS IDENTIFIED WITH HIGHER PEAKS (A,B), COLOMBIA IS IDENTIFIED WITH THE LIGHT LINE (C,D), BRAZIL IS IDENTIFIED WITH HIGHER PEAKS (E,F), AND CHILE IS IDENTIFIED WITH THE LIGHT LINE (G,H).



Source: Authors' own elaboration based on the Bayesian Estimation, Analysis and Regression Toolbox (BEAR) from the European Central Bank.

Table 1 shows the descriptive statistics and the unit root test for all series under study. Results from the Residual Augmented Least Squares (RALS) test from Im, Lee, and Tieslau (2014) does not require a specific density function for the error term are reported in the last column of Table 1. For the RALS test, the null hypothesis is that there exists a unit root. The number of lags was selected using the sequential analysis proposed by Im *et al.* (2014). The null hypothesis

TABLE 1
TIME SERIES DESCRIPTIVE STATISTICS (N = 275)

Country	Variable	Mean	Median	Min	Max	Variance	SD	Skewness	Kurtosis	RALS
US	CPI	–0.041	–0.003	–11.054	6.914	0.920	0.959	–5.167	79.819	–11.239
	IP	0.001	0.001	–0.035	0.024	0.000	0.007	–1.174	8.351	–5.319
	IR	0.003	0.000	–0.454	0.800	0.014	0.117	0.997	13.045	–4.158
	EPU	0.043	–0.018	–0.601	1.935	0.103	0.321	2.207	11.930	–6.306
Mexico (MEX)	CPI	–0.005	–0.010	–0.249	0.404	0.006	0.075	0.738	6.472	–6.153
	IP	0.002	0.002	–0.053	0.049	0.000	0.012	–0.281	6.380	–7.879
	IR	–0.003	0.000	–0.225	0.484	0.004	0.062	1.488	17.532	–6.887
	ER	0.004	0.000	–0.084	0.188	0.001	0.025	1.588	12.957	–13.175
	EPU	0.119	–0.002	–0.742	9.015	0.534	0.731	6.980	81.660	–19.543
Colombia (COL)	CPI	–0.004	–0.004	–0.201	0.233	0.004	0.067	–0.097	3.507	–4.369
	IP	0.002	0.004	–0.098	0.158	0.001	0.031	0.599	7.692	–5.671
	IR	–0.005	–0.004	–0.218	0.154	0.002	0.043	–0.932	7.848	–4.859
	ER	0.005	0.001	–0.073	0.120	0.001	0.030	0.838	4.776	–12.322
	EPU	0.049	0.011	–0.548	1.869	0.116	0.340	1.716	8.631	–8.647
Brazil (BRA)	CPI	0.001	–0.003	–0.277	0.538	0.009	0.094	1.465	9.017	–4.076
	IP	0.001	0.002	–0.120	0.141	0.000	0.020	–0.511	18.475	–22.638
	IR	0.000	–0.007	–0.310	0.970	0.014	0.116	3.498	26.979	–4.265
	ER	0.006	0.004	–0.107	0.274	0.002	0.043	1.996	12.556	–4.601
	EPU	0.132	0.041	–0.736	3.155	0.349	0.591	1.728	7.700	–8.412
Chile (CHI)	CPI	0.296	–0.007	–3.160	83.725	25.621	5.062	16.369	270.336	–160.178
	IP	0.002	0.002	–0.184	0.223	0.001	0.026	0.960	31.599	–4.162
	IR	0.004	0.000	–0.503	1.880	0.031	0.175	5.251	54.317	–5.224
	ER	0.002	0.000	–0.073	0.176	0.001	0.026	1.179	9.911	–5.002
	EPU	0.060	0.003	–0.572	1.921	0.131	0.362	1.112	5.340	–5.322

Source: Authors' own elaboration

is rejected for all variables using a 99% confidence level. The results suggest the series in growth rates can be considered stationary.

3. SVAR Specification and Empirical Results

In this section, we report the empirical results to attempt to quantify the impact of an EPU shock from the US on the macroeconomic indicators of the LAC under study. Following Colombo (2013), we estimate a set of two-country structural VAR models. Each VAR model includes the US and one of the LAC from the country sample. The IRF are estimated and account for the magnitude of the impact, if any, and its dynamics.[3]

Consistent with the main objective of this paper, countries are ordered assuming that the variables in the US are "more" exogenous than the variables from LAC. Within each economy and consistent with the literature, we order the macroeconomic variables from "more" to "less" exogenous. Macroeconomic variables for each country are ordered as follows:

Mexico: $y_t = [EPU^{USA}\ CPI^{MEX}\ IP^{MEX}\ IR^{MEX}\ ER^{MEX}\ EPU^{MEX}]'$,

Colombia: $y_t = [EPU^{USA}\ CPI^{COL}\ IP^{COL}\ IR^{COL}\ ER^{COL}\ EPU^{COL}]'$,

Brazil: $y_t = [EPU^{USA}\ CPI^{BRA}\ IP^{BRA}\ IR^{BRA}\ ER^{BRA}\ EPU^{BRA}]'$,

Chile: $y_t = [EPU^{USA}\ CPI^{CHI}\ IP^{CHI}\ IR^{CHI}\ ER^{CHI}\ EPU^{CHI}]'$.

In this research IRF identification is obtained via Cholesky decomposition of the variance-covariance matrix of the reduced-form VAR estimates. SVAR models have a lag length of 1 according to Bayesian Information Criterion (BIC).

Figure 2 shows the IRF estimates from a shock of one standard deviation in the US EPU index on macroeconomic variables for each LAC obtained from a two-country SVAR model.[4] In particular, Figure 2 shows that a positive shock

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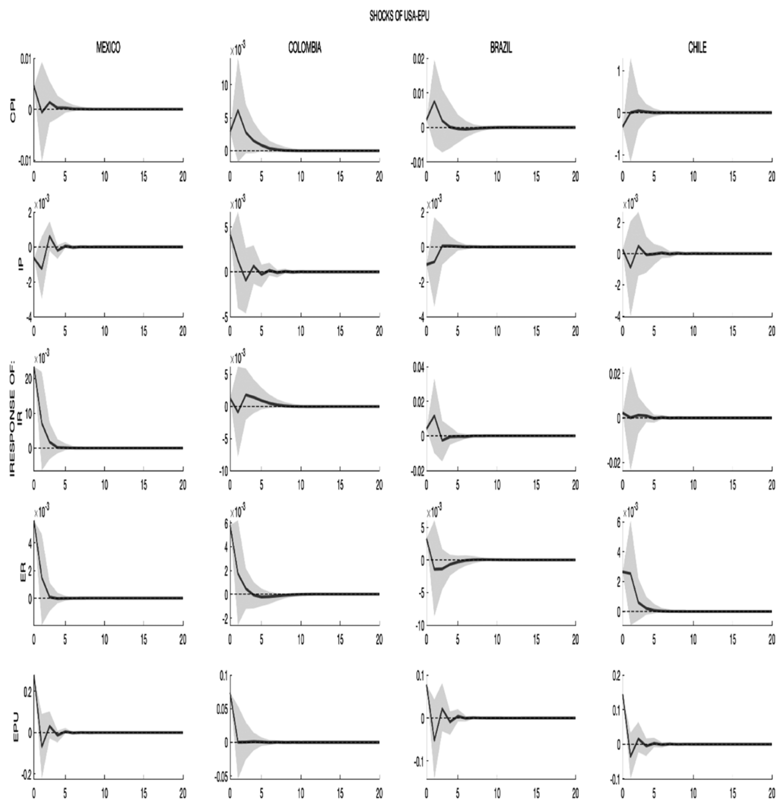
[3] For robustness, we applied two main specifications for VAR models: a Bayesian VAR model with stochastic volatility (BVARSV) and time-varying parameters Bayesian VAR (TV-BVAR). It has been documented extensively in the literature that stochastic volatility is important in fitting the dynamics of macro/finance variables as the ones analyzed in this research. The authors estimated the models by using Bayesian Estimation, Analysis and Regression Toolbox (BEAR) from the European Central Bank. For the structural VAR model specification, we follow Dieppe, Legrand, and Van Roye (2018). For a full description of the SVAR, BVARSV and TV-BVAR models and estimation procedures see Cogley and Sargent (2005), and Dieppe *et al*. (2018).

[4] We carry out the estimation exercise using BVARSV and TV-BVAR models, but all estimates were statistically insignificant. The results of BVARSV and TV-BVAR are available upon request. We also replied the same exercise with the variables of the US as in Colombo (2013) to LAC.

to the US EPU index results in statistically significant currency depreciation for each LAC, and the magnitude of the impact is the largest for Mexico, followed by Colombia, Brazil, and Chile. This suggests the impact of an EPU index shock on LAC currencies is inversely related to the geographical distance from the US to the specific LAC.

FIGURE 2
TWO-COUNTRY SVAR MODELS
(US EPU SHOCK TO LAC)

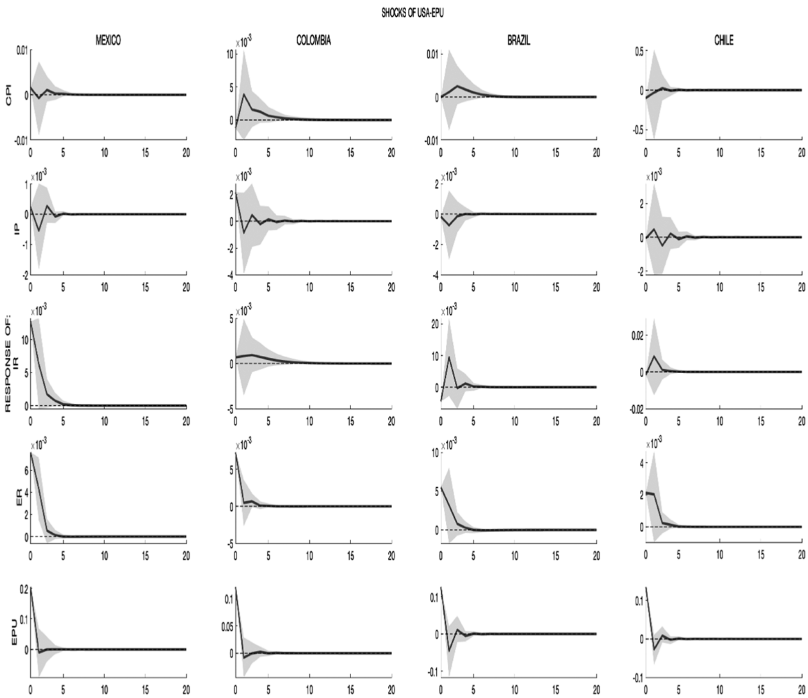


Source: Authors' own elaboration based on the sample and using the Bayesian Estimation, Analysis and Regression Toolbox (BEAR) from the European Central Bank.

In terms of the EPU index from each LAC, the impacts from a shock to the EPU index from the US are positive and statistically significant for each country, and the effects are larger for Mexico. The estimates suggest that economic policy uncertainty from the US has a direct and strong impact on economic policy uncertainty of LAC and this impact is absorbed almost entirely by currency depreciation. Other statistically significant results are: a brief and small positive impact on Colombia's IP and a positive impact on Mexico's IR. These estimates suggests that the geographical proximity to the U.S. makes Mexico and Colombia more susceptible to economic policy uncertainty shocks from the US. The IRF estimates for all other macroeconomic variables are not statistically significant.

Figure 3 and 4 present the IRF estimates from a shock of one standard deviation in the EPU index from the US on macroeconomic variables for LAC before and after the 2008 financial crisis, respectively.[5] The periods considered are for January 1997-December 2007 and for January 2008-December 2019.

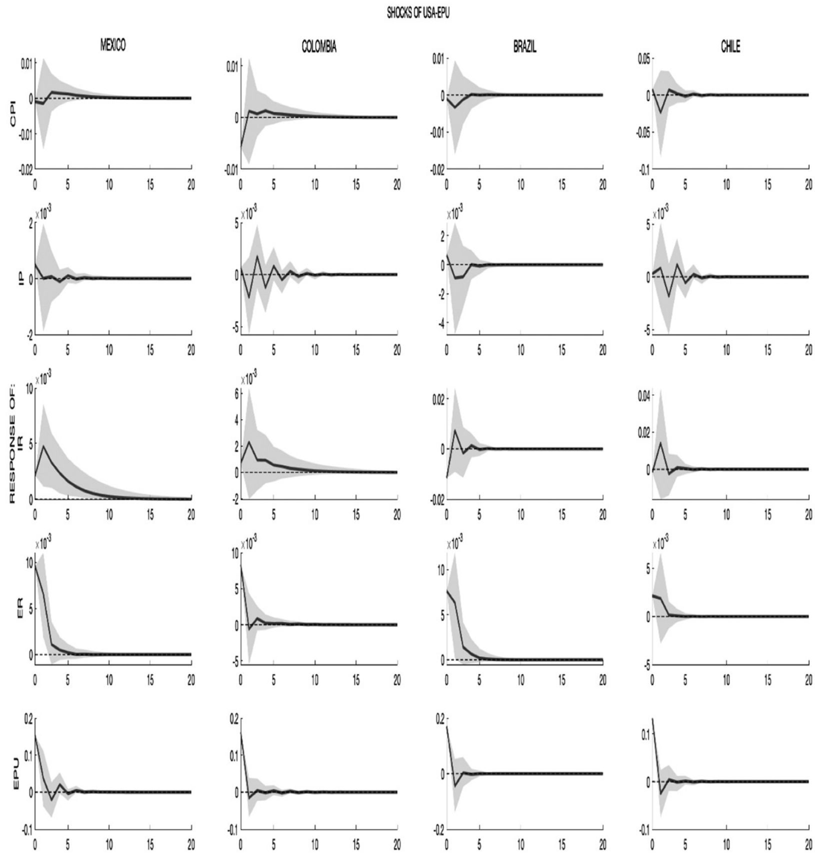
FIGURE 3
BEFORE THE 2018 CRISIS: TWO-COUNTRY SVAR MODELS
(US EPU SHOCK TO LAC)



Source: Authors' own elaboration based on the sample and using the Bayesian Estimation, Analysis and Regression Toolbox (BEAR) from the European Central Bank.

5 Following the idea of Alam and Istiak (2019) that made a split to the Mexican case.

FIGURE 4
AFTER THE 2018 CRISIS: TWO-COUNTRY SVAR MODELS
(US EPU SHOCK TO LAC)



Source: Authors' own elaboration based on the sample and using the Bayesian Estimation, Analysis and Regression Toolbox (BEAR) from the European Central Bank.

IRF estimates for the period before the 2008 financial crisis show that a shock to the EPU index from the US continues to have a statistically significant impact on the EPU indexes for each LAC, and the impact on Mexico's EPU continues to be larger than those for the other LAC. Similarly, and in terms of exchange rates, the impact of a shock to the EPU index from the US show a depreciation effect on the currencies for each LAC, and the impact is the largest for Mexico. Other positive and statistically significant impacts are for Mexico's IR and Colombia's IP.

IRF estimates for the period after the 2008 economic crisis continue to show a statistically significant impact from a US shock in the EPU index on the corresponding currency depreciation and EPU indexes for each LAC, and the largest of these impacts is observed for Mexico. For the most part, the IRF estimates for LAC show that the impact from a shock to the EPU index from the US resulted in a slightly larger impact on macroeconomic variables when compared to the estimates before the 2008 economic crisis. One potential explanation is that, given that the US was the epicenter of the 2008 economic crisis, countries started paying closer attention to the economic policy uncertainty coming from the US. In general terms, these results suggest that LAC became more responsive to EPU index shocks from the US after the 2008 economic crisis.

4. Granger Causality Tests

In order to corroborate the structural relationship between US EPU index and currency depreciation for all four LAC, Granger Causality (GC) test is applied to analyze the dynamic macroeconomic relationship between these variables.[6] Two types of GC tests are implemented, the classical test provided by Granger (2001) that assumes constant parameters and the robust GC that takes into account structural breaks. The classical GC test results may be not reliable and not significant if there are structural breaks in the period (Yang, 2015; Zeileis, Leisch, Kleiber, & Hornik, 2005). For this reason, we also applied a robust GC test that considers structural breaks due to Rossi and Wang, (2019) throughout the causal relationship among different variables.

Table 2 presents the GC tests results that correspond to the entire period. The second column corresponds to the classical test and the remaining columns correspond to different versions of the robust GC. The corresponding statistics are: ExpW (the exponential Wald test), MeanW (the mean Wald test), Nyblom (the Nyblom test), and QLR (the Quant likelihood-ratio test or SupLR test).[7] The third column (ExpW, the exponential Wald test) provides the most robust test and our preferred specification of the GC test. The results provide evidence of a Granger-Causality relationship from the EPU index of the US toward the currency depreciation for Mexico, Colombia, and Chile. The results for Brazil are not statistically significant.

Appendix B presents graphs of the Wald statistic for structural breaks in the GC for the entire period and for the periods that corresponds to before and after the 2008 financial crisis. Based on the specific dates from structural breaks, currency depreciation forecasts for all four LAC for 1 and 3 periods into the future were computed. Based on our preferred specification of the robust GC test, all estimates were statistically significant at the 5 % level for the entire period and for the period before and after the 2008 financial crisis.

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6 The usual caveat: This is not "causality" in common sense, this is predictive causality (Granger's causality or causality in the Granger sense), which tests how past values of one variable correlate with current values of another variable.

7 See Rossi (2005) for more details about these statistics.

TABLE 2
GRANGER-CAUSALITY TEST AND ROBUST GRANGER-CAUSALITY TESTS
(1997M2-2019M12)

Variables	χ^2 Statistic (*p*-value)	ExpW Statistic (*p*-value)	MeanW Statistic (*p*-value)	Nyblom Statistic (*p*-value)	SupLR Statistic (*p*-value)
$EPU^{USA} \rightarrow CPI^{MEX}$	0.331	0.400	0.682	0.730	5.169
	(0.565)	(1.000)	(1.000)	(1.000)	(0.735)
$EPU^{USA} \rightarrow IP^{MEX}$	1.278	1.419	2.647	0.941	4.510
	(0.258)	(0.715)	(0.672)	(0.403)	(8.132)
$EPU^{USA} \rightarrow IR^{MEX}$	0.399	5.306	1.592	0.202	20.162
	(0.529)	(0.040)**	(0.889)	(1.000)	(0.000)**
$EPU^{USA} \rightarrow ER^{MEX}$	3.482	5.799	8.078	3.105	15.801
	(0.062)*	(0.027)**	(0.069)*	(0.031)**	(0.030)**
$EPU^{USA} \rightarrow EPU^{MEX}$	0.410	0.407	0.751	0.110	2.234
	(0.522)	(1.000)	(1.000)	(1.000)	(1.000)
$EPU^{USA} \rightarrow CPI^{COL}$	0.263	0.367	0.683	0.197	2.212
	(0.608)	(1.000)	(1.000)	(1.000)	(1.000)
$EPU^{USA} \rightarrow IP^{COL}$	0.048	2.094	3.708	0.763	6.417
	(0.827)	(0.487)	(0.466)	(0.495)	(0.578)
$EPU^{USA} \rightarrow IR^{COL}$	0.083	0.278	0.511	0.175	1.670
	(0.773)	(1.000)	(1.000)	(1.000)	(1.000)
$EPU^{USA} \rightarrow ER^{COL}$	2.770	4.704	7.847	0.321	13.061
	(0.096)*	(0.068)*	(0.078)*	(0.831)	(0.073)*
$EPU^{USA} \rightarrow EPU^{COL}$	2.154	1.494	2.764	1.003	5.274
	(0.142)	(0.688)	(0.647)	(0.376)	(0.717)
$EPU^{USA} \rightarrow CPI^{BRA}$	0.051	0.703)	1.257	0.139	2.778
	(0.821)	(1.000)	(1.000)	(1.000)	(1.000)
$EPU^{USA} \rightarrow IP^{BRA}$	0.301	0.504	0.874	0.363	2.980
	(0.583)	(1.000)	(1.000)	(0.792)	(1.000)
$EPU^{USA} \rightarrow IR^{BRA}$	1.087	3.316	2.629	0.595	13.713
	(0.297)	(0.204)	(0.676)	(0.607)	(0.060)*
$EPU^{USA} \rightarrow ER^{BRA}$	0.2358	1.162	1.769	0.391	4.616
	(0.878)	(0.808)	(0.855)	(0.768)	(0.802)
$EPU^{USA} \rightarrow EPU^{BRA}$	0.003	0.393	0.660	0.128	3.768
	(0.953)	(1.000)	(1.000)	(1.000)	(0.891)
$EPU^{USA} \rightarrow CPI^{CHI}$	0.015	0.017	0.021	0.002	0.028
	(0.901)	(1.000)	(1.000)	(1.000)	(1.000)
$EPU^{USA} \rightarrow IP^{CHI}$	0.217	0.696	1.312	0.426	2.474
	(0.641)	(1.000)	(1.000)	(0.737)	(1.000)
$EPU^{USA} \rightarrow IR^{CHI}$	0.017	0.231	0.417	0.082	1.847
	(0.895)	(1.000)	(1.000)	(1.000)	(1.000)
$EPU^{USA} \rightarrow ER^{CHI}$	0.280	13.906	12.885	2.995	34.078
	(0.596)	(0.000)**	(0.000)**	(0.034)**	(0.000)**
$EPU^{USA} \rightarrow EPU^{CHI}$	0.346	0.467	0.871	0.283	2.187
	(0.556)	(1.000)	(1.000)	(0.865)	(1.000)

Note: Second column shows the χ^2 statistic for the hypothesis null is that the VAR series x_t does not Granger cause series y_t. Third to sixth column shows ExpW statistic, MeanW, Nyblom and SupLR statistic for the hypothesis null is that the VAR series x_t does not Granger cause series y_t, assuming homoskesdatsic idiosyncratic shocks.** significant < 5% level and * significant < 10% level for all statistics.

Source: Prepared by the authors based on the sample and using the STATA Software.

Table 3 presents the GC tests results that correspond to period before the 2008 financial crisis. As before, the second column corresponds to the classical tests and the remaining columns correspond to different versions of the robust GC test. Based on our preferred specification of the robust test (third column, ExpW, the exponential Wald test), the results provide evidence only for Mexico of the Granger-Causality relationship between EPU index from the US and currency depreciation. For all other countries, the results are not statistically significant.

TABLE 3
GRANGER-CAUSALITY TEST AND ROBUST GRANGER-CAUSALITY TESTS (1997M2-2007M12)

Variables	Statistics (p-value)	ExpW Statistics (p-value)	MeanW Statistics (p-value)	Nyblom Statistics (p-value)	SupLR Statistics (p-value)
$EPU^{USA} \rightarrow CPI^{MEX}$	0.568 (0.451)	0.680 (1.000)	1.259 (1.000)	0.060 (1.000)	3.523 (1.000)
$EPU^{USA} \rightarrow IP^{MEX}$	3.875 (0.049)**	2.317 (0.422)	4.493 (0.344)	1.355 (0.249)	7.590 (0.438)
$EPU^{USA} \rightarrow IR^{MEX}$	0.011 (0.915)	5.447 (0.036)**	4.824 (0.301)	0.549 (0.641)	15.859 (0.030)**
$EPU^{USA} \rightarrow ER^{MEX}$	0.328 (0.567)	13.939 (0.000)**	14.533 (0.000)**	2.399 (0.069)*	35.010 (0.000)**
$EPU^{USA} \rightarrow EPU^{MEX}$	0.284 (0.594)	0.502 (1.000)	0.879 (1.000)	0.026 (1.000)	3.039 (1.000)
$EPU^{USA} \rightarrow CPI^{COL}$	0.340 (0.560)	0.846 (1.000)	1.597 (0.877)	0.076 (1.000)	2.839 (1.000)
$EPU^{USA} \rightarrow IP^{COL}$	1.487 (0.223)	1.221 (0.788)	2.324 (0.741)	0.881 (0.433)	4.631 (0.801)
$EPU^{USA} \rightarrow IR^{COL}$	1.292 (0.256)	1.629 (0.640)	2.903 (0.617)	0206 (1.000)	6.672 (0.547)
$EPU^{USA} \rightarrow ER^{COL}$	0.001 (0.979)	2.215 (0.451)	3.150 (0.570)	0.548 (0.642)	8.027 (0.390)
$EPU^{USA} \rightarrow EPU^{COL}$	0.412 (0.521)	0.592 (1.000)	1.001 (1.000)	0.347 (0.806)	3.177 (1.000)
$EPU^{USA} \rightarrow CPI^{BRA}$	0.607 (0.436)	0.473 (1.000)	0.875 (1.000)	0.407 (0.754)	2.513 (1.000)
$EPU^{USA} \rightarrow IP^{BRA}$	0.349 (0.555)	3.756 (0.141)	3.431 (0.516)	0.664 (0.560)	12.818 (0.081)*
$EPU^{USA} \rightarrow IR^{BRA}$	0.892 (0.345)	16.514 (0.000)**	8.375 (0.060)*	1.456 (0.218)	40.631 (0.000)**
$EPU^{USA} \rightarrow ER^{BRA}$	0.619 (0.431)	1.337 (0.745)	2.392 (0.726)	0.059 (1.000)	4.917 (0.763)
$EPU^{USA} \rightarrow EPU^{BRA}$	0.139 (0.709)	4.442 (0.081)*	5.042 (0.276)	0.405 (0.756)	13.439 (0.064)*
$EPU^{USA} \rightarrow CPI^{CHI}$	0.001 (0.982)	0.122 (1.000)	0.003 (1.000)	0.001 (1.000)	0.017 (1.000)
$EPU^{USA} \rightarrow IP^{CHI}$	1.882 (0.170)	1.531 (0.675)	2.918 (0.614)	1.162 (0.311)	6.422 (0.577)
$EPU^{USA} \rightarrow IR^{CHI}$	0.486 (0.486)	0.991 (0.864)	1.236 (1.000)	0.230 (1.000)	6.379 (0.583)
$EPU^{USA} \rightarrow ER^{CHI}$	0.818 (0.366)	0.994 (0.863)	1.815 (0.847)	0.839 (0.454)	4.845 (0.773)
$EPU^{USA} \rightarrow EPU^{CHI}$	0.415 (0.519)	0.373 (1.000)	0.685 (1.000)	0.063 (0.865)	2.029 (1.000)

Note: Second column shows the χ^2 statistic for the hypothesis null is that the VAR series x_t does not Granger cause series y_t. Third to sixth column shows ExpW statistic, MeanW, Nyblom and SupLR statistic for the hypothesis null is that the VAR series x_t does not Granger cause series y_t, assuming homoskedastic idiosyncratic shocks.** significant < 5% level and * significant < 10% level for all statistics.

Source: Prepared by the authors based on the sample and using the STATA Software.

Table 4 shows our final set of the GC tests results, which corresponds to period after the 2008 financial crisis. Based on almost all different specifications of the robust GC test, the results provide evidence of the Granger-Causality from EPU index of the US toward the currency depreciation for all four LAC. These results are in line with the perception that LAC became slightly more responsive to uncertainty shocks from the US after the 2008 financial crisis.

TABLE 4
GRANGER-CAUSALITY TEST AND ROBUST GRANGER-CAUSALITY TESTS
(2008M1-2019M12)

Variables	Statistics (*p*-value)	ExpW Statistics (*p*-value)	MeanW Statistics (*p*-value)	Nyblom Statistics (*p*-value)	SupLR Statistics (*p*-value)
$EPU^{USA} \rightarrow CPI^{MEX}$	0.0728 (0.787)	1.208 (0.792)	1.845 (0.841)	0.196 (1.000)	6.676 (0.546)
$EPU^{USA} \rightarrow IP^{MEX}$	0.083 (0.773)	0.252 (1.000)	0.400 (1.000)	0.070 (1.000)	1.766 (1.000)
$EPU^{USA} \rightarrow IR^{MEX}$	0.924 (0.336)	1.813 (0.577)	2.617 (0.678	0.345 (0.790)	7.610 (0.436)
$EPU^{USA} \rightarrow ER^{MEX}$	2.634 (0.105)	15.135 (0.000)**	15.664 (0.000)**	5.375 (0.000)**	35.649 (0.000)**
$EPU^{USA} \rightarrow EPU^{MEX}$	4.934 (0.026)*	2.992 (0.261)	5.865 (0.193)	2.561 (0.057)	7.880 (0.406)
$EPU^{USA} \rightarrow CPI^{COL}$	0.036 (0.849)	0.342 (1.000)	0.579 (1.000)	0.155 (1.000)	2.409 (1.000)
$EPU^{USA} \rightarrow IP^{COL}$	1.019 (0.313)	1.620 (0.643)	2.579 (0.686)	0.356 (0.799)	5.362 (0.706)
$EPU^{USA} \rightarrow IR^{COL}$	1.044 (0.307)	0.640 (1.000)	1.256 (1.000)	0.342 (0.811)	1.817 (1.000)
$EPU^{USA} \rightarrow ER^{COL}$	4.182 (0.041)**	6.008 (0.023)**	9.721 (0.030)**	0.893 (0.427)	16.394 (0.022)**
$EPU^{USA} \rightarrow EPU^{COL}$	1.346 (0.246)	1.818 (0.575)	3.012 (0.595)	1.215 (0.292)	6.160 (0.608)
$EPU^{USA} \rightarrow CPI^{BRA}$	0.0823 (0.774)	1.258 (0.773)	2.322 (0.742)	0.267 (0.880)	4.646 (0.799)
$EPU^{USA} \rightarrow IP^{BRA}$	0.013 (0.911)	0.938 (0.881)	1.699 (0.869)	0.338 (0.815)	4.507 (0.813)
$EPU^{USA} \rightarrow IR^{BRA}$	0.440 (0.507)	1.879 (0.555)	2.623 (0.676)	0.097 (1.000)	7.699 (0.426)
$EPU^{USA} \rightarrow ER^{BRA}$	0.886 (0.347)	7.375 (0.000)**	9.898 (0.028)**	2.998 (0.035)**	19.546 (0.000)**
$EPU^{USA} \rightarrow EPU^{BRA}$	0.001 (0.969)	0.333 (1.000)	0.571 (1.000)	0.102 (1.000)	1.780 (1.000)
$EPU^{USA} \rightarrow CPI^{CHI}$	2.528 (0.112)	1.426 (0.712)	2.854 (0.628)	0.657 (5.643)	3.735 (0.894)
$EPU^{USA} \rightarrow IP^{CHI}$	0.999 (0.752)	0.457 (1.000)	0.821 (1.000)	0.276 (0.878)	2.094 (1.000)
$EPU^{USA} \rightarrow IR^{CHI}$	0.131 (0.718)	0.332 (1.000)	0.609 (1.000)	0.238 (1.000)	1.358 (1.000)
$EPU^{USA} \rightarrow ER^{CHI}$	0.054 (0.816)	30.530 (0.000)**	30.752 (0.000)**	4.878 (0.000)**	67.766 (0.000)**
$EPU^{USA} \rightarrow EPU^{CHI}$	0.066 (0.797)	0.777 (1.000)	1.324 (1.000)	0.388 (0.770)	3.573 (1.000)

Note: Second column shows the χ^2 statistic for the hypothesis null is that the VAR series x_t does not Granger cause series y_t. Third to sixth column shows ExpW statistic, MeanW, Nyblom and SupLR statistic for the hypothesis null is that the VAR series x_t does not Granger cause series y_t, assuming homoskedastic idiosyncratic shocks.** significant < 5% level and * significant < 10% level for all statistics.

Source: Prepared by the authors based on the sample and using the STATA Software.

5. Conclusions

We have studied how a shock of economic policy uncertainty from the US might spillover to macroeconomic conditions of the LAC under study. We use EPU from the United States to attempt to account for uncertainty spillovers. We estimate a set of two-country structural VAR models. The SVAR model had a better performance to analyze the uncertainty spillovers than other models. Each model has included the US EPU index and one LAC with their corresponding macroeconomic variables from the country sample. The impulse response functions (IRF) are computed accounting for the magnitude of the impact, if any, and its shot-run dynamics.

Considering the entire period, structural VAR model estimates showed that a shock of one standard deviation in the EPU index of the US tend to lead to currency depreciation and positive impacts on EPU indexes for all four LAC, and these estimates tend to be larger for Mexico. Estimates from before and after the 2008 financial crisis suggest that LAC economies became slightly more responsive to EPU index shocks from the US after the 2008 financial crisis.

Finally, robust Granger causality tests that consider structural breaks were applied for the entire period and for the periods before and after the 2008 financial crisis. The estimates before and after the 2008 financial crisis suggest that LAC became slightly more responsive to US EPU shocks after the crisis.

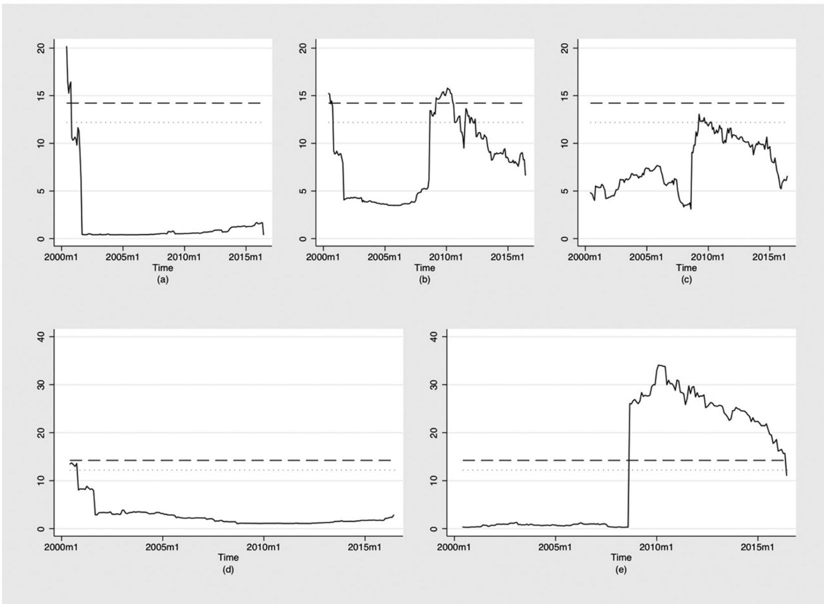
Appendix A

Variables	Source
EE.UU.	
Consumer Price Index (Inflation)	OECD Data https://data.oecd.org
Industrial Production (Industrial)	OECD Data https://data.oecd.org
Exchange Interest (Interest Rate)*	https://fred.stlouisfed.org/series/IR3TIB01USM156N
Economic Policy Uncertainty (Economy Policy, EPU)	http://www.policyuncertainty.com
Brazil	
Consumer Price Index (Inflation)	OECD Data https://data.oecd.org
Industrial Production (Industrial)	OECD Data https://data.oecd.org
Exchange Interest (Interest Rate)*	Banco Central do Brasil https://www.bcb.gov.br/
Exchange Rate	OECD Data https://data.oecd.org
Economic Policy Uncertainty (Economy Policy, EPU)	http://www.policyuncertainty.com
Chile	
Consumer Price Index (Inflation)	OECD Data https://data.oecd.org
Industrial Production (Industrial)	OECD Data https://data.oecd.org
Exchange Interest (Interest Rate)*	Banco de Chile http://www.bancochile.cl
Exchange Rate	OECD Data https://data.oecd.org
Economic Policy Uncertainty (Economy Policy, EPU)	http://www.policyuncertainty.com
Colombia	
Consumer Price Index (Inflation)	OECD Data https://data.oecd.org
Industrial Production (Industrial)	OECD Data https://data.oecd.org
Exchange Interest (Interest Rate)*	Banco de Colombia https://www.grupobancolombia.com/
Exchange Rate	OECD Data https://data.oecd.org
Economic Policy Uncertainty (Economy Policy, EPU)	http://www.policyuncertainty.com
Mexico	
Consumer Price Index (Inflation)	OECD Data https://data.oecd.org
Industrial Production (Industrial)	OECD Data https://data.oecd.org
Exchange Interest (Interest Rate)*	Banco de México http://www.banxico.org.mx
Exchange Rate	OECD Data https://data.oecd.org
Economic Policy Uncertainty (Economy Policy, EPU)	http://www.policyuncertainty.com

* 3 months.

Appendix B

FIGURE B.1
WALD STATISTICS TESTING OF STRUCTURAL BREAKS IN GRANGER CAUSALITY FOR PERIOD 1997M2-2019M12

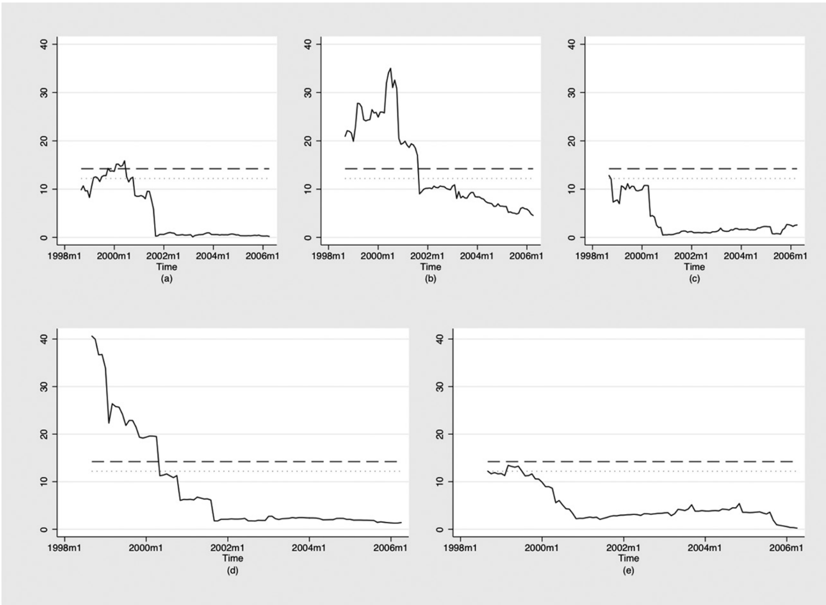


Note: (a) $EPU^{USA} \rightarrow IR^{MEX}$, (b) $EPU^{USA} \rightarrow ER^{MEX}$ (c) $EPU^{USA} \rightarrow ER^{COL}$, (d) $EPU^{USA} \rightarrow IR^{BRA}$, and (e) $EPU^{USA} \rightarrow ER^{CHI}$ against the alternative of break in Granger causality at time on axis. In all figures, a solid line represents the sequence of the Wald Statistic over time. The dashed line < 5% critical value, and the dotted line < 10% critical value.

Source: Prepared by the authors based on the sample and using the STATA Software.

FIGURE B.2

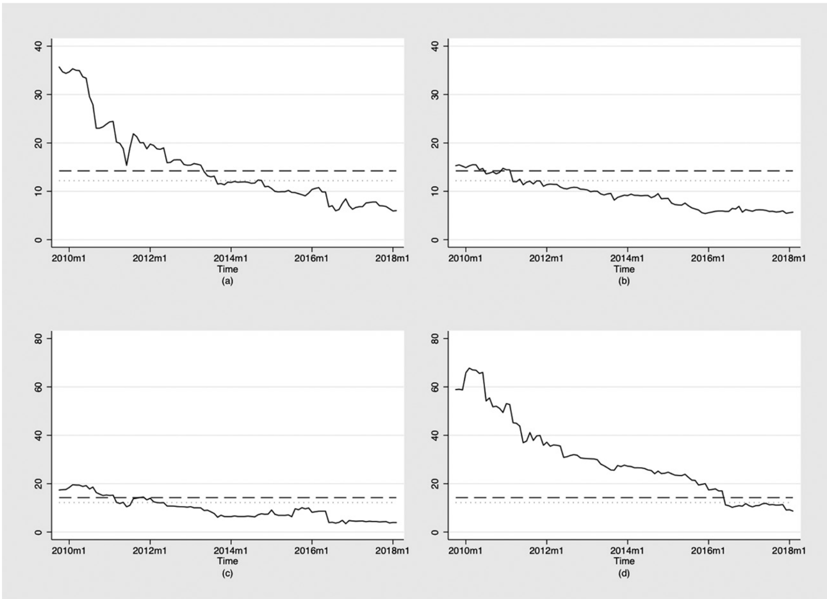
WALD STATISTICS TESTING OF STRUCTURAL BREAKS IN GRANGER CAUSALITY FOR PERIOD 1997M2-2008M12



Note: (a) $EPU^{USA} \rightarrow IR^{MEX}$, (b) $EPU^{USA} \rightarrow ER^{MEX}$ (c) $EPU^{USA} \rightarrow ER^{COL}$, (d) $EPU^{USA} \rightarrow IR^{BRA}$. and (e) $EPU^{USA} \rightarrow ER^{CHI}$ against the alternative of break in Granger causality at time on [illegible] axis. In all figures, a solid line represents the sequence of the Wald Statistic over time. The dashed line < 5% critical value, and the dotted line < 10% critical value.

Source: Prepared by the authors based on the sample and using the STATA Software

FIGURE B.3
WALD STATISTICS TESTING OF STRUCTURAL BREAKS IN GRANGER CAUSALITY
FOR PERIOD 2008M1-2019M12



Note: (a) $EPU^{USA} \rightarrow IR^{MEX}$, (b) $EPU^{USA} \rightarrow ER^{MEX}$ (c) $EPU^{USA} \rightarrow ER^{COL}$, (d) $EPU^{USA} \rightarrow IR^{BRA}$. and (e) $EPU^{USA} \rightarrow ER^{CHI}$ against the alternative of break in Granger causality at time on x axis. In all figures, a solid line represents the sequence of the Wald Statistic over time. The dashed line < 5% critical value, and the dotted line < 10% critical value.

Source: Prepared by the authors based on the sample and using the STATA Software.

TABLE B.1

GRANGER CAUSALITY TESTS IN THE DIRECT MULTISTEP VAR-LP FORECASTING MODEL

PANEL A (1997m2-2019m12)	h=0				h=3			
Variables	ExpW Statistics (p-value)	MeanW Statistics (p-value)	Nyblom Statistics (p-value)	SupLR Statistics (p-value)	ExpW Statistics (p-value)	MeanW Statistics (p-value)	Nyblom Statistics (p-value)	SupLR Statistics (p-value)
$EPU^{USA} \rightarrow IR^{MEX}$	14.874	9.147	3.778	40.074	61.166	51.598	4.473	132.815
	(0.000)	(0.041)	(0.016)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$EPU^{USA} \rightarrow ER^{MEX}$	56.892	31.619	**1.768**	124.082	272.664	138.050	3.730	555.820
	(0.000)	(0.000)	**(1.149)**	(0.000)	(0.000)	(0.000)	(0.017)	(0.000)
$EPU^{USA} \rightarrow ER^{COL}$	14.553	7.059	**0.766**	37.913	46.490	26.184	4.413	102.447
	(0.000)	(0.110)	**(0.492)**	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$EPU^{USA} \rightarrow IR^{BRA}$	41.946	30.919	**1.643**	94.046	36.660	31.394	2.243	83.777
	(0.000)	(0.000)	**(0.178)**	(0.000)	(0.000)	(0.000)	(0.086)	(0.000)
$EPU^{USA} \rightarrow IR^{CHI}$	32.476	27.285	**1.687**	73.459	47.288	25.564	2.914	104.874
	(0.000)	(0.000)	**(0.169)**	(0.000)	(0.000)	(0.000)	(0.039)	(0.000)
PANEL B (1997m2-2007m12)	h=0				h=3			
$EPU^{USA} \rightarrow IR^{MEX}$	221.281	59.746	**1.745**	450.901	51.124	50.425	5.076	111.162
	(0.000)	(0.000)	**(0.155)**	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$EPU^{USA} \rightarrow ER^{MEX}$	24.294	14.294	**1.807**	56.802	134.009	91.971	4.755	276.990
	(0.000)	(0.000)	**(0.142)**	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$EPU^{USA} \rightarrow IP^{BRA}$	491.281	131.192	**1.078**	991.568	134.631	64.155	2.772	278.238
	(0.000)	(0.000)	**(0.000)**	(0.000)	(0.000)	(0.000)	(0.046)	(0.000)
$EPU^{USA} \rightarrow IR^{BRA}$	165.113	27.790	**1.112**	339.232	76.951	63.126	**1.464**	162.831
	(0.000)	(0.000)	**(0.331)**	(0.000)	(0.000)	(0.000)	**(0.216)**	(0.000)
$EPU^{USA} \rightarrow EPU^{BRA}$	146.483	139.878	4.492	301.972	16.549	9.830	**0.737**	41.795
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.029)	**(0.511)**	(0.000)
PANEL C (2008m1-2019m12)	h=0				h=3			
$EPU^{USA} \rightarrow IR^{MEX}$	23.615	14.585	**1.449**	55.459	268.339	182.245	4.031	545.432
	(0.000)	(0.000)	**(0.220)**	(0.000)	(0.000)	(0.000)	(0.011)	(0.000)
$EPU^{USA} \rightarrow ER^{COL}$	92.248	37.701	**1.493**	193.368	39.135	14.24	7.409	85.831
	(0.000)	(0.000)	**(0.210)**	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$EPU^{USA} \rightarrow ER^{BRA}$	74.998	72.625	**1.820**	159.092	30.847	22.997	2.222	70.572
	(0.000)	(0.000)	**(0.140)**	(0.000)	(0.000)	(0.000)	(0.088)	(0.000)
$EPU^{USA} \rightarrow ER^{CHI}$	18.963	16.440	3.614	46.321	83.473	42.691	3.789	176.117
	(0.000)	(0.000)	(0.019)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Note: ExpW, MeanW, Nyblom and SupLR are statistics for the null hypothesis that the VAR series x_t does not Granger cause series y_t assuming heteroskedastic and serially correlated idiosyncratic shocks. The bolded values are not statistically significant. The rest are significant at the < 5% level.

Source: Prepared by the authors based on the sample and using the STATA Software.

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