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THE INFLUENCE OF THE U.S. UNCERTAINTY SHOCKS ON LATIN AMERICAN ECONOMIES

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Abstract: We investigated the impact of U.S. uncertainty shocks on Latin American economies with a proxy of uncertainty from Ludvigson et al. (2021). Our results showed that these shocks affect both the real (private consumption, investment, and GDP) and financial (stock market and exchange rate) sectors. We compared the influence of local, regional, and external sources to uncertainty. The variance decomposition indicated that the U.S. financial and macroeconomic uncertainties are relevant to comprehend domestic fluctuations. We detected heterogeneity in the Latin American economies and significant spillover effects from the U.S.

Keywords: Uncertainty; financial market; real sector; GDP.

JEL Code: E37; E44; E47.

Declarations:

The authors report there are no competing interests to declare.

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The data supporting the findings of this study are available from the corresponding author upon reasonable request.

1. Introduction

Many articles portray the prominent influence the U.S. has on the global economy. For example, Favero et al. (2011) and Rey (2011) analyzed fiscal and monetary shocks and found that the U.S. causes significant effects on other regions. We also observe similar results in investigations of the U.S. uncertainty shocks (Bhattarai et al., 2020). These studies highlight the U.S. economy's influence on domestic dynamics of international economies. Our article is a contribution to this literature.

Our objective is to evaluate what influence U.S. uncertainty shocks have on Latin American economies and examine their diffusion in the real and financial sectors. We compare these shocks to other relevant shocks from industrialized economies. Finally, we test the importance of regional shocks to Latin American economies.

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Our method involves the use of the Global Vector Autoregressive (GVAR). The GVAR connects economies using bilateral trade, builds the international scenario, and presents feedback effects to global shocks. Hence, the GVAR models spillover effects and shows how domestic economies adjust to shocks. Given that we seek to analyze U.S. shocks and the responses of Latin American economies, the GVAR addresses our goal.

The results show that U.S. uncertainty shocks provoke profound fluctuations in the real and financial sectors of Latin American economies. The estimates point out the stock markets and the exchange rates as potential transmission channels with subsequent effects on demand components, such as private consumption, investment, and GDP. Positive U.S. uncertainty shocks corresponded to depressing movements of these variables. Hence, increasing U.S. uncertainty causes recessions in Latin American economies.

We compared U.S. uncertainty to local, regional, and external sources of oscillations, and while the U.S. influence presented oscillations, its impact on Latin economies remains relevant and persistent. Hence, despite the structural changes that Latin American economies have had over the last three decades, the influence of the U.S. continues to be noteworthy. For Latin American economies, the U.S. is a relevant source of external fluctuation - in this case, for changes in uncertainty.

Concerning prior contributions to the literature, Bhattarai et al. (2020) investigated U.S. uncertainty shocks on emerging market economies (EME) using the PVAR. One limitation of PVAR model is that it does not provide domestic responses to shocks - it shows only aggregate responses. We detected the same pattern in other studies, like Kim (2001), who analyzed U.S. fiscal and monetary shocks but - similar to Bhattarai et al. (2020) - did not show individual responses. The GVAR, on the other hand, provides individual responses to shocks. Thus, we can verify how economies react to global shocks, including their financial and real variables. However, between the PVAR and the GVAR, we faced a trade-off: While the PVAR does not show individual responses, it does identify shocks. On the other hand, the GVAR displays individual responses, but does not identify shocks. The primary goal of the GVAR is to exhibit transmission channels and fluctuations of the entire system.

Another contribution is our use of a new uncertainty proxy. We employ financial uncertainty from Ludvigson et al. (2021), which, according to the authors, gathers a rich set of indexes and time series related to the financial sphere, resulting in an accurate uncertainty index. In their study, Ludvigson et al. (2021) recommended new articles testing the fitness of this proxy. We decided to follow their advice and provide a study of uncertainty employing their proxy.

Boschi and Girardi (2011) compared the importance of regional and external demand shocks to the fluctuation of Latin American economies, an investigation that we complement by including financial and macroeconomic uncertainty shocks. Moreover, we analyze how financial markets from advanced economies impact Latin American economies. Thus, our investigation provides a comparative analysis, which allows us to verify the relative importance of local, regional, external, and U.S. shocks to domestic fluctuations of the Latin American economies.

This article is structured as follows: Section 2 describes the GVAR; Section 3 presents the data; Section 4 shows the econometric results; and Section 5 concludes the study with final comments.

2. The GVAR Model

We present the GVAR following the same methodology of Pesaran et al. (2004) and Dees et al. (2007). Initially, we use VARXs models with domestic and foreign variables. Secondly, we connect the regions using bilateral trade. This variable makes the GVAR a small open economy model (Esse artigo não está nas referências. Favor inserir lá: Attílio, L. A., Faria, J. R., & Rodrigues, M. (2023). Does monetary policy impact CO2 emissions? A GVAR analysis. Energy Economics, 119, 106559). In Section 3, we adapt this configuration for the U.S. since it is a large economy, and the assumption of a small open economy does not fit it.

Equation 1 presents the VARX (p,q). The term p denotes the lags of the x_{it} domestic variables, and the term q the lags for the foreign variables. The vector is the domestic variables of the region i in time t; x_{it}^{*} is the vector of the foreign variables; a_{i0} is the constant to the reference (the U.S.); a_{i1} is the trend; $x_{i,t-1}$ and $x_{i,t-1}^{*}$ are the lagged vectors of domestic and foreign variables; ε_{it} is the vector of idiosyncratic shocks.

$$x_{it} = a_{i0} + a_{i1}t + \Phi_i x_{i,t-1} + \Lambda_{i0} x_{it}^{*} + \Lambda_{i1} x_{i,t-1}^{*} + \varepsilon_{it}. \quad (1)$$

Concerning the domestic variables, in one of the configurations, we use GDP (gdp_{it}), private consumption (c_{it}), investment (inv_{it}), short-term interest rate (i_{it}), the exchange rate (e_{it}), and the stock market (st_{it}) – in Section 3, we describe these variables in more detail. Hence, the vector of domestic variables is: $x_{it} = (gdp_{it}, c_{it}, inv_{it}, i_{it}, e_{it}, st_{it})$.

We create the foreign variables using the term w_{ij} (Equation 2). This term represents bilateral trade between regions *i* and *j*. Thus, the foreign variable shows the vulnerability to shocks between regions. Another way to interpret this is that foreign variables are proxies for the international economy. Finally, according to Dees et al. (2007), foreign variables present weak exogeneity, a characteristic that illustrates the small open economy assumption (Attílio et al., 2023).

$$x_{it}^{*} = \sum_{j=0}^{N} w_{ij} x_{jt}. \tag{2}$$

Equation 2 allows us to construct the vector of foreign variables: $x_{it}^{*} = (gdp_{it}^{*}, c_{it}^{*}, inv_{it}^{*}, i_{it}^{*}, e_{it}^{*}, st_{it}^{*})$. The next step to generate the GVAR is to create the vector z_t, a vector that unites domestic and foreign variables:

$$z_t = (x_{it}\ x_{it}^{*}). \tag{3}$$

Besides the vector z_t, we create the global vector $x_t = (x_{0t}', x_{1t}', \ldots, x_{Nt}')'$ a vector with all domestic variables of the model. Each term of the global vector represents all domestic variables of that region. We use vectors z_t and x_t to make the identity: $z_t = W_i x_t$. We employ these modifications to rewrite Equation 1:

$$A_i W_i x_t = a_{i0} + a_{i1} t + B_i W_i x_{t-1} + \varepsilon_t \tag{4}$$

where $A_i = [I_{k_i}, -\Lambda_{i0}]$ and $B_i = [\Phi_i, \Lambda_{i1}]$.

We stack Equation 4:

$$Gx_t = a_0 + a_1 t + Hx_{t-1} + \varepsilon_t,$$

$$\text{where } G = \begin{pmatrix} A_0 W_0 \\ A_1 W_1 \\ A_2 W_2 \\ \ldots \\ A_N W_N \end{pmatrix}, H = \begin{pmatrix} B_0 W_0 \\ B_1 W_1 \\ B_2 W_2 \\ \ldots \\ B_N W_N \end{pmatrix}, a_0 = \begin{pmatrix} a_{00} \\ a_{10} \\ a_{20} \\ \ldots \\ a_{N0} \end{pmatrix}, a_1 = \begin{pmatrix} a_{01} \\ a_{11} \\ a_{21} \\ \ldots \\ a_{N1} \end{pmatrix}, \varepsilon_t = \begin{pmatrix} \varepsilon_{0t} \\ \varepsilon_{1t} \\ \varepsilon_{2t} \\ \ldots \\ \varepsilon_{Nt} \end{pmatrix} \tag{5}$$

We obtain the GVAR by multiplying Equation 5 by the inverse of the matrix *G*, usually a nonsingular matrix:

$$x_t = G^{-1} a_0 + G^{-1} a_1 t + G^{-1} H x_{t-1} + G^{-1} \varepsilon_t. \tag{6}$$

Our last comment concerns the GVAR in the error correction form (Equation 7) – more detail concerning this form can be found in Pesaran et al. (2004). We can use this configuration when unit-root tests indicate nonstationarity in the time series, and cointegration tests indicate long-term relationships (Tables A, B, and C in the appendices portray these tests and denote we should use the GVAR in the error correction form). In Equation 7, the vector d_t is the vector of global variables. Global variables present only one time series, such as commodities price. In our article, we incorporate the uncertainty variables in the vector d_t.

$$\Delta x_{it} = a_{i0} + a_{i1} t + \Pi_i v_{i,t-1} + \Lambda_{i0} \Delta x_{it}^{*} + \psi_{i0} \Delta d_t + \varepsilon_{it}, \tag{7}$$

where $\Pi_i = (A_i - B_i, -\psi_{i0} - \psi_{i1})$ and $v_{i,t-1} = \begin{pmatrix} z_{i,t-1} & d_{t-1} \end{pmatrix}$.

In Section 4, we discuss the econometric analysis with the Generalized Impulse Response Function (GIRF) and the Generalized Forecast Error Variance Decomposition (GFEVD). GIRFs show how the system reacts to shocks, and the GFEVD decomposes the variation of specific variables. We investigate how the U.S. uncertainty shocks impact Latin American economies using the GIRFs, and we evaluate the contribution of these shocks to the domestic variation of Latin American variables using GFEVDs.

3. Data

Table 1 presents the variables of our model. We study five Latin American economies (Argentina, Brazil, Chile, Mexico, and Peru) and the U.S. Our period is from 1983Q4 to 2015Q1. We transformed all variables to the logarithmic form (Table D in the appendices shows the descriptive statistics of the variables). In the econometric results section, we expand this sample to incorporate advanced economies and test the robustness of our results.

Table 1
Variables and Sources

Variables	Definition	Source
gdp	real gross domestic product index	Mohaddes and Raissi (2020)
c	real private consumption	World Bank
inv	real total investment	World Bank
i	short-term interest rate	Mohaddes and Raissi (2020)
e	real exchange rate (domestic currency per dollar)	Mohaddes and Raissi (2020)
st	real stock market index	Mohaddes and Raissi (2020)
finc	financial uncertainty index	Ludvigson et al. (2021)
macro	macroeconomic uncertainty index	Ludvigson et al. (2021)

We used national databases to complete time series of the stock markets of Brazil, Mexico, and Peru. As the private consumption and investment variables are annual, we employed the Denton method to change the frequency to quarterly.

The global variables are financial (*finc*) and macroeconomic (*macro*) uncertainties, which we extracted from Ludvigson et al. (2021). These indexes aggregate important time series, giving rise to a broad picture of the uncertainties around the economy. In particular, the financial uncertainty index uses 148 financial indicators, and the macroeconomic uncertainty index unites 134 indicators. As both indexes portray mainly U.S. information, we included these variables in its model.

Equation 8 presents the vectors of domestic and foreign variables. The principal differences between Latin American economies and the U.S. models are the inclusion of global variables as domestic variables only in the U.S. and the exchange rate as a foreign variable in the U.S. model. Regarding this last configuration, we follow the same procedure as Dees et al. (2007) and Attílio et al. (2023) According to the authors, given that the exchange rate is the ratio of the domestic currency to the U.S. dollar, we do not need to include it as a foreign variable to the regions, except the U.S.

$$
\begin{aligned}
&x_{it} = (gdp_{it}, c_{it}, inv_{it}, i_{it}, e_{it}, st_{it}),\\
&x^*_{it} = (gdp^*_{it}, c^*_{it}, inv^*_{it}, i^*_{it}, e^*_{it}, st^*_{it}, finc^*_{it}, macro^*_{it}), \text{ for ARG, BRA, CHL, MEX, PER}\\
&x_{it} = (gdp_{it}, c_{it}, inv_{it}, i_{it}, st_{it}, finc_{it}, macro_{it}),\\
&x^*_{it} = (e^*_{it}), \text{ for the U.S.}
\end{aligned}
\tag{8}
$$

We were selective about including foreign variables in the U.S. model. Dees et al. (2007) explained that foreign variables under the hypothesis of weak exogeneity are long-term constraints to the economies. We relaxed this hypothesis for the U.S. since its economy is internationally relevant, which is why we included only the exchange rate in its model. Table E in the appendices presents the results of the weak exogeneity test - in most cases, the estimates supported our configuration, e.g., Latin American countries as small open economies and the U.S. as an economy able to affect the long-term scenario.

Another consequence of the weak exogeneity is that Latin American economies can affect the fluctuation of the global variables in the short run. However, in the long-term equilibrium, only the U.S. provokes changes in the global variables. Thus, our model allows feedback effects between the regions, adding more information to the analysis.

Over the econometric analysis, we expand our sample to include other advanced economies: the Eurozone, the U.K., Japan, and China. For the former, we formed the region by aggregating eight countries (Austria, Belgium, Finland, France, Germany, Italy, the Netherlands, and Spain) using the real GDP in PPP in the years 2014-2016 - a procedure similar to those applied in Pesaran et al. (2004), Dees et al. (2007), and Attílio et al. (2023). Therefore, this second configuration uses 17 countries (or 10 regions, considering the Eurozone). Finally, we used bilateral trade in the years 2013-2015 from Mohaddes and Raissi's (2020) database to construct the foreign variables and solve and estimate the model.

4. Results

4.1. Base Model

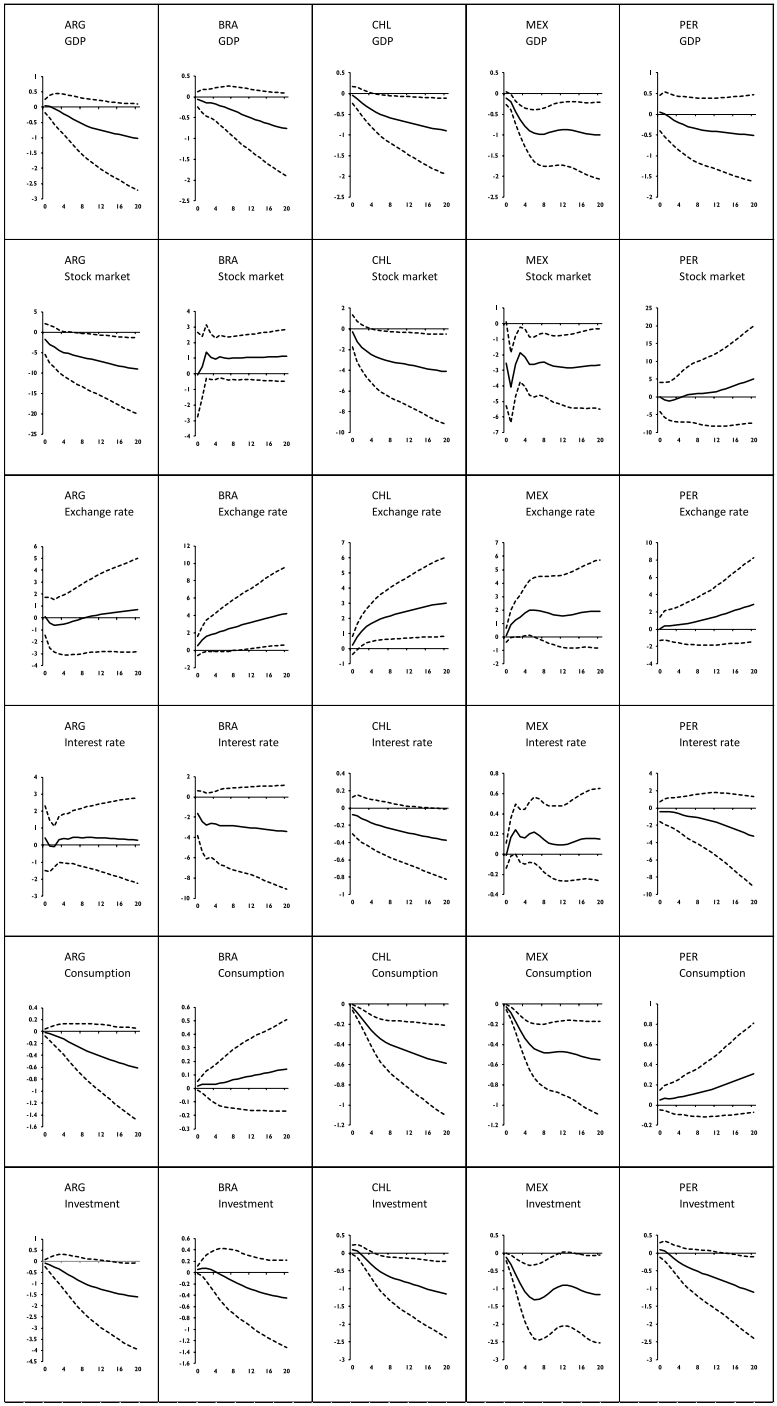
In all figures of this section, we present GIRFs with confidence intervals at 90% calculated by bootstrap and values in percentage. Figure 1 shows the reactions of the Latin American economies' variables to a positive U.S. financial uncertainty shock.

In the first part of Figure 1, the GDP decreases in all economies, but the values are statistically significant only in Chile and Mexico. This result is similar to the findings of Bhattarai et al. (2020), who showed that U.S. uncertainty shocks provoke oscillations in the GDP of emerging market economies (EMEs). However, while Bhattarai et al. (2020) used the VIX index to measure uncertainty, we employed the Ludvigson et al. (2021) index. Furthermore, Figure 1's estimates suggest the existence of U.S. spillover effects on Latin American countries.

We explore three financial channels to understand the transmission of uncertainty shock: stock, exchange, and credit markets. The estimates suggest that the stock market decreased in Argentina, Chile, and Mexico, which reinforces the conclusion of Chudik and Fratzscher (2011): EME financial markets are sensitive to U.S. fluctuations. According to Krugman (2009), one explanation for these stock market oscillations is that investors react to the U.S. movements - in uncertain times, many investors prefer to allocate their investments in safer economies, such as the U.S. If this is the case, in Figure 1, we should expect to see outflows of capital from the Latin American economies.

The shock's second possible transmission channel addresses this question: the exchange rates presented domestic currency depreciations in Brazil, Chile, and Mexico. Although the model does not allow us to attribute these fluctuations to a migration of capital from the Latin economies to the U.S., the estimates suggest this possibility. The Brazilian, Chilean, and Mexican currencies devaluated by 4%, 3%, and 2%, respectively. These values indicate relevant sensitivity to and economic integration with the U.S. economy. In his study, Rey (2016) contended that flexible exchange rates do not fully protect domestic economies. We could even refer to these exchange rate depreciations in response to global shocks as "flight to quality," as Eickmeier and Ng (2015) called them in their article.

Figure 1 – GIRF of a U.S. Financial Uncertainty Shock



While the estimates showed fluctuations in the stock and exchange markets, the credit markets failed to present significant values. Bhattarai et al. (2020) argued that the monetary authorities of Asian economies behave differently from those of Latin America. Asian central banks react promptly to capital outflows by setting contractionary monetary policies. On the other hand, central banks in Latin economies are more permissive to fluctuations in capital. Considering that Figure 1's sample is composed of only Latin American economies, we could argue that Figure 1 supports this claim.

Concerning the financial markets, the estimates indicated that the stock and exchange markets reacted to the U.S. uncertainty shock. Chile and Mexico presented higher sensitivity to this shock, with fluctuations in GDP and financial markets. Now we analyze the demand components, private consumption, and investment.

Following the oscillations in the financial markets, private consumption decreased in Chile and Mexico. In other economies, this variable remained nonresponsive. We detected a more disseminated impact of the U.S. shock on investment, with fluctuations in Argentina (at the end of the shock), Chile, Mexico, and Peru. Only Brazil's demand components posed no reaction to the shock.

In short, the U.S. financial uncertainty shock provoked fluctuations in the financial and real markets of the Latin American economies. Thus, our estimates show that U.S. uncertainty has spillover effects on Latin America. Additionally, Figure 1 indicates that Chile and Mexico are more sensitive to this shock than the other economies. However, we decided to test if the kind of uncertainty is relevant to comprehend the fluctuations we saw in our sample. In Figure 1A in the appendices, we changed the U.S. financial uncertainty to the U.S. macroeconomic uncertainty, and while we observed mostly the same principal results found in Figure 1, we detected new fluctuations, such as a reduction in Brazilian private consumption in response to this macroeconomic shock, and the fall of sensitivity of Mexico's demand components. These estimates suggest that the specific kind of U.S. uncertainty shock is relevant to understanding the subsequent fluctuations in Latin American economies.

Our next econometric exercise is to decompose the GDPs of Argentina, Brazil, Chile, Mexico, and Peru to U.S. variables. In Table 2, we split the U.S. factors into two columns. The first column is made up of real and financial factors: private consumption, GDP, and investment shocks are the real variables, and the stock market and interest rate are the financial variables. The second column consists of the U.S. uncertainty variables. Given that we want to verify the relative importance of the U.S. factors on the GDP fluctuations in Latin American economies, we normalized each line to a sum of 100%.

TABLE 2
GFEVD OF GDP TO DOMESTIC AND U.S. FACTORS

	U.S. real and financial factors					U.S. uncertainty	
	gdp	*c*	*inv*	*i*	*st*	*finc*	*macro*
ARG							
1	12.20	32.89	13.32	22.90	5.77	1.64	11.28
4	2.11	9.35	37.55	16.84	13.20	18.80	2.15
8	2.22	2.01	40.51	7.90	10.16	30.61	6.59
12	2.79	1.95	39.25	4.47	8.18	34.58	8.79
20	3.46	5.44	38.14	1.81	8.42	35.26	7.47
BRA							
1	0.78	6.05	5.69	26.36	10.79	16.41	33.91
4	9.09	2.69	21.39	8.26	2.45	28.07	28.05
8	13.45	13.80	32.07	2.10	0.92	23.94	13.71
12	12.43	24.52	34.69	1.71	0.33	20.50	5.82
20	10.43	32.08	35.02	1.83	0.32	17.94	2.37
CHL							
1	29.02	14.18	13.38	1.78	8.44	6.06	27.16
4	21.40	5.40	7.51	4.22	9.24	18.57	33.66
8	18.71	4.81	5.29	4.38	8.20	25.32	33.28
12	18.57	6.25	4.99	3.70	8.11	28.53	29.85
20	18.43	10.58	6.39	2.29	9.50	30.91	21.90
MEX							
1	1.05	3.72	25.15	3.47	50.98	15.57	0.05
4	0.64	3.84	17.50	2.18	40.69	33.60	1.55
8	0.76	2.39	13.35	3.92	32.31	42.55	4.71
12	0.69	1.85	12.57	4.36	26.07	46.72	7.75
20	0.61	2.26	13.51	3.72	21.21	50.05	8.64
PER							
1	2.05	21.21	18.16	1.13	54.05	1.06	2.34
4	0.66	13.09	23.61	0.37	54.31	1.53	6.43
8	0.76	9.68	24.64	0.27	48.73	4.68	11.23
12	0.81	8.70	24.93	0.27	43.40	6.44	15.45
20	0.85	8.49	25.35	0.22	38.28	8.22	18.59

The results of Table 2 allow us to draw some conclusions about the impact these shocks had on the economies studied, the first being that U.S. investment accounts for around a quarter of the fluctuations. Furthermore, the estimates suggest ample heterogeneity concerning the U.S. influence on these economies. For example, looking at the last period (20th), the principal U.S. variable i) on Argentina and Brazil is investment, ii) on Chile and Mexico is financial uncertainty, and iii) on Peru is the stock market. Finally, the critical information Table 2 adds to our investigation is that the U.S. uncertainty measures are pervasive in all economies.

Regarding the U.S. uncertainty variables in the last period, we observe that the financial factors were more relevant than the macroeconomic factors in all economies, except Peru, where macroeconomic uncertainty was principal. These estimates reinforce our focus on analyzing the financial uncertainty rather than macroeconomic uncertainty. Thus, these estimates further sustain what we saw in Figure 1, supporting the conclusion that Latin American economies are sensitive to U.S. uncertainty, with spillover effects impacting both their financial and real markets. As noteworthy examples of the pervasiveness of this influence, we highlight the U.S. financial uncertainty's remarkable influence on Mexico's GDP fluctuation, reaching more than 50% in the last period, and Chile, where both uncertainty variables explain more than 50% of the GDP.

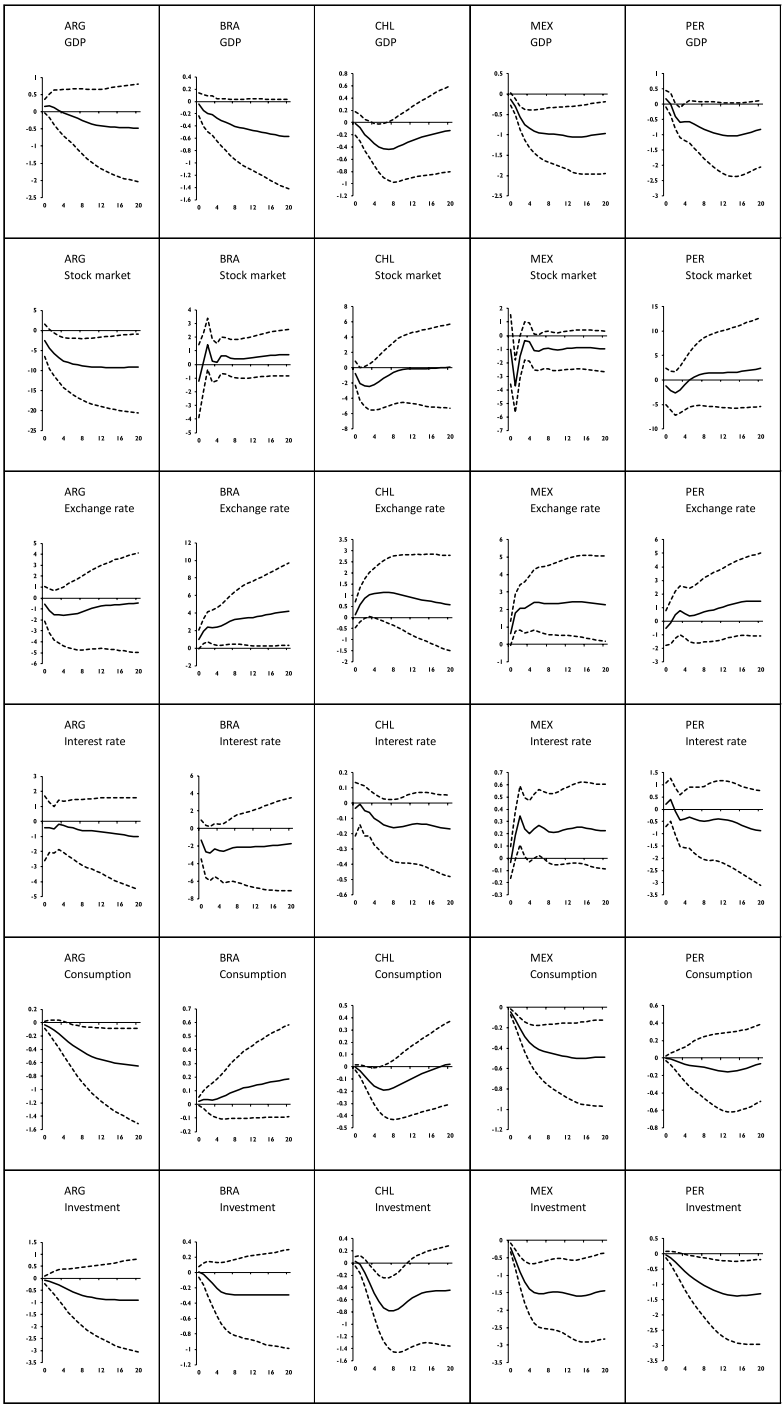
Therefore, we can assert that Table 2 supports Chudik and Fratzscher's (2011) conclusion that emerging market economies are sensitive to U.S. stock market fluctuations. In our results, the U.S. stock market caused significant fluctuations in all economies except Chile. In the demand components, private consumption and investment showed a sizeable influence on GDP.

We test the results by incorporating relevant global economies, such as China and the Eurozone, in the following subsection. This configuration also allows us to evaluate new transmission channels of the U.S. uncertainty shocks.

4.2. External Financial Shocks

We expand our sample to 17 countries including Austria, Belgium, France, Finland, Germany, Italy, the Netherlands, Spain, China, Japan, and the U.K. We aggregate the first eight of these economies to create the Eurozone. This expansion enlarges our representation of the international economy, allowing us to compare our new results with the previous. Figure 2 replicates Figure 1, showing a U.S. financial uncertainty shock and the responses of the Latin American economies.

Figure 2 – GIRF of a U.S. Financial Uncertainty Shock (expanded model)



After applying the aforementioned changes, we fail to observe any noteworthy differences between Figures 1 and 2. The estimates confirm the same principal results as before: the uncertainty shock provoked changes in the financial and real sectors of the Latin American economies, and Chile and Mexico were more sensitive than other economies. Thus, Figures 1 and 2 support the conclusion that the U.S. economy can cause international fluctuations in other economies (Kim, 2011; Bowman et al., 2015; Rey, 2016; Mumtaz and Theodoridis, 2020; Miranda-Agrippino and Ricco, 2021).

Another conclusion we can draw from Figures 1 and 2 is that incorporating new economies has no relevant impact in comprehending the diffusion of U.S. uncertainty shocks on Latin American economies. In other words, the estimates suggest the absence of a relevant link between these economies and the enlarged sample when it comes to understanding the transmission of the U.S. uncertainty shock.

We decompose the GDP of Latin American economies in Table 3, which has one additional column than Table 2, called external factors. The external factors column encompasses the influence of the financial markets of the Eurozone, the U.K., Japan, and China (for the first three regions, we investigate the stock markets, while for China, due to data availability, we analyze the interest rate). As in Table 2, we repeat the influence of U.S. domestic variables in the second column and the uncertainty indexes in the last column. Our idea is to verify if the inclusion of the four advanced economies in some way lessens the influence of U.S. uncertainty on the GDP fluctuation of these Latin economies.

TABLE 3
GFEVD OF GDP TO EXTERNAL AND U.S. FACTORS

	External factors				U.S. real and financial factors					U.S. uncertainty shocks	
	CHN	EURO	JPN	U.K.	*gdp*	*c*	*inv*	*i*	*st*	*finc*	*macro*
ARG											
1	2.62	6.91	8.99	2.05	9.88	22.18	2.57	16.12	0.67	23.92	4.10
4	12.14	8.22	18.71	1.20	18.01	11.90	10.80	7.98	1.10	4.83	5.11
8	14.83	6.75	16.67	1.25	24.02	4.15	18.95	3.41	1.33	2.04	6.60
12	15.69	6.48	12.76	1.28	29.47	1.97	23.43	1.90	1.14	2.68	3.20
20	17.45	6.16	8.59	1.13	33.80	2.09	24.41	0.80	0.73	3.47	1.37
BRA											
1	0.39	15.28	7.03	6.09	3.89	3.43	0.92	33.97	11.12	11.60	6.29
4	0.90	23.47	1.23	1.95	20.44	1.85	9.65	8.83	7.92	18.80	4.96
8	2.03	20.09	0.63	0.79	27.01	8.16	12.70	2.39	5.84	16.56	3.79
12	2.91	16.65	0.77	0.54	27.63	15.17	13.53	1.05	5.12	14.34	2.30
20	2.91	11.58	0.84	0.45	25.47	24.48	15.01	0.64	5.52	12.13	0.98
CHL											
1	13.69	4.60	4.54	8.35	9.88	12.17	30.08	1.96	6.44	2.87	5.41
4	5.65	8.65	2.03	2.20	20.06	8.51	21.34	2.44	8.59	8.98	11.53
8	2.83	11.89	1.21	1.01	25.73	6.67	14.77	3.47	10.23	8.94	13.24
12	2.53	14.31	1.19	0.78	28.90	6.56	12.15	4.41	10.89	7.86	10.42
20	3.60	16.75	1.32	0.56	29.41	7.42	9.13	5.79	12.65	5.96	7.40
MEX											
1	0.44	3.87	1.15	2.15	14.57	8.83	21.94	2.45	31.17	10.20	3.23
4	0.07	3.33	0.26	1.09	20.09	7.30	18.06	1.33	24.32	15.09	9.07
8	0.10	3.06	0.35	0.93	21.97	5.28	17.77	1.29	19.72	15.43	14.09
12	0.07	2.97	0.37	0.68	22.72	4.80	18.17	1.36	16.24	15.18	17.45
20	0.09	2.81	0.40	0.49	23.80	3.98	17.12	1.80	13.12	14.47	21.92
PER											
1	1.10	7.48	4.99	11.25	0.08	42.48	8.67	5.26	1.41	10.75	6.52
4	12.28	4.74	3.24	4.53	15.07	7.37	20.08	0.77	2.44	18.62	10.87
8	28.25	4.77	1.50	3.16	15.13	2.31	15.11	0.23	1.90	17.79	9.85
12	29.66	2.54	0.72	3.33	9.09	2.54	8.34	0.11	1.61	19.44	22.62
20	25.00	1.46	0.69	4.34	5.18	3.57	4.09	0.06	5.55	19.45	30.61

The estimates show that external factors are relevant sources of domestic fluctuation in all economies (Cesa-Bianchi et al., 2012; Wall and Eyden, 2016), except Mexico, where the U.S. influence is particularly noteworthy. In the last period, around 22-33% of the GDP's variation came from external sources. Contrary to Table 2, the enlargement of the sample gave more explanatory power to the GDP of the U.S. Similarly to Table 2, we detect heterogeneity among the factors causing fluctuation in the Latin American economies.

Regarding the U.S. uncertainty variables, both indexes show relevant influence on the domestic fluctuation of Latin American economies, with Peru and Mexico presenting the highest values. Contrary to Table 2, in Table 3 we see that U.S. macroeconomic uncertainty caused more fluctuation than financial uncertainty. One possible hypothesis to explain this finding is that the increase in sample size may have absorbed some of the impact before being attributed to U.S. financial uncertainty.

Our last econometric exercise is to evaluate domestic and regional factors' contribution to the GDP fluctuation. We repeated Table 3 to create Table 4, adding all domestic variables (GDP, investment, consumption, interest rate, stock market, and exchange rate) and regional factors. For example, in Argentina, the domestic factors column encompasses the influence of all domestic variables on the GDP decomposition. In the regional factors column, we aggregated the influence of the stock markets of Brazil, Chile, Mexico, and Peru. The other columns follow the previously adopted pattern-external factors include the Eurozone, the U.K., Japan, and China; U.S. factors include all U.S. domestic variables except uncertainty variables; and U.S. uncertainty presents the uncertainty indexes. This procedure allows us to compare domestic (or local), regional, and external sources of fluctuation in Latin American economies.

Again, Table 4 confirms the significant heterogeneity that is present in Latin American economies. In some economies, domestic factors are most prevalent (Argentina, Chile, and Peru), while the U.S. factors in others (Brazil and Mexico). Although the increase of the sample and factors partially diluted the effect of U.S. uncertainty on the Latin economies, we can still find a relevant influence of financial and macroeconomic uncertainty on them, especially in Mexico and Peru. Thus, U.S. uncertainty is an important source of domestic fluctuation in these economies.

TABLE 4
GFEVD OF GDP TO DOMESTIC, REGIONAL, EXTERNAL, AND U.S. FACTORS

	Domestic factors	Regional factors	External factors	U.S. factors	U.S. uncertainty	
					finc	*macro*
ARG						
1	95.91	1.39	0.56	1.39	0.65	0.11
4	96.89	0.95	0.87	1.08	0.10	0.11
8	96.62	1.00	0.94	1.23	0.05	0.16
12	96.15	1.08	1.01	1.61	0.07	0.09
20	95.39	1.16	1.15	2.13	0.12	0.05
BRA						
1	68.28	6.89	7.15	13.24	2.88	1.56
4	60.05	8.78	8.59	15.17	5.86	1.55
8	50.46	7.95	9.79	23.34	6.89	1.58
12	41.33	7.19	10.74	32.18	7.38	1.18
20	27.11	5.96	10.56	47.61	8.12	0.65
CHL						
1	89.43	2.98	2.37	4.59	0.22	0.41
4	77.83	3.99	3.37	11.08	1.63	2.10
8	69.29	4.65	4.42	15.87	2.33	3.45
12	69.72	4.93	4.77	15.94	1.99	2.64
20	74.32	4.84	4.63	13.42	1.24	1.54
MEX						
1	61.14	3.40	2.70	28.00	3.62	1.14
4	38.87	3.36	2.74	41.07	8.72	5.24
8	33.23	2.98	2.83	42.13	9.85	8.99
12	34.03	2.63	2.59	40.08	9.62	11.05
20	33.01	2.47	2.44	38.60	9.33	14.14
PER						
1	90.53	4.74	1.17	2.74	0.51	0.31
4	62.40	6.65	7.67	14.15	5.76	3.37
8	58.77	7.64	12.66	11.65	5.98	3.31
12	60.66	6.21	12.01	7.18	6.44	7.50
20	52.28	6.33	13.04	7.64	8.05	12.67

4. Conclusion

This article explored the effects of U.S. uncertainty shocks on Latin American economies, and our estimates indicated a substantial impact of these shocks on both the financial and real markets of these countries, with pervasive spillover effects. We tested this result by increasing our sample and including other countries as possible alternative sources of fluctuation; the subsequent estimates supported our initial conclusion: The U.S. uncertainty is a relevant source of fluctuation in Latin American economies.

We contributed to the literature by testing a new proxy for the U.S. uncertainty using an econometric model that allows for spillover effects and captures the external influence on domestic fluctuations. Furthermore, the GVAR connects economies using economic integration variables - we connected the economies using bilateral trade. We constructed our model under the understanding that the U.S. uncertainty affects other economies through bilateral trade, but future studies could use other variables to connect the economies. Perhaps the bilateral flow of financial capital could be a promising area for future investigation.

Finally, we agree with Rey's (2016) conclusion that economies can not isolate themselves from external shocks, a finding that our econometric investigation reinforces. But we are also inclined to agree with Miranda-Agrippino and Ricco's (2021) statement that proper economic practices and reforms can increase domestic resilience to shocks. Therefore, we recommend that policy makers implement reforms that contribute to developing financial markets, increasing fiscal sustainability, and increasing productivity.

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Appendices

Table A
Weighted Symmetric (WS) Unit Root Test Statistics for Domestic Variables

Domestic Variables	C.V.	ARG	BRA	CHL	MEX	PER	U.S.
gdp (with trend)	-3.24	-2.26	-2.51	-1.20	-3.08	-1.39	-1.10
gdp (no trend)	-2.55	-0.02	1.77	2.23	1.17	0.72	1.54
Dgdp	-2.55	-5.19	-5.42	-4.67	-6.76	-8.05	-4.42
c (with trend)	-3.24	-1.90	-2.30	-1.87	-1.70	-1.50	-1.80
c (no trend)	-2.55	1.09	0.49	1.11	1.23	1.11	0.84
Dc	-2.55	-3.05	-1.93	-2.21	-2.54	-5.61	-1.77
inv (with trend)	-3.24	-2.47	-2.10	-1.04	-3.36	-1.78	-2.01
inv (no trend)	-2.55	-0.89	0.51	2.03	0.23	0.35	0.78
Dinv	-2.55	-7.01	-2.28	-2.97	-3.20	-2.60	-1.68
i (with trend)	-3.24	-2.75	-3.30	-4.17	-2.87	-3.65	-4.67
i (no trend)	-2.55	-2.07	-2.63	-2.23	-1.27	-3.15	-1.47
Di	-2.55	-16.23	-9.33	-5.94	-10.28	-4.50	-4.77
e (with trend)	-3.24	-1.96	-2.08	-2.07	-2.95	-1.22	
e (no trend)	-2.55	-1.68	-0.89	-0.97	-0.60	0.58	
De	-2.55	-7.65	-7.64	-5.19	-5.30	-8.84	
st (with trend)	-3.24	-3.66	-6.31	-0.73	-8.21	-1.96	-1.94
st (no trend)	-2.55	-3.16	-6.11	1.02	-8.03	-0.76	0.02
Dst	-2.55	-7.05	-9.28	-6.35	-8.50	-7.54	-6.62

Notes: C.V. stands for the critical value. In blank cells, the test could not be implemented because of missing values.

TABLE B
WEIGHTED SYMMETRIC (WS) UNIT ROOT TEST STATISTICS FOR FOREIGN AND GLOBAL VARIABLES

Foreign Variables	C.V.	ARG	BRA	CHL	MEX	PER	U.S.
gdp* (with trend)	-3.24	-2.72	-3.75	-2.97	-1.15	-1.70	-3.46
gdp* (no trend)	-2.55	2.29	1.39	1.96	1.53	2.01	1.46
Dgdp*	-2.55	-5.89	-5.45	-6.19	-4.47	-5.77	-5.17
c* (with trend)	-3.24	-2.49	-2.81	-2.34	-1.75	-1.03	-1.91
c* (no trend)	-2.55	1.47	1.93	1.68	0.86	1.43	1.53
Dc*	-2.55	-1.99	-3.28	-2.61	-1.78	-2.66	-2.77
inv* (with trend)	-3.24	-2.19	-2.83	-2.55	-2.00	-1.72	-3.39
inv* (no trend)	-2.55	1.50	1.01	1.45	0.83	1.81	0.75
Dinv*	-2.55	-2.22	-3.36	-2.82	-1.74	-2.56	-3.27
i* (with trend)	-3.24	-3.27	-2.63	-3.40	-3.57	-3.04	-2.58
i* (no trend)	-2.55	-2.55	-1.82	-2.04	-1.44	-1.99	-1.25
Di*	-2.55	-9.23	-15.48	-10.60	-9.61	-11.33	-12.42
e* (with trend)	-3.24	-2.03	-1.75	-1.48	-1.76	-1.79	-2.26
e* (no trend)	-2.55	-0.66	-0.94	-0.08	-0.46	-0.33	-0.12
De*	-2.55	-7.54	-7.11	-6.36	-6.20	-6.71	-8.23
st* (with trend)	-3.24	-2.92	-2.98	-2.17	-1.91	-1.94	-8.00
st* (no trend)	-2.55	-0.39	-0.35	-0.11	0.10	0.52	-4.77
Dst*	-2.55	-8.26	-6.69	-6.77	-6.75	-6.26	-8.51
Global variables							
finc (with trend)	-3.24						-2.87
finc (no trend)	-2.55						-2.89
Dfinc	-2.55						-7.71
macro (with trend)	-3.24						-3.50
macro (no trend)	-2.55						-3.27
Dmacro	-2.55						-7.91

Note: C.V. stands for the critical value.

TABLE C
VARX ORDER AND NUMBER OF COINTEGRATING RELATIONS

	VARX (p,q)		cointegrating relationships
	p	q	
ARG	2	1	1
BRA	2	1	2
CHL	1	1	1
MEX	2	1	2
PER	1	1	1
U.S.	2	1	1

Note: We used the Akaike Information Criterion (AIC) to choose the lags of domestic and foreign variables.

TABLE D
DESCRIPTIVE STATISTICS

Variables	ARG		BRA		CHL	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
gdp	4.61	0.30	4.62	0.25	4.50	0.48
c	10.68	0.12	11.35	0.12	10.23	0.23
inv	10.02	0.18	10.85	0.13	9.69	0.35
i	0.11	0.21	0.22	0.31	0.03	0.02
e	-4.09	0.45	-4.12	0.43	1.71	0.32
st	0.34	0.53	2.16	0.22	2.20	1.14

	MEX		PER		U.S.	
	Mean	Std. dev.	Mean	Std. dev.	Mean	Std. dev.
gdp	4.52	0.25	4.67	0.36	4.51	0.24
c	11.12	0.12	10.18	0.14	12.28	0.12
inv	10.62	0.13	9.58	0.25	11.75	0.13
i	0.05	0.05	0.09	0.17	0.01	0.01
e	-2.18	0.38	-3.25	0.63	-4.56	0.25
st	1.81	0.17	2.64	1.69	1.85	0.54
finc					-0.06	0.08
macro					-0.19	0.05

TABLE E
TEST FOR WEAK EXOGENEITY AT THE 5% SIGNIFICANCE LEVEL

Regions	C.V.	gdp*	c*	inv*	i*	e*	st*	finc*	macro*
ARG	3.94	1.15	0.60	0.15	4.88		4.16	0.22	1.20
BRA	3.09	0.97	2.31	4.24	0.34		0.13	2.63	0.32
CHL	3.94	4.62	0.88	1.42	0.95		3.36	4.01	1.19
MEX	3.09	0.92	0.09	0.01	0.05		1.17	1.36	0.81
PER	3.94	6.83	0.08	0.59	2.61		2.64	1.46	0.18
U.S.	3.93					0.13			

Note: C.V. stands for the critical value.

Figure 1A – U.S. Macroeconomic Uncertainty Shock