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External Shocks and Asset Prices in Latin America before and after Lehman Brothers' Bankruptcy*

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Abstract. The international financial crisis of 2007-2009 strongly affected asset prices, risk and growth in the advanced economies, leading to large capital movements between these economies and the emerging countries. The capital movements were reflected in sharp fluctuations in the emerging countries' asset prices and presented management challenges to their authorities. The purpose of this paper is to analyze and quantify the effects of external shocks and "news" on interest rates, exchange rates and stock prices in the larger economies of Latin America before and after the announcement of Lehman's collapse. To that end, use is made of daily information over the period 2006-2011 from Argentina, Brazil, Chile, Colombia and Mexico to carry out multiplier analyses. The findings show that the multipliers are statistically significant and relatively small, generally present the expected signs, are heterogeneous in size, sign and variance across the countries, have short duration, and, in many cases, respond asymmetrically before and after Lehman's collapse. They also indicate little coupling between external and domestic asset prices, except in the case of stock prices, which turn out to be fully and unambiguously, coupled regardless of the country being analyzed or the status of the crisis. Lastly, there are indications that the behavior of international capital markets underwent a structural change during the crisis.

Key words: External shocks, LAC-5, "news", asset prices, VARX-MGARCH model, multiplier analysis

JEL Classification: F31, F36, G15, C5

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1. Introduction

In 2007-2009 the advanced economies, particularly the United States, experienced one of the worst financial crises in decades. The crisis is still having and will continue to have in the medium and long term real financial repercussions on the advanced economies (AEs) and the rest of the world. One immediate effect of the crisis was to cause strong movements in the advanced economies' asset prices and in capital flows between these economies and emerging markets (EMs). Immediately after Lehman Brothers' (L-B) collapse on September 15, 2008, capital outflows to EMs shrank but then resumed very quickly and with greater force. They were accompanied by sharp changes in their currencies and other financial-asset prices, posing a management challenge to the economic authorities of these countries. There is international evidence that large capital inflows can produce current-account imbalances, asset-price bubbles, and financial and macroeconomic instability.

This paper aims to provide greater understanding of the association between international financial markets and the financial markets of EMs, the channels by which shock is transmitted from the former to the latter, and the size of the impact produced. To this end, it analyzes and quantifies the effects of external shocks on asset prices such as interest rates, exchange rates and stock prices in the larger Latin-American countries (Argentina, Brazil, Chile, Colombia and Mexico) before and after the announcement of Lehman Brothers' bankruptcy.

Accordingly, this paper goes more deeply into and further develops some literature findings such as those of Dooley and Hutchison (2009), who find that EMs' asset prices remained "decoupled" from the behavior of financial markets in the AEs until mid-2008 but then fell dramatically and by a greater extent than asset prices in these economies ("coupling"). According to Dooley and Hutchison (2009), with the collapse of Lehman the financial shock to EMs ("recoupling") was reflected in credit tightening and trade contraction (ibid., pp. 1332-1335).

Thus, this paper provides answers to such questions as: Did the degree of coupling between movements in asset prices, liquidity and risk in the advanced economies and asset prices in emerging Latin-American countries change before and after L-B's collapse? What impact did shocks to the former produce on the latter before and after L-B? What could explain the changes, if any, in the size of the impact? Do the macroeconomic and policy announcements ("news") by the AEs' authorities during the crisis matter for the EMs' asset prices? Given the continuation of the crisis in the AEs, it is of particular interest to the economic authorities of emerging countries to know how dependent or isolated their economies are from the rest of the world and to be aware of the magnitude of the effects they might experience from different external shocks and "news".

To meet the stated aims, use is made of daily information for the period 2006-2011 from the countries referred to above, which make up the LAC-5 group. Specifically, the effects of shocks to real financial US variables on LAC-5 interest and exchange rates and stock prices are quantified and analyzed, with the US variables serving as proxies for the

behavior of AEs' variables.¹ The econometric methodology is based on estimation of a VARX-GARCH regression model and multiplier analysis.

This study contributes to the literature in four respects. First, it uses daily information, which allows it to complement existing international literature on 'high-frequency transmission' of financial crises, contagion and event study (for example, Bekaert *et al.* (2011), Fratzscher (2011), Dooley and Hutchison (2009)). We are not aware of any studies that have used daily data to examine such issues with regard to Latin America. In contrast to much of the international literature on these subjects, including the works referred to in here, this paper models volatility and thus controls it, thereby avoiding the biases originally described by Forbes and Rigobon (2002) in this type of analysis.^{2,3} Second, it incorporates event-study methodology by building qualitative "news" variables, which are incorporated as control variables in estimations, but it avoids the characteristic problems of such studies by capturing the overall behavior and dynamics of fundamental variables in operation around the time of the announcements. Third, it adds to the literature on the real effects of the crisis on emerging economies, particularly its effects on asset prices. Lastly, by focusing only on the common effects of shocks this paper avoids the problems of simultaneity that arise in using standard VAR models (see Faust and Rogers (1999), and Faust *et al.* (2003)). Policywise, this fourth contribution allows impulse responses to be directly interpreted as multipliers.

The main findings indicate that the multipliers are statistically significant, relatively small and short lived, generally present the expected signs, are heterogeneous in size, sign and variance across the countries, and in many cases respond asymmetrically before and after L-B's collapse. They also indicate that there is little coupling between external and domestic asset prices, except in the case of stock prices, which turn out to be fully and unambiguously coupled, regardless of the country analyzed or the status of the crisis. Lastly, there are indications that the behavior of international capital markets underwent a structural change during the crisis, which is consistent with the recent findings of Fratzscher (2011) for a sample of fifty countries, and of Julio *et al.* (2012) for the case of Colombia. As for the "news", the results indicate that the impact was instantaneous before and after Lehman, but the effects were generally small and short-lived. It is noteworthy that the Fed's monetary policy during the period analyzed, specifically its policy on monetary aggregates, does not appear to have had any great effect on asset prices in most of the countries.

¹ Peru was not included in the analysis because unfortunately no consistent series, particularly of interest rates, could be found for it. In the case of Venezuela, the region's other larger country and a member of the so-called LAC-7 countries, it was not possible with the available information to perform the analysis aimed at by this paper

² These authors show that the presence of heteroskedasticity biases tests for contagion based on correlation coefficients (which depend on market volatility), thereby contradicting many findings of the literature on this subject.

³ One of the referees noticed imprecisely that modeling volatility could not be said to be a contribution of this paper, since that was "standard" in the literature that analyzes financial markets. However, what is common is to use the standard GARCH methodology in univariate or multivariate models. Here the multivariate GARCH is type BEKK and applied to a VARX model.

This paper consists of the present Introduction and the following further Sections. Section 2 identifies and analyzes the major channels by which external shocks are transmitted to local asset prices. Section 3 provides a brief description of what happened to the main US and LAC-5 financial and macroeconomic variables over the period 2006-2011. Section 4 models local asset prices econometrically as variables that depend solely on such variables as capture US financial and real market behavior and sentiment. This is done to capture only the effects of external shocks common to the countries under study and so avoid any endogeneity problems in estimations if local variables were to be included. It is also assumed that the EMs of the sample are small open economies, so as to rule out any impact of endogenous variables on external ones. To control for the effects of decisions by US economic authorities, “news” announcements are included as control variables. Section 5 presents and discusses the estimations. Section 6 summarizes the conclusions.

2. Conceptual framework: transmission channels of external shocks

The behavior of interest rates, risk perception, growth expectations and the price of assets and goods in the advanced economies before, during and after the 2007-2009 crisis brought about changes in emerging-economy capital flows, trade and services.⁴ The shocks were immediately transferred through financial, risk and expectations channels and, ultimately, through the real channel (Figure 1).

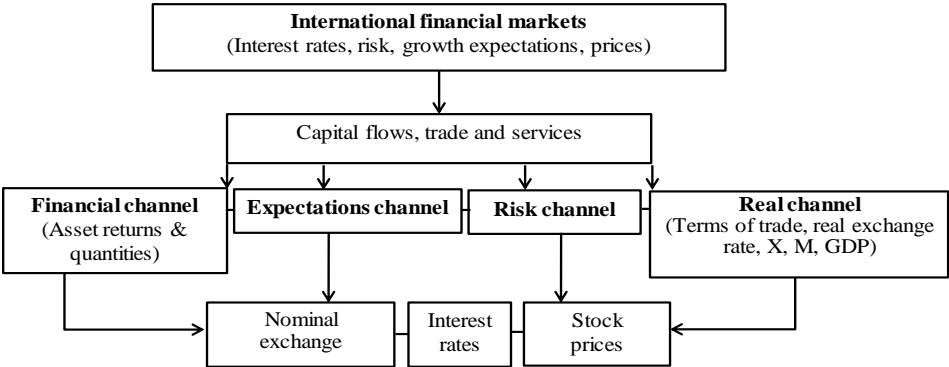


Figure 1. Channels of transmission of external shocks. Source: Prepared by the authors.

The spreading of shocks through the financial channel occurs first through changes in returns on assets, which are transmitted to agents’ wealth and, in a world increasingly more integrated and diversified financially but beset with financial frictions such as leveraging limits, to the balance sheets of highly indebted banks (Calvo, 1998; Devereux and Yetman, 2010). The banks restrict liquidity in domestic and foreign markets, generating at the same time greater contraction in asset prices in both markets. The outcome is a vicious circle of

⁴ Chen et al. (2011) made a detailed study of policy decisions taken by the Fed during and after the crisis and of the channels of transmission to interest rates, financial-market liquidity, assets prices, and growth expectations in the US economy.

falling assets prices, worsening of bank balance sheets, greater liquidity restrictions and, once again, falling asset prices, in what has been called “the international finance multiplier” (Krugman, 2008).⁵

The reasons put forward in the literature to explain such transmission include: greater risk aversion on the part of international investors (Kaminsky *et al.*, 2003; Krugman, 2008; Kannan and Kohler-Geib, 2009); a search for safer markets (Caballero and Kurlat, 2008; Krishnamurthy, 2009); a bias toward investing locally (French and Poterba, 1991; Blanchard *et al.*, 2010); and, in this crisis in particular, shocks to bank liquidity. This practically led to the closing down of interbank lending and of the commercial paper market in the AEs, which was reflected in a dramatic decrease in international liquidity (Cetorelli and Goldberg, 2011; Krishnamurthy, 2009). According to the International Monetary Fund (2009), international interbank lending fell from \$500bn in 2007 to some \$100bn in 2008. This tightening was immediately reflected in higher interbank-lending costs and greater spreads on both advanced- and emerging-economy debt.

The second mechanism of financial propagation consists of portfolio rebalancing by private agents in terms of both maturities and destinations (local vis-à-vis abroad). If returns on medium and long term assets in AEs decreased, for example, as occurred during and after the crises as a result of monetary shock policies in said economies, investors transfer their resources to EMs, causing unexpected and possibly undesired increases in emerging-market asset prices.

A second channel of transmission is that of growth expectations. In times of crisis if growth expectations deteriorate in the AEs, an immediate response will probably be a capital outflow from EMs in search of safer havens, which will depreciate their currencies and reduce asset prices. This should be reflected in capital outflows from emerging economies, depreciation of their currencies, and a decrease in their asset prices. Endogenously, their interest rates should rise, although this response is not clear, for it depends on the initial levels of external interest rates and on the local policy response. In contrast, in normal times, other things being equal, a relative worsening of AEs’ growth expectations will simply lead to capital outflows to EMs.

A third channel, which operates simultaneously with the others, has to do with risk, or rather, risk pricing or risk tolerance by international investors. In normal times higher risk in AEs should lead to capital outflows to EMs, and vice versa. In times of crisis, however, the response is not necessarily the same. According to Fratzscher’s (2011) findings, before Lehman higher risk in the AEs did cause capital outflows to emerging markets. But, at the time of the greatest risk in the AEs, around the day of L-B’s collapse there occurred a massive outflow of capital from the EMs, suggesting that “the pricing of risk changed fundamentally during the crisis” (Fratzscher, 2011, p.17).

The last transmission channel is the real channel, which propagates shocks through changes in the terms of trade, the real exchange rate, trade (exports and imports)—known as the trade multiplier—, and finally output. Transmission occurs in the following manner: With lower

⁵ Brunnermeier (2009) identifies the financial channel operating during the 2007-2009 crises in the US.

prospects for global growth, imports/exports by advanced/emerging economies decrease. This is reflected in lower global trade and lower prices for traded goods, particularly commodities produced and exported by EMs.⁶ Ultimately, economic growth in these countries is negatively affected. Note that once the real channel comes into play, second-round effects are produced from it to the financial channel. This paper analyzes only first-round effects.

3. Events before, during and after the crisis in the United States and LAC-5 countries

Before proceeding to the empirical implementation, we describe briefly in this Section what happened in the United States and the emerging countries under study before, during and after the crisis (figures A.1 to A.6 of Appendix A). The description is intended to provide context and contrast for the econometric results.

After the dot.com crisis of 2002 interest rates in the United States dropped to all-time lows, before starting to surge from the middle of the decade, when the first signs of concern emerged in international financial markets. Such signs included the rising path of asset prices, particularly stock prices, and high rates of economic growth. The LAC-5 countries for their part saw strong capital inflows (driven by expectations of appreciation in their currencies and by considerable decreases in their risk premiums),⁷ particularly after the middle of the decade. They also saw substantial improvement in their terms of trade (especially the commodity-exporting countries), higher asset prices, historically strong credit growth, and rates of economic growth beyond their potential.

Lehman's collapse led to immediate reversal of capital flows—causing outflows from the LAC-5 countries to the advanced economies—, depreciation of LAC-5 currencies in spot and futures markets, higher risk levels and, hence, higher local interest rates. In some EMs the positive effect on interest rates received exogenous feedback initially through the reaction of monetary authorities intent on averting capital outflows. But in most emerging countries the prospect of a worsening of real variables prompted a countercyclical reaction of drastically cutting policy rates.

The negative shock in the United States quickly led to the LAC-5 countries undergoing falling asset prices and lower terms of trade and, eventually, a strong swift decline in exports and growth. All these changes occurred despite the absence of any major changes in these countries' fundamentals. For example, commodity prices fell by 36% from 2007 to 2008 according to the Bloomberg CRY Index; and exports from emerging and developing countries shrank by 25%, from \$6.1trn in 2008 to \$4.6trn in 2009, according to the IMF's International Financial Statistics.

⁶ International evidence shows that the trade channel has become relatively less important than the financial channel when it comes to explaining the international propagation of shocks, because "it is difficult to explain the scale and synchronicity of the global downturn based on trade alone" (Devereux and Yetman, 2010, pp. 6).

⁷ Probably feedbacked by balance-sheet effects: the greater the external debt but greater also expectations of appreciation, the smaller the real value of such debt and the greater the balance-sheet effect on output.

The LAC-5 countries began again from 2009 to receive large volumes of capital inflows and to enjoy a macroeconomic and financial situation similar to their situation before the L-B's bankruptcy. In contrast, the AEs continued to bear the aftermath of the crisis, as evidenced by the radical policy measures taken by their authorities, particularly the US authorities, once the policy rate stood close to zero at the end of 2008. Over the two years from November 2008 to November 2010 the Federal Reserve implemented two massive monetary-expansion programs, referred to as "quantitative easing or QE". The Fed's short-term aims were to provide greater liquidity to the US financial system, re-establish credit channels and flows, and lower funding costs (Chen *et al.* 2011, p. 6). Its long-term objectives were to expand economic growth and employment.

Simply for purposes of comparison with what is usually found in the literature, we evaluate graphically the degree of association between some of the domestic and external variables referred to earlier, which are defined more precisely in the following Section. The dispersion figures presented in Appendix B (figures B.1 to B.5) show the associations for each country for the periods before and after Lehman (m1 and m2, respectively). It can be seen that for many of the variables there is no clear consistent association for the periods before and after the crisis. In the next Section we carry out a rigorous econometric analysis of those associations and quantify the effects of the shocks on the endogenous variables involved.

4. Econometric methodology and data

To evaluate the effects of external shocks and the "news" on asset prices in Argentina, Brazil, Chile, Colombia and Mexico a VARX-MGARCH model was built and estimated for a daily sample from each country for the period from January 3, 2006 to January 31, 2011.

The dependent variables considered for each country are the short-term interest rate (i), the nominal exchange rate (TC), measured in local-currency units per US dollar (\$/USD), and the stock price (IAcc). The explanatory variables are the short-term benchmark interest rate (Libor90); the stock price index (SP500); the volatility index of the Chicago options market (VIX), as a measure of risk in international financial markets; the spread between the 10-year Treasury bond rate and the Federal Reserve fund rate (Spr.FED10.FEDF), as a measure of economic-growth expectations (the greater the spread, the lower growth expectations);⁸ the spread between BBB and AAA corporate bond rates (Spr.Baa.Aaa), as a measure of investors' appetite or tolerance for market-risk (the greater the spread, the greater the risk and so the greater the demand for safer bonds); the spread between the 90-day Libor rate (Libor90) and the overnight index swap rate (Spr.LIBOR.OIS), as a measure of liquidity tightness (the greater the spread, the greater the liquidity tightness in the credit

⁸ Note that where the policy interest rate is close to zero and the central bank is fostering greater growth, it will use quantitative-type measures to reduce long-term interest rates and reduce the spread (flatten the yield curves). As stated earlier, this type of policy has been massively used by the AEs since the end of the past decade.

market);⁹ commodity prices (ICOM), as a measure of shocks to the terms of trade;¹⁰ and, lastly, the qualitative “news” variables (WD, BR, CRD, FSD, FSE, L-B, TARP_CANCEL, EGA, IG, MP-I, MP-A).

As stated above, the United States is the source of all external variables, which are used as measures of the behavior of financial and real markets in the AEs. Appendices C describes the variables used and their sources. Except where the series represent percentages, such as interest rates and spreads and “news”, the natural log of the series is used and is indicated by the letter “L” put before the name of the variable.

The methodology proposed by Dooley and Hutchison (2009) was used to construct the “news” variables. This methodology identifies the more important endogenous and exogenous financial and real shocks experienced by the United States based on reports of events from Bloomberg and the Federal Reserve Bank of St. Louis. Drawing on these sources Dooley and Hutchison build qualitative variables that capture the events and policy decisions they considered most important in 2007-2009. In this paper we have expanded the sources of information by including reports from the Federal Reserve Bank of New York and have added new categories. Appendix D defines the “news” variables and describes their construction methodology.

The VARX(p,q)-MGARCH(1,1) model, where the GARCH multivariate is type BEKK (for Engle and Kroner (1995)), is represented by equations (1) and (2):

$$\Delta Y_t = \mu + \sum_{i=1}^p A_i \Delta Y_{t-i} + \sum_{i=0}^q B_{1i} \Delta X_{1,t-i} + B_{20} \Delta X_{2t} + \varepsilon_t \quad (1)$$

$$\Sigma_t = C_0' C_0 + F_1' \varepsilon_{t-1} \varepsilon_{t-1}' F_1 + G_1' \Sigma_{t-1} G_1 \quad (2)$$

Where $\varepsilon_t | \mathfrak{F}_t \sim RB(\mathbf{0}, \Sigma_t)$, and:

$$\begin{aligned} Y_t' &= (i, L. TC, L. IAcc) \quad X_{1t}' = \\ & (SP500, ICOM, VIX, Spr. Baa, Aaa, Spr. LIBOR, OIS, Spr. FED10, FEDF, Libor90) \quad X_{2t}' = \\ & (WD, BR, CRD, FSD, FSE, L - B, TARP_CANCEL, EGA, IG, MP - I, MP - A) \quad Z_t' = \\ & (\Delta X_{1t}', \Delta X_{2t}') \end{aligned}$$

Once the econometric model has been specified, the aim then is to estimate for each country the simultaneous response of the model’s endogenous variables (i, TC, IAcc) to shocks to the exogenous variables considered (X_{1t}') and to the AEs’ macroeconomic and policy announcements or “news” (X_{2t}'). This is done by means of multiplier analysis

⁹ “In times of stress, the LIBOR, referencing a cash instrument, reflects both credit and liquidity risk, but the OIS has little exposure to default risk because these contracts do not involve any initial cash flows. The OIS rate is therefore an accurate measure of investor expectations of the effective federal funds rate (and hence the Fed’s target) over the term of the swap, whereas LIBOR reflects credit risk and the expectation on future overnight rates...” Therefore, “[e]ntering into the OIS exposes the bank to future fluctuations in the reference rate. However, the bank can guarantee itself longer-term funding while still paying close to the overnight rate” (*Economic Synopses*, No. 25, page 1, Federal Reserve Bank of St. Louis, 2008).

¹⁰ The sample countries are mostly exporters of minerals and/or farm commodities.

(MA).¹¹

5. Findings

5.1 Prior statistical testing. As a first step, unit-root and cointegration tests were carried out to analyze the stochastic behavior of the series. The order of integration of the variables was determined on the basis of the unit-root tests: KPSS, Elliott-Rothemberg-Stock and Phillips-Perron. The results of these tests are presented in Table 1 and indicate generally that all the series analyzed are order-one integrated.¹²

| Series | KPSS | ERS | PP |
|-------------------|-----------------|-----------------|-----------------|
| | Ho : Xt ~ I (0) | Ho : Xt ~ I (1) | Ho : Xt ~ I (1) |
| L.ICOM | 0.941 | -1.880 | -1.359 |
| Spr.Baa.Aaa | 1.955 | -2.118 | -1.062 |
| Spr.LIBOR.OIS | 2.101 | -2.236 | -2.164 |
| Spr.FED10.FEDF | 1.623 | -1.400 | -1.042 |
| L.VIX | 2.177 | -1.763 | -2.472 |
| Libor90 | 1.430 | -1.312 | -0.233 |
| L.SP500 | 1.555 | -1.574 | -1.291 |
| L.TC.Arg | 2.388 | -1.431 | 0.401 |
| L.TC.Bra | 0.922 | -2.075 | -1.816 |
| L.TC.Chi | 0.986 | -2.429 | -1.735 |
| L.TC.Col | 0.959 | -2.458 | -1.611 |
| L.TC.Mex | 1.094 | -2.137 | -1.550 |
| i.Arg | 2.283 | -2.301 | -7.429 |
| i.Bra | 1.063 | -1.354 | -2.748 |
| i.Chi | 1.515 | -1.800 | -1.403 |
| i.Col | 3.486 | -0.814 | -1.717 |
| i.Mex | 2.271 | -2.089 | -0.655 |
| L.IAcc.Arg | 1.844 | -1.417 | -0.536 |
| L.IAcc.Bra | 1.083 | -1.820 | -1.726 |
| L.IAcc.Chi | 1.778 | -1.413 | -0.65 |
| L.IAcc.Col | 2.416 | -1.478 | -1.051 |
| L.IAcc.Mex | 1.459 | -1.447 | -1.515 |
| 5% Critical Value | 0.146 | -2.890 | -2.864 |

Source: Authors' calculations.

Table 1. Unit-root tests for LAC-5 countries in the period 3 Jan2006 – 31Jan2011.

Considering that the model (1) endogenous series were order-one integrated, the Johansen test was carried out to establish whether there was cointegration between the variables of each country. This test was done by Bootstrap techniques controlling for GARCH effects. The results based on 1000 replications are the following:

¹¹ Two points need to be clarified here. First, in multiplier analysis the shock occurs to an exogenous variable; therefore no identification problems arise. Second, since the endogenous and exogenous series are order-one integrated and are not co-integrated, the resulting multipliers need not be integrated to obtain the responses of endogenous variables in levels.

¹² Unit-root tests were also carried out on the first difference of these variables which confirm that the level series are I(1).

| Country | Trace (P-value) | Maximum Eigenvalue (P-value) |
|-----------|--------------------|---------------------------------|
| Argentina | 0.960 | 0.954 |
| Brazil | 0.941 | 0.776 |
| Chile | 0.936 | 0.790 |
| Colombia | 0.982 | 0.977 |
| Mexico | 0.822 | 0.706 |

Source: Authors' calculations.

Table 2. Johansen cointegration tests for $range(\pi) = 0$ for LAC-5 countries in the period 3 Jan2006 – 31Jan2011.

The P -values presented in Table 2 indicate that the null hypothesis of no cointegration is not rejected. Given the stochastic characteristics of the series obtained by the results of the previous tests, the VARX-MGARCH model was estimated for each country, as described by equations (1) and (2), on differenced variables.¹³

Estimation of the VARX-MGARCH model was carried out in two stages. The first stage consisted of estimating the VARX model on the ΔY_t , ΔX_{1t} and X_{2t} series specified above. In the second stage the BEKK-type MGARCH was estimated on the residuals of the previous stage. Subsequently specification tests were carried out on the model's standardized residuals. The test results are presented in Appendix E (Tables E.1 to E.4 and figures E.1 to E.5), and they do not, in general, indicate bad specification.

Lastly, multiplier analysis is used to estimate the response of endogenous variables (Y_t) to shocks to exogenous variables (X_{1t}) and to “news” (X_{2t}). This exercise was carried out for two samples: before L-B's bankruptcy (m_1 , 3Jan2006-14Sept2008) and after it (m_2 , 15Sep2008-31Jan2011). The results are shown in Appendix F (Figures F.1 to F.10) and G (figures G.1 to G.5).¹³

5.2 Multiplier analysis. This Section estimates the effects of shocks to exogenous variables on the LAC-5 countries' interest rates, exchange rates and stock prices. The results are used to evaluate the degree of coupling between external and local asset prices. To this end the degree and duration of shocks are analyzed by means of multiplier analysis for the samples before (m_1) and after (m_2) Lehman's bankruptcy. As discussed earlier, multiplier analysis differs from the standard VAR analysis in that there are no shocks to endogenous variables, only to exogenous ones. Simultaneity and identification problems are thus precluded and the effects can be directly interpreted as multipliers.

¹³ The number of lags of the endogenous and exogenous variables, p and q in equation (1), were determined by using information criteria, taking into account that the standardized residuals were white noise. Note also that both unit-root and co-integration tests were carried out separately for sample period 1 (3Jan2006-14Sept2008) and sample period 2 (15Sept2008-31Jan2011). In every case the results obtained were similar to those shown in Tables 1 and 2, and they are available to anyone requesting them.

Figures F.1 to F.10 show the responses of the levels of endogenous variables for Argentina (x.Arg), Brazil (x.Bra), Chile (x. Chi), Colombia (x.Col) and Mexico (x.Mex), to a one-unit shock to the level of each exogenous variable. Note that 'x' represents the name of the variable, m1 and m2 are the two samples, and MA stands for 'multiplier analysis'. The respective 95% confidence intervals are represented by I.C.m1 and I.C.m2.¹⁴ The columns from left to right represent the interest rate (i), the log of the exchange rate (L.TC) and the log of the stock price (L.IAcc). The rows from top to bottom are the multipliers for each of the endogenous variables in the face of positive shocks of one unit to the log of the stock price index (L.SP500), the log of the terms of trade (L.ICOM), the log of the VIX index (L.VIX), to appetite for risk (Spr.Baa.Aaa), to liquidity tightening (Spr.LIBOR.OIS), to (lower) growth expectations (Spr.FED10.FEDF) and to the interest rate (LIBOR9), respectively.

From findings four general conclusions can be derived. First, the sizes of the multipliers are much less than proportional for most types of shocks and countries before and after L-B's collapse. For example, in almost all the countries, a 1% shock to any of the exogenous variables changes the endogenous variables, other than the interest rate, by less than 0.1%. One exception to this behavior is the interest rate in Argentina and, to a much lesser extent, in Colombia and Chile. In Argentina's case, an increase in any of the exogenous variables changes the asset prices more than proportionally.¹⁵ The Argentine interest rate's 10% over-reaction to a 1% increase in the external stock price is striking. In Colombia's case, shocks to the terms of trade and the appetite for risk are noteworthy: before the crisis, a 1% increase in foreign investors' appetite for risk or the terms of trade raised the domestic interest rate by around 2%. This behavior is not present after Lehman. In Chile's case, a 1% increase in the external stock price caused the domestic interest rate to fall more than proportionally, before and after L-B, while a 1% positive shock in the external interest rate raised Chile's rate more than proportionally before the crisis.

Secondly, the multipliers are statistically significant, although their duration is not more than a week. In the case of Argentina's and Chile's interest rates, the multiplier effects seem to have a longer duration than Brazil's and Mexico's, the two biggest countries of the region. Colombia ranks in the middle. Note that the multipliers for the exchange rates and stock prices last for an even shorter time: one to three days.

Thirdly, for most of the countries the asset prices react in opposite and asymmetric fashion (in different proportions) to most external shocks before and after L-B. Argentina's interest rate is an unambiguous case of contrary response to external shocks. For example, the domestic interest rate proved to be completely decoupled from the external rate after Lehman: a 1% shock in Libor before Lehman raised the Argentine rate by a little more than 1%, but after Lehman a 1% rise in Libor caused the Argentine rate to fall by 0.5%. Much the same occurred with the stock price, particularly in response to external liquidity, growth and interest-rate shocks. Quite the opposite happened in Colombia's case, for the stock price reacted to shocks to the external price in the same direction, indicating that the two

¹⁴ The confidence intervals were estimated by Bootstrap techniques.

¹⁵ As usual, the shock to log variables is 1%, while for non-logarithmic variables it is one unit.

variables were fully coupled before and after Lehman. In contrast the Colombian interest rate reacted inversely and asymmetrically: before the crisis it moved in the same direction as increases in the external interest rate, though in a smaller proportion; but after the crisis there was a complete decoupling between the two.

Fourthly, multiplier signs generally coincide with expected signs according to the transmission channels identified and discussed in the conceptual framework. However, analysis of specific cases shows this not to be true for some countries and some multipliers.

We shall now analyze in detail each endogenous variable's multipliers in response to shocks to each exogenous variable.

Interest-rate multipliers show that a positive shock to external interest rates generates an increase (full coupling) for all countries other than Chile before the crisis. After the crisis, there is a significant decoupling between the two variables, particularly for Argentina and Colombia, where local rates decrease in response to a positive shock to external interest rates. For Brazil and Mexico increases in the external rate are reflected in higher local rates before and after the L-B's collapse.

Interest-rate responses to other shocks are as follows. The response to higher stock prices is positive only in Colombia and negative in Chile. In the other cases, the behavior of local interest rates depends on the stage of the crisis. Positive external-risk shocks cause the interest rate to respond negatively in Brazil, Chile and Mexico before L-B, and positively in Brazil and Mexico after Lehman, while in Chile the rate decreased; the opposite occurred in the case of Argentina. Colombia was the exception in that the interest rate increased in response to higher risk both before and after the crisis; note, however, that the multiplier was three times greater before than after. External shocks to the appetite or tolerance for risk caused the interest rate to rise in all countries except Chile before and after Lehman (in Chile the rate decreased after L-B). This would indicate that local interest rates in countries but Chile substantiated international investors' greater risk appetite and did so more strongly before Lehman.

Now, in response to positive shocks to liquidity tightening and lower external growth expectations, interest-rate multipliers behaved unevenly across countries in their various dimensions (size, symmetry, permanence and direction). In response to positive shocks to liquidity tightening, local interest rates fell in Brazil, Colombia and Mexico before Lehman, but all rose together afterward, as was to be expected (in Chile the interest rate fell unexpectedly). The shock to lower external growth expectations caused interest rates to respond positively in Brazil, Chile and Mexico but negatively in Argentina and Colombia, before the crisis. After L-B the response was negative in Brazil, Colombia and Mexico, as was to be expected where the interest rate plays a countercyclical part. In contrast, the positive interest-rate response in Argentina and Chile after Lehman would indicate a procyclical behavior by authorities.

The currencies of the countries under study responded unambiguously negatively (by appreciating) in the face of positive shocks to the stock price, terms of trade, liquidity tightening (except in Argentina and Colombia) and lower growth expectations (except in

Brazil), before Lehman. After the collapse they continued to respond negatively in the face of these shocks in all the countries, except in Argentina in the case of the stock-price shock and in Brazil in the case of the shock to lower growth expectations. This would indicate that the status of the crisis did not affect the sign of currency multipliers in the face of those shocks. Negative shocks to international liquidity after L- B unexpectedly caused the currencies of the region's three largest countries (Brazil, Mexico and Argentina) to appreciate, while the currencies of Chile and Colombia depreciated.

With further regard to the impact on the different currencies, positive shocks to risk led, unambiguously and as expected, to depreciation in the currencies of all the countries except Argentina and did so regardless of the status of the crisis. This would corroborate the fact that external risk is a major determinant of exchange-rate behavior. Interestingly, the charts analyzed show that exchange rates do not seem to react substantially to shocks to lower external growth expectations, judging by the size of the multipliers. Nor does their response depend on the status of crisis, for they behave as in normal times; that is to say, local currencies appreciate when external growth expectations worsen and vice versa. Lastly, as expected, the exchange rates of all the countries responded positively (by depreciating) to shocks of the same sign in external interest rates; but this happened before the crisis. After the crisis, exactly the opposite occurred, except in the case of Argentina, as if the mechanism indicated by the Uncover Interest Parity condition was broken, at least temporarily.

Regarding stock prices, the multipliers indicate unambiguously that a positive shock to external stock prices produces a positive response in local stock prices (full coupling); and this behavior is the same before and after Lehman's collapse. For Brazil and Mexico the multipliers indicate almost proportional changes, suggesting a greater degree of integration between their stock exchanges and those of the US; next in order come Argentina, Chile and, last, Colombia. In Colombia's case a 1% increase in external stock prices raises local stock prices by only one-tenth. Similarly, the stock-price response to positive shocks to the terms of trade is also positive, as expected. In contrast, albeit to a much lesser extent, the response is negative to increases in international investors' risk appetite before and after L- B justifying the hypothesis of their search for safer havens. Mexico's case is interesting in that the stock price responded negatively before but not after the crisis, as though investors had raised their risk tolerance by investing in Mexican stocks.

In the face of positive shocks to liquidity tightening, to lower growth expectations and to the external interest rate, stock prices did not respond so homogeneously, either by country or by crisis status. Shocks to liquidity tightening unexpectedly caused stock prices to rise in Argentina, Brazil and Chile, the region's southern-cone countries, before the crisis but, as expected, reduced them after the crisis. Colombia and Mexico exhibited two interesting behaviors, in that external liquidity tightening does not seem to have affected them, for stock prices rose in both cases (owing perhaps to relatively higher foreign investments or more accommodating monetary policies?). Regarding shocks to lower external growth expectations, Argentina and Brazil stood on the same side, Colombia on the opposite side, and Chile beside Mexico.

Lastly, in response to a positive shock to the external interest rate, stock prices in Argentina and Brazil were again on the same side: they fell before L-B and rose after it, their fall being expected where there is transmission of international rates and full substitution between stocks and other assets such as deposits both abroad and locally. In Chile stock prices rose in both situations, while in Colombia and Mexico they fell—as expected, where the conditions described a few lines back are met.

A final finding of interest is that the multipliers exhibit high volatility for all the countries, particularly the interest-rate and exchange-rate multipliers. It is noteworthy that for the exchange-rate variable, volatility was higher for the countries with an apparently “free” currency system, namely, Chile, Colombia and Mexico.

5.3 Impact of “news” on asset prices. Having analyzed the effects of external shocks on local asset prices, we proceed in this subsection to study the effects on these prices of macroeconomic or policy announcements or “news” from the AEs, as substituted by announcements from the US authorities. In reading the multiplier results presented here, the following points should be borne in mind: 1) The endogenous-variable responses should be read as variations rather than changes in levels. 2) Given the discrete character of the announcements, the multipliers should be interpreted as the difference between two expected conditional values with and without the shock. 3) Given the lags and the division of the overall sample period into two effective estimation periods, the multipliers for some “news” events cannot be calculated. This is why for some “news” only the multipliers before or after Lehman are charted.

In Appendix G, Charts G1 to G5 show the responses of returns on local assets to announcements of Federal Reserve Swap lines with some of the larger emerging countries (FSE), to Lehman Brothers’ bankruptcy (L-B), and to massive monetary expansions by the Federal Reserve (MP-A).¹⁶ The columns from left to right depict changes in the interest rate, the exchange-rate return, and returns on assets. The rows from top to bottom are the multiplier responses of each endogenous variable to each announcement.

The multipliers indicate that announcement of the Fed’s Swap lines with EMs (FSE) caused a statistically significant small positive variation (0.2%) in the annual interest rate of every country except Brazil. The effect, however, lasted for less than five days. The exchange-rate return rose slightly (by an annualized 1.5%) in Brazil, Colombia and Mexico and fell by that amount in Argentina and Chile, the fall in Argentina lasting, interestingly, for about ten days. The return on stocks rose in all countries except Mexico, and the effect was significantly greater in Chile.

News of Lehman’s collapse (L-B) caused interest rates to go up in all countries except Chile. It also caused the exchange-rate return to increase in Argentina, Brazil and Chile but decrease in Colombia and Mexico. In Colombia’s case, the effects of L-B continued to

¹⁶ The Figures show only the multipliers for these announcements. The multiplier results for the remaining announcements are available, on request, from the authors. Note that the FSE and L-B announcements had a statistical significant impact on the emerging countries studied by Dooley and Hutchison (ibid.), which include the five countries studied in this paper.

operate in a lagged manner for at least three weeks, generating high exchange-rate volatility. Lastly, return on stocks fell in all countries except Colombia.

The announcements of Federal Reserve monetary expansion (MP-A) generated a negative variation in the interest rate of almost all countries before and after Lehman. The exception was Mexico, where the rate fell in the first period but rose in the second, albeit slightly. The exchange-rate return behaved in different ways in the different countries over the two periods. Two cases deserve mention: Colombia and Mexico. In Colombia the Fed's monetary announcements led to a considerable fall (annualized 18%) in the exchange-rate return before Lehman, but after Lehman the effect was nil. In Mexico the exchange-rate return decreased slightly in both periods. As regards the return on assets, the multipliers show no typical trend, their common denominator being their relatively small size.

To sum up, the results indicate that the impact of the macroeconomic announcements on asset prices in the countries under study was instantaneous before and after Lehman, but the effects were generally small and short-lived. It is noteworthy that the Fed's monetary policy during the period analyzed, specifically its policy on monetary aggregates, does not appear to have had any great effect on asset prices in most of the countries.

5.4. Why results differ across countries? Before ending this Section we need to consider two possible reasons, not otherwise analyzed here, that might help to explain some of the results and also explain why transmission by the different channels may have been accelerated or limited. First, throughout the crisis the standard portfolio channel continued to operate, so that foreign investors' search for interest differentials (the 'carry trade') was a common denominator before, during and after the crisis. Note that differentials include correction for exchange-rate differential in local-currency investments. For purposes of this paper, that means that a certain decoupling, for example between the assets prices of AEs and those of the EMs in the sample, might be explained by both interest differentials, prices, and investment implicit risks but also by expectations about the value of EMs' currencies. By way of illustration, suppose that before the crisis interest rates were rising in the AEs but falling in a given emerging country, however, the latter was experiencing capital inflows. That would mean that the local returns for foreign investors represented, relatively, a smaller risk and also prospects of higher foreign-currency returns, given some expectations of higher local currency appreciation.

Secondly, the association between external and local variables and the effects of shocks depends also on the local variables' initial conditions, their financial regulation, capital-flow management policies, and how the authorities react to the crisis. In the case of the sample of countries analyzed in this paper, the level of their economic and institutional development, their monetary and currency regimes and the state of their fundamentals were not equal either before or after L-B (Izquierdo and Talvi (2011), Chen *et al.* (2011)). Furthermore, they did not all possess the same degree of international financial integration (see the indicator developed by Chinn and Ito (2008)). For example, they did not all have capital controls, nor were they all exposed to the same extent to the securities involved in the US subprime crisis or to the market of foreign-currency transactions and derivatives.

Neither did they apply the same macroprudential policy measures that could have averted or at least alleviated the negative effects of the crisis on their financial and real sectors (Fratzscher (2011), Terrier *et al.* (2011), Montoro and Rojas-Suarez (2012)).¹⁷ Even, as shown by Bekaert *et al.* (2011), the “contagion” (negative association) during the recent international financial crisis occurred mainly within the countries and did not come “systematically” from external shocks (*ibid*, p.4).¹⁸

6. Conclusions

From 2007 to 2009 the advanced economies experienced one of the worst financial crises since the thirties. The crisis was transmitted to emerging markets through different channels, ranging from purely financial ones to real ones. The effects on the emerging economies were immediate and of different orders and magnitudes, impacting their main macroeconomic variables and posing a management challenge to the macroeconomic authorities.

This paper has analyzed the responses of interest rates, exchange rates and stock prices in Argentina, Brazil, Chile, Colombia and Mexico in the face of shocks to variables that capture the behavior of international financial and real markets before and after the bankruptcy of Lehman Brothers. The empirical exercise was carried out by using daily data from 2006 to 2011 and performing multiplier analysis based on a VARX-MGARCH model.

The main findings results show that the multipliers are statistically significant, relatively small and short lived, generally present the expected signs, are heterogeneous in size, sign and variance across the countries and in many cases respond asymmetrically before and after Lehman’s collapse, which would indicate that around the date of the collapse a structural change may have occurred in the behavior of international financial markets. The results further show that there was little coupling between external and domestic asset prices, except between stock prices, which proved to be unambiguously and fully coupled, regardless of the country analyzed or the status of the crisis. As for the “news”, findings indicate that the impact was instantaneous before and after Lehman, but the effects were generally small and short-lived. It is noteworthy that the Fed’s monetary policy during the period analyzed, specifically its policy on monetary aggregates, does not appear to have had any great effect on asset prices in most of the countries.

¹⁷ One of the paper’s evaluator drew attention to the need to control for some of the variables referred to in the previous two paragraphs, so as to take into account, for example, the heterogeneity of currency regimes across the countries, their different financial regulations, and the different degrees of their capital-account openness (potential problem of left-out-variable bias). The authors were aware of this problem, but it was not possible with the data-frequency used and the paucity of available information to build proxies for those variables. Note, however, that the problem is minimized in the estimations in two ways. First, the model is built to include endogenous-variable lags, which capture to a certain extent the effects of any left-out explanatory variables. And, second, the exogenous variables included cover the main fundamentals identified in the literature. This is corroborated empirically by the good behavior of the residuals, as shown by the different statistical tests performed.

¹⁸ These authors use both external and local variables (measures of fundamentals, financial deepening, commercial and financial openness, policy measures, etc.) to analyze transmission of the 2007-2009 crisis to stock prices in a sample of 55 countries, including this paper’s sample countries.

The results have telling implications for economic policy, for they show that local asset prices are closely related to foreign ones but they do not respond automatically, proportionally, symmetrically or unidirectionally to different external shocks. The results also show that the multipliers depend on the state of international financial markets and the “news”, and that, contrary to expectation, external shocks or announcements do not affect the countries of the region equally. Lastly, they suggest that during the past financial crisis the behavior of international investors may have undergone a structural change with respect to their decisions to invest in the region’s emerging markets.

A possible extension of this paper would consist of incorporating a number of control variables that capture the heterogeneity of the sample countries’ currency regimes, the different degrees of openness of their capital accounts, or the different policy responses to the crisis. It would then be possible to analyze in depth the reasons for such dissimilar responses from the different countries’ endogenous variables. It should be pointed out that the task might require using lower frequency data and employing a different econometric methodology to deal with the well-known problems of endogeneity. Another extension could focus on analyzing empirically whether a structural change did in fact occur during the recent international crisis, determining why it occurred, and assessing any potential future repercussions it might have, for example, on capital flows and the macroeconomic and financial stability of the countries studied. Some of the references cited in this paper put forward a number of theoretical arguments and cite empirical evidence that might serve as a basis for such a study, for example, in relation to changes in the risk valuation by international investors.

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Appendix A. Changes in macro and asset-price variables in LAC-5 countries and the USA

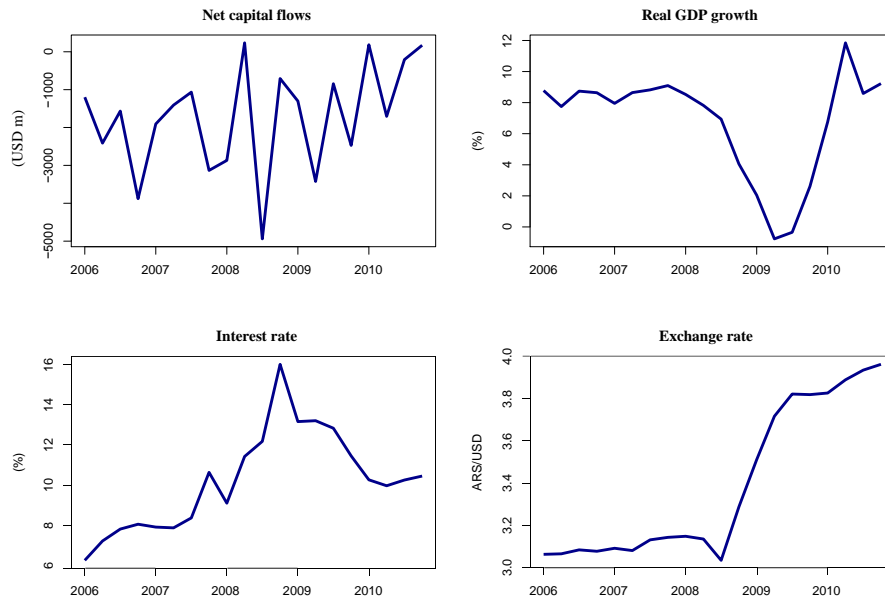


Figure A.1 Argentina. Source: International Financial Statistics, IMF.

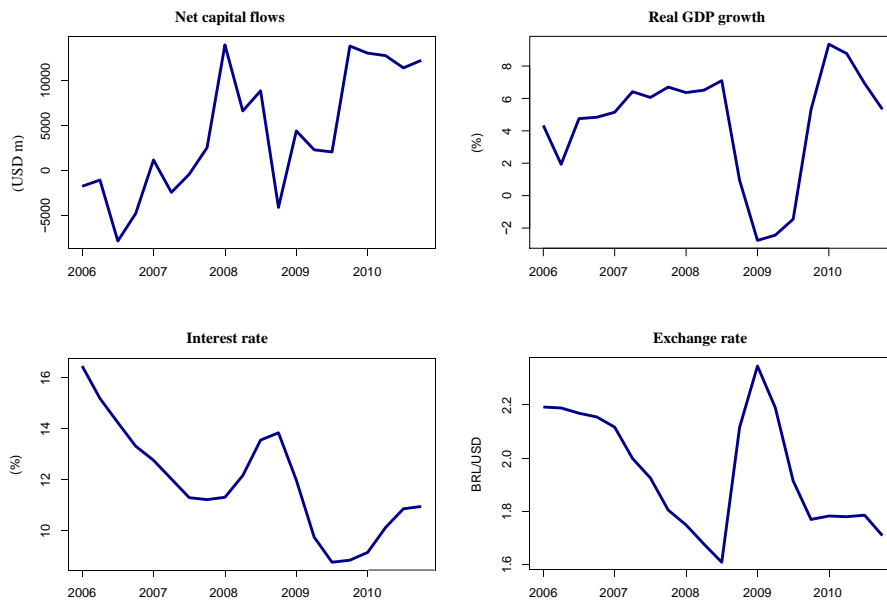


Figure A.2 Brazil. Source: International Financial Statistics, IMF.

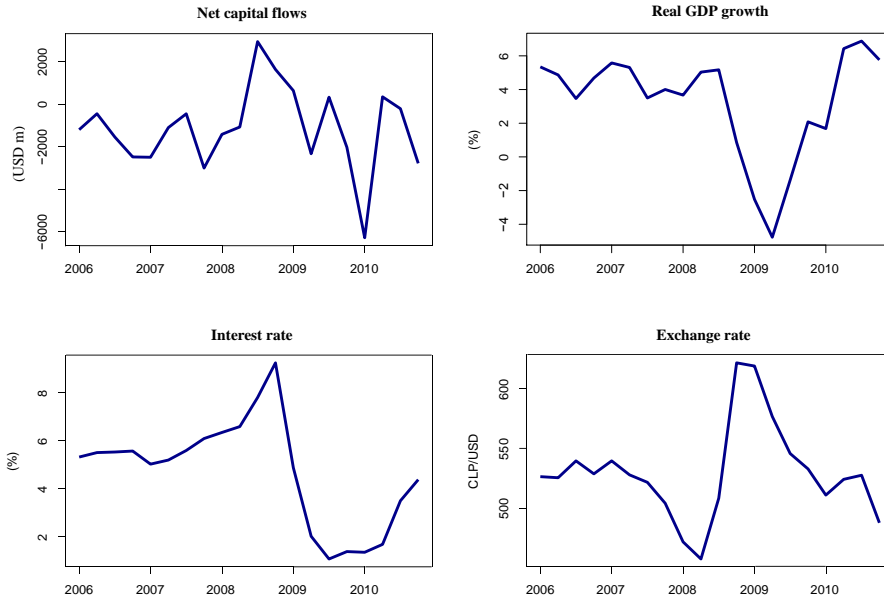


Figure A.3 Chile. Source: International Financial Statistics, IMF.

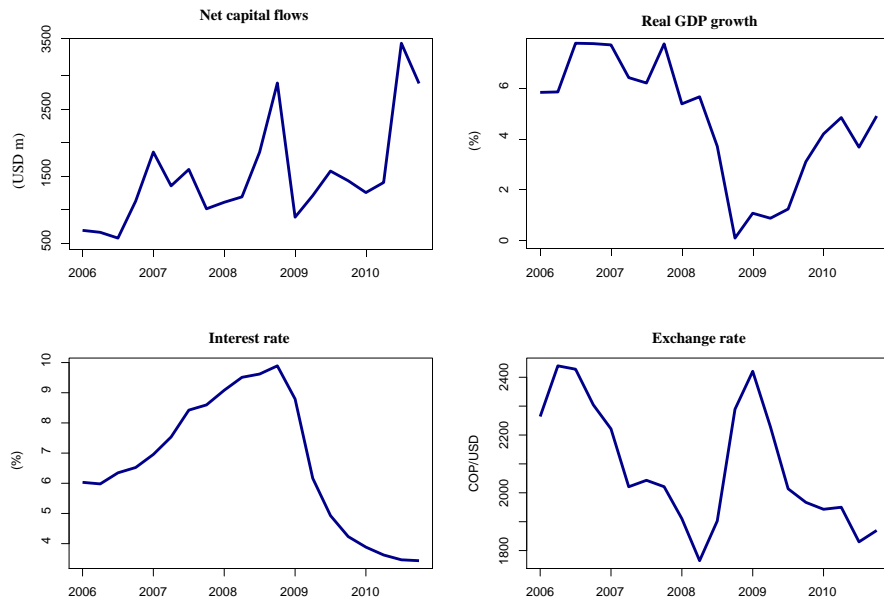


Figure A.4 Colombia. Source: International Financial Statistics, IMF.

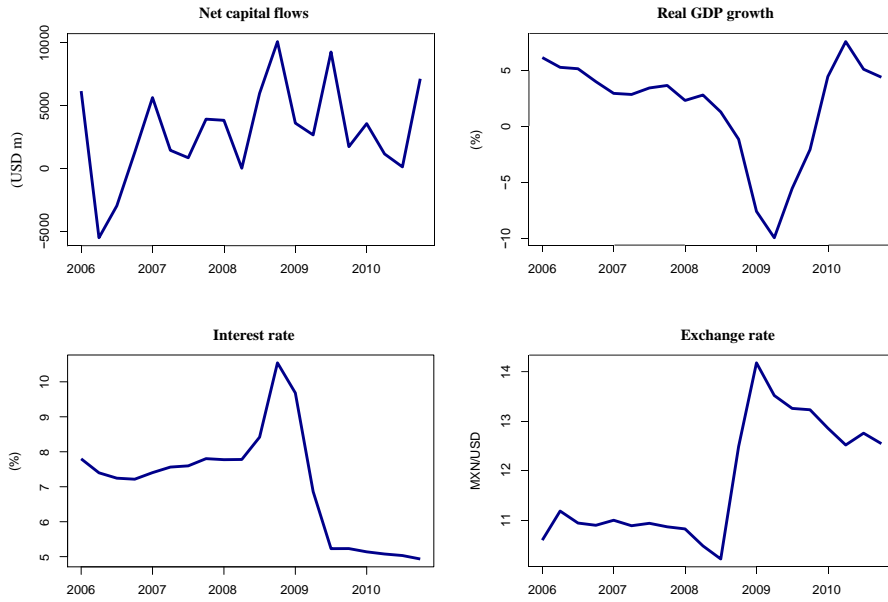


Figure A.5 Mexico. Source: International Financial Statistics, IMF.

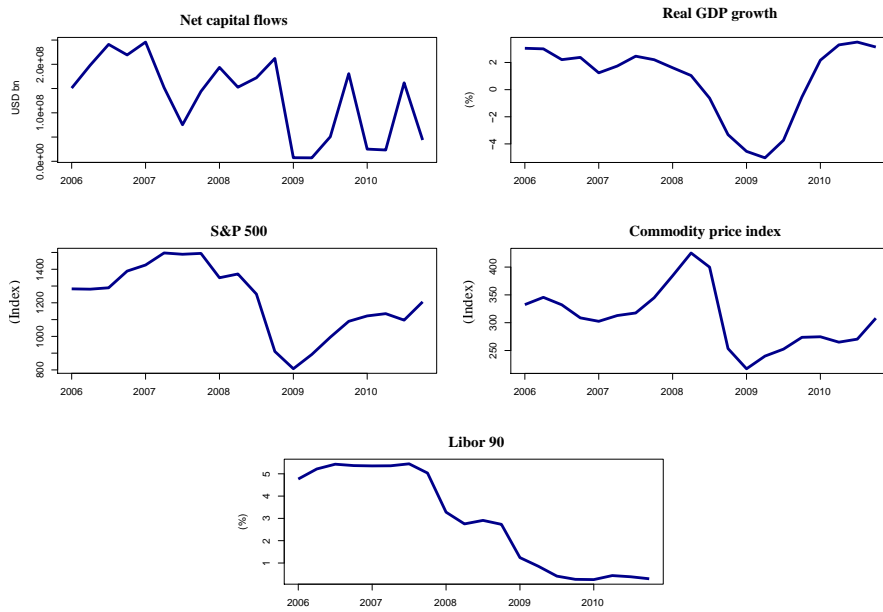


Figure A.6 Chile. Source: International Financial Statistics, IMF.

Appendix B. Dispersion charts by country

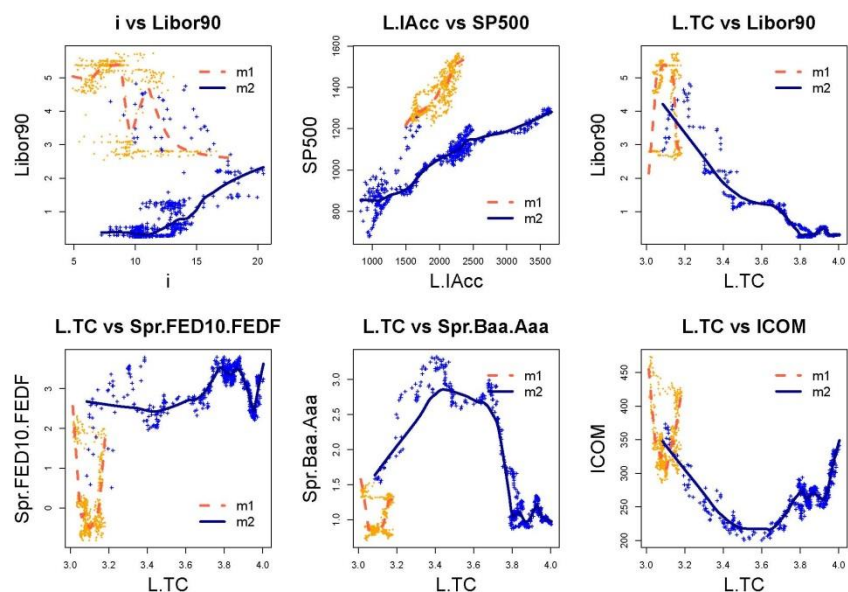


Figure B.1 Argentina. ‘m1’ denotes sample one: 3Jan2006-14Sept2008, and ‘m2’ sample two: 15Sept2008-31Jan2011. Source: Authors’ calculations.

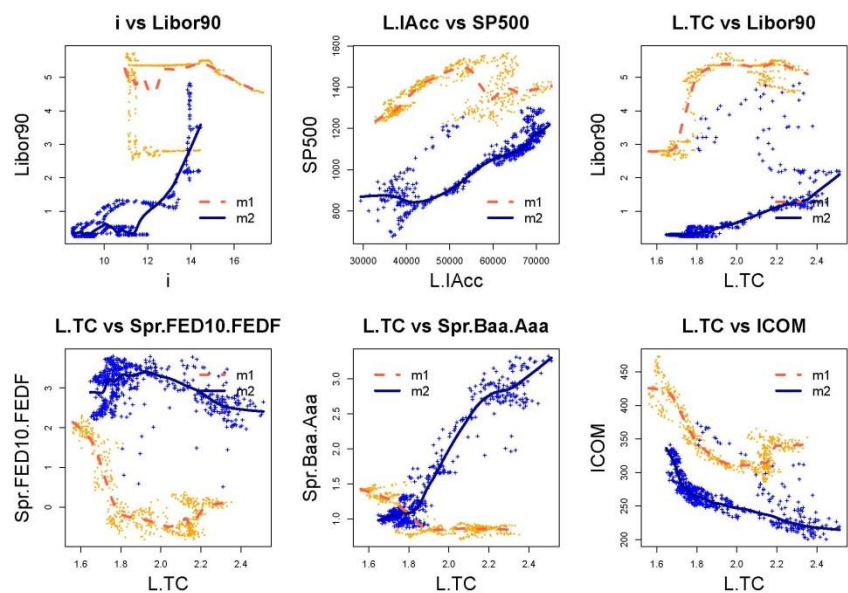


Figure B.2 Brazil. ‘m1’ denotes sample one: 3Jan2006-14Sept2008, and ‘m2’ sample two: 15Sept2008-31Jan2011. Source: Authors’ calculations.

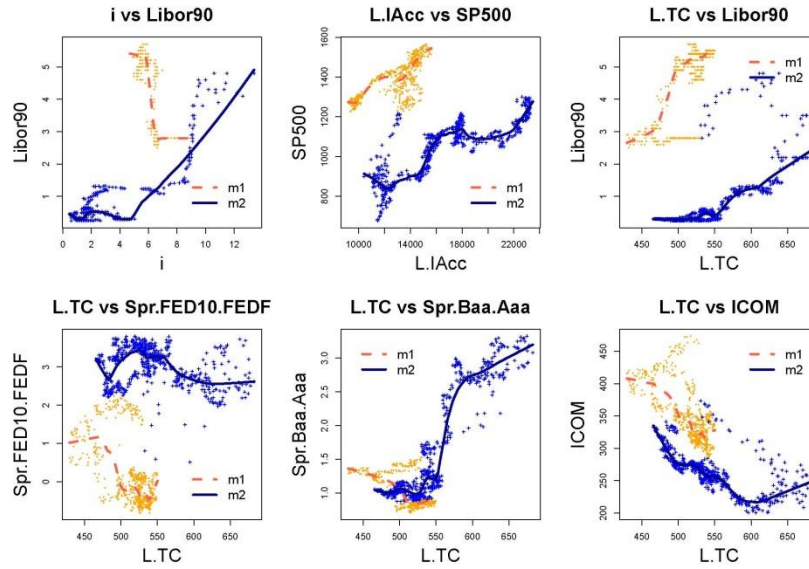


Figure B.3 Chile. ‘m1’ denotes sample one: 3Jan2006-14Sept2008, and ‘m2’ sample two: 15Sept2008-31Jan2011. Source: Authors’ calculations.

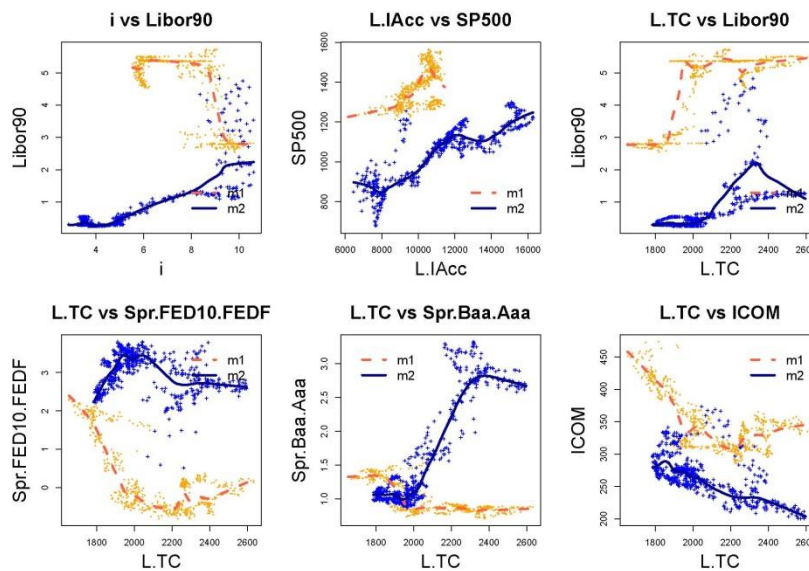


Figure B.4 Colombia. ‘m1’ denotes sample one: 3Jan2006-14Sept2008, and ‘m2’ sample two: 15Sept2008-31Jan2011. Source: Authors’ calculations.

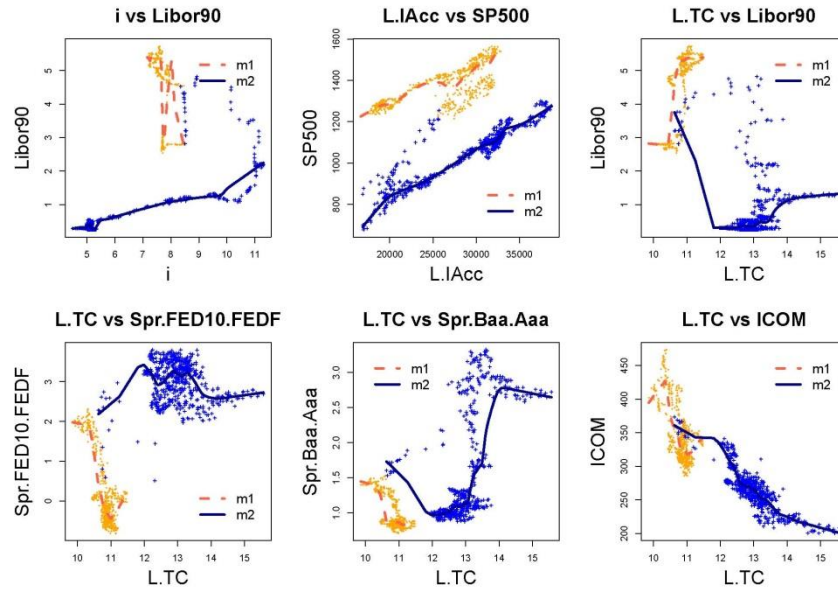


Figure B.5 Mexico. ‘m1’ denotes sample one: 3Jan2006-14Sept2008, and ‘m2’ sample two: 15Sept2008-31Jan2011. Source: Authors’ calculations.

Appendix C. Definitions and sources of the variables used in the model

| Variable | Definition and source |
|-----------------------|---|
| i.Arg | Argentina: interest rate on savings-account deposits in pesos and in dollars for a term of over 60 days. Source: Bloomberg (ARDRT90P Index) |
| i.Bra | Brazil: interest rate on three-month certificates of deposit. Source: Bloomberg (BCCDBCE Currency) |
| i.Chi | Chile: the average weighted interest rate offered in one day for deposits with a term of 90 to 365 days. Source: Bloomberg (CTIPBN90 Index) |
| i.Col | Colombia: interest rate on 90-day certificates of deposit. Source: Bloomberg (COMM90D Index) |
| i.Mex | Mexico: 90-day deposit rate offered by commercial banks to the public. Source: Bloomberg (MXDR90D Index) |
| ISt.Arg | Buenos Aires Stock Market Index. Source: Bloomberg (MERVAL Index) |
| ISt.Bra | Sao Paulo Stock Exchange Index. Source: Bloomberg (IBOV index) |
| ISt.Chi | Santiago de Chile General Commercial Exchange Stock Price Index. Source: Bloomberg (IGPA Index) |
| ISt.Col | Colombia General Stock Exchange Index. Source: Bloomberg (IGBC Index) |
| ISt.Mex | Mexico Stock Exchange Index. Source: Bloomberg (MEXBOL Index) |
| Spr.LIBOR.OIS | Spread between the 3-month LIBOR rate and the 3-month Overnight Indexed Swap (OIS) rate. Source: Bloomberg (USSOC Currency) |
| Spr.FED10.FEDF | Spread between the 10-year Treasury rate and the Federal Fund rate. Source: Federal Reserve |
| Spread.Baa.aaa | Spread between Moody's Baa and Aaa investment grade corporate bond index rates. Source: Federal Reserve Bank of St. Louis |
| Libor90 | London Interbank Offered Rate for 90-day loans. Source: Bloomberg (US0003M Index) |
| SP500 | Stand & Poor's 500 Index. Source: Bloomberg (SPX Index) |
| ICOM | Arithmetic average of commodity futures prices with monthly rebalancing. Source: Bloomberg (CRY Index) |
| VIX | Chicago options market volatility index. Source: Bloomberg (VIX Index) |
| ER.Arg | Argentine peso / dollar exchange rate. Source: Bloomberg (ARS Currency) |
| ER.Bra | Brazilian real / dollar exchange rate. Source: Bloomberg (BRL Currency) |
| ER.Chi | Chilean peso / dollar exchange rate. Source: Bloomberg (CLP Currency) |
| ER.Col | Colombian peso / dollar exchange rate. Source: Bloomberg (COP Currency) |
| ER.Mex | Mexican peso / dollar exchange rate. Source: Bloomberg (MXN Currency) |

Source: Authors' compilation.

Appendix D. Construction of “news” variables

The news variables are built to measure the macroeconomics events that occurred or the policy decisions that were taken by the US authorities in connection with the 2007-2009

crisis. This paper follows the methodology of Dooley and Hutchison (2009) and builds 11 categories (11 “news” variables) based on the timelines of the Federal Reserve Banks of St. Louis and New York and Bloomberg. Some of these categories are the same as those defined by Dooley and Hutchison, but others were built and further sources of information were used to add new categories. The “news” variables are:

WD: Announcements of write-downs of US financial institutions’ assets.

BR: Bankruptcy or forced merger of US financial institutions.

CRD: Adverse news from US credit markets.

FSD: Expansion of Federal Reserve Swap lines to industrialized countries.

FSE: Expansion of Federal Reserve Swap lines with emerging economies.

L-B: Announcement of Lehman Brothers’ bankruptcy.

TARP_CANCEL: Announcement by the US Treasury that Troubled Assets Relief Program (TARP) funds would not be used to buy mortgage assets.

EGA: Announcements to boost US economic growth.

IG: Increase in guarantees on bank liabilities.

MP-I: Monetary-policy decisions by the Fed in connection with the interest rate.

MP-A: Monetary-policy decisions connected with monetary aggregates (“balance-sheet operations”).

The methodology consists of building dummy-type variables for each category. Thus, each announcement of the respective category is assigned a one, so that at the end the series will have a given number of ones and zeros. News items released on weekends or holidays are moved forward to the following working day. For example, news items dated February 17, 2008 (a Sunday) on the St. Louis Fed’s timeline is classified as dated February 18, 2008. Table D.1 presents one example for each of the “news” variables defined above.

| Event | Definition of the event | Example: date and description |
|--------------------|--|--|
| WD | Announcements of write-downs of US financial institutions' assets | <i>Jan. 16, 2009</i> "Merrill Lynch posts a fourth-quarter net loss of \$15.3 billion and Bank of America reports a fourth-quarter loss of \$1.79 billion" |
| BR | Bankruptcy or merger of US financial institutions | <i>July 11, 2008</i> "IndyMac Bancorp Inc., the second-biggest independent U.S. mortgage lender, is seized by federal regulators after a run by depositors depleted its cash". |
| CRD | Adverse news from US credit markets | <i>Nov. 19, 2008</i> "Credit markets from commercial mortgages to junk bonds fall to record lows. The average yield on high-yield, high-risk debt rises beyond 20 percent for the first time in two decades". |
| FSD | Expansion of Federal Reserve Swap lines to industrial countries | <i>July 30, 2008</i> "The FOMC increases its swap line with the ECB to \$55 billion". |
| FSE | Expansion of Federal Reserve Swap lines with emerging markets | <i>October 29, 2008</i> "The FOMC also establishes swap lines with the Banco Central do Brasil, Banco de Mexico, Bank of Korea, and the Monetary Authority of Singapore for up to \$30 billion each". |
| L-B | Announcement of Lehman Brothers' bankruptcy | <i>Sept. 15, 2008</i> "Lehman Brothers Holdings Inc. files the largest bankruptcy in history". |
| TARP_CANCEL | Announcement by the US Treasury that Troubled Assets Relief Program (TARP) funds would not be used to buy mortgage assets. | <i>November 12, 2008</i> "U.S. Treasury Secretary Paulson formally announces that the Treasury has decided not to use TARP funds to purchase illiquid mortgage-related assets from financial institutions". |
| EGA | Announcements to boost US economic growth | <i>February 17, 2009</i> "President Obama signs into law the "American Recovery and Reinvestment Act of 2009", which includes a variety of spending measures and tax cuts intended to promote economic recovery". |
| IG | Increase in guarantees on bank liabilities | <i>October 7, 2008</i> "The FDIC announces an increase in deposit insurance coverage to \$250,000 per depositor as authorized by the Emergency Economic Stabilization Act of 2008". |
| MP-I | Monetary-policy decisions connected with the interest rate. | <i>June 28, 2007</i> "The Federal Open Market Committee (FOMC) votes to maintain its target for the federal funds rate at 5.25 percent". |
| MP-A | Monetary-policy decisions connected with monetary aggregates (balance-sheet operations) | <i>October 28, 2008</i> "The U.S. Treasury Department purchases a total of \$125 billion in preferred stock in nine U.S. banks under the Capital Purchase Program". |

Source: Table prepared by the authors on the basis of timelines from the Federal Reserve Banks of St. Louis and New York and Bloomberg. The variables "WD" to "TARP_CANCEL" follow the definitions of Dooley and Hutchison (2009) but do not contain the same information.

Table D.1 News categories and examples

Appendix E. Diagnostic tests

| Country | Standardized residuals | | Standardized residuals squared | |
|-----------|------------------------|---------|--------------------------------|---------|
| | Statistic | P-value | Statistic | P-value |
| Argentina | 1478,779 | 0.475 | 1558,571 | 0.066 |
| Brazil | 1528,529 | 0.261 | 1392,287 | 0.971 |
| Chile | 1508,696 | 0.390 | 1409,717 | 0.941 |
| Colombia | 1375,990 | 0.848 | 1527,246 | 0.038 |
| Mexico | 1469,548 | 0.779 | 1404,927 | 0.976 |

Source: Authors' calculations.

Table E.1 Q-test on standardized residuals of the VARX-MGARCH model for the LAC-5 countries in the period 3Jan2006-14Sept2008.

| Country | Standardized residuals | | Standardized residuals squared | |
|-----------|------------------------|---------|--------------------------------|---------|
| | Statistic | P-value | Statistic | P-value |
| Argentina | 1335,035 | 0.403 | 1215,012 | 0.984 |
| Brazil | 1345,032 | 0.396 | 1333,017 | 0.487 |
| Chile | 1245,269 | 0.956 | 939,211 | 0.998 |
| Colombia | 1243,755 | 0.848 | 1205,080 | 0.965 |
| Mexico | 1162,051 | 0.998 | 1211,695 | 0.979 |

Source: Authors' calculations.

Table E.2 Q-test on standardized residuals of the VARX-MGARCH model for the LAC-5 countries in the period 15Sept2008-31Jan2011.

| Country | Maximum eigenvalue | |
|-----------|--------------------|--------|
| | VAR | MGARCH |
| Argentina | 0.860 | 0.986 |
| Brazil | 0.922 | 0.994 |
| Chile | 0.737 | 0.994 |
| Colombia | 0.950 | 0.999 |
| México | 0.045 | 0.990 |

Source: Authors' calculations.

Table E.3 Eigenvalues of the VARX-MGARCH model for the LAC-5 countries in the period 3Jan2006 – 14Sept2008.

| Country | Maximum eigenvalue | |
|-----------|--------------------|--------|
| | VAR | MGARCH |
| Argentina | 0.649 | 0.995 |
| Brazil | 0.556 | 0.983 |
| Chile | 0.508 | 0.971 |
| Colombia | 0.792 | 0.991 |
| México | 0.881 | 0.986 |

Source: Authors' calculations.

Table E.4 Eigenvalues of the VARX-MGARCH model for the LAC-5 countries in the period 15Sept2008 – 31Jan2011.

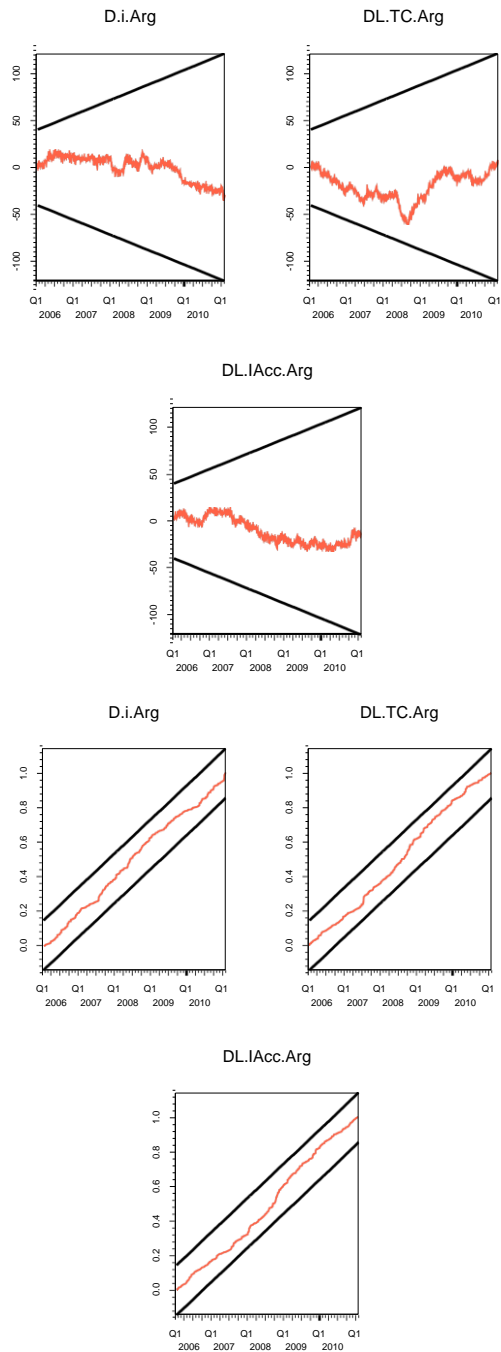


Figure E.1 Argentina: CUSUM and CUSUM-squared charts for the period 3Jan2006-31Jan2011. Source: Authors' calculations.

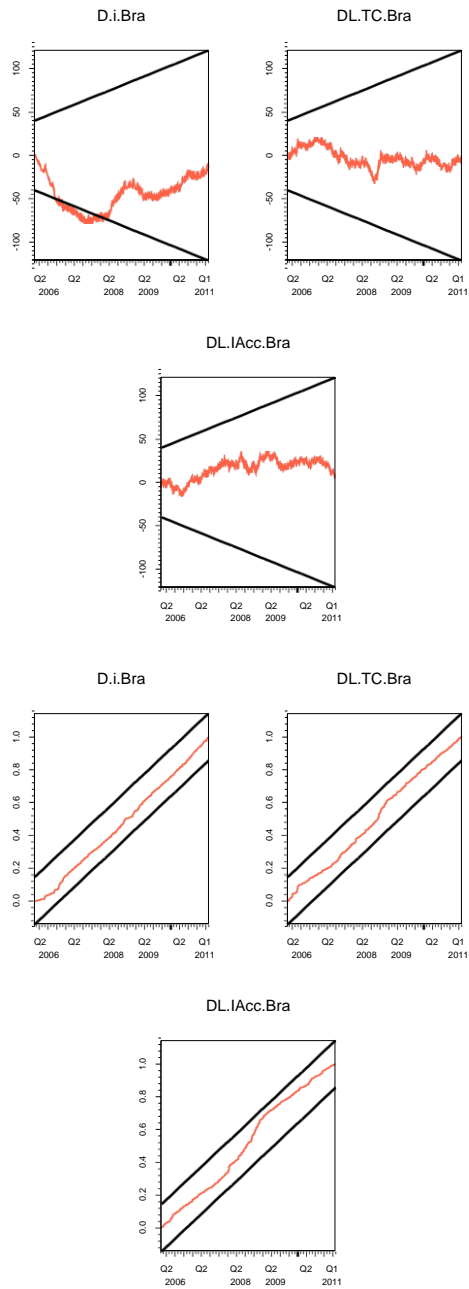


Figure E.2 Brazil: CUSUM and CUSUM-squared charts for the period 3Jan2006-31Jan2011. Source: Authors' calculations.

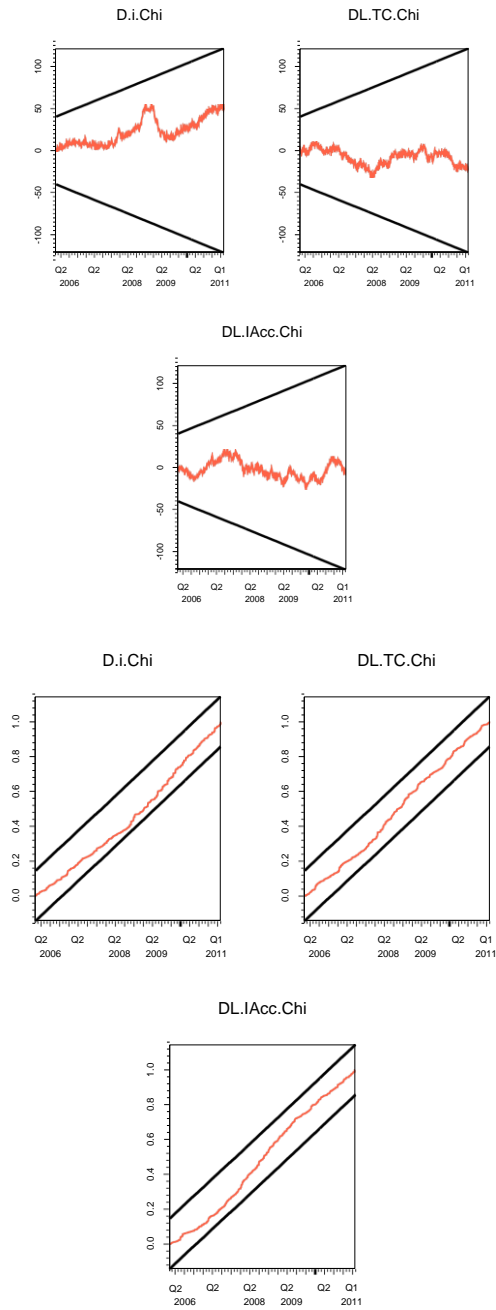


Figure E.3 Chile: CUSUM and CUSUM-squared charts for the period 3Jan2006-31Jan2011. Source: Authors' calculations.

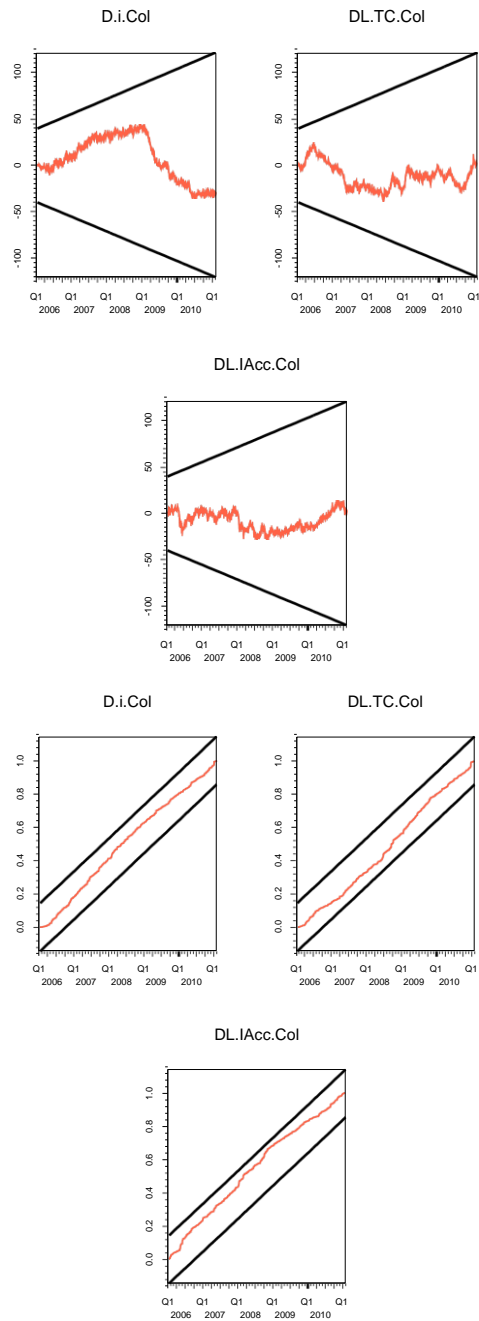


Figure E.4 Colombia: CUSUM and CUSUM-squared charts for the period 3Jan2006-31Jan2011. Source: Authors' calculations.

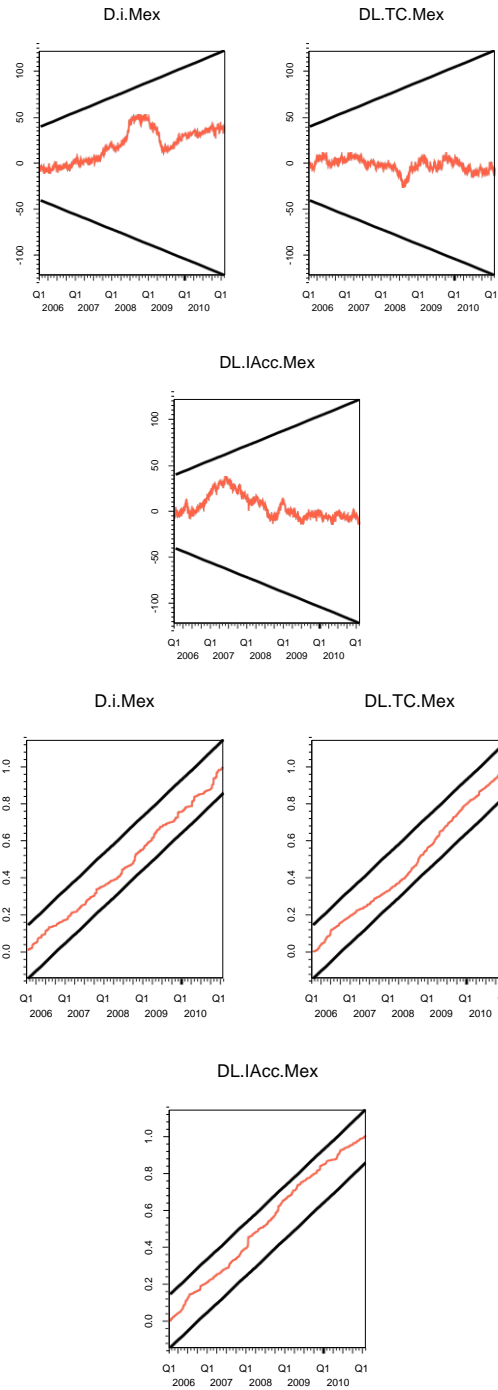


Figure E.5 Mexico: CUSUM and CUSUM-squared charts for the period 3Jan2006-31Jan2011. Source: Authors' calculations.

Appendix F. Multiplier analyses

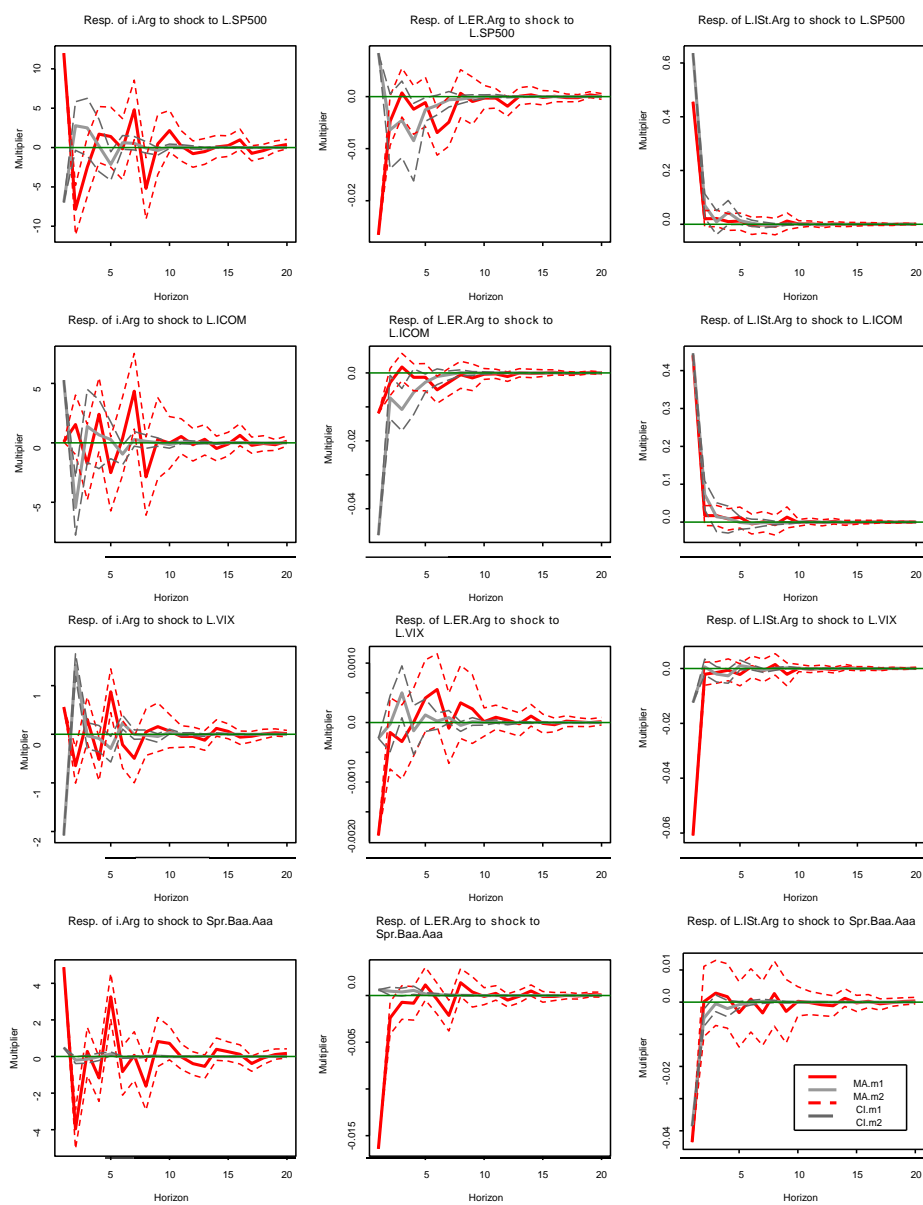


Figure F.1 Argentina. ‘m1’ denotes sample one: 3Jan2006-14Sept2008, and ‘m2’ sample two: 15Sept2008-31Jan2011. Source: Authors’ calculations.

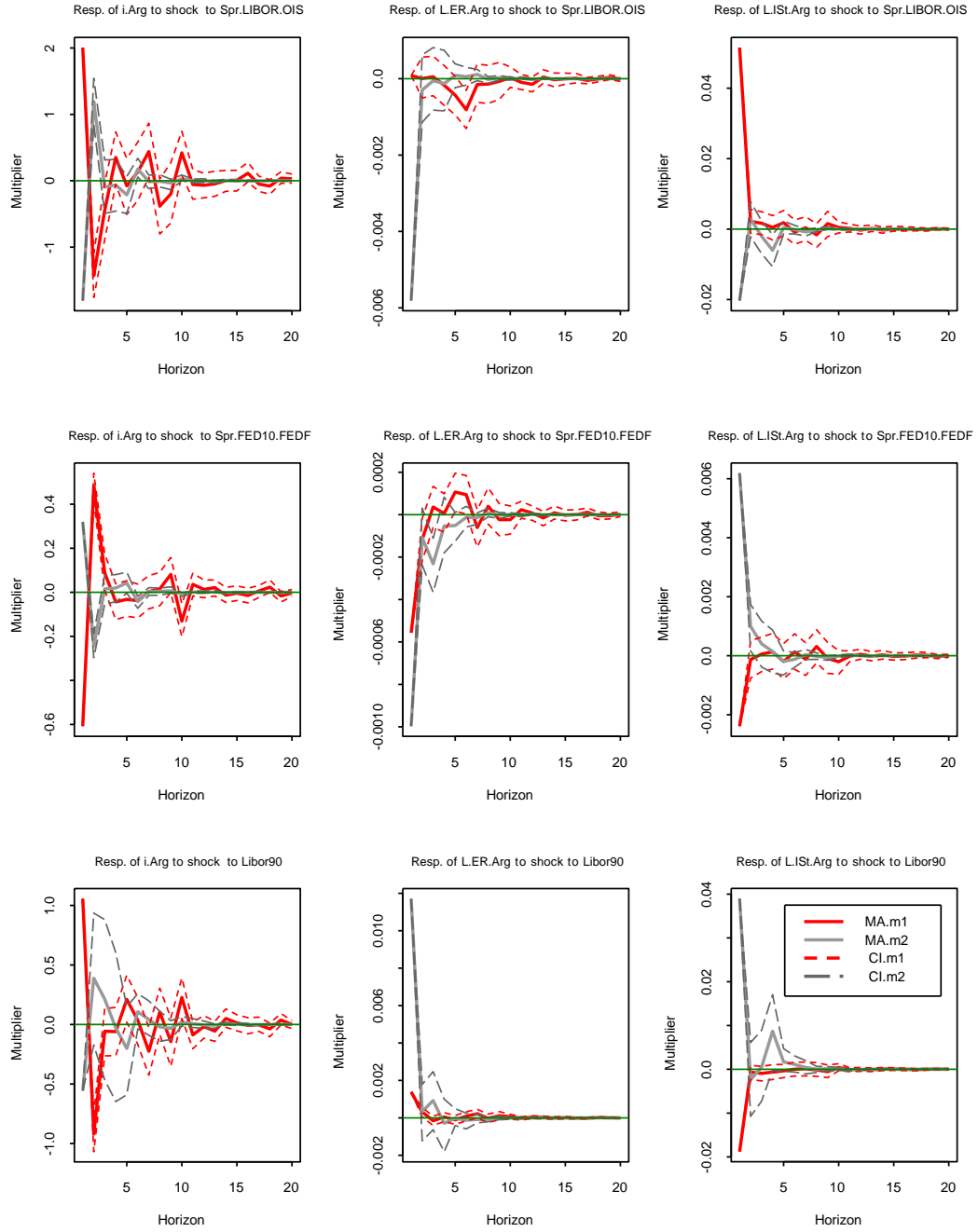


Figure F.2 Argentina (continued). Source: Authors' calculations.

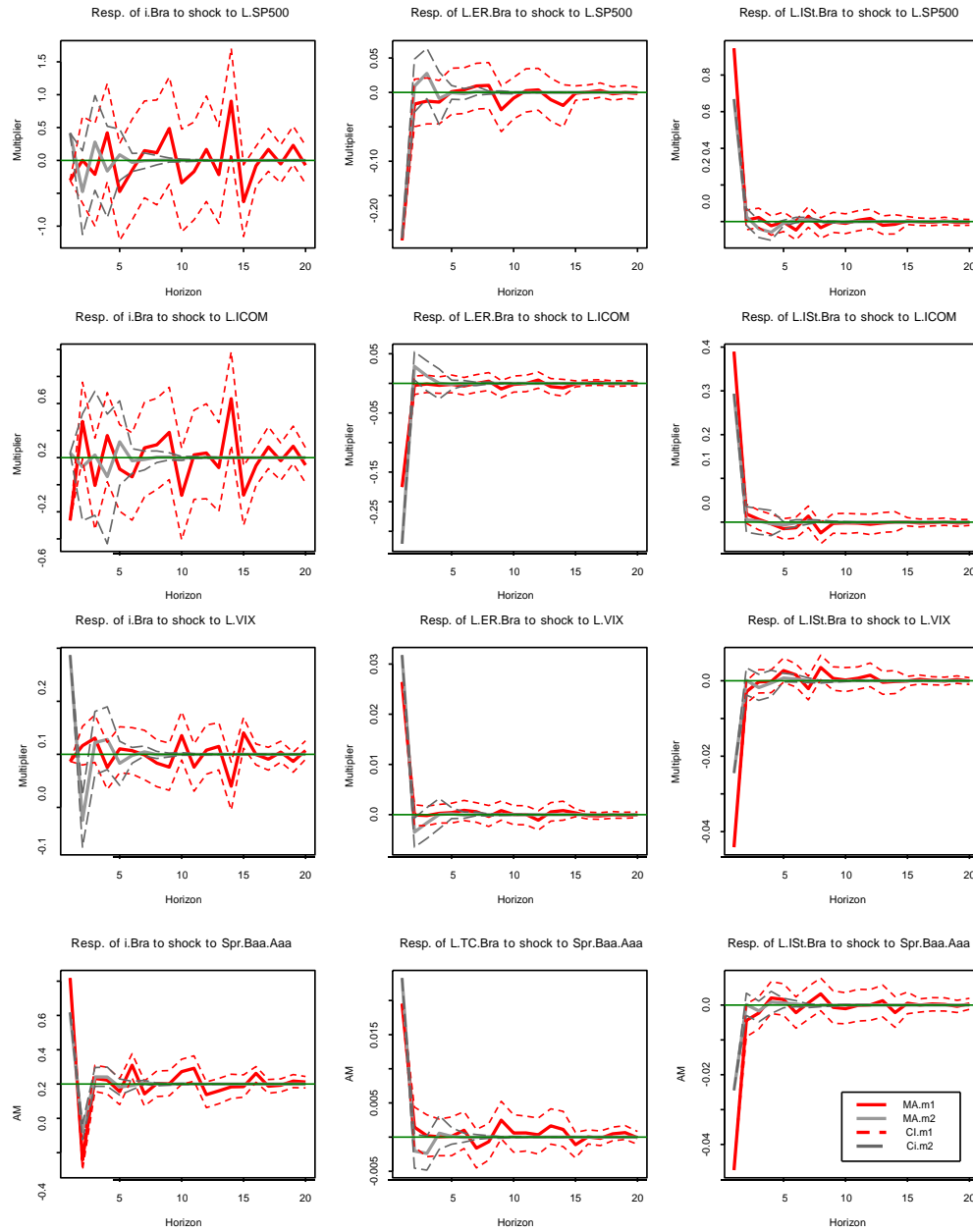


Figure F.3 Brazil. ‘m1’ denotes sample one: 3Jan2006-14Sept2008, and ‘m2’ sample two: 15Sept2008-31Jan2011. Source: Authors’ calculations.

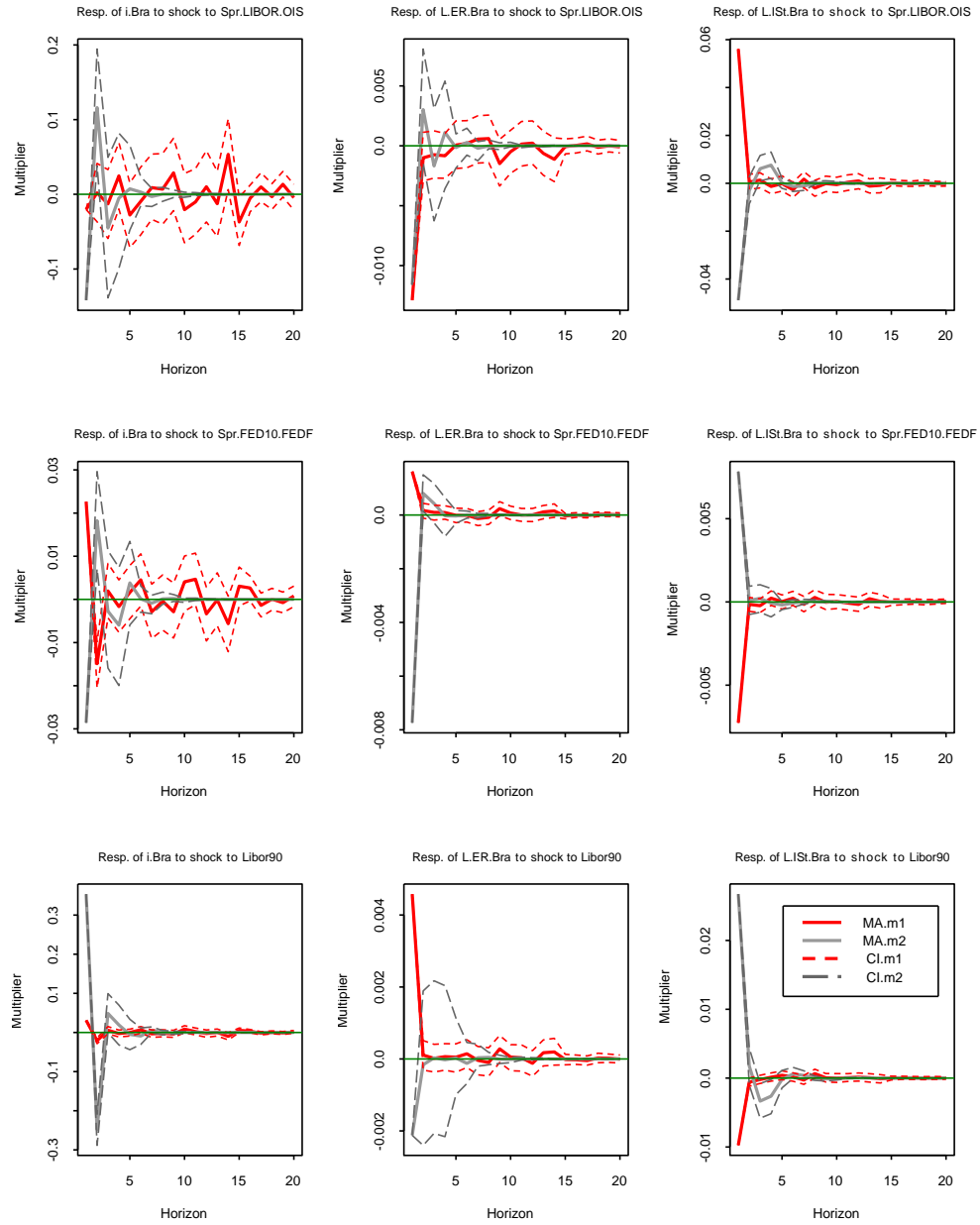


Figure F.4 Brazil (continued). Source: Authors' calculations.

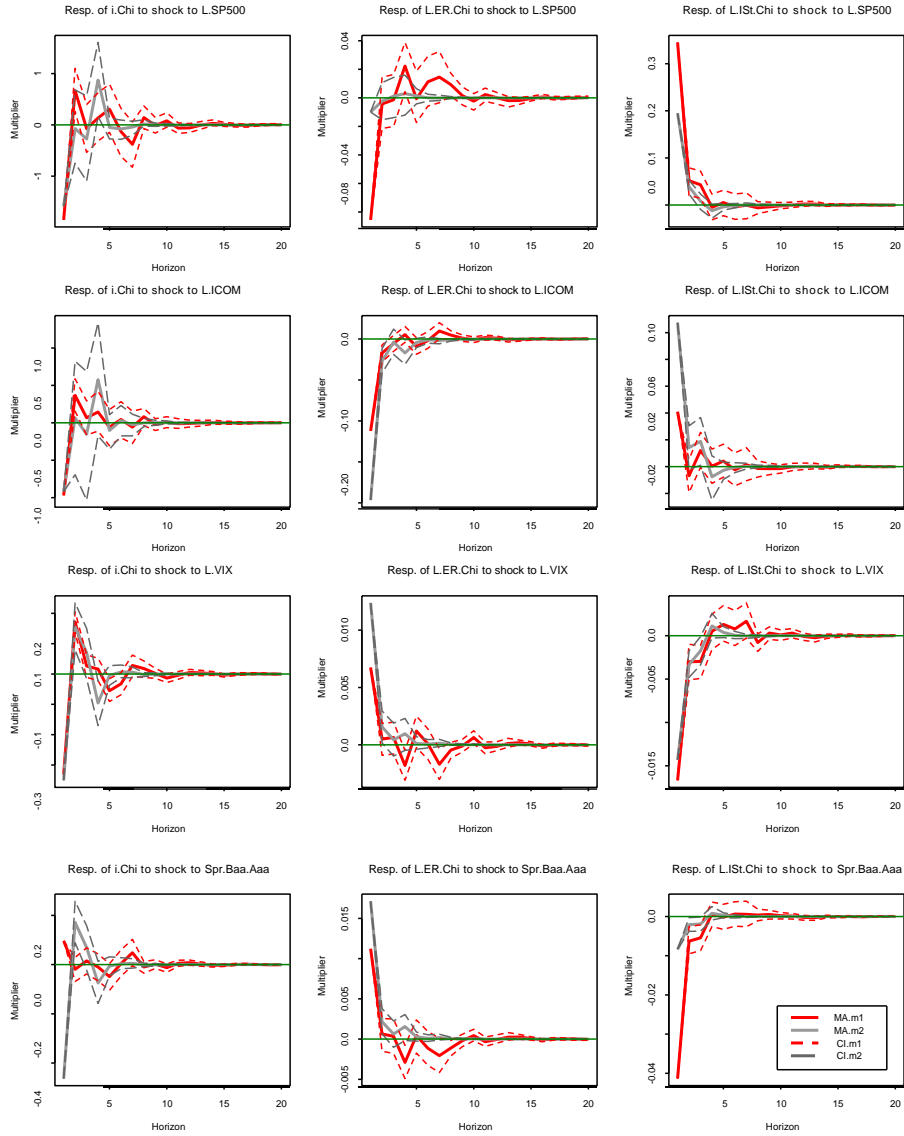


Figure F.5 Chile. ‘m1’ denotes sample one: 3Jan2006-14Sept2008, and ‘m2’ sample two: 15Sept2008-31Jan2011. Source: Authors’ calculations.

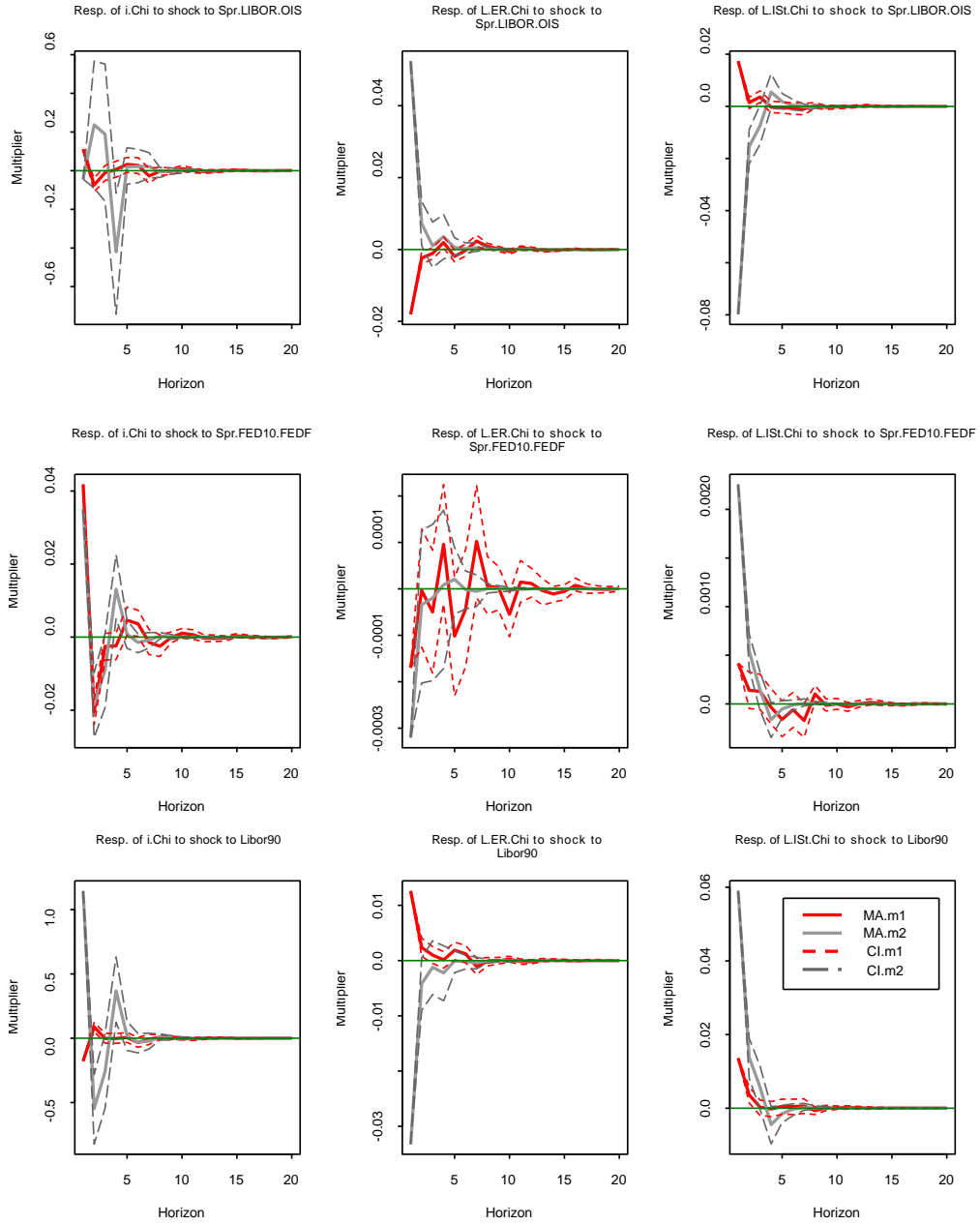


Figure F.6 Chile (continued). Source: Authors' calculations.

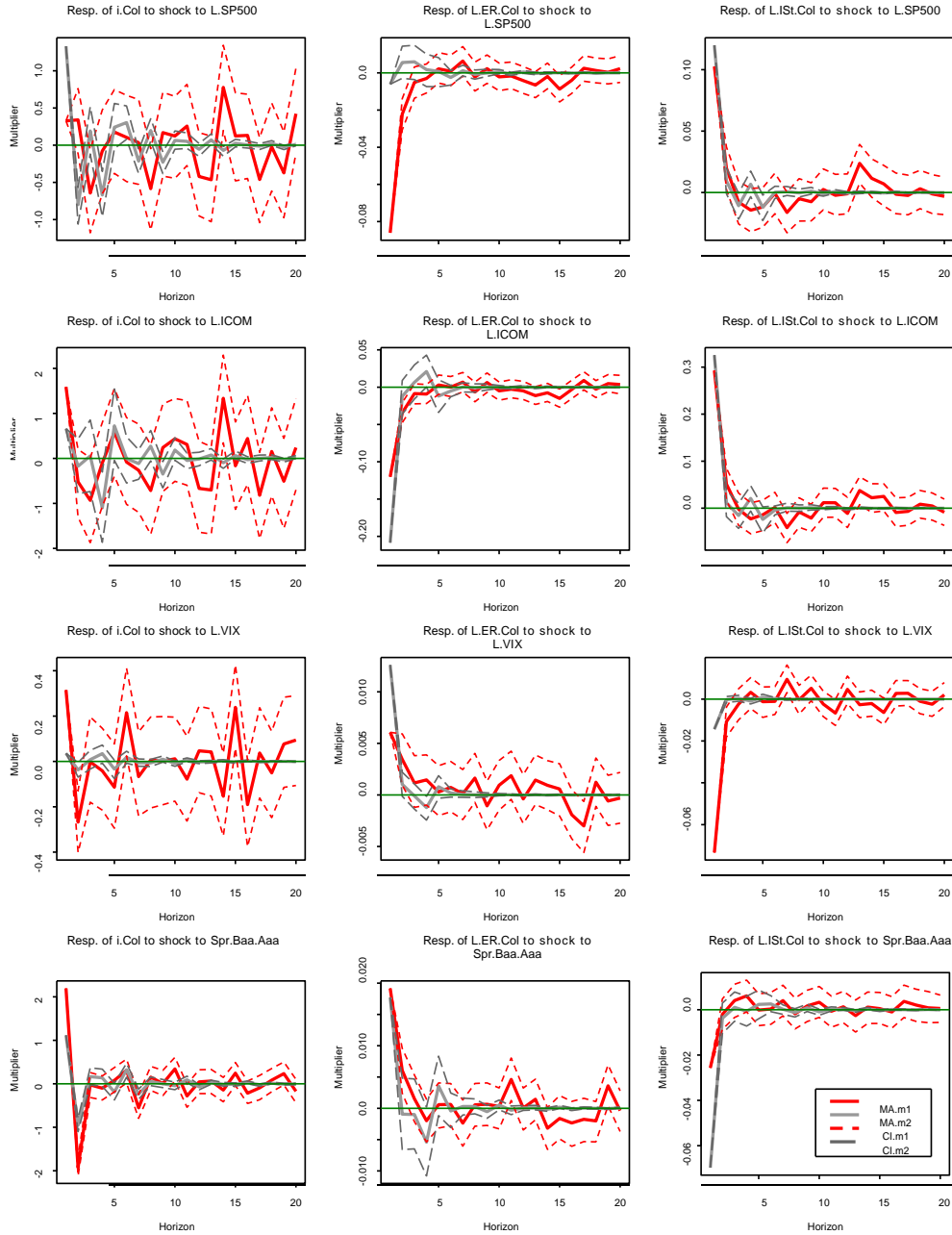


Figure F.7 Colombia. ‘m1’ denotes sample one: 3Jan2006-14Sept2008, and ‘m2’ sample two: 15Sept2008-31Jan2011. Source: Authors’ calculations.

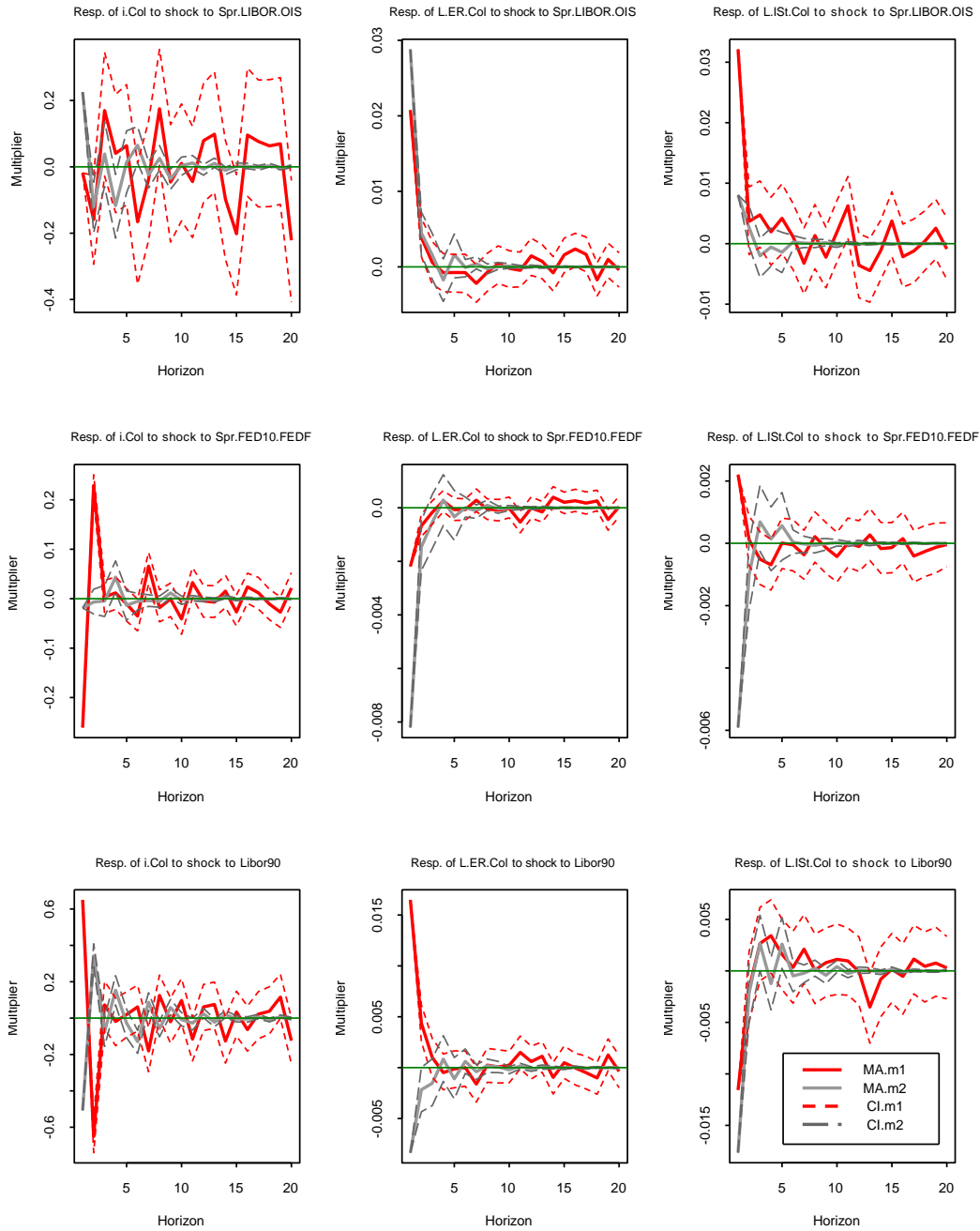


Figure F.8 Colombia (continued). Source: Authors' calculations.

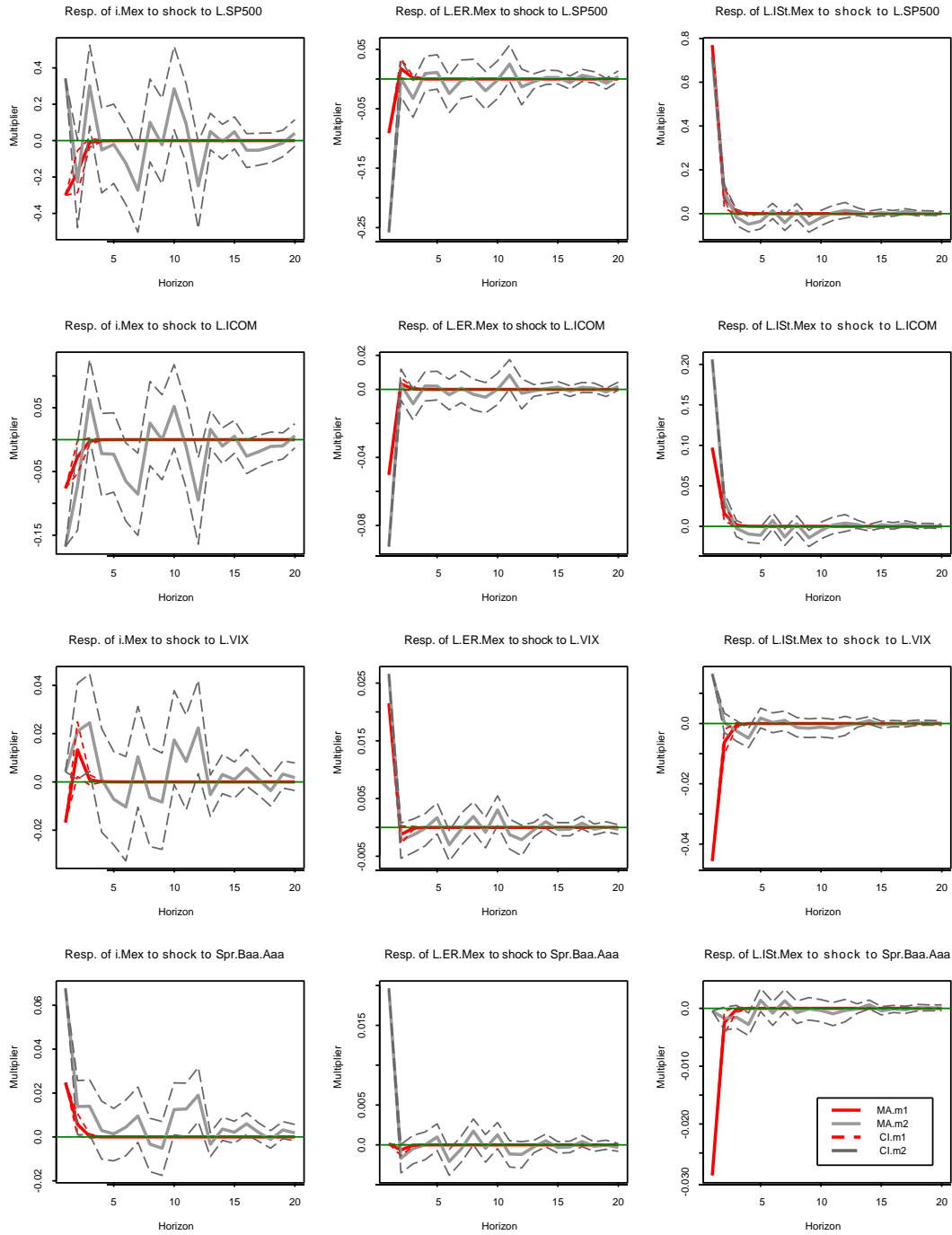


Figure F.9 Mexico. ‘m1’ denotes sample one: 3Jan2006-14Sept2008, and ‘m2’ sample two: 15Sept2008-31Jan2011. Source: Authors’ calculations.

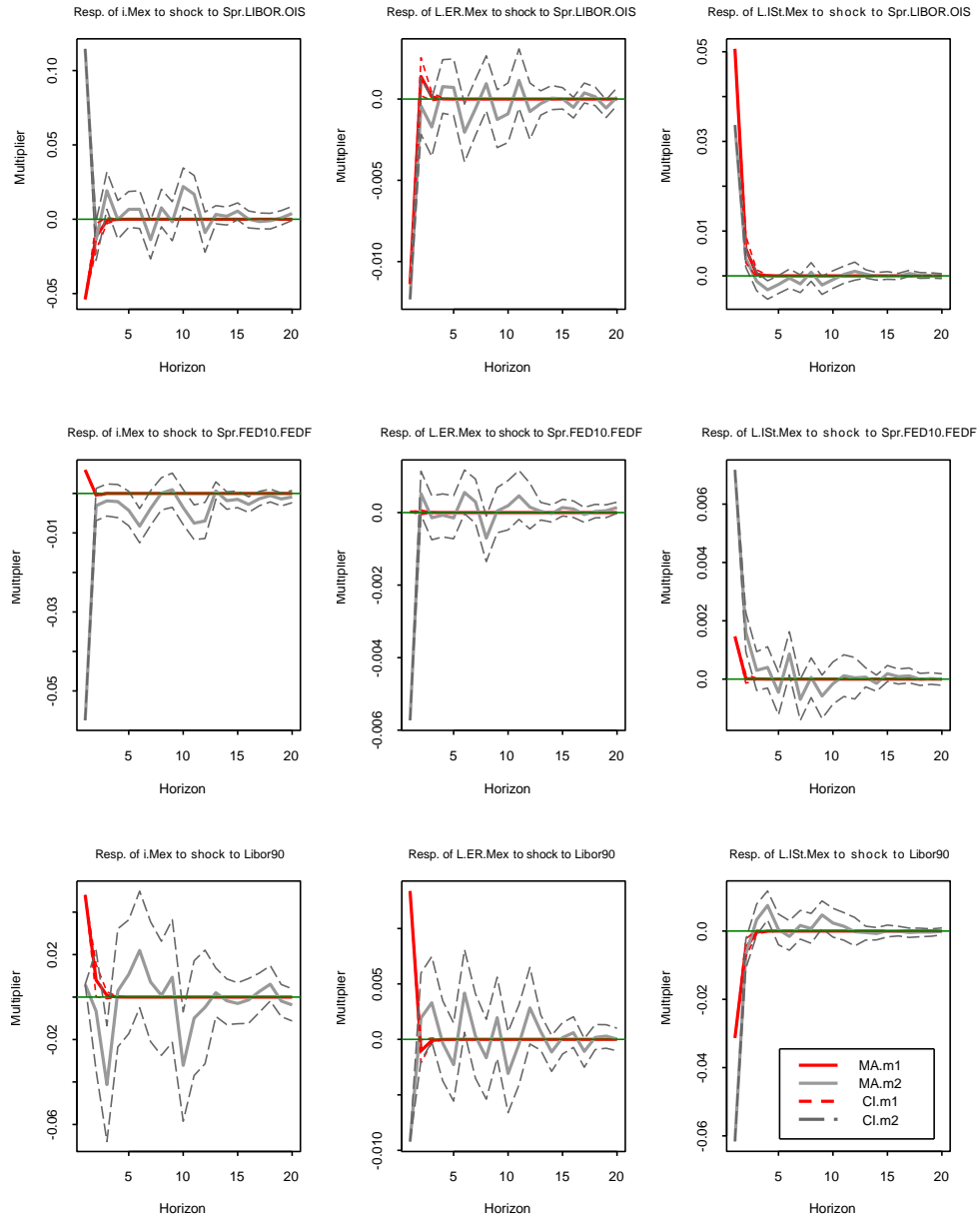


Figure F.10 Colombia (continued). Source: Authors' calculations.

Appendix G. Multiplier analysis for “news”

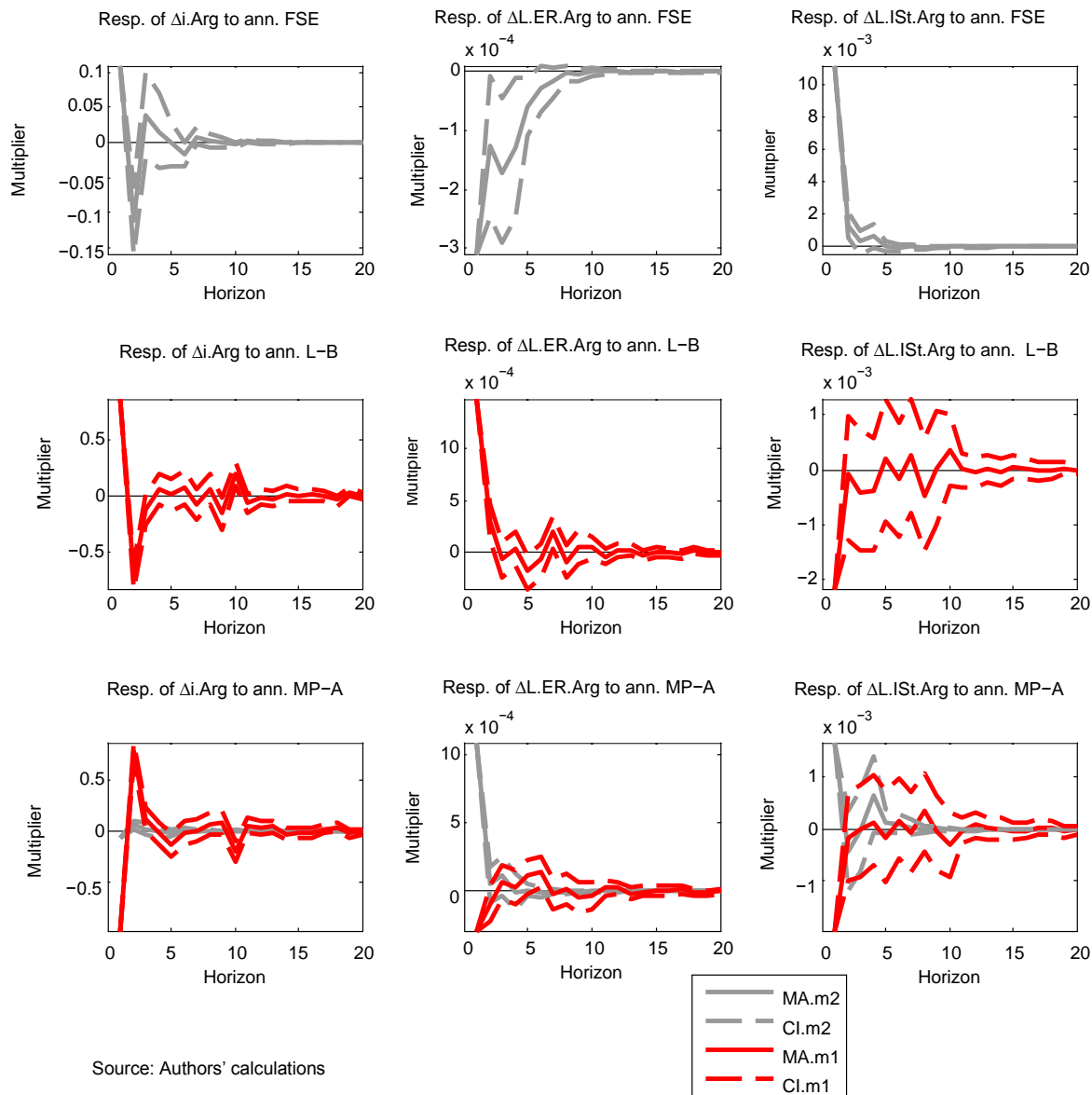


Figure G.1 Argentina. ‘m1’ denotes sample one: 3Jan2006-14Sept2008, and ‘m2’ sample two: 15Sept2008-31Jan2011. Source: Authors’ calculations.

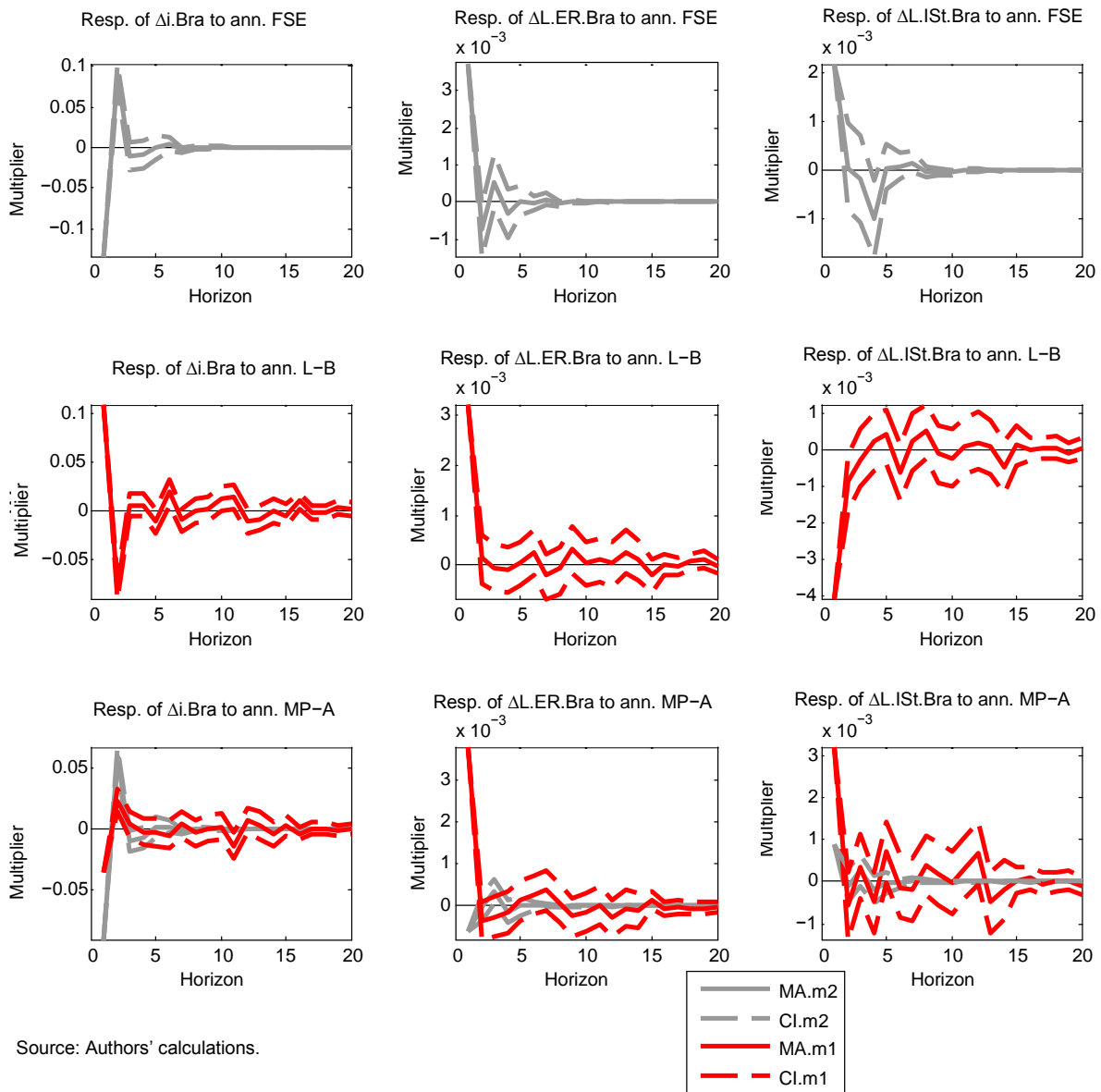


Figure G.2 Brazil. ‘m1’ denotes sample one: 3Jan2006-14Sept2008, and ‘m2’ sample two: 15Sept2008-31Jan2011. Source: Authors’ calculations.

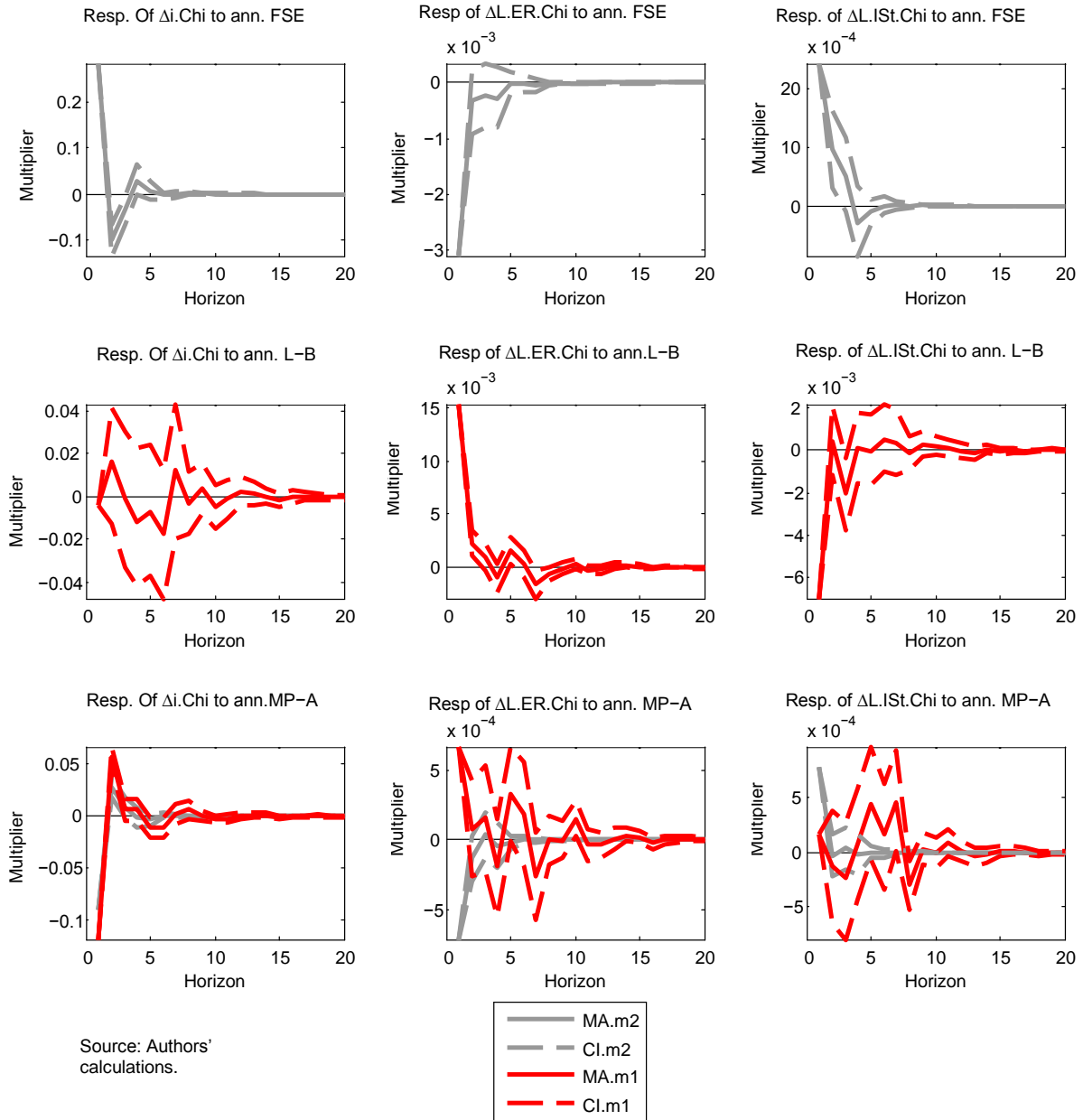


Figure G.3 Chile. 'm1' denotes sample one: 3Jan2006-14Sept2008, and 'm2' sample two: 15Sept2008-31Jan2011. Source: Authors' calculations.

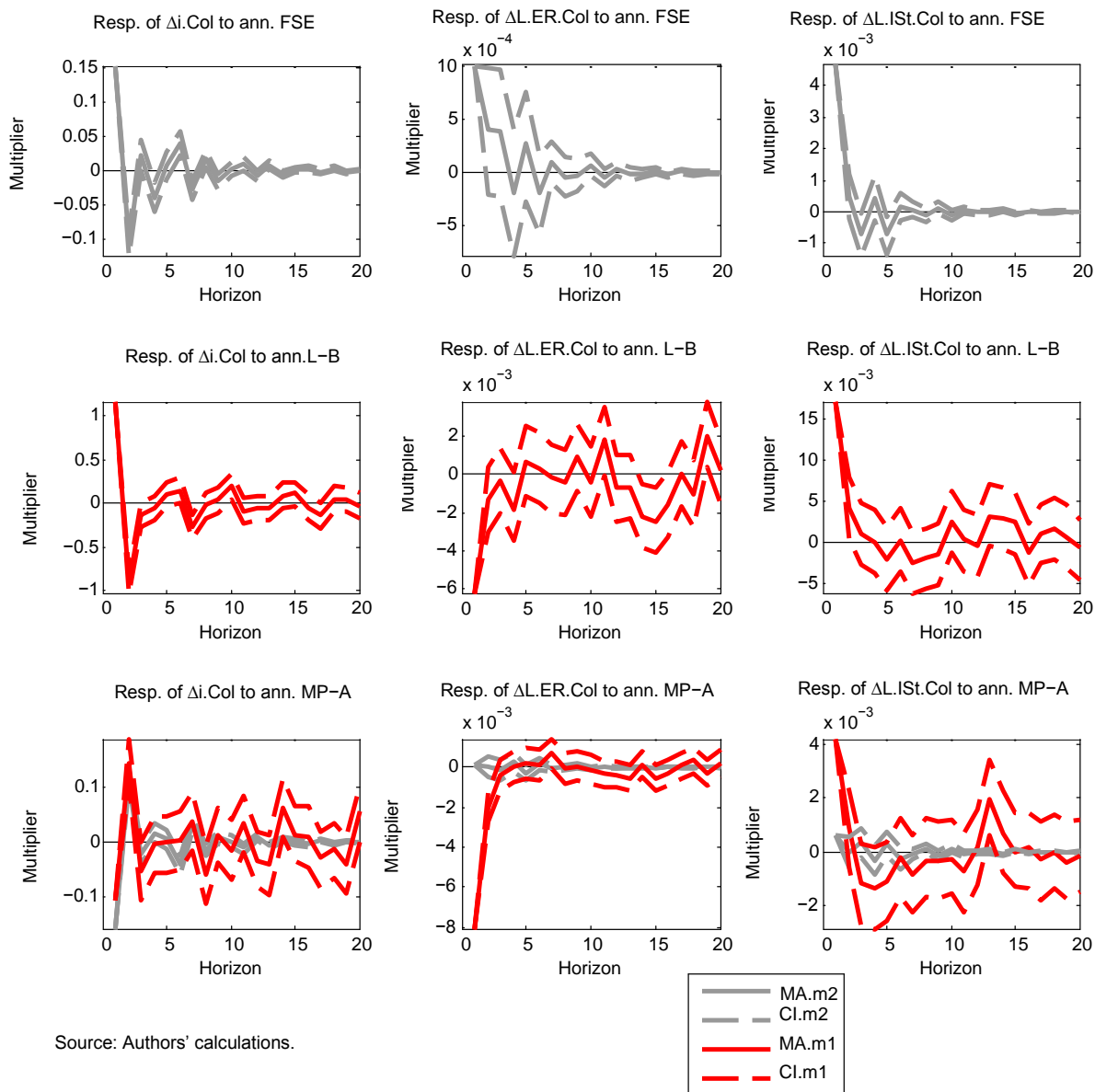


Figure G.4 Colombia. ‘m1’ denotes sample one: 3Jan2006-14Sept2008, and ‘m2’ sample two: 15Sept2008-31Jan2011. Source: Authors’ calculations.

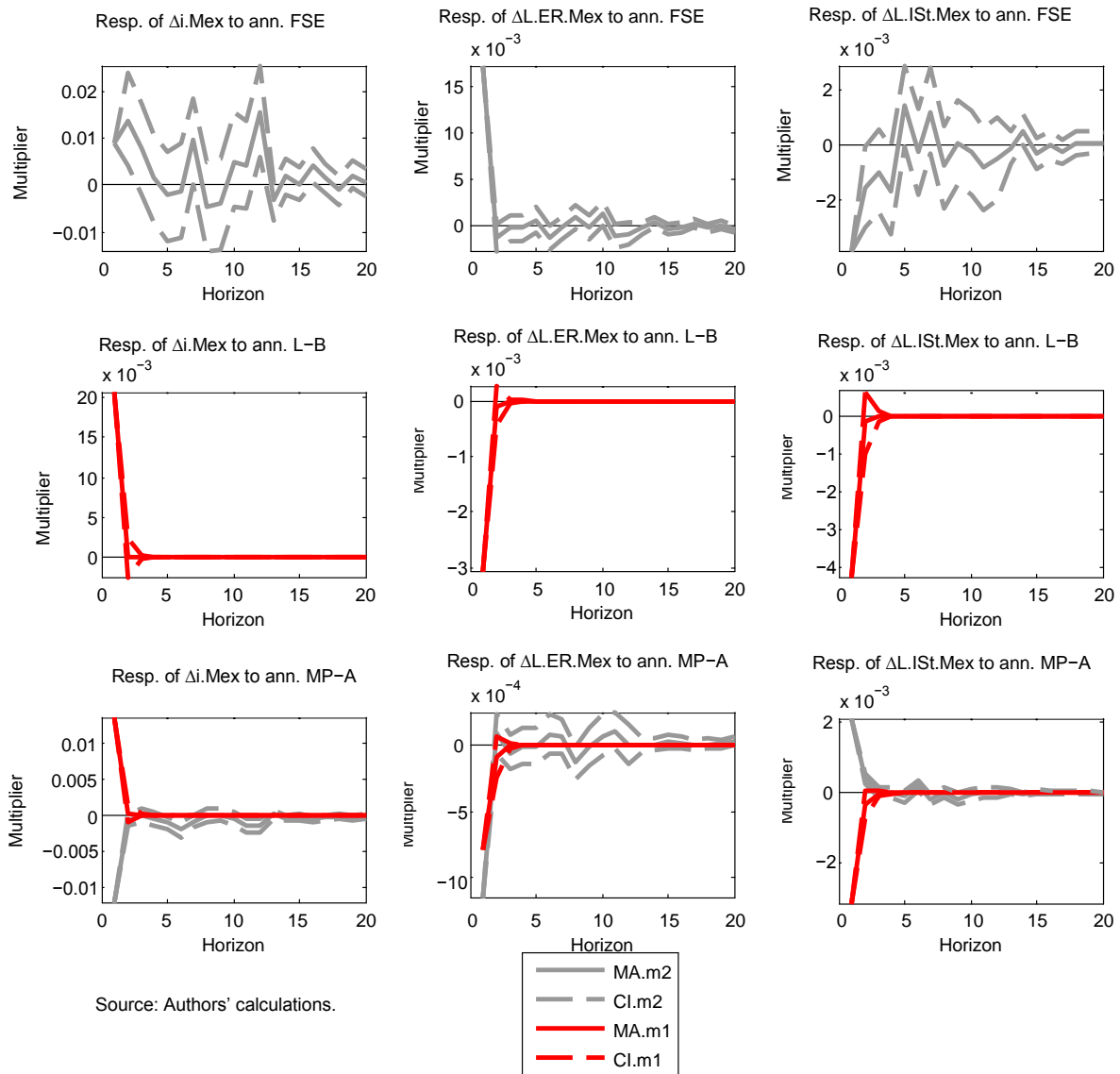


Figure G.5 Mexico. 'm1' denotes sample one: 3Jan2006-14Sept2008, and 'm2' sample two: 15Sept2008-31Jan2011. Source: Authors' calculations.