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Abstract

This paper investigates how changes in trade linkages between China, Latin America, and the rest of the world have altered the transmission of international business cycles to Latin America. Evidence based on a GVAR model for five large Latin American economies shows that the long-term impact of a China GDP shock on the typical Latin American economy has tripled since the mid-1990s, while the long-term impact of a US GDP shock has halved and the transmission of shocks to Latin America and the rest of emerging Asia GDP (excluding China and India) has not changed. These changes owe more to changes in China's impact on Latin America's traditional and largest trading partners than to increased direct bilateral trade linkages boosted by the decade-long commodity price boom. These findings have important implications for both Latin America and the international business cycle.

JEL Classification: C32, F44, E32, O54
Keywords: China, GVAR, Great Recession, Emerging Markets, International Business Cycle, Latin America, Trade linkages

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1 Introduction

As vividly illustrated by the impact of the recent global crisis on Latin America, the international business cycle is very important for the region's economic performance.[1] The world economy, however, has undergone profound structural changes over the past two to three decades because of globalization and the emergence of China, India, and other large developing economies (including Mexico and Brazil in Latin America) as global economic players. As a result, the transmission mechanisms of the international business cycle to Latin America may have changed.

This paper focuses on the emergence of China as a global force in the world economy and investigates how changes in trade patterns between China and the rest of the world may have affected the transmission of the international business cycle to Latin America. Specifically, we investigate empirically how shocks to Gross Domestic Product (GDP) in China and the United States are transmitted to Latin America conditional on alternative configurations of cross-country linkages in the world economy. We focus on China because, as we shall see, its trade linkages with Latin America and the rest of the world are those that have undergone the most dramatic shift over the period we consider. We focus on the United States because this country remains the largest trading partner of the Latin America region as a whole and, historically, has been the major source of external shocks for Latin America. To complement this analysis, we also consider a GDP shock to the Latin America region itself and to emerging Asia (excluding China and India) because the analysis of these shocks helps shed light on the ongoing debate on the "decoupling" of emerging markets' business cycle from that of advanced economies.

To conduct the empirical analysis we use a variant of the global vector autoregressive (GVAR) model originally proposed by Pesaran, Schuermann, and Weiner (2004) and further developed by Dees, di Mauro, Pesaran, and Smith (2007). This is a relatively novel approach to global macroeconomic modelling that combines time series, panel data, and factor analysis techniques, making it possible to address a wide set of issues.[2] In the first step of the methodology, each country is modeled individually as a small open economy by estimating country-specific vector error-correction models in which domestic variables are related to country-specific foreign variables as well as global variables that are common across all countries (such as the international

[1] For empirical analyses of the impact of external factors on Latin American's economic performance, see, among many other contributions, Little, Cooper, Corden, and Rajapatirana (1993), Hoffmaister and Roldos (1997), Rebucci (1998), Canova (2005), Osterholm and Zettelmeyer (2007) and Izquierdo, Romero, and Talvi (2008).

[2] The GVAR approach can be used to address a wide range of questions. For instance, Dees, di Mauro, Pesaran, and Smith (2007) study the transmission of shocks to US real equity prices, short term interest rates and oil prices on euro area. Pesaran, Schuermann, and Smith (2009a) consider the problem of forecasting economic and financial variables across a large number of countries in the global economy. Xu (2010) investigates the impact of a credit crunch in the US on advanced and emerging market economies including Asia and Latin America. Cesa-Bianchi (2012) studies the transmission of a global house price shock. Cesa-Bianchi, Powell, and Rebucci (2011) use the GVAR as a filter to identify non-fundamental movements in equity prices in the global economy.

price of oil). In the second step, a global model is constructed combining all the estimated country-specific models and linking them with a matrix of predetermined (i.e., not estimated) cross-country linkages. Consistent with the existing GVAR literature and the main purpose of the application in this paper, we use trade shares to quantify the linkages among all the economies we include in the GVAR model.[3]

It is important to note that the shocks we investigate are not structural. But given the focus of our analysis, which is on the study of the transmission of GDP shocks across countries, identifying the sources of the shocks (whether they are due to demand, supply, productivity or monetary policy) is not central to our analysis. The GVAR model that we use identifies the country-specific shocks by conditioning each variable on contemporaneous values of foreign-specific variables, which renders the cross-country dependence of the shocks weak and of second-order importance.

A novel, methodological contribution of this paper is to set up and estimate a GVAR model in which the country-specific foreign variables are constructed with time-varying trade weights, while the GVAR is solved with time-specific counterfactual trade weights. This allows us to study and compare the impact of GDP shocks with alternative configurations of cross-country linkages, and to investigate how the transmission of shocks has changed after the emergence of China in the world economy. Specifically, we simulate GDP shocks in the GVAR model using trade weights at different points in time, thus capturing the fundamental aspect of China's rapidly changing role in the world economy: its new pattern of trade linkages with Latin America and the rest of the world. The paper also provides a new procedure for bootstrapping the estimated parameters with time-varying weights. The use of time-varying weights is important in our application not only because it allows us to account for the fast evolution of trade relations in the world economy, but also more generally because it also enhances parameter stability, which in turn permits more reliable counterfactual simulation exercises. According to our empirical findings, in fact, even for Latin American economies that have experienced frequent changes in policy regime and other deep structural changes, standard statistical tests do not detect significant parameter instability in the GVAR model we estimate.

In our application, the GVAR model includes 25 major advanced and emerging economies plus the euro area, covering more than 90 percent of world GDP, and including five large Latin American economies (Argentina, Brazil, Chile, Mexico, and Peru). The data set is quarterly, from 1979Q2 to 2009Q4, thus including both the great recession of 2008 and 2009 and the first few quarters of the global recovery.[4]

[3] As we shall discuss in more detail in the paper, trade in goods represents the most important, quantifiable channel through which shocks are transmitted across countries.

[4] The dataset and the GVAR code used for our analysis are available at http://www-cfap.jbs.cam.ac.uk/research/gvartoolbox/index.html.

The main results of the empirical analysis are fourfold. First, the long-run impact of a China GDP shock on the five Latin American economies has increased dramatically (by three times) since the mid-1990s. Second, and consistent with the previous result, we find that the long-run effect of a US GDP shock on Latin America has halved over the same period, with even sharper declines in the short term. Third, the transmission of domestic shocks originating in Latin America or the rest of emerging Asia (excluding China and India) has not changed over the same period. Fourth and finally, the results predict that the increased impact of a China GDP shock on Latin America owes as much to indirect effects, which are associated with stronger trade linkages between China and Latin America's largest trade partners–the United States and the euro area–as to direct effects that stem from tighter trade linkages between China and Latin America, boosted by the decade-long boom in commodity prices.

These findings have important policy implications for Latin America. First, they help to explain why these five Latin American economies recovered much faster than initially anticipated from the recent global crisis. In fact, the evidence shows that Latin America growth owes more to a fast-growing economy that enacted a powerful fiscal stimulus during the global crisis (China), and relatively less to the economy that was at the epicenter of the crisis (United States). Had the trade linkages been those prevailing in the mid-1990s, the region would have suffered a much sharper downturn than it actually experienced. This evidence also suggests that the so called "decoupling" found in the existing literature (e.g., Kose and Prasad, 2010) might be related to the emergence of China as an important source of world growth as opposed to a widespread "decoupling" of emerging markets' business cycle from that of advanced economies. Second, the results point to hidden vulnerabilities. Latin America remains a small open economy vulnerable to external shocks, without the necessary weight to affect the international business cycle with its own growth dynamics. And while the changes documented here have had positive, stabilizing effects on Latin America's business cycle during the recent global crisis, they predict negative, destabilizing effects if and when China's growth begins to slow down significantly, especially if this happens before the United States and the Euro area have fully recovered from the global crisis.

The rest of the paper is organized as follows. In the next section, we discuss how trade linkages between China and the rest of the world, particularly Latin America, have evolved over time, thus justifying the specific set of trade matrices we use in the counter factual simulations. In Section 3, we describe the GVAR methodology that we use. In Section 4, we discuss estimation and testing of the GVAR model. Section 5 reports the counterfactual simulation results. Section 6 concludes. Three appendices describe the construction of the data set, explain the econometric methodology and bootstrap procedure used in details, and report additional estimation and bootstrapped results for the GVAR model with time-varying weights.

2 The Changing Weight of China in Latin American and World Trade

The importance of China for Latin America's (LAC5) trade has increased more than three-fold over the past 30 years or so, from roughly 1 percent in 1980 to more than 12 percent in 2009 (Figure 1).[5] The take-off of China's trade with LAC5, however, starts only in the mid-1990s, with little or no change in the previous decade.[6]

Growing bilateral trade linkages between China and LAC5 are also associated with more synchronized business cycles over the last 15 years or so. Figure 2 plots a rough measure of business cycle synchronization (a 10-year rolling window correlation between LAC5 and China GDP growth), showing a steady increase from the beginning of the 1990s to the end of the sample period in 2009.[7] In 2009, the average LAC5 rolling correlation stood at a level four times higher than in 1995, increasing from 0.12 to 0.61. Furthermore, all LAC5 countries considered display a pattern similar to the regional one. Even in the case of Mexico, which belongs to NAFTA and hence has stronger ties with the United States, the correlation changed from around 0.1 in 1995 to around 0.4 in 2009, while in the case of Brazil it increased from about -0.1 to 0.5.[8]

While China may now undoubtedly be more important for LAC5's business cycle than 15 years ago, how much more important is it? In particular, is the stronger direct bilateral trade linkage the main channel through which China now affects LAC5's business cycle? Or are there other indirect channels of interdependence? For instance, Calderon (2008) finds that China affects LAC5's business cycle mostly via its demand for commodities. And the decade-long commodity price boom might be inflating the bilateral trade shares between China and LAC5 plotted in Figure 1. In addition, there are also other indirect channels of influence related to international capital flows and China's exchange rate regime that might play a role.[9]

Indeed, available trade statistics show that China may have played an increasingly more important role over the past 15 years not only directly, but also indirectly *via* its increased importance for LAC5's traditional and largest trading partners such as the United States and the euro area. Tables 1 and 2 report a complete set of trade shares for the United States, the euro area, Japan, China, LAC5, the rest of the Latin American and Caribbean countries (Other LAC), and the rest of the world (labelled "others") at two different points in time, 1995 and 2009, respectively. First, the

[5] The changing economic relationship between China and Latin America is discussed in Devlin, Estevadeordal, and Rodriguez-Clare (2006).

[6] The trade share of country i in country $j's$ total trade is defined as the sum of country i's imports from country j and exports to country j divided by the sum of country j's total merchandise imports and exports. Note that available trade statistics for the relevant countries and time periods cover only trade in goods, thus omitting trade in services. Also, the trade statistics are net of transit trades.

[7] LAC5 region GDP growth is calculated as a weighted average of individual countries GDP using PPP-GDP weights averaged over the period 2006-08 (Source: World Development Indicators Database, World Bank).

[8] Similar evidence (up to end-2004) is reported by Calderon (2008).

[9] See Cova, Pisani, and Rebucci (2010) and Izquierdo and Talvi (2011) for a more detailed discussion.

table shows that, when integration is measured by total trade as opposed to export only, the United States and the euro area continue to be the largest partners of LAC5 by a sizable margin: at the end of 2009, the United States and the euro area combined weight accounted for more than 60 percent of total LAC5 trade (the United States 51 percent and the euro area 15 percent, respectively), even though their combined weight declined over time from almost 80 percent in 1995, when the weights of the United States and the euro area were 60 percent and 18 percent, respectively. In contrast, China's share of LAC5's total trade surged in all LAC5 countries except Mexico (only a moderate increase) over the same period, mostly at the expense of the United States and the euro area (see Table 2), but rit emains much smaller than the United States and the euro area. Second, the table shows that China's emergence as a global trade power has also affected LAC5's largest trade partners: China's share in total trade of the United States, the euro area, and Japan grew to 18 percent, 15 percent and 26 percent in 2009, from 5 percent, 4 percent, and 9 percent, respectively, in 1995.

This stylized evidence suggests that China today might be affecting LAC5's business cycle not only via its stronger direct trade linkages, but also through its stronger indirect linkages with LAC5's main traditional trade partners. In the rest of the paper we shall quantify how these changes in the geographical composition of trade have affected the transmission of specific shocks to LAC5 and the rest of the world economy, and also attempt, to the extent possible, to disentangle direct effects *via* stronger bilateral link boosted by commodity price increases, and the indirect effects *via* larger influences on traditional trading partners.[10]

3 The GVAR Methodology

In this section we present the GVAR methodology, discuss some of its underlying assumptions, the nature of the counterfactual experiments conducted, and the type of shocks to be considered.

The GVAR modelling strategy consists of two main steps. First, each country is modeled individually as a small open economy by estimating a country-specific vector error-correction model in which domestic variables are related to country-specific foreign variables and global variables that are common across all countries (such as the price of oil). The foreign variables provide the link between the evolution of the domestic economy and the rest of the world and, in estimating the country-specific models, are taken as (weakly) exogenous—an assumption that is tested in the paper. Second, a global model is constructed combining all the estimated country-specific models

[10]Other indirect transmission channels, such as financial linkages, are taken into account in the GVAR model through the inclusion financial variables, but are not discussed separately in the paper, because comparable counterfactual simulation exercises to those used to investigate trade linkages cannot be constructed, due to the limited availability of reliable data on bilateral financial positions.

and linking them with a matrix of predetermined (i.e., not estimated) cross-country linkages. We now present and discuss each of these two steps in turn.[11]

3.1 The First Step: Specification and Estimation of Country-Specific Models

Consider $N+1$ countries in the global economy, indexed by $i = 0, 1, 2, ...N$. In the first step, with the exception of country "0" (that in our application is the United States), all other N countries are modelled as small open economies in which a set of domestic variables ($\mathbf{x}_{it}$, to be specified below) is related to a set of country-specific foreign variables, $\mathbf{x}^*_{it}$, using an augmented vector autoregressive model (VARX*) specification. Specifically, for each country i, we set up a VARX*(p_i,q_i) model in which the $k_i \times 1$ vector, $\mathbf{x}_{it}$, is related to the $k^*_i \times 1$ vector of country-specific foreign variables, $\mathbf{x}^*_{it}$, and the $m_d \times 1$ global variables, $\mathbf{d}_t$, plus a constant and a deterministic time trend:

$$\mathbf{\Phi}_i(L, p_i)\mathbf{x}_{it} = \mathbf{a}_{i0} + \mathbf{a}_{i1}t + \mathbf{\Upsilon}_i(L, q_i)\mathbf{d}_t + \mathbf{\Lambda}_i(L, q_i)\mathbf{x}^*_{it} + \mathbf{u}_{it}, \tag{1}$$

with $t = 1, 2, ..., T$. Here $\mathbf{\Phi}_i(L, p_i) = I - \sum_{i=1}^{p_i} \mathbf{\Phi}_i L^i$ is the matrix lag polynomial of the coefficients associated with $\mathbf{x}_{it}$; $\mathbf{a}_{i0}$ is a $k_i \times 1$ vector of fixed intercepts; $\mathbf{a}_{i1}$ is the $k_i \times 1$ vector of coefficients on the deterministic time trends; $\mathbf{\Upsilon}_i(L, q_i) = \sum_{i=0}^{q_i} \mathbf{\Upsilon}_i L^i$ is the matrix lag polynomial of the coefficients associated with $\mathbf{d}_t$; $\mathbf{\Lambda}_i(L, q_i) = \sum_{i=0}^{q_i} \mathbf{\Lambda}_i L^i$ is the matrix lag polynomial of the coefficients associated with $\mathbf{x}^*_{it}$; $\mathbf{u}_{it}$ is a $k_i \times 1$ vector of country-specific shocks, which we assume to be serially uncorrelated, with zero mean and a nonsingular covariance matrix, $\mathbf{\Sigma}_{ii}$, namely $\mathbf{u}_{it} \sim i.i.d.(\mathbf{0}, \mathbf{\Sigma}_{ii})$.[12]

The vector of country-specific foreign variables, $\mathbf{x}^*_{it}$, plays a central role in the GVAR methodology. Consistent with the existing GVAR literature, for each country i at each time t, this vector is constructed as the weighted average across all countries j of the corresponding variables in the model ($\mathbf{x}_{jt}$ for $j \neq i$). As a way of dealing with the curse of dimensionality when N is relatively large, the weights used in the construction of $\mathbf{x}^*_{it}$ are not estimated but specified *a priori*, based on information that measures the strength of bilateral linkages in the global economy. While the GVAR methodology can be implemented with any set of weights, the existing GVAR literature, as well as the application in this paper, use trade weights. Specifically, the weight of country j in the foreign variables of country i is given by the share of country j in the total trade of country i (as described in footnote 6).

The choice of trade weights is based on a number of considerations. First, trade in goods represents an important (if not the most important) channel through which shocks are transmitted

[11] See Dees, di Mauro, Pesaran, and Smith (2007) and Garratt, Lee, Pesaran, and Shin (2006) for a detailed illustration of the GVAR methodology.

[12] Notice that we allow $\mathbf{\Phi}_i(L, p_i)$, $\mathbf{\Upsilon}_i(L, q_i)$, and $\mathbf{\Lambda}_i(L, q_i)$ to differ across countries. The lag orders, p_i and q_i, are also selected on a country- by-country basis.

across countries. Second, trade linkages tend to reflect deeper technological, political and cultural linkages that exist between countries and provide a good measurable proxy for such interconnections. Third, among the alternative measures that could be used, trade weights are perhaps the most reliable, and data sources are readily available to quantify them. Reliable bilateral trade statistics are published annually for all countries (with a few exceptions), while data on bilateral financial flows are either nonexistent or tend to be much more volatile and less reliable, as their collection has started only more recently. The use of bilateral financial flows could therefore exaggerate the cross-country transmission of shocks and lead to parameter instability. Finally, we note that trade integration started much earlier than financial integration and has been present throughout our sample period. China, the main focus of this paper, is an example of a country whose expansion has affected the rest of the world dramatically and yet its financial system is not internationally connected; the same applies to other emerging market economies in our model.

It is also worth highlighting that, in the case of a GVAR model comprising small open economies, the choice of weights is of secondary importance for the estimation of country-specific parameters, particularly since the variables tend to be highly correlated across countries. In fact, as shown by Pesaran (2006), for sufficiently large N, the estimation results are asymptotically invariant to the choice of weights so long as they are "granular," namely of order $1/N$. However, as the application in this paper shows, the impulse response of shocks to a particular variable in the GVAR does depend on the choice of weights even if similar parameter estimates are obtained using different sets of weights. This is a particularly important consideration for the present paper, where the focus of the analysis is on the possible effects of changing trade linkages between LAC5 and the world economy.

With this in mind, we develop a GVAR model where trade weights are allowed to change at the estimation stage as well as at the solution stage (when impulse responses are computed), in contrast to most other applications of the GVAR to date that are based on fixed trade weights. This methodological innovation is important as it allows us to take into account the evidence that trade integration has progressed over time and the geographical patterns of trade have changed dramatically with the acceleration of globalization in the mid-1990s, as we documented in Section 2. Specifically, when estimating the parameters of the GVAR model, the $\mathbf{x}_{it}^*$ are constructed as follows:

$$\mathbf{x}_{it}^*\left(\mathbf{W}_{i,\tau(t)}\right) = \sum_{j=0}^{N} \mathbf{W}_{ij,\tau(t)}\mathbf{x}_{jt} = \mathbf{W}_{i,\tau(t)}\mathbf{x}_t, \tag{2}$$

where $\mathbf{x}_t = (\mathbf{x}_{0t}', \mathbf{x}_{1t}', ..., \mathbf{x}_{Nt}')'$ is the $k \times 1$ vector of the endogenous variables ($k = \Sigma_{i=0}^{N} k_i$); $\mathbf{W}_{ij,\tau(t)}$ is the $k_i^* \times k_j$ matrix that contains the trade weights of country j in country i at time t, for a given $\tau(t)$; and $\mathbf{W}_{i,\tau(t)} = (\mathbf{W}_{i0,\tau(t)}, \mathbf{W}_{i1,\tau(t)}, ..., \mathbf{W}_{iN,\tau(t)})$ with $\mathbf{W}_{ii,\tau(t)} = 0$ is the $k_i^* \times k$ weights matrix for country i at time t. Here $\tau(t)$ is a generic rule that indexes the time-varying weights at each time period t. For instance, in our empirical application, for each quarter t, $\tau(t)$ refers to three-year average trade weights for the current year, t, and the previous two years, $t-1$ and $t-2$.[13] It is important that for each choice of weight matrix, $\mathbf{W}_{i,\tau(t)}$, $\mathbf{x}^*_{it}\left(\mathbf{W}_{i,\tau(t)}\right)$ and its lagged value are constructed according to (2), and it is not necessarily the case that $\mathbf{x}^*_{i,t-1}$ is equal to the lagged value of $\mathbf{x}^*_{it}$. This is only true if the weights are time invariant.[14]

Equipped with this notation, equation (1) can be rewritten as[15]

$$\mathbf{x}_{it} = \mathbf{\Phi}_i \mathbf{x}_{i,t-1} + \mathbf{\Lambda}_{i0}\mathbf{W}_{i,\tau(t)}\mathbf{x}_t + \mathbf{\Lambda}_{i1}\mathbf{W}_{i,\tau(t-1)}\mathbf{x}_{t-1} + \mathbf{u}_{it},\ \mathit{for}\ i = 0, 1, 2, ..., N. \tag{3}$$

It is clear that for a given set of weights, the error correction form representation of the country-specific models in (3) can be tested for cointegration and estimated following Harbo, Johansen, Nielsen, and Rahbek (1998) and Pesaran, Shin, and Smith (2000). Using the sample $\mathbf{x}_t$, $t = 1, 2, ..., T$, such estimates can be denoted by $\hat{\mathbf{\Phi}}_i$, $\hat{\mathbf{\Lambda}}_{i0}$ and $\hat{\mathbf{\Lambda}}_{i1}$, with associated country-specific residuals

$$\hat{\mathbf{u}}_{it} = \mathbf{x}_{it} - \hat{\mathbf{\Phi}}_i \mathbf{x}_{i,t-1} - \hat{\mathbf{\Lambda}}_{i0}\mathbf{W}_{i,\tau(t)}\mathbf{x}_t - \hat{\mathbf{\Lambda}}_{i1}\mathbf{W}_{i,\tau(t-1)}\mathbf{x}_{t-1},\ t = 2, 3, ..., T. \tag{4}$$

The country-specific foreign variables are assumed to be weakly exogenous for the purpose of estimating the parameters of country-specific models. The results of testing the weak exogeneity assumption are reported below, and shown to hold in most cases. These test outcomes are important since they allow each country model to be estimated separately from the rest. In economic terms, the weak exogeneity assumption permits treating each country as a small open economy with respect to the rest of the world. Also note that the number of countries does not need to be large to build a GVAR model. Nonetheless, when the number of countries is relatively small, the weak exogeneity assumption may not be satisfied for all countries. It is only when the number of countries is relatively large (technically, tending to infinity), and all countries are comparable in size, that we can have a fully symmetric treatment of all the models in the GVAR. For this reason, as we shall see below, we treat the United States differently as a dominant economy, consistent with previous applications of GVAR.

[13] For example, for t at 1989Q4, $\tau(t)$ refers to the three-year average trade weights of 1987, 1988 and 1989; for t at 1990Q1, $\tau(t)$ refers to the three year average trade weights of 1988, 1989 and 1990. The three-year moving average is chosen to smooth variations of trade data over time.

[14] Note that, when the trade weights are constant over time, (2) reduces to the more familiar weighted average definition of $\mathbf{x}^*_{it} = \mathbf{W}_i\mathbf{x}_t = \sum_{j=0}^{N}\omega_{ij}\mathbf{x}_{jt}$ used in the previous GVAR literature (see for instance Dees, di Mauro, Pesaran, and Smith, 2007).

[15] To simplify the exposition here we abstract from common observed variables and deterministic components and consider a first- order VARX* specification.

3.2 The Second Step: Building the GVAR

In the second step, the GVAR model is set up by stacking the estimated individual country-specific models and linking them with a matrix of predetermined cross-country linkages. Having estimated the country-specific parameters using the time varying weights, the estimated country-specific models can now be combined and solved for *any* given trade weights based on a particular year, or on an average of weights from different time periods. In what follows, denote such a link weight matrix by $\mathbf{W}_i^0$, with $i = 0, 1, ...N$, and define the $k_i \times k$ selection matrix $\mathbf{S}_i$ such that

$$\mathbf{x}_{it} = \mathbf{S}_i \mathbf{x}_t. \tag{5}$$

Then rewrite equation (3) in terms of $\mathbf{x}_t = (\mathbf{x}'_{0t}, \mathbf{x}'_{1t}, ..., \mathbf{x}'_{Nt})'$, which contains all the endogenous variables in the global model:

$$\mathbf{S}_i \mathbf{x}_t = \hat{\mathbf{\Phi}}_i \mathbf{S}_i \mathbf{x}_{t-1} + \hat{\mathbf{\Lambda}}_{i0} \mathbf{W}_i^0 \mathbf{x}_t + \hat{\mathbf{\Lambda}}_{i1} \mathbf{W}_i^0 \mathbf{x}_{t-1} + \tilde{\mathbf{u}}_{it},$$

or

$$\mathbf{G}_i \mathbf{x}_t = \mathbf{H}_i \mathbf{x}_{t-1} + \tilde{\mathbf{u}}_{it}, \tag{6}$$

where

$$\mathbf{G}_i = \mathbf{S}_i - \hat{\mathbf{\Lambda}}_{i0} \mathbf{W}_i^0, \tag{7}$$

$$\mathbf{H}_i = \hat{\mathbf{\Phi}}_i \mathbf{S}_i + \hat{\mathbf{\Lambda}}_{i1} \mathbf{W}_i^0. \tag{8}$$

Now stacking (6) for $i = 0, 1, ..., N$ we have

$$\mathbf{G} \mathbf{x}_t = \mathbf{H} \mathbf{x}_{t-1} + \tilde{\mathbf{u}}_t, \tag{9}$$

where

$$\mathbf{G} = (\mathbf{G}'_0, \mathbf{G}'_1, ..., \mathbf{G}'_N)', \text{ and } \mathbf{H} = (\mathbf{H}'_0, \mathbf{H}'_1, ..., \mathbf{H}'_N)'.$$

Finally, assuming then that $\mathbf{G}$ is non-singular we obtain

$$\mathbf{x}_t = \mathcal{F} \mathbf{x}_{t-1} + \mathbf{G}^{-1} \tilde{\mathbf{u}}_t, \tag{10}$$

where $\mathcal{F} = \mathbf{G}^{-1}\mathbf{H}$. The GVAR model in (10) can then be used to compare impulse responses for any set of link matrices $\mathbf{W}_i^0$, $i = 0, 1, ...N$.[16] But several remarks are in order.

[16] See Appendix B.1 for more detailed discussion and derivation of the solution to the GVAR with a given weight matrix.

First, given that we are interested in the impact of changing trade patterns on the transmission of shocks of global relevance, we propose to solve the GVAR (estimated in the first step) for weights or link matrices at different points in time. Thus, in the empirical section of the paper, we consider the implications of the same estimated country-specific models but for different choices of trade weights. Note that the GVAR model parameters are estimated only in the first stage and are taken as given in the second stage. Under the assumption that these parameters are stable over time, the global model can be safely used counterfactually with alternative trade matrices, as we do in our application.

Second, each alternative trade matrix represents a particular counterfactual of interest that leads to a different set of residuals. In fact, $\tilde{\mathbf{u}}_{it}$ defined by (6) is not the same as $\hat{\mathbf{u}}_{it}$ in (4), unless the weights used in the first stage at each time t are the *same* as in the second stage, namely if $\mathbf{W}_{i,\tau(t-1)} = \mathbf{W}_i^0$, for all t. This condition can only occur when the weights used in the first stage are fixed and match the weights used in the second stage, which is not the case in our application. Thus, in general, the $\tilde{\mathbf{u}}_{it}$'s might be contemporaneously as well as serially correlated, even if the residuals of the fitted model in (4) are not.

To quantify the uncertainty around the GIRF point estimates, we use a non-parametric bootstrap procedure, which requires an estimate of the covariance matrix of the stacked country-specific residuals $\tilde{\mathbf{u}}_t = (\tilde{\mathbf{u}}'_{0t}, \tilde{\mathbf{u}}'_{1t}, ..., \tilde{\mathbf{u}}'_{Nt})'$, $\mathbf{\Sigma}_{\tilde{u}}$. One possible estimate is the sample moment matrix,

$$\hat{\mathbf{\Sigma}}_{\tilde{u}} = \frac{\sum_{t=2}^{T-1} \tilde{\mathbf{u}}_t \tilde{\mathbf{u}}'_t}{(T-1)}.$$

Notice, however, that in our application where the dimension of the endogenous variables in the GVAR model (k) is larger than the time series dimension (T), $\hat{\mathbf{\Sigma}}_{\tilde{u}}$ is not guaranteed to be a positive definite matrix. This is an important consideration when computing bootstrapped error bands for the impulse responses or bootstrapped critical values for the structural stability tests. To avoid this problem, following Dees, Pesaran, Smith, and Smith (2010) we use a shrinkage estimator of the covariance matrix in the empirical analysis, as explained in Appendix B.

Third, interdependence among countries in the GVAR model arises through many different channels. Direct trade linkages are only one of the important channels. The different country variables are also connected through the dependence of $\mathbf{x}_{it}$ on global variables $\mathbf{d}_t$, and through the contemporaneous interdependence of shocks in country i on shocks in country j, as summarized by the estimated cross-country covariances, $\mathbf{\Sigma}_{ij}$, where $\mathbf{\Sigma}_{ij} = Cov(\mathbf{u}_{it}, \mathbf{u}_{jt}) = E(\mathbf{u}_{it}\mathbf{u}'_{jt})$ for $i \neq j$. It is also worth noting that, unless we link the country-specific models in a coherent manner, as in the second step of the modeling strategy explained above, impulse responses of shocks to domestic and foreign variables cannot take account of the second and higher- order interaction in the global system. For this reason, as we shall see below, altering the direct trade linkages between county i and j by altering the respective coefficient in the link matrix above does not necessarily change the bilateral interdependence between the two countries.

Finally, the shocks we consider in the paper are not identified, unlike what is claimed in the structural VAR literature.[17] We focus instead on shocks that could be triggered by different fundamental sources of disturbances, such as productivity, monetary policy, or other structural shocks, without attempting to identify the ultimate source of the disturbance. To distinguish between the different factors that contribute to a particular variable change, it often involves incredible identifying assumptions. For instance, researchers are still debating about the identification of a US technology shock in a closed economy model. Moving to a global model, such issues become even more vexing, and in this paper we do not try to distinguish the effects of a US (or China for that matter) technology shock from all the other sources of disturbances that could prevail in the global economy.[18]

To investigate the transmission of shocks to the country-specific variables, we use generalized impulse response functions (GIRFs). GIRFs, developed in Koop, Pesaran, and Potter (1996) and Pesaran and Shin (1998), take into account the possibility that the error terms of the GVAR are contemporaneously correlated across variables and countries. For instance, a country-specific GDP shock can ultimately be stemming from a shift in demand or supply of output in that country, in other countries, or globally. GIRFs for such a shock show how changes in a given variable (say US GDP), or a linear combination of changes in a number of variables (say global output), affect the other variables in the GVAR on impact (first-round effects) and over time (second and higher-order effects) regardless of the source of the change. As noted above, GIRFs do not answer the "deeper" question of whether such changes originate from technology shock, monetary policy shocks, oil shocks, or other structural shocks. Instead, they describe what happens if there are changes to the errors, $\mathbf{u}_{it}$, of the conditional model, (1), without trying to identify the sources of such changes. Unlike the errors in the standard VAR models, the shocks in the conditional models that comprise the GVAR are only weakly cross-sectionally correlated, which lends further support to the use of GIRFs for the analysis of the transmission of shocks across countries. The evidence on cross-country correlation of the errors of the country-specific VARX* model is given in Section C.5.2.

[17] In principle, traditional impulse responses to orthogonalized shocks could also be computed, but they would depend on the specific identification scheme adopted. For instance, in the case of the typically used Cholesky scheme, the results would depend on the ordering of the variables and/or countries in the model, while GIRFs are invariant to such orderings.

[18] See Dees, Pesaran, Smith, and Smith (2010) for an attempt to do so in a GVAR version of the canonical (three-equation) New Keynesian model.

4 A GVAR Model for Latin America in the World Economy

In this section we discuss the model specification and report test results to check the validity of the weak exogeneity assumption of country-specific foreign variables and the stability of the parameters.

4.1 Model Specification

The GVAR model that we specify includes 26 country-specific VARX* models, as displayed in Table 3. We consider all major advanced and emerging economies in the world, accounting for about 90 percent of world GDP, including five Latin American economies (Argentina, Brazil, Chile, Peru, and Mexico)[19] and a euro area block. The euro area block is made up of its eight largest economies: Germany, France, Italy, Spain, Netherlands, Belgium, Austria and Finland.[20] Thus, the version of the GVAR model that we specify uses data for 33 countries. The models are estimated over the period 1979Q2-2009Q4, thus including both the great recession of 2008 and 2009 and the first two quarters of the recent global recovery.

With the exception of the US model, all country models include the same set of variables, where available (see Table 4). The variables included in each country model are real GDP (y_{it}), the rate of inflation ($\pi_{it} = p_{it} - p_{i,t-1}$), the real exchange rate defined as ($e_{it} - p_{it}$), and, when available, real equity prices (q_{it}), a short rate (ρ_{it}^S) and a long rate of interest (ρ_{it}^L), with: $y_{it} = ln(GDP_{it}/CPI_{it})$, $p_{it} = ln(CPI_{it})$, $q_{it} = ln(EQ_{it}/CPI_{it})$, $e_{it} = ln(E_{it})$, $\rho_{it}^S = 0.25 \cdot ln(1 + R_{it}^S/100)$, $\rho_{it}^L = 0.25 \cdot ln(1 + R_{it}^L/100)$, where GDP_{it} is nominal Gross Domestic Product of country i at time t (in domestic currency); CPI_{it} is the Consumer Price Index in country i at time t (equal to 100 in year 2000); EQ_{it} is a nominal Equity Price Index; E_{it} is the nominal exchange rate of country i at time t in terms of US dollars; R_{it}^S is the short rate of interest in percent per year (typically a three-month rate); R_{it}^L is a long rate of interest in percent per year (typically a 10-year rate). All country models (except the US) also include the log of nominal oil prices (p_t^o) as a weakly exogenous foreign variable.

The US model is specified differently. First, oil price is included as an endogenous variable. In addition, given the importance of the US financial variables in the global economy, the US-specific foreign financial variables, $q_{US,t}^*$, and $\rho_{US,t}^{*L}$, are not included in the US model (see below for a discussion on the results of the weak exogeneity test applied to these variables). Note also that the real value of the US dollar, by construction, is determined outside the US model, and the US-specific real exchange rate (defined as $e_{US,t}^* - p_{US,t}^*$) is included in the US model as a weakly exogenous foreign variable.

[19] Data availability is the only constraint to the number of Latin American countries included.

[20] The time series data for the euro area are constructed as weighted averages using Purchasing Power Parity GDP weights, averaged over the 2006-2008 period (Source: World Bank). A more detailed description of data is reported in the Appendix A.

4.2 Country-Specific Estimates and Tests

Given the importance of the weak exogeneity assumption in the construction of the GVAR model, and the parameter stability for the counterfactual simulation exercise that we conduct in the paper, we focus on the evidence on these two sets of test statistics in our discussion.[21]

As noted above, for all countries, we treat the foreign variables as weakly exogenous. To test for the weak exogeneity of country-specific foreign variables and oil prices, the individual country models are first estimated under the null hypothesis that foreign variables are indeed weakly exogenous. The resultant error correction terms are then included in the auxiliary equations for country-specific foreign variables, and their statistical significances are tested jointly. Under the null hypothesis that foreign variables are weakly exogenous, the error correction terms must not be statistically significant.[22]

We find that the weak exogeneity hypothesis could not be rejected for the majority of variables considered, especially for core economies such as the United States, the euro area and China. Specifically, only 10 out of the 156 exogeneity tests performed result in rejection of the weak exogeneity hypothesis. Not surprisingly, given the relative size and role of Latin America in the world economy, almost all foreign variables in the LAC5 models can be treated as weakly exogenous. Only foreign output in the model for Mexico and oil prices in the model for Brazil cannot be considered as weakly exogenous according to the test statistics reported. But such results can also arise by chance: given that we use a 5 percent significance level, we would expect at least 5 percent of the 130 tests performed to fail (i.e., 6 or 7) even if the weak exogeneity hypothesis were valid in all cases. Note that China meets the weak exogeneity assumption despite its greatly increased importance in the world economy. Indeed, while it is possible that with China continuing its current rate of expansion at some point in the future it ceases to become "small," our test results suggest that at present China can still be viewed as a small open economy for the purpose of estimating the model parameters. As we shall see, however, this does not mean that its increased weight in the world economy does not matter when we come to analyze the transmission of shocks emanating from its economy.

For the United States, the null hypothesis of weak exogeneity can be rejected for US-specific foreign equity prices at the 5 percent level, due to the prominence of US equity markets in the global context. The weak exogeneity of US-specific foreign long run interest rates, however, cannot be rejected at the 5 percent level. Given the size and importance of US equity and bond

[21] Due to space considerations, detailed empirical evidence on the statistical assumptions made to specify the GVAR model is reported in Appendix C, together with a description of the impact multipliers and average pair-wise correlations for all variables and countries included in the model. We also report evidence on unit root tests, lag order selection, and the cointegration rank for all country models in Appendix C.

[22] The details of the testing procedure and the results for the weak exogeneity test are presented in Appendix C (see Table C.6 for results).

markets in international financial markets, we decided to exclude foreign long-run interest rates and foreign equity prices from the US model. The foreign counterpart of output, inflation and real exchange rate (defined above) pass the weak exogeneity test and are therefore included in the US model. Note that, differently from the specification estimated by Dees, di Mauro, Pesaran, and Smith (2007), the US-specific foreign short term interest rate, $\rho^{*S}_{US,t}$, also passes the weak exogeneity test and is included as a weakly exogenous variable in the US model.

The possibility of structural breaks is of particular concern in the case of emerging countries, which have been subject to significant political, social and structural changes during our sample period. Note, however, that the GVAR implicitly accommodates co-breaking (Mizon and Hendry, 1998), implying that the VARX* models that make up the GVAR are more robust to the possibility of structural breaks as compared to standard VAR models or single equation models. Focusing on Latin American real GDP variables, in particular, structural breaks are found in years when these countries were subject to severe shocks that coincide with the starting and ending of the hyperinflation periods in Brazil and Peru. While acknowledging that this evidence is problematic, we follow earlier GVAR work (see, for example, Pesaran, Schuermann, and Weiner, 2004 and Dees, di Mauro, Pesaran, and Smith, 2007) and provide bootstrap means and confidence bounds for the point estimates that do allow for breaks in the error variance-covariances.[23]

5 Transmission of Shocks before and after China's Rise in the World Economy

To quantify the change in the transmission of external shocks to Latin America before and after the acceleration of the globalization process at the beginning of the 1990s, and the emergence of China as a significant trading nation, we conduct a set of counterfactual simulation exercises along the lines discussed in Section 3. That is, while keeping constant the parameters of the VARX* models estimated in the first step of the GVAR methodology (with foreign variables constructed using time-varying trade weights), we solve the GVAR model in the second step with four different sets of trade matrices, based on fixed trade weights for the years 1985, 1995, 2005, and 2009. We then compare the resulting time profiles of the transmission of specific GDP shocks across different counter-factual trade linkages.

By focusing on these four sets of trade weights we can quantify how changed geographical trade patterns may have altered the impact and transmission of shocks to LAC5 and the world economy, abstracting from any implied changes to parameter estimates that might have taken place as a result of changing trade weights. As we saw in Section 2, trade weights were relatively stable over the period 1985-1995, while they started to change steadily after 1995. Therefore, we expect the most marked changes to be associated with weights in years 1995 and 2009. Trade weights in

[23] See Appendix C.4 for a detailed account of parameter stability tests.

the years 1985 and 2005 are also considered because they give a better sense of the time-evolution of the estimated impacts and provide some evidence on the robustness of the results.

Our GVAR model has 134 variables (all endogenously determined), and there are numerous potentially relevant shocks that could be considered.[24] We consider two country-specific shocks with potential global impacts, namely a China GDP shock and a US GDP shock, and investigate how their effects on the GDP of selected countries in the GVAR model (including particularly LAC5 economies) change using alternative trade matrices. In addition to a China GDP shock that is the main focus of our application, we look at a shock to US GDP because it provides a natural benchmark against which to contrast the results for China. We focus on GDP shocks because they are of particular interest in light of the recent global crisis. We also consider a LAC5 GDP shock and a GDP shock to the rest of emerging Asia (excluding India) because they shed light on the ongoing debate on the "decoupling" of emerging markets' business cycles from those of advanced economies. In the analysis of the international transmission of these shocks we look at both regional and country-specific responses. The regional responses are constructed as weighted averages of the country specific responses, using weights based on the PPP valuation of country GDP, which provide good measures of the relative sizes of the economies under consideration.

As we noted earlier, unlike Dees, Pesaran, Smith, and Smith (2010), we do not attempt to interpret these GDP shocks structurally, for instance, distinguishing between demand and supply sources of output change in the analysis. Note however that in the GVAR model, once $\mathbf{x}_{it}$ is conditioned on $\mathbf{x}_{it}^{*}$, the estimated country specific shocks have effectively little or no correlation *across* countries.[25] Thus, country-specific GDP shocks, conditional on the rest of the world GDP variables (that are present in every country model considered), albeit not orthogonal, have little or no cross-country correlation. This makes it possible to consider GIRFs to US or China GDP shocks with little concern about reverse spillover effects from one country to the other. Nonetheless, we find that contemporaneous correlation of the shocks *within* country models remains sizable even after conditioning on global variables, thus precluding a structural interpretation of these country GDP shocks as supply or demand shocks, for example, without further *a priori* restrictions.

With these preliminary considerations in mind, the rest of this section reports and discusses the results of the counterfactual simulations that we have carried out. We report the point estimates of the GIRFs in the main text in Figures 3 to 7, while the bootstrap error band results are reported in Figures C.2 to C.9 in Appendix C.

[24] A full set of GIRFs for the baseline model is not reported but is available from the authors upon request. In Appendix C, we report a full set of impact multipliers that represent one summary dimension of the international linkages in the GVAR.

[25] See Tables C.10 and C.11 in Appendix C for a detailed account of the average pairwise correlations of errors in the country-specific models of the GVAR.

5.1 A China GDP Shock

Figure 3 presents the GIRFs for a one-percent increase in China GDP, using 2009, 2005, 1995 and 1985 trade weights. In the LAC5 region as a whole, the long-run response to this shock with 2009 weights is almost three times as large as the one associated with 1995 weights. The responses of all individual LAC5 countries are qualitatively similar, but there are quantitative differences across countries in the region. The long-run responses of Chile and Brazil increase the most (almost four times), while those of Mexico and Peru increase the least. Interestingly, however, even the changes in the short run response of Mexico GDP are sizable (reaching almost 0.3 percent, as with the other LAC5 countries in 2009), despite the much larger importance of NAFTA trade in Mexico's total trade. This is because, as we shall see below, a China GDP shock affects both the United States and Canada in a much stronger way with 2009 weights, and thus also Mexico, albeit indirectly rather than directly. In contrast, it is puzzling that the strength of the impact and the transmission of the shock does not increase in the case of a commodity exporter like Peru, despite the fact that its trade shares have evolved in a manner similar to other LAC5 countries (see Figure 1).

With more recent trade weights (2005 and 2009 weights), a China GDP shock matters much more for both advanced and other emerging economies, in particular in the long run. For instance, the long-run impact of the shock on the United States with 2009 weights has increased by about 50 percent compared to 1995 weights and by about 100 percent since 1985. For the euro area and Canada, the changes in the transmission of a China GDP shock are even more marked than in the case of the United State with 2005 and 2009 weights. While in the case of Japan the increase in the impact is less pronounced, the rest of emerging Asia exhibits the same pattern of progressively increasing responses to a China GDP shock when using more recent weights than the rest of the world displays. Only India, whose trade integration with the rest of the world is mainly driven by trade in services (not accounted for in the available trade statistics that we use to compute trade linkages), seems to be affected relatively less by a China GDP shock with more recent trade weights. Moreover, differences between 2009 and 1985 responses to a China GDP shock are not only quantitatively sizable but also statistically significant in the sense that, in most cases, the 95 percent error bands for the bootstrapped 2009 responses do not contain zero values. In contrast, the effects are not statistically different from zero if we consider the 1985 trade weights.[26]

The reported changes in the transmission of the China GDP shock to LAC5 and the rest of the world economy are likely to have played an important role in the unfolding of the recent global financial and economic crisis. For instance, Cova, Pisani, and Rebucci (2010) estimate that, absent the large fiscal stimulus enacted by China during the global crisis, China's GDP would be

[26] See Figures C.2 and C.3 in Appendix C for the bootstrapped impulse responses. Note that the point estimates do not need to coincide with the mean of the bootstrapped distribution. The point estimates are based on a one percent shock to GDP, while the bootstrapped distributions are based on a one-standard deviation shock to GDP.

2.6 percentage points lower in 2009. The estimated elasticities to a China GDP change reported in Figure 3 imply that US GDP growth would have been a quarter percentage point lower, and LAC5 GDP growth would have been almost a full percentage point lower in 2009.[27] Conversely, suppose that China growth slowed in the medium to long term to about 7 percent per annum, as for instance currently forecasted in China's 12th official five-year plan. This would shave almost a half percentage point from LAC5 long-term growth–probably more than 10 percent of the region's growth potential–with much larger short-term effects.[28] These are quite sizable effects, especially considering that these back-of-the-envelope calculations do not account for any likely associated financial market overreaction to such important changes in the fundamental driver of the region's business cycle.

In light of Mexico's responses to a China GDP shock, and more generally the stylized facts discussed in Section 2, it is interesting to see whether the increased impact of a China GDP shock on other LAC5 countries is due to stronger direct or indirect trade linkages. That is, it would be interesting to quantify whether the stronger impact of China on LAC5 is more due to stronger bilateral trade ties between China and LAC5, or to a stronger indirect effects emanating from the impact of China on LAC5's traditional and largest trade partners, namely, the United States and the euro area. To separate out these two effects we conduct an additional counterfactual simulation. In this experiment, we take the 2009 trade matrix and change the weights of China in total trade of LAC5 economies with the exception of Mexico to 1995 levels (thus resetting the direct trade links between the region and China to the 1995 level). All other entries in the link matrix are initially kept at their 2009 values (thus leaving the indirect links *via* United States and the euro area unchanged). The difference between the 1995 and the 2009 weight of China in the total trade of each of the four LAC countries is then redistributed proportionally to the remaining countries excluding the United States and the euro area, which are left unchanged at their 2009 levels. Note that, in this experiment, we also leave Mexico's direct trade link with China unchanged at its 2009 level. This is because, otherwise, the response of the United States to the China GDP shock with this "hybrid" link matrix would change due to Mexico's large trade share in US total trade, and the exercise would overstate the effects on Mexico.[29]

[27] With 2009 trade weights, the peak impacts of a China GDP shock on US GDP and LAC5 GDP are 0.12 percent and 0.3 percent, respectively.

[28] We conduct the following calculations: if China's growth rate falls by 3 percentage points to 7 percent per year, given the long run elasticity of a China GDP shock on LAC5 GDP is estimated to be about 0.15, it implies a fall in LAC5 GDP growth of around 0.4-0.5 percentage points in the long run. Assuming that the long run growth rate of LAC5 is between 4 and 5 percent per year (say for example, as in the case of Brazil), a reduction of GDP growth by 0.4-0.5 percentage points represents a decline in potential growth of approximately 10 percent.

[29] In fact, in 2009 Mexico accounted for 14 percent of the United State's total trade, according to the IMF Directory of Trade Statistics.

The results, reported in Figure 4, show that the indirect linkages are likely to be more important than the direct linkages, thus highlighting the strength of the general equilibrium dynamics that the GVAR modelling strategy captures. As we can see, muting the change in the direct trade link between China and LAC5 (excluding Mexico) has no consequences on the United States, the euro area, and Mexico itself by construction. This is because LAC5 excluding Mexico (whose trade shares are kept constant) is too small in trade terms to affect the United States. In the case of Brazil, Chile and Argentina, the changes in the impact of the China GDP shock due to changed indirect linkages are at least as large as those due to changes in the direct links: changed indirect linkages in fact explain at least half of the total change in the transmission of the shock, and almost all of the change in the case of Brazil. In the case of Peru, there is a very small total change, and hence the distinction is immaterial. We interpret this evidence as suggesting that both direct and indirect effects contribute to the stronger impact of a China GDP shock on LAC5 countries, but the indirect channel of transmission is at least as important as the more obvious direct links. In some cases, like Brazil, the indirect effects seem to be even more important than the direct effects.

This is clear evidence that, as we shall see more formally below, the changed trade linkages between China, Latin America and the rest of the world are affecting the region not only *via* stronger direct trade linkages (boosted by a persistent increase in commodity prices that inflate the trade shares of LAC), but also *via* stronger ties between China and LAC5's traditional trading partners. An important implication of this result is that other countries in the broader LAC region, such as countries in Central America and the Caribbean, might now be more affected by China *via* increased impact of China GDP shock on the United States and the euro area. This result also suggests that the increased impact of a China GDP shock on Mexico discussed above can be interpreted as a result of stronger indirect trade linkages between China and the other NAFTA member countries.

5.2 A US GDP Shock

Figure 5 presents the GIRFs for a one percent increase in US GDP. The impact of a US GDP shock on advanced and emerging market economies falls considerably with more recent trade weights, especially in the short term, mirroring the shift in the geographical distribution of trade discussed in Section 2. Specifically, the impact of the shock on the United States itself with 2009 weights is almost half its size with 1995 weights in the first few quarters, and is about 20-25 percent weaker over the longer term. The results for Canada are similar. In the case of the euro area the transmission of the shock weakens more uniformly across the horizon of the GIRF. The bootstrapped impulse responses to this shock suggest that these differences are not only quantitatively sizable, but also statistically significant (Figures C.4 and C.5 in Appendix C).

In the case of LAC5, the short-term impact of this shock falls dramatically (becoming statistically insignificant) with 2009 weights, while the long-run impact halves as compared to the one with 1995 weights. As in the case of the China GDP shock, there are quantitative differences in responses of individual LAC5 countries, but the qualitative pattern is common across all the five countries. The long-run responses of Chile decrease the most, by almost a half compared with 1995 trade weights. In comparison to LAC5 average, perhaps not surprisingly the reduction in the responses of Mexico is the smallest but still sizable, given Mexico's membership in NAFTA.

The changes in the impact of the US GDP shock on Asia are more mixed. The long-run impact on China GDP falls dramatically with 2009 weights compared with the estimates corresponding to the 1985 weights. However, these differences are significant only for the first two quarters. Japan and the rest of emerging Asia (driven by Korea that is not reported separately) show some differences in short-run effects, but the evidence does not imply a reduction in the impact of a US GDP shock on these economies in the long run. The bootstrapped responses, moreover, show that these changes are not statistically significant.

These results imply that the effect of the recent US "great recession" on LAC5 would have been much more severe if this event had taken place in the mid-1990s. For instance, Izquierdo and Talvi (2011) estimate that the level of US GDP at the peak of the recession was more than 7 percent below its potential. If the crisis had taken place in the mid-1990s rather than at the end of the 2000s, our simulations show that LAC5 could have experienced the same output gap as the United States based on these estimates.[30] It is evident that while good initial conditions at the beginning of the crisis and prompt international financial support have helped the LAC5 region to cope well with the recent global crisis, less dependency on the country in the epicenter of the crisis (the United States) has proven to be fortunate for the economic performance of the region during the crisis.

5.3 A GDP Shock in Latin America and the Rest of Emerging Asia

Consider now a one percent increase in LAC5 GDP, and in the GDP of emerging Asia excluding China and India. Figures 6 and 7 display the point estimates of the GIRFs for these two regions. These shocks are constructed as the weighted average (PPP-GDP average) of shocks to GDP in all LAC5 and emerging Asian countries in the model, respectively.[31] As can be seen, the effects of these shocks have remained virtually unchanged in the case of LAC5, and they have even weakened slightly in the case of the emerging Asian economies with 2009 trade weights. The reason is that these shocks have negligible effects on the largest economies of the world. For instance, with 2009 weights, a one percent increase in LAC5 GDP has no effects on China and Japan GDP, and its effects on the euro area GDP is equal to half of the impact of a China GDP shock discussed before. The LAC5 shock has an impact on US GDP that is similar to that of a China GDP shock, but the

[30] The long-run impact of a 1 percent rise in US GDP shock on LAC5 output is about 1 percent with 1995 weights, but only about 0.4 percent with 2009 weights.

[31] The list of countries in the "Rest of Emerging Asia" group is in Table 3.

impact of the LAC5 shock (mostly through Mexico) dies out in two quarters, while the shock to China GDP has a hump-shaped response, peaking above 0.1 percent within three to four quarters.

The bootstrapped GIRFs confirm that the transmission of these shocks to the rest of the world economy is not statistically significant with 2009 trade weights.[32] In contrast, we can see that while a LAC5 GDP shock has a widespread, if short-lived, impact on the rest of the world economy with 1985 weights, this impact becomes insignificant with 2009 weights. In the case of a GDP shock to emerging Asia, the transmission to the rest of the world is not statistically significant even with 1985 weights.

These results speak to an extent to the much-debated "decoupling" hypothesis. According to this hypothesis (see Kose and Prasad, 2010 for instance), emerging markets have "decoupled" from advanced economies in recent years in the sense that their growth dynamics have become more autonomous. As a result, emerging markets as a group are starting to be a autonomous source of world growth. The results above, taken together with those on the transmission of a China GDP shock, show that LAC5 and the rest of emerging Asia (excluding China and India) are still too small to have a meaningful impact on the world economy. They cannot, therefore, be counted as an autonomous source of world growth, like China, at least as yet.

What our findings also suggest is that LAC5 and the rest of emerging Asia remain a collection of small open economies whose fluctuations can be affected strongly by the international business cycle. The key change we document is that their cycle is now more exposed to China and less exposed to the US compared to the past (although the impact of a US GDP shock remains sizable). And not only directly *via* stronger bilateral trade ties, but also, and perhaps more importantly, *via* China's stronger ties with advanced economies. In other words, the evidence reported in this paper suggests that the "decoupling" of emerging market from advanced economies found in the existing literature (e.g., Kose and Prasad, 2010) is more likely related to the emergence of China as an important source of world growth as opposed to a widespread "decoupling" of emerging markets' business cycle from that of advanced economies.

6 Conclusions

In this paper we investigated how China's emergence in the world economy has affected the international transmission of business cycles to five large Latin American economies. Using a GVAR model for the 26 largest advanced and emerging economies in the world, estimated with quarterly data from 1979Q2 to 2009Q4 with time-varying trade weights, we conducted a series of counterfactual exercises with different sets of trade weights for years 1985, 1995, 2005, and 2009.

[32] See Figures C.6 to C.9 for the bootstrapped impulse responses to a LAC5 GDP shock and a GDP shock to emerging Asia.

We found that the long-run impact of a China GDP shock on the typical Latin American economy has tripled since the mid-1990s. In contrast, and consistent with the previous findings, the long-run effect of a US GDP shock has halved over the same period, with even sharper declines in short-term impact. We show that the larger impacts of a China GDP shock owe as much to indirect effects, associated with stronger trade linkages between China and Latin America's largest trade partners–the United States and the euro area–as to direct effects stemming from tighter trade linkages between China and Latin America, boosted by the decade-long boom in commodity prices that has inflated trade shares. The results also suggest that the transmission of domestic shocks originating in Latin America and the rest of emerging Asia (excluding China and India) has not changed much over the same period.

These findings help to explain why the five Latin American economies we consider recovered much faster than initially anticipated from the recent global crisis. In fact, the evidence shows that Latin America growth now owes more to a fast-growing economy that enacted a powerful fiscal stimulus during the global crisis and relatively less to the economy that was at the epicenter of the crisis. Had the trade linkages been those prevailing in the mid-1990s, the region would have likely suffered a much sharper downturn than it actually experienced. This evidence also suggests that the "decoupling" found in the existing literature might be related to the emergence of China as an important source of world growth as opposed to a more general tendency of emerging markets' business cycles to decouple from those of advanced economies.

But the same findings expose new vulnerabilities for Latin America and the rest of the world economy. Latin America remains a small open economy vulnerable to external shocks, without the necessary weight to affect the international business cycle with its own growth dynamics. Latin America, and the rest of the world economy, including its traditional and still largest trading partners, now relies relatively more on China and less on the United States compared to only 15 years ago. China is a large, low-middle income economy whose transition to a high-income economy will continue for many years to come. But China is also a relatively less stable and more volatile economy than the United States.[33] While the changes documented have had positive, stabilizing effects on Latin America business cycle during the recent global crisis, the same facts may predict negative, and destabilizing effects if and when China's growth begins to slow down. Thus, going forward, Latin America and the rest of the world economy are likely to become more volatile places.

[33] In fact, the average conditional standard deviation of a China GDP shock in the first stage of the GVAR analysis is more than twice as large as that of the United States.

Table 1: Trade shares for major trading blocks in 2009 and 1995

a) 2009

	US	Euro area	Japan	China	LAC5
US	-	0.17	0.18	0.22	0.51
Euro area	0.15	-	0.11	0.18	0.15
Japan	0.07	0.05	-	0.15	0.04
China	0.18	0.15	0.26	-	0.12
LAC5	0.18	0.06	0.03	0.05	-
Others	0.42	0.58	0.42	0.39	0.18
Sum	1.00	1.00	1.00	1.00	1.00

b) 1995

	US	Euro area	Japan	China	LAC5
US	-	0.19	0.31	0.21	0.60
Euro area	0.16	-	0.13	0.17	0.18
Japan	0.17	0.09	-	0.30	0.07
China	0.05	0.04	0.09	-	0.02
LAC5	0.13	0.05	0.03	0.02	-
Others	0.50	0.63	0.43	0.29	0.13
Sum	1.00	1.00	1.00	1.00	1.00

Note: Trade share of country i with respect to country j is defined as the sum of country i's imports from country j and exports to country j divided by the sum of country i's total imports and exports. They are displayed in columns by country such that a column sums to one. Source: Direction of Trade Statistics, IMF.

Table 2: Trade shares for LAC5 countries in 2009 and 1995

a) 2009

	Argentina	Brazil	Chile	Mexico	Peru
US	0.12	0.17	0.20	0.70	0.25
Euro area	0.17	0.23	0.16	0.07	0.14
Japan	0.02	0.05	0.08	0.02	0.06
China	0.13	0.16	0.18	0.06	0.16
Other LAC	0.43	0.17	0.20	0.03	0.20
Others	0.13	0.21	0.18	0.12	0.18
Sum	1.00	1.00	1.00	1.00	1.00

b) 1995

	Argentina	Brazil	Chile	Mexico	Peru
US	0.16	0.25	0.23	0.83	0.29
Euro Area	0.26	0.28	0.21	0.06	0.22
Japan	0.03	0.08	0.14	0.03	0.08
China	0.03	0.03	0.02	0.00	0.05
Other LAC	0.39	0.18	0.20	0.02	0.19
Others	0.13	0.18	0.19	0.06	0.18
Sum	1.00	1.00	1.00	1.00	1.00

Note: Trade weights are computed as shares of exports and imports. They are displayed in columns by country such that a column sums to one. Source: Direction of Trade Statistics, IMF.

Table 3: Countries and Regions in the GVAR Code

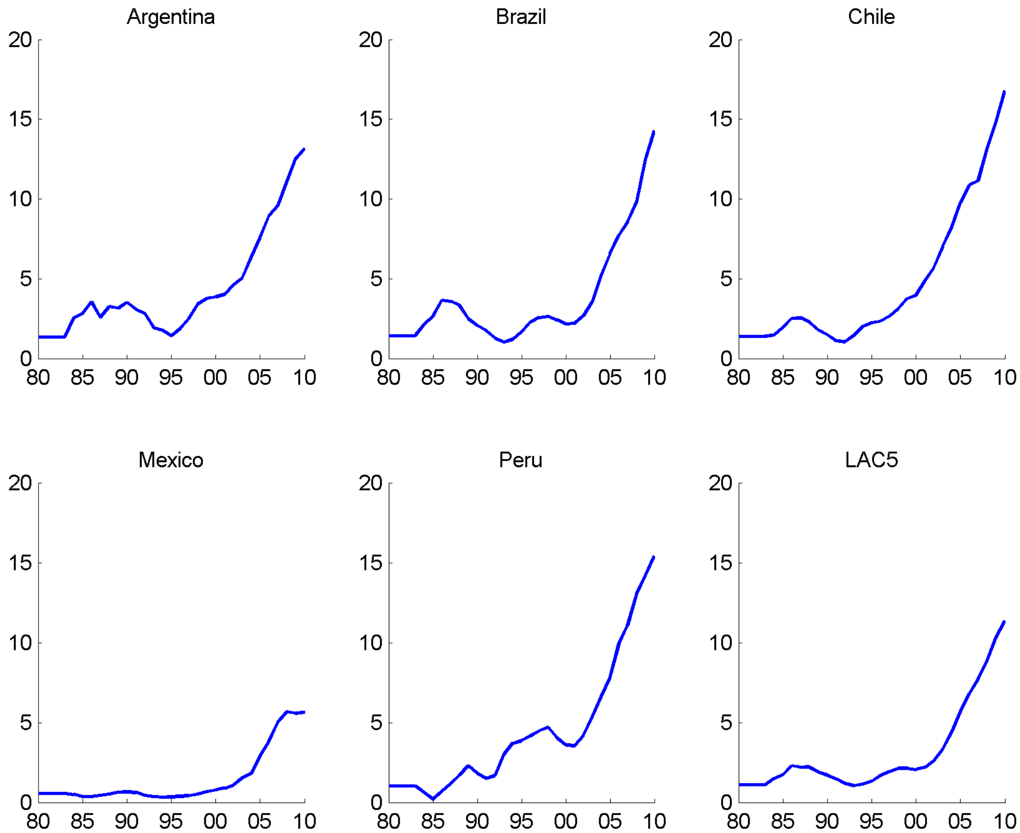
Core economies	**Euro Area**	**Latin America**
US	Austria	Argentina
China	Belgium	Brazil
UK	Finland	Chile
Japan	France	Mexico
	Germany	Peru
Other developed countries	Italy	
Australia	Netherlands	
Canada	Spain	
New Zealand		
Rest of Emerging Asia	**Rest of Western Europe**	**Rest of the world**
Indonesia	Norway	India
Korea	Sweden	South Africa
Malaysia	Switzerland	Saudi Arabia
Philippines		Turkey
Singapore		
Thailand		

Table 4: Variables Specification of the Country-specific VARX* Models

Non-US models		**US model**	
Domestic	Foreign	Domestic	Foreign
y_{it}	y_{it}^*	y_{US}	y_{US}^*
π_{it}	π_{it}^*	π_{US}	π_{US}^*
q_{it}	q_{it}^*	q_{US}	
ρ_{it}^S	ρ_{it}^{S*}	ρ_{US}^S	ρ_{US}^{S*}
ρ_{it}^L	ρ_{it}^{L*}	ρ_{US}^L	-
$e_{it} - p_{it}$	-	-	$e_{US}^* - p_{US}^*$
-	p_t^o	p_t^o	-

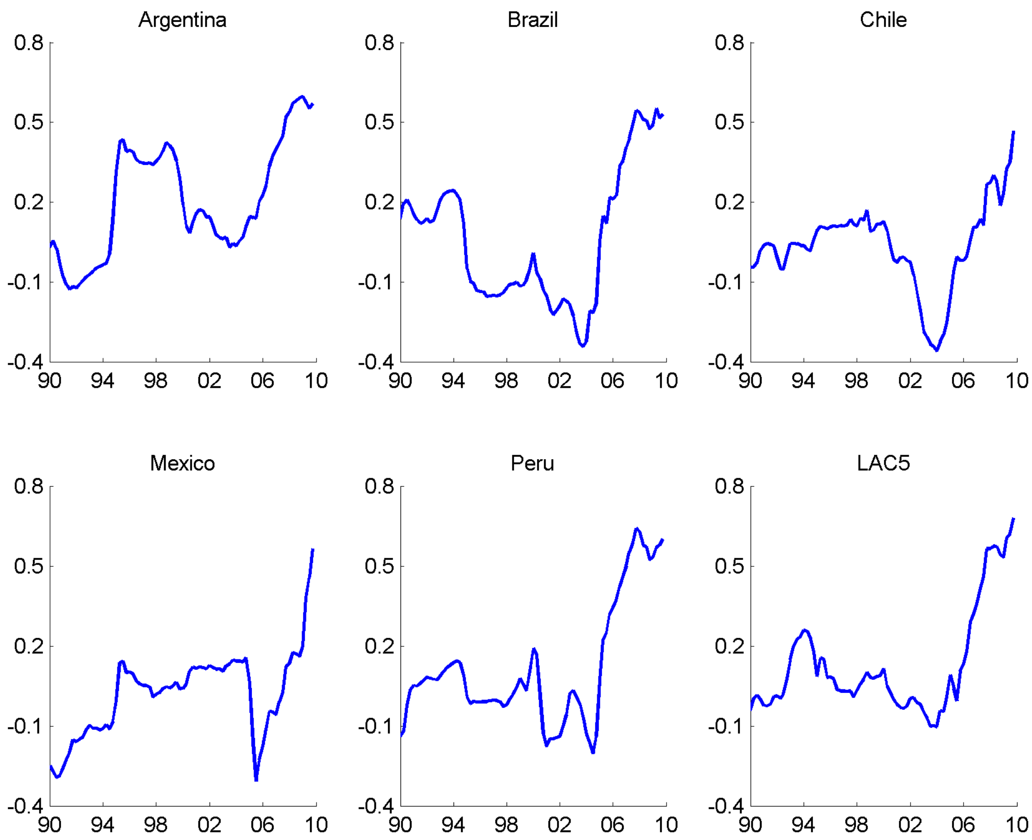
Note: In the non-US models the inclusion of the listed variables depends on data availability.

Figure 1: China's Trade Share in LAC5's Total Trade (Annual; in percent; 1980- 2009)



Note: Trade share of country i with respect to country j is defined as the sum of country i's imports from country j and exports to country j divided by the sum of country i's total imports and exports. LAC5 is constructed by using weights based on the PPP valuation of country GDP. Source: IMF Direction of Trade Statistics.

Figure 2: Comovements Between LAC5 and China GDP Growth (10-year moving correlation of annual growth rates; 1990-Q1 - 2009-Q4)



Note: LAC5 is constructed by using weights based on the PPP valuation of country GDP. Source: IMF International Financial Statistics.

Figure 3: GIRFs for One Percent Increase in China GDP (World economy and LAC5; point estimates; 1985, 1995, 2005, and 2009)

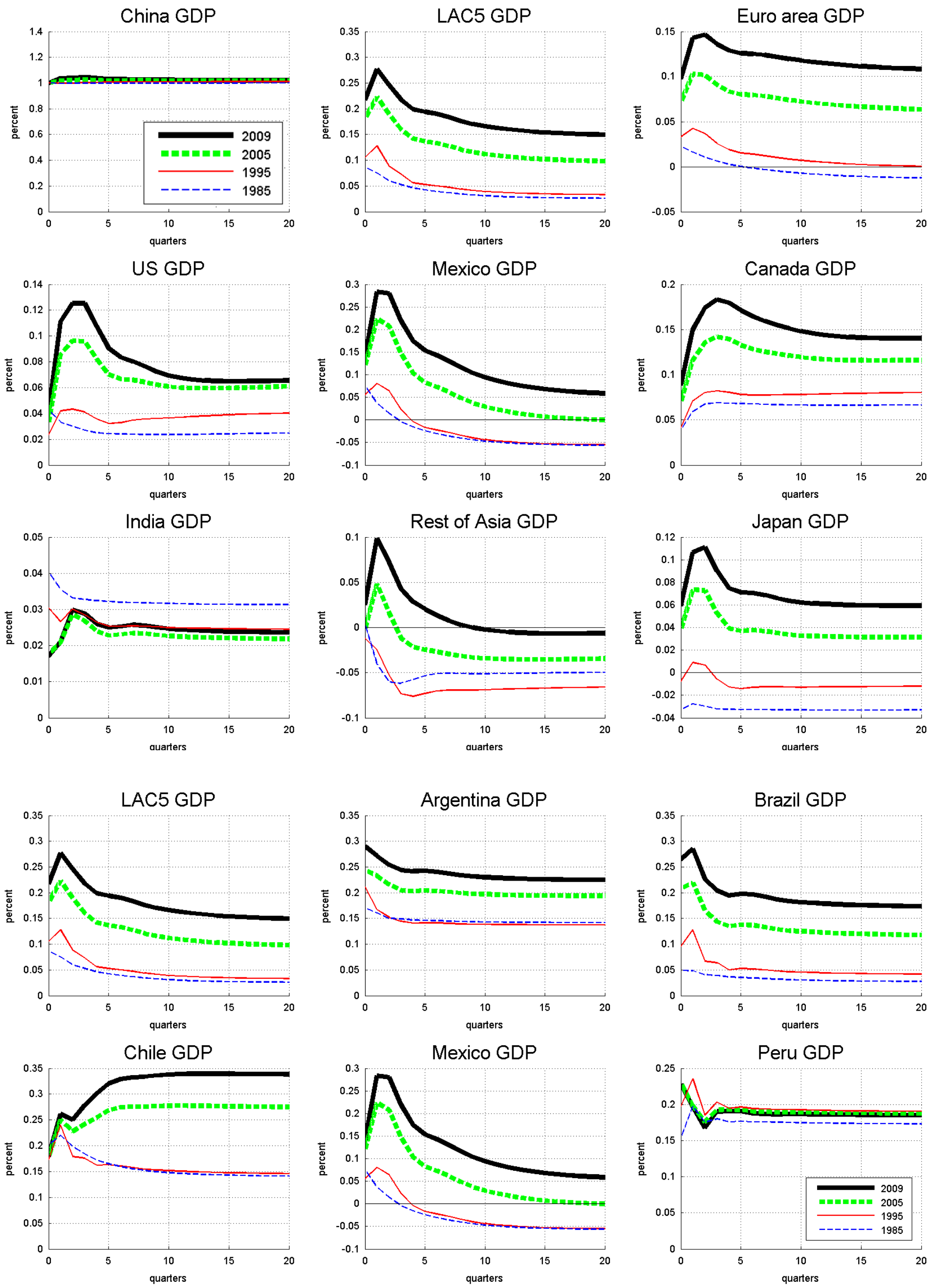
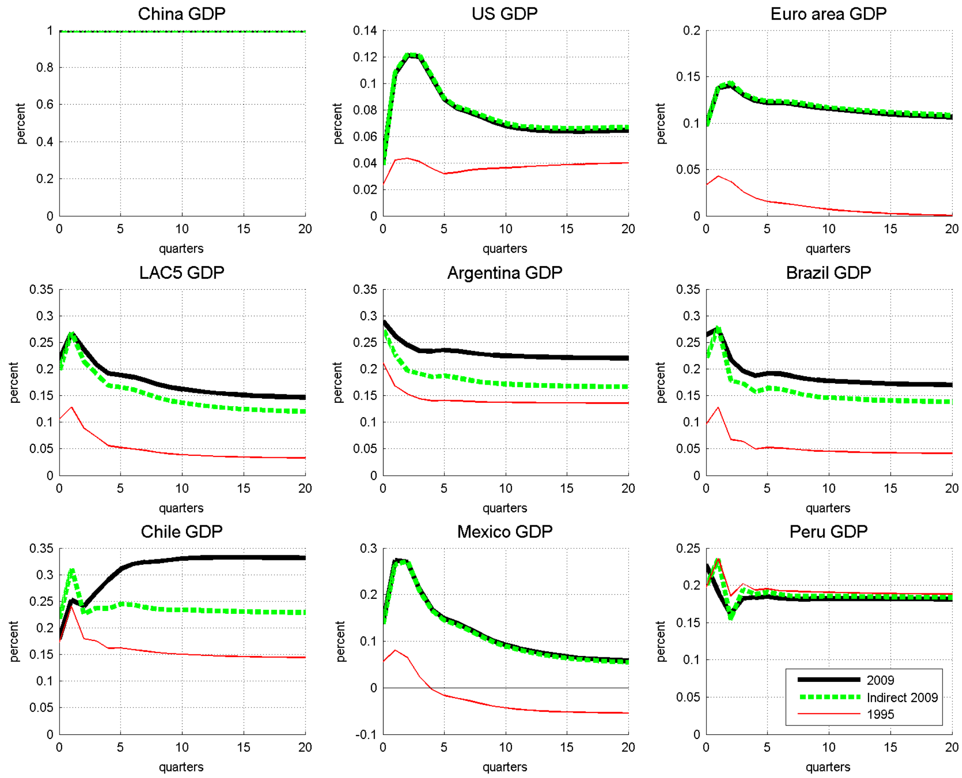


Figure 4: GIRFs for One Percent Increase in China GDP: Total and Indirect Effect (World economy and LAC5; point estimates; 2009, Indirect 2009, and 1995)



Note: The indirect effect (labeled "Indirect 2009") is computed by lowering the trade shares of China in the LAC5 countries (except Mexico) to their 1995 levels.

Figure 5: GIRFs for One Percent Increase in US GDP (World economy and LAC5; point estimates; 1985, 1995, 2005, and 2009)

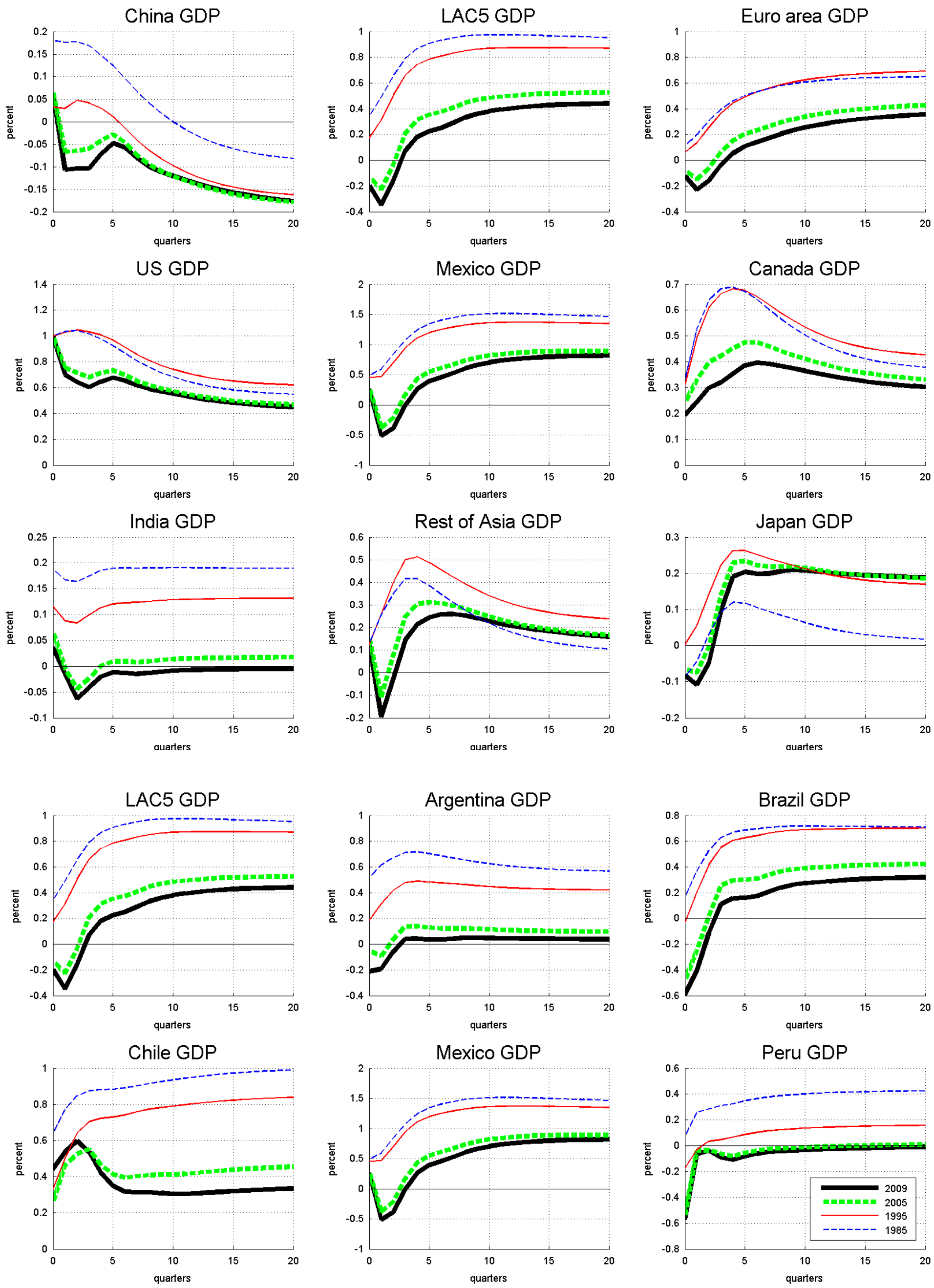


Figure 6: GIRFs for One Percent Increase in LAC5 GDP (World economy and LAC5; point estimates; 1985, 1995, 2005, and 2009)

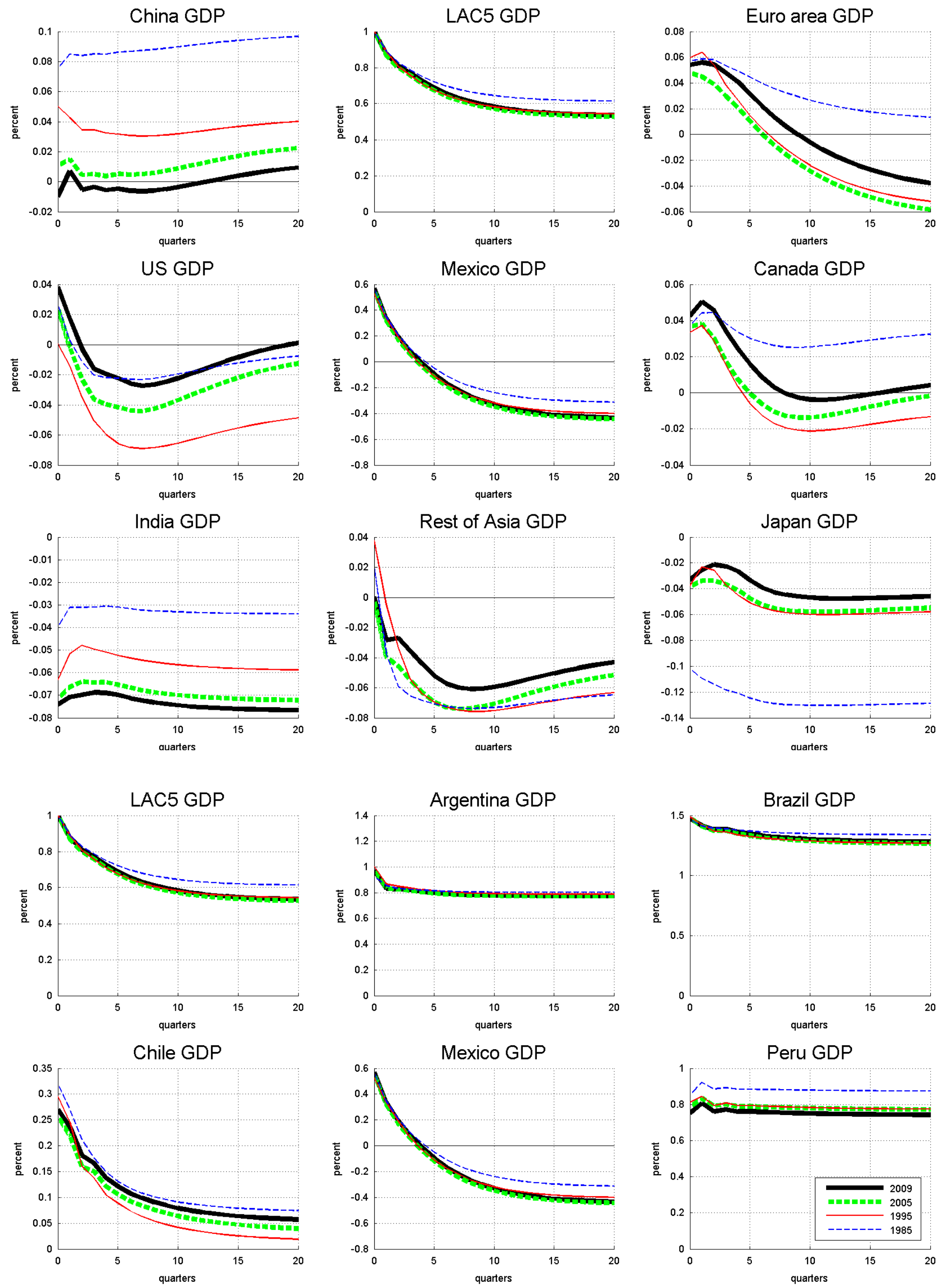


Figure 7: GIRFs for One Percent Increase in rest of Asia GDP (World economy and LAC5; point estimates; 1985, 1995, 2005, and 2009)