The contribution of domestic, regional and international factors to Latin America's business cycle

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The contribution of domestic, regional and international factors to Latin America's business cycle

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Abstract

This paper quantifies the relative contribution of domestic, regional and international factors to the fluctuation of domestic output in six key Latin American (LA) countries: Argentina, Bolivia, Brazil, Chile, Mexico and Peru. Using quarterly data over the period 1980:1-2003:4, a multi-variate, multi-country time series model was estimated to study the economic interdependence among LA countries and, in addition, between each of them and the three world largest industrial economies: the US, the Euro Area and Japan. Falsifying a common suspicion, it is shown that the proportion of LA countries' domestic output variability explained by industrial countries' factors is modest. By contrast, domestic and regional factors account for the main share of output variability at all simulation horizons. The implications for the choice of the exchange rate regime are also discussed.

Key words: International business cycle, Latin America, exchange rate regimes, Global VAR methodology, VECM.

JEL Codes: C32, E32, F31, F41.

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1 Introduction

In keeping with the central message of the Optimal Currency Areas (OCAs) literature initiated by Mundell (1961) and McKinnon (1963), detecting the sources of business cycle has important implications for the choice of exchange rate regimes. If, in fact, one economy is hit by shocks dissimilar to those hitting its trading partner countries, the cost of adopting a fixed exchange rate regime, and thus giving up monetary policy, can be correspondingly large. The canonical criteria suggested by early contributions to OCAs (e.g. Artis (2003), HM Treasury (2003)) also state that if the standard pre-requisites for successful currency area hold, a fixed exchange rate regime may gain stability before adverse shocks make it fail. In many academic and policy circles, these criteria, although more than forty-years-old, are still considered to be a useful framework to consult when deciding upon the adoption of a common currency.

Following the currency and financial crises of the nineties, and especially the Argentine turmoil of 2001-2002, a wide debate has concerned the choice among available currency regimes options for Latin American countries (e.g. Edwards (2002), Berg *et al.* (2002)). This work aims to analyse to what extent domestic, regional and international economic conditions affect domestic output fluctuations in six key Latin American (LA) countries – namely Argentina, Bolivia, Brazil, Chile, Mexico and Peru – and the implications for the choice of the exchange rate regime. This country sample is chosen mainly to compare more easily our results to those of the existing literature to be reviewed below, and especially Ahmed (2003) and Canova (2005). Our analysis is naturally related to the strand of research studying the co-movement of LA countries' business cycles with each other and with developed economies'. Hoffmaister and Roldos (1997) document that domestic country-specific aggregate supply shocks are by far the most important source of output fluctuations in LA countries. Aiolfi *et al.* (2006) uncover a sizeable common component in LA countries' business cycles using common dynamic factors techniques, thus suggesting the existence of a regional cycle. On the other hand, Agénor *et al.* (2000) point out that the business cycle in 12 developing countries is positively related to the output and real interest rate fluctuations in industrial economies, albeit they do not try to quantify the importance of external shocks compared to domestic ones. Employing a Bayesian dynamic latent factor model, Kose *et al.* (2003) and Kose *et al.* (2008) estimate the world, region and country-specific components in output, consumption and investment of sixty countries covering seven regions. As far as concerns Latin America, Kose *et al.* (2003) find that country-specific factors explain the largest part of the variance of output in all LA countries considered in this study, with the exception of Bolivia, for which the regional world component is more important than the region and country-specific one.

From a wider perspective, our analysis is also related to the literature on the link between international business cycles and the choice of a proper exchange rate regime for a small open economy. Berg *et al.* (2002) find that supply shocks in LA countries are weakly correlated among them and, most importantly, with the US ones, providing evidence against the adoption of a common currency in the region or against straight "dollarisation". Ahmed (2003) focuses on the existence of the prerequisites for six LA countries to adopt a fixed exchange rate regime with their main trading partners (the US). While domestic business cycles seems to be driven by US monetary policy rather than by foreign output shocks, external shocks taken as a whole (foreign output, US interest rates, terms of trade) explain a smaller component of the LA business cycle than domestic shocks (output, real exchange rate, inflation); this results points towards the adoption of a freely floating exchange rate. By contrast, Canova (2005) finds that US monetary policy shocks, magnified by the interest rates transmission channel, are a relevant source of fluctuations of LA countries' inflation and output.

The critical difference between the papers cited above and our study is three-fold. *First*, besides the US we also consider the Euro Area and Japan as possible sources of external shocks to domestic business cycles in LA countries. This is partly motivated by the trade relationship between LA and Euro Area countries. But, as it will become apparent below, this is not the entire story since financial linkages – through NFA and short-term interest rates – play a determinant role. *Second*, we examine the role exerted by neighbour countries on each LA country's business cycle in order to assess the existence of the pre-requisites for the adoption of a common currency area. *Third*, our empirical framework is explicitly designed to identify shocks according to their geographical origin. The latter point is particularly important when comparing our results to those obtained by Kose *et al.* (2003) and Kose *et al.* (2008). In fact, while they can only recover the different components of the variables of interest, using the GVAR methodology it is possible to identify the role played by specific foreign economies to the domestic business cycle.

The econometric methodology consists of a procedure for aggregating a number of VEC systems in a global vector autoregressive (GVAR) model describing the world economy (Pesaran *et al.* (2004a)) in order to perform dynamic simulation exercises. Using quarterly data over the period 1980:1-2003:4, nine country/region-specific vector error correction (VEC) models were estimated, each containing four endogenous domestic variables (output, real interest rate, real exchange rate, net foreign assets), two foreign variables (foreign output and foreign real interest rate) and the price of oil. This is consistent with a parsimonious, reduced form, small open economy model such as that presented in Boschi (2007). Country-specific foreign variables, constructed as weighted averages of the endogenous variables of the other countries/regions, and the real oil price are modelled as weakly exogenous.

The main findings can be summarised as follows. *First,* domestic factors explain by far the largest share of domestic output variability over all simulation horizons in all LA countries. *Second,* regional factors, though much less important than domestic ones, contribute to the variability of domestic output more than industrial countries' ones. This is true for all LA countries except Mexico. *Third*, in all LA countries the proportion of the forecast error variance of output explained by industrial countries factors is overall modest. These results should inform the choice between freely floating and fixed exchange rate regimes. Also, they should be taken into account when choosing a reference currency in a fixed exchange rate arrangement: "dollarisation" does not appear an obvious option. Aside from their scientific merits and policy implications, our findings that international risk sharing could be problematic at a regional level but it is still viable when capital crosses continents is consistent with the conclusions in Aiolfi *et al.* (2006) and may also be of benefit to international investors.

The remainder of the paper is structured as follows. Section 2 reviews the inter-regional macro-econometric framework. Section 3 presents preliminary analysis on the individual series as well as the main estimation results relative to country/region VEC systems and the properties of the GVAR model. The quantitative assessment of the geographical sources affecting output fluctuations in LA countries is discussed in Section 4 along with the main policy implications. Concluding remarks follow.

2 Modelling Latin American economies in a multi-country framework

The empirical framework we use to model LA economies in the international context relies on the GVAR approach (Pesaran *et al.* (2004a)). As customary in the VEC modelling framework, the GVAR methodology builds on the association between the economic concept of long-run and the statistical concept of stationarity through the identification of stationary linear combinations of the data, known as cointegration vectors. These vectors describe the steady-state configuration which the model tends to revert to in the long-run. The advantages of the GVAR over panel cointegration techniques are well-known (Baltagi (2004) and Pesaran *et al.* (2004b)) and relate to the possible distortion of within-group cointegration test results caused by the existence of between-group cointegration, as shown by Banerjee *et al.* (2004). Also, the GVAR allows for a coherent analysis of short-run dynamics of the systems through scenario simulations.

Specifically, the GVAR methodology consists of a procedure for stacking in a single coherent model of the world economy a number of country-specific VEC systems and explicitly allows for interdependences across economies in a true multi-country setting. The crucial advantage of this methodology is that although the shocks hitting the variables of the global system are unidentified according to their economic nature (for instance, supply, demand or policy disturbances), nevertheless they are identified basing on their geographic origin. This is because each country/region-specific system in the multi-country model is estimated conditionally on foreign variables, thus leaving only modest correlation among cross-country shocks to endogenous factors. Thus, our empirical framework makes it possible to distinguish and identify the shocks which originated in the three industrial countries/regions (US, Euro Area and Japan), in addition to those which originated in each LA country, rather than considering only one country (commonly the US in the previous literature) or an ambiguous "rest of the world" as the main source of external shocks.

2.1 The GVAR model

Adopting the same notation as in Pesaran *et al.* (2004a), there is benefit in reviewing the econometric setup employed in this work. There are $N+1$ countries/regions in the world economy indexed by $i = 0, 1, ...N$.[1] For each country the following VEC model is estimated:[2]

$$\begin{aligned}\Delta\mathbf{x}_{it} &= \mathbf{a}_{i0} + \mathbf{a}_{i2}\mathbf{D}_{it} + \mathbf{\Pi}_i\boldsymbol{\kappa}_i - \mathbf{\Pi}_i\left[\mathbf{v}_{i,t-1} - \boldsymbol{\kappa}_i\left(t-1\right)\right] + \mathbf{\Lambda}_{i0}\Delta\mathbf{x}^*_{it} \\ &\quad + \mathbf{\Psi}_{i0}\mathbf{\Delta}\mathbf{d}_t + \boldsymbol{\varepsilon}_{it} \qquad (1)\end{aligned}$$

where $\mathbf{x}_{it}$ is a $(k_i \times 1)$ vector of country i domestic variables, $\mathbf{x}^*_{it}$ is a $(k^*_i \times 1)$ vector of foreign variables specific to country i (to be defined below), and $\mathbf{d}_t$ is a $(k_d \times 1)$ vector of $I(1)$ variables common to all country-specific models and exogenous to the global economy (such as oil prices), $\mathbf{v}_{i,t-1} \equiv \left(\mathbf{z}'_{i,t-1}, \mathbf{d}''_{t-1}\right)$, $\mathbf{z}_{it} \equiv (\mathbf{x}'_{it}, \mathbf{x}^{*\prime}_{it})'$, $\mathbf{a}_{i0}$ is a $(k_i \times 1)$ vector of fixed intercepts, $\mathbf{a}_{i2}$ is a $(k_i \times m)$ matrix of coefficients of the exogenous deterministic components included in the $(m \times 1)$ vector $\mathbf{D}_{it}$, $\mathbf{\Lambda}_{i0}$ is a $(k_i \times k^*_i)$ matrix of coefficients associated to the foreign variables, $\mathbf{\Psi}_{i0}$ is a $(k_i \times k_d)$ vector associated to the global variables, $\boldsymbol{\varepsilon}_{it}$ is a $(k_i \times 1)$ vector of country-specific shocks, with $\boldsymbol{\varepsilon}_{it} \sim N\left(\mathbf{0}, \mathbf{\Sigma}_{ii}\right)$, where $\mathbf{\Sigma}_{ii}$ is a non-singular variance-covariance matrix, and where $t = 1, 2, .., T$ indexes time. The number of long-run relations is given by the rank $r_i \leq k_i$ of the $k_i \times (k_i + k^*_i + k_d)$ matrix $\mathbf{\Pi}_i$. Finally, in order to avoid introducing quadratic trends in the levels of the variables when $\mathbf{\Pi}_i$ is rank-deficient, $(k_i - r_i)$ restrictions $\mathbf{a}_{i1} = \mathbf{\Pi}_i\boldsymbol{\kappa}_i$ are imposed on the trend coefficients, where $\mathbf{a}_{i1}$ is the coefficient of the time trend term in the isomorphic level VAR form of (1) and $\boldsymbol{\kappa}_i$ is a $(k_i + k^*_i + k_d) \times 1$ vector of fixed constants.

The foreign variables $\mathbf{x}^*_{it}$ are weighted averages of the variables of the rest of the world with country/region-specific weights, w_{ij}, given by trade shares, i.e. the share of country j in the total trade of country i over the years 1995-2001, measured in 1995 US dollars. Thus a generic foreign variable x^*_{it} is given by:

$$x^*_{it} = \sum_{j=0}^{N} w_{ij}x_{jt} \qquad (2)$$

[1] $N = 8$ in this paper. $i = 0$ is the reference country (the US).

[2] The exposition refers to a VARX* of order one, as suggested by the standard information criteria and by the diagnostic tests discussed below.

where $w_{ii} = 0$, $\forall i = 0, 1, ..., N$ and $\sum_{j=0}^{N} w_{ij} = 1$, $\forall i, j = 0, 1, ..., N$. In our set-up, all foreign variables collected in the vector $\mathbf{x}_{it}^{*}$ as well as the global exogenous variables, $\mathbf{d}_t$, are treated as long-run forcing variables.

Rather than estimating directly the complete system composed by the $N + 1$ country-specific models (1) together with the relations (2), we followed Pesaran *et al.* (2004a) and estimate the parameters of each country-specific model separately and then stack the coefficients estimates in a GVAR model. All country/region-specific endogenous variables are collected in the $k \times 1$ global vector $\mathbf{x}_t = (\mathbf{x}'_{0t}, \mathbf{x}'_{1t}, ..., \mathbf{x}'_{Nt})'$ where $k = \sum_{i=0}^{N} k_i$. Then we have that $\mathbf{z}_{it} = \mathbf{W}_i \mathbf{x}_t$, where $\mathbf{W}_i$ is the $(k_i + k_i^*) \times k$ matrix collecting the trade weights w_{ij}, $\forall i, j = 0, 1, ...N$.

Therefore, for each country/region the following VAR form of model (1) is obtained:

$$\mathbf{A}_i \mathbf{W}_i \mathbf{x}_t = \mathbf{a}_{i0} + \mathbf{a}_{i1} t + \mathbf{a}_{i2} \mathbf{D}_{it} + \mathbf{B}_i \mathbf{W}_i \mathbf{x}_{t-1} + \mathbf{\Psi}_{i0} \mathbf{d}_t + \mathbf{\Psi}_{i1} \mathbf{d}_{t-1} + \boldsymbol{\varepsilon}_{it} \quad (3)$$

where $\mathbf{A}_i$ and $\mathbf{B}_i$ are matrices of dimension $k_i \times (k_i + k_i^*)$ and matrix $\mathbf{A}_i$ has full row rank. Stacking the $N + 1$ systems (3) yields the following GVAR in level form:

$$\mathbf{G} \mathbf{x}_t = \mathbf{a}_0 + \mathbf{a}_1 t + \mathbf{a}_2 \mathbf{D}_t + \mathbf{H} \mathbf{x}_{t-1} + \mathbf{\Psi}_0 \mathbf{d}_t + \mathbf{\Psi}_1 \mathbf{d}_{t-1} + \boldsymbol{\varepsilon}_t \quad (4)$$

where $\mathbf{G}$ is a $k \times k$ full rank matrix, $\mathbf{a}_h = (\mathbf{a}_{0h}, ..., \mathbf{a}_{Nh})'$ for $h = 0, 1, 2$, $\mathbf{G} = (\mathbf{A}_0 \mathbf{W}_0, ..., \mathbf{A}_N \mathbf{W}_N)'$, $\mathbf{H} = (\mathbf{B}_0 \mathbf{W}_0, ..., \mathbf{B}_N \mathbf{W}_N)'$, for $h = 0, 1$, $\mathbf{\Psi}_h = (\mathbf{\Psi}_{0h}, ..., \mathbf{\Psi}_{Nh})'$ for $h = 0, 1$, $\mathbf{D}_t = (\mathbf{D}_{0t}, ..., \mathbf{D}_{Nt})'$. The GVAR has the reduced form:

$$\mathbf{x}_t = \mathbf{b}_0 + \mathbf{b}_1 t + \mathbf{b}_2 \mathbf{D}_t + \digamma \mathbf{x}_{t-1} + \mathbf{\Upsilon}_0 \mathbf{d}_t + \mathbf{\Upsilon}_1 \mathbf{d}_{t-1} + \mathbf{u}_t \quad (5)$$

where $\mathbf{b}_h = \mathbf{G}^{-1} \mathbf{a}_h$, for $h = 0, 1, 2$, $\digamma = \mathbf{G}^{-1} \mathbf{H}$, $\mathbf{\Upsilon}_h = \mathbf{G}^{-1} \mathbf{\Psi}_0$, for $h = 0, 1$, and $\mathbf{u}_t = \mathbf{G}^{-1} \boldsymbol{\varepsilon}_t$.[3]

[3] As pointed out by Pesaran *et al.* (2004a), three conditions need to be fullfilled so as to ensure that the GVAR estimation procedure is indeed equivalent to the simultaneous estimation of the VAR model of the world economy. *First*, the global model must be dynamically stable, i.e. the eigenvalues of matrix $\digamma$ in equation (5) lie either on or inside the unit circle. *Second*, trade weights must be such small that $\sum_{j=0}^{N} w_{ij}^2 \to 0$, as $N \to \infty$, for all i. *Third*, the cross-dependence of the idiosyncratic shocks must be sufficiently small, so that $\frac{\sum_{j=0}^{N} \sigma_{ij,ls}}{N} \to 0$, as $N \to \infty$, for all i, l, and s, where $\sigma_{ij,ls} = cov(\varepsilon_{ilt}, \varepsilon_{jst})$ is the covariance of the l^{th} variable in country i with the s^{th} variable in country j. These conditions amount to an econometric formalisation of the economic concept of "small open economy" and are discussed in details in Section 3 below.

2.2 Generalised Forecast Error Variance Decomposition

The bulk of our empirical investigation is conducted using the Generalised Forecast Error Variance Decomposition (GFEVD) developed by Koop *et al.* (1996) and Pesaran and Shin (1998). The GFEVD considers the proportion of the variance of the n-step ahead forecast error of the variable of interest which is explained by conditioning on the non-orthogonalised shocks u_{jt}, $u_{j,t+1}$, ..., $u_{j,t+n}$, for $j = 1,..., k$, while explicitly allowing for the contemporaneous correlations between these shocks and the shocks to the other equations in the system.[4] Although this methodology prevents a structural interpretation of the impulses, it overcomes the identification problem by providing a meaningful characterisation of the dynamic responses of variables of interest to typically observable shocks.[5] One useful feature of the GFEVD is its invariance to the ordering of the variables. Formally, the proportion of the n-step ahead forecast error variance of the l^{th} element of $\mathbf{x}_t$ accounted for by the innovations in the j^{th} element of $\mathbf{x}_t$ can be expressed as:

$$\begin{aligned} \text{GFEVD}(\mathbf{x}_{(l)t;}u_{(j)t}, n) &= \frac{\sigma_{jj}^{-1}\sum_{l=0}^{n}\left(\mathbf{s}_l' F^n \mathbf{G}^{-1}\boldsymbol{\Sigma}\mathbf{s}_j\right)^2}{\sum_{l=0}^{n}\mathbf{s}_l' F^n \mathbf{G}^{-1}\boldsymbol{\Sigma}\mathbf{G}'^{-1} F'^n \mathbf{s}_l} \\ n &= 0, 1, 2, ...; l = 1, ..., k; j = 1, ..., k \end{aligned} \qquad (6)$$

where all symbols are defined above.[6]

[4] It is worth emphasising that this is the reason why the GFEVD encompasses simpler methods traditionally used to assess cross-country business cycle asymmetry such as the correlation analysis of shocks (e.g. Berg *et al.* (2002)).

[5] We resort to GFEVD because it is impossible to recover the structural shocks from the GVAR residuals due to the large number of variables whose contemporaneuos relationship is ignored. In the GVAR estimated in this paper, including $k_i = 4$ endogenous variables for each of the $N+1 = 9$ country models, exact identification of shocks would require 108 (i.e. $\sum_{i=0}^{N} k_i(k_i - 1)$) restrictions derived by economic theory, which seems an impossible task to undertake. Dees *et al.* (2007a) identify the shocks to US monetary policy by imposing a recursive structure on the US block of the variance-covariance matrix of the GVAR. However, this excercise is beyond the scope of this paper.

[6] Notice that due to the possible non-diagonal form of matrix $\boldsymbol{\Sigma}$, the elements of GFEVD across j need not sum to unity since shocks are not orthogonal. However, in order to facilitate cross-country comparisons and interpretation of results, the sum of variance decompositions are normalised to 100.

3 Preliminary analyses and estimation results

Data description Time series data for the following countries/regions were considered: Argentina, Bolivia, Chile, Brazil, Mexico, Peru, the US, Japan and the Euro Area. We use quarterly seasonally adjusted series covering the period 1980:1-2003:4.[7] The Euro Area variables were constructed as weighted averages of the corresponding time series of the following countries in the region, with weights given by the *per capita* PPP-GDP share of the period 1995-2000: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain.[8] For each country/region, a VEC model (1) was estimated, where the vector of endogenous variables, $\mathbf{x}_{it}$, includes (y_t, sr_t, q_t, nfa_t), denoting real per-capita output, short-term real interest rate, real exchange rate and the net foreign asset/nominal GDP ratio respectively; the vector of country-specific foreign variables, $\mathbf{x}^*_{it}$, includes (y^*_t, sr^*_t), representing the rest of the world real per-capita output and short-term interest rate, respectively; finally, the vector $\mathbf{d}_t$ includes the oil price in real terms, oil_t, as a global weakly exogenous variable.[9] The matrix of trade weights used to construct the country/region-specific foreign variables is reported in Table 1, where the 1995 - 2001 trade shares are displayed in column by country/region. The Appendix indicates in detail data sources and variables construction.

[Table 1 about here]

Unit root tests As a preliminary exercise, we carried out standard ADF unit root tests on the time series involved. Panel [A] of Table 2 reports results based on AIC order selection, while statistics shown in Panel [B] use the modified AIC method proposed by Ng and Perron (2001) to correct the size distortion of

[7] Note that the 1980s mark the beginning of the modern wave of international capital flows to Latin America and thus analysing the role of this factor in domestic business cycle prior to the sample start makes little sense.

[8] On the validity of the aggregating expedient to construct synthetic time-series for the Euro Area economy as a whole see Girardi and Paesani (2008) among others.

[9] Boschi (2007) motivates the inclusion of these variables in the GVAR basing on a small open economy model of net foreign assets and real exchange rate determination. Furthermore, we follow Dees *et al.* (2007b) in treating the real exchange rate as an endogenous variable. As for net foreign assets, a number of studies (Girardi and Paesani (2008), Lane and Milesi-Ferretti (2004) among others) suggest that it is driven by both domestic and foreign factors, giving support to our modelling strategy.

ordinary ADF test statistics.

[Table 2 about here]

Furthermore, in order to take into account the possibility of structural breaks due to financial crises and recessions, we performed the ADF unit root test with breaks proposed by Saikkonen and Lütkepohl (2002) and Lanne *et al.* (2002, 2003). The results are reported in Table 3, Panels [A] and [B]. Since the distribution under the null hypothesis is non-standard, we use the critical values provided by Lanne *et al.* (2002).

[Table 3 about here]

Overall, the combination of both types of tests (standard and with breaks), indicate that all variables can be reasonably considered to be driven by $I(1)$ stochastic trends. On the other hand, differencing the series appears to induce stationarity.[10]

Determination of the autoregressive order We chose the lag length of the endogenous variables, p_i, by combining standard selection criteria; namely the Akaike information criterion (AIC), the Schwarz Bayesian criterion (SBC) and the log-likelihood ratio statistic (LR). These criteria were adjusted to take into account the potential small sample problems, starting from a maximum lag order of four. The results, reported in Table 4, indicate that the SBC suggests order one for all models except Bolivia, Mexico and US, the AIC selects order four for Chile, Mexico and the Euro Area, order three for Peru, order two for Argentina, Bolivia, Japan and the US, and order one for Brazil, while the LR favours an order of autoregression higher than four for Mexico, three for Chile, Peru, and Euro Area, two for Bolivia, Japan, and US, one for Argentina and Brazil.

[Table 4 about here]

[10] The only exceptions are the real exchange rate of Mexico that seems to be stationary, and the net foreign assets of Bolivia, which appear to be $I(2)$. We choose to model these variables as realizations of $I(1)$ processes since the actual integration properties of the real exchange rate series of Mexico are likely to depend on the composition of its trading partners prices and exchange rates. For example, using a different basket of trading partners, Boschi (2007) finds that the real exchange rate of Mexico is $I(1)$. The net foreign assets of Bolivia were treated as $I(1)$ since this hypothesis is rejected at the 5 percent confidence level but not at the 10 percent.

Given the alternatives, and taking into account the limited sample size compared to the number of unknown parameters in each VARX* model, where X* indicates foreign exogenous variables, the lag order p_i is set equal to 1. This choice is comforted by the fact that the SBC estimates the lag order consistently, while the AIC does not (Lütkepohl (2006), p. 151). In order to choose the lag order of the foreign specific variables, q_i, an unrestricted VAR was run for each country/region in which the foreign variables are treated as endogenous, obtaining similar results.[11] Basing on this evidence and considering data limitations, we set q_i equal to one in all models.

Misspecification tests The selected lag order and the inclusion of dummy variables corresponding to residual values larger than 3.5 times the standard error is sufficient to obtain a satisfactory specification of the models, giving support to our model specification strategy. Univariate specification tests, reported in Table 5, show that the null hypothesis of no serial correlation is rejected only in 5 out of 36 equations at the standard confidence level, while the null of normality is rejected only in 3 equations. Finally, the univariate F test rejects the null of homoscedasticity only for Japanese output and US real exchange rate at 5 percent level.

[Table 5 about here]

In order to detect possible parameters instability due to structural breaks conventional CUSUM and CUSUMSQ tests at single equation level for each model were undertaken. The results, unreported here to preserve space, were comforting since episodes of parameters instability emerge only for a limited number of equations and only for very short periods of time.[12]

Cointegration tests Table 6 reports the maximum eigenvalue and trace tests statistics together with their associated 90 and 95 percent critical values. Both tests select unambiguously a cointegration rank equal to 1 for Brazil, Mexico, Peru, and Japan, and 4 for the US. For the other models, where the results were less

[11] These results are unreported to save space, but are available on request.

[12] These are the beginning of the nineties for the Argentinian, Chilean, Peruvian, and US net foreign assets, for the Chilean, Mexican, and Peruvian real interest rate, and for the Mexican and US real exchange rate; the beginning of the eighties for the Chilean and US output. Complete CUSUM and CUSUMSQ tests results are available on request.

clear cut, we favoured the conclusion of the trace test comforted by Johansen (1992), according to which the maximum eigenvalue test may produce a non-coherent testing strategy. Thus, we set a cointegration rank of 1 for Argentina, and 2 for Bolivia and the Euro Area. As for Chile, after considerable experimentation, a rank of 2 was chosen in order to have a more stable Global VAR.[13]

[Table 6 about here]

Properties of the Global VAR Since in the GVAR the total number of endogenous variables is 36 and that of cointegrating relations is at most 15,[14] it then follows that matrix F in equation (5) must have at least 36-15=21 eigenvalues that fall on the unit circle in order to ensure stability of the global model. Our results confirm this; the matrix F estimated from the country-specific models has exactly 21 eigenvalues falling on the unit circle, while the remaining 15 are all less than one (in modulus).

A second key assumption of the GVAR approach is that idiosyncratic shocks are cross-sectionally weakly correlated. The basic idea is that conditioning the estimation of country/region-specific VEC models on foreign variables considered as proxies of "common" global factors will leave only a modest degree of correlation of the remaining shocks across countries/regions. This is also important if we were to interpret the disturbances in the GFEVD analysis as "geographically structural": an external shock is truly external if its contemporaneous correlation with internal shocks is weak. In order to verify these claims, contemporaneous correlations of residuals across different country-specific models for each equation were computed. Table 7 reports such correlation coefficients, computed as averages of the correlation coefficients between the residuals of each equation (variable) with all other countries/regions equations residuals. A two-tailed t-test rejects the hypothesis that these coefficients are significantly different from zero at the conventional level. Thus, the

[13] Notice that the long-run structure defined by the cointegration space of each country/region specific model could be restricted according to the implications of a small open economy model (e.g. Boschi (2007) and Dees *et al.* (2007b)), but given the explicit focus of this paper on the relationship among economies at a business cycle fequency, we limited our excercise to unrestricted models.

[14] That is the sum of the ranks of matrix $\mathbf{\Pi}_i$ in equation (1) for each country $i = 0, ..., N+1$ (Pesaran *et al.* (2004a)).

model seems to be successful in capturing the effect of common factors driving domestic variables.

[Table 7 about here]

A third econometric concern refers to the assumption that foreign variables and oil price are weakly exogenous in the country/region-specific VEC models. Along the lines described by Johansen (1992) and followed by Pesaran *et al.* (2004a), we examined the weak exogeneity of these variables by testing the joint significance of the error correction terms in auxiliary equations of the country/region-specific foreign variables, $\mathbf{x}_{it}^*$ and the oil price. Specifically, we carried out the following regression for each l^{th} element of country i vector of foreign variables, $\mathbf{x}_{it}^*$ and for the oil price:

$$\Delta x_{il,t}^* = \mu_{il} + \sum_{j=1}^{r_i} \gamma_{ijl} ECM_{i,t-1}^j + \boldsymbol{\varphi}_{il}' \Delta \mathbf{v}_{i,t-1} + \zeta_{il,t}$$

where μ_{il} is a constant, $ECM_{i,t-1}^j$, $j = 1, 2, ..., r_i$ are the estimated error correction terms corresponding to the r_i cointegrating relations found in the i^{th} model, $\varphi_{il,k}$ are coefficients, $\mathbf{v}_{i,t-1}$ is defined by (1), and $\zeta_{il,t}$ is the residual. Then, an F test of the joint hypotheses that $\gamma_{ijl} = 0$, $j = 1, 2, ..., r_i$ is carried out. Table 8 reports the results.

[Table 8 about here]

Most of the test statistics are not significant at the 5 percent level.[15] Given the overall statistical support and the strong theoretical prior in favour of the weak exogeneity hypothesis, foreign variables and the oil price were treated as weakly exogenous.

4 Assessing the geographical origin of business cycle fluctuations in Latin America

As discussed above, the modest degree of cross-country correlation of reduced form residuals allows for an approximated identification of disturbances according to their geographical origin. Given the focus of the

[15] The weak exogeneity assumption is rejected at the 1 percent level only in the model of Peru for the short-term rates and in the Euro Area model for oil prices, while it is rejected at the 5 percent level in the models of Mexico and US for output.

present study, we confined our analysis to output fluctuations. Table 9 reports the GFEVD of each LA country's domestic output over a simulation horizon of 40 quarters. Panel [A] refers to the contribution to domestic output forecast error variance of domestic shocks, i. e. y, sr, q and nfa. Panel [B] summarises the contribution of external shocks classified according to whether their origin is regional, i.e. from other LA countries, or from one of the three industrial economies we consider in the analysis. Finally, Panel [C] reports an overall comparison of domestic versus foreign contribution to each country's domestic output fluctuations.

[Table 9 about here]

Domestic shocks A mixed picture of the local determinants of output variability emerged. Real factors (output itself) are neatly predominant over the whole forecast horizon only in Argentina and, especially, Brazil, while this is true only up to the 12th quarter for Bolivia, Chile and Mexico, and up to the 20th quarter for Peru. Financial factors seem to play a significant role in all countries apart from Argentina and Brazil (and even here still play a role).[16] This is consistent with Canova's (2005) findings that financial factors are an important channel of transmission of foreign shocks; or it could be interpreted as idiosyncratic sources of variability. However, this first block of results should be taken with caution since, as detailed above, the GFEVD tool does not allow for an *economic* identification of shocks, but rather it provides a meaningful characterisation of disturbances according to their geographical origin, tracing out the dynamic responses of variables to *typical* (i.e. historically observed) shocks. Therefore, the rest of this Section will focus on the contribution of shocks having different geographical origin to LA countries' domestic output fluctuation.

Regional vs domestic shocks Over the entire forecast horizon, regional factors contribute approximately 20 percent of domestic output variability in Argentina, Bolivia and Chile but drops to approximately 10 percent in Brazil and Mexico. This pattern is somehow more variegated in Peru where the contribution of regional shocks ranges from 13 to 42 percent. Overall this result supports evidence of a sizeable regional

[16] Specifically, net foreign assets are the main source of variability in Chile (from the second simulation year on) and Peru (at all horizons), while the real interest rate is the main source of output variability for some quarters in Bolivia, Mexico, and Peru.

business cycle component in Latin America. Aiolfi *et al.* (2006) attribute this feature to the role of common global factors on the grounds of limited trade and financial linkages among these economies. However, the breakdown (unreported) of the figures in column 5 of Tables 9-14 show that regional factors affect domestic business cycle through financial channels (short-term rates and net foreign assets) in a non-negligible way. Thus, since the main common global real and financial factors were controlled for in this study in a coherent model of the world economy, the findings are interpreted as due to similarities in the economic structure of the LA countries examined.

Industrial countries' vs regional and domestic shocks In *all* Latin American countries considered here, domestic factors contribute far more than industrial countries' factors to the variability of domestic output.[17] Overall, industrial countries explain a small fraction of output fluctuation, ranging from 7 percent in Bolivia to almost 13 percent in Mexico. Specifically, the US economy is the most important contributor to domestic output forecast variability at all horizons for Argentina and Peru. The role of Euro Area is never very large on impact, but tends to increase over time. Japan gives an important contribution to output variability in all countries, and especially in Argentina, Bolivia, Brazil and Chile. This central finding disputes the other relevant literature on international business cycles, most of which concentrate on the role of US macroeconomic variables and implicitly assume that the US role in the global economy and its trade and financial links with Latin America (the US "backyard") are the main driving force behind business cycles co-movements in this region (Ahmed (2003), Canova (2005)). Falsifying a common suspicion, estimates show that the proportion of LA countries' domestic output variability explained by the US (and by the other industrial countries) is modest when compared to the contribution of regional shocks.

Robustness checks In order to gain some insights on the reasons why our results differ from those studies where the US role seems bigger, a number of alternative models were estimated.[18] In particular, we estimated first a VEC model including only output of all countries/regions considered in the GVAR – i.e.

[17] This is true for all countries at all horizons, with an average difference between the percentage contribution of domestic shocks and that of industrial ones stretching from 53 percentage points for Chile to 74 percentage points for Brazil.

[18] Results of these additional estimations are unreported to save space, but they can be provided by the authors upon request.

Argentina, Bolivia, Brazil, Chile, Mexico, Peru, the US, Euro Area and Japan. The results show that the role of the US and regional shocks are larger than in the GVAR, especially at longer forecast horizons, with the exception of Mexico for which the importance of US shocks decreases over time. In addition, six VEC models, one for each LA country – each model including the relevant LA country's factors, i.e. y_t, sr_t, q_t and nfa_t, along with the US counterparts – were estimated. As expected, in these six models the US factors play an even bigger role than in the VEC model containing only output of all countries/regions. The US explain on average more than 20 percent of domestic output forecast error variance in all LA countries, with the only exception of Brazil.

All in all, considering the evidence provided by the simple VEC models, the reason why in the GVAR the influence exerted by the US is smaller seems to be related more to the inclusion of a larger set of countries/regions than to the larger number of factors. This helps to understand why previous literature – where the US is the only external economy taken into account – overestimated the contribution of the US shocks to LA business cycle. In this respect, the paper by Kose *et al.* (2003) goes along the right direction since it considers a large group of countries. They find, like in this study, that country-specific factors are the main determinant of output fluctuations in Latin America, but they reserve a smaller role to the regional factors compared to this paper. However, the methodology in their paper, namely a Bayesian dynamic latent factor model, does not allow to recover the geographical origin of factors affecting the domestic business cycle, but rather identifies the generic components of a series as divided in world, region and country-specific.[19] For this reason the GVAR appears a more suitable methodology to address the problem of choosing the proper exchange rate regime for an emerging market basing on the main geographical determinants of its business cycle.

[19] Notice that from a more technical perspective, the methodology used in Kose *et al.* (2003) differs from ours because they compute the variance decomposition of the raw series of interest, while in this paper the forecast error variance decomposition is derived. Then, while we analyse the innovation (or unsystematic) part of the series as recovered from the residual of the estimated model, they decompose the systematic part of it.

Which exchange rate regime for Latin American countries? The findings of this paper have important implications for the choice among such alternative extreme exchange rate regimes, i.e. hard pegs (currency board or unilateral "dollarisation"), the formation of an independent common currency area and the freely floating exchange rate. *First*, as long as "dollarisation" requires a large degree of business cycle synchronisation among the country adopting the dollar and the US economy, the GFEVD analysis shows that in the LA countries this regime may be subject to strong destabilising shocks originated in countries other than the US, either developed or developing. A sensible way to take into account this fact could be pegging the domestic currency to a "synthetic" foreign currency built as a weighted average of the currencies of the main industrial and developing countries affecting domestic business cycle. *Second*, although the contribution of regional factors to domestic business cycle in LA countries is noticeable, and indeed larger than industrial countries influence, nevertheless idiosyncratic shocks play a dominant role in all LA countries' economies. This result cast doubts on the viability of a common currency area along the path set by the European Monetary Union. Idiosyncratic shocks could destabilise such a monetary arrangement well before it could enhance the required real and financial integration necessary to make it work. All results above suggest that a freely floating exchange rate might be the most viable option to be pursued in LA countries, in line with what argued by Ahmed (2003) and Berg *et al.* (2002).

Implications for portfolio diversification Aside from the academic and policy implications, our results may be of interest for international investors as well. The large contribution of regional factors to domestic business cycle suggests that economic conditions are highly correlated in LA countries. However, the GFEVD analysis show that this does not result from a sizeable regional business cycle component in LA as found by Aiolfi et al. (2006), but rather from the relevant role of all neighbour countries' factors – real and financial – for domestic output fluctuations. This caveat notwithstanding, the evidence here reported should discourage investors to engage in regional risk-sharing. By contrast, portfolio diversification may still be a viable option when capital crosses continents.

5 Conclusion

Over recent years, the increasing international economic integration driven by the liberalisation of current and capital accounts has stimulated a growing number of studies on the causative determinants of macroeconomic fluctuations in emerging markets. The vast majority of existing contributions implicitly assume that US are the main origin country of external shocks. In this paper we have demonstrated that this is not the case, at least not in LA countries.

To quantify the relative contribution of domestic, regional and international shocks in explaining domestic output fluctuations, quarterly data over the period 1980:1-2003:4 was used and a multi-variate time series model was estimated to include six key LA countries (Argentina, Bolivia, Brazil, Chile, Mexico and Peru) as well as three major industrial economies (the US, Euro Area and Japan). The main findings can be summarised as follows. Domestic and regional factors account for the main share of output variability at all horizons, while the proportion explained by industrial countries factors is modest. All in all, assessing the relevant contribution of shocks originating in other neighbour countries and in countries/regions other than the US will provide a better understanding of the actual geographical origin of external drivers of output variability in LA countries.

From a macro-econometric research perspective, our findings suggest that presuming the US are the main source of external shocks can lead to misleading results. Other industrial countries and, especially, neighbour developing countries are largely influential on LA domestic economic conditions. Furthermore, admitting both real and financial channels of transmission of shocks across economies helps to avoid over-estimating the effects exerted by individual variables (for instance GDP) in explaining output fluctuation in LA countries. This result, in turn, should inform the choice of a reference currency when adopting a fixed exchange rate arrangement. "Dollarisation" does not appear an obvious option. Analogously, the formation of a common currency area in LA may be subject to excessively large destabilising shocks before the region economy is homogenous enough to make the arrangement work. In a nutshell, freely floating exchange rates remain a sensible option. On a more practical level, investors willing to diversify their portfolios' risk could benefit from broadening their international composition, while concentration of asset acquisition in the same region appears inadequate given the large contribution of neighbouring countries' factors to domestic output fluctuations.

6 Appendix

6.1 Data sources

Net Foreign Assets (NFA) The NFA series is obtained for each country as the sum, period-by-period, of foreign assets and liabilities given by the following quarterly time series taken from the IFS database: DIA (Direct Investment Abroad - code 78...BDDZF), PIA (Portfolio Investment Assets - code 78...BFDZF), OIA (Other Investment Assets - code 78...BHDZF), DIL (Direct Investment Liabilities - code 78...BEDZF), PIL (Portfolio Investment Liabilities - code 78...BGDZF), and OIL (Other Investment Liabilities - code 78...BIDZF). Therefore: $NFA = DIA + PIA + OIA - DIL - PIL - OIL$.

Population (POP) The source is the IFS database. The code is 99Z..ZF.... Available annual data are interpolated linearly.

Nominal Output (YNC) The series is the volume of GDP in billions of national currency. It is taken from IFS for all countries except for Brazil. The code is 99B./CZF.... The series for Brazil is obtained from IPEADATA.

Output (YCC) The source for all countries, except Brazil, is the IFS database. The code is ..99BVP/RZF.. (2000=100). The quarterly data for Argentina's GDP volume index are only available from 1993:1; the series is extended backward using the rates of growth of the GDP index series provided by Oxford Economic Forecasting. The GDP index of Brazil is obtained by deflating (with the CPI) the GDP volume in billions of national currency provided by IPEADATA.

Price index (CPI) The source is the IFS' Consumer Prices Index (CPI), which code is 64...ZF... (2000=100).

Exchange rates (NER) The source is the IFS' series of National Currency per US Dollar, with code .RF.ZF... except fo Mexico for which the series ..WF.ZF... is used.

Nominal short-term interest rates (SR) The series is the Money Market Rate or equivalent (code 60B..ZF...) from the IFS.

Oil price (OIL) The series is the price of Brent from IFS, with code 11276AAZZF....

6.2 Variables construction

The Euro Area variables are constructed as weighted averages of the corresponding series of Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, and Spain. The weights are each country's mean shares of the Euro Area's real GDP in PPP over the period 1995-2000. The real GDP in PPP series are obtained from the World Bank's World Development Indicators 2002.

Following Pesaran et al. (2004a), the variables used in the estimation of each country/region-specific VEC model are constructed from the series above as follows:

$y = \ln[100 \cdot (YCC/POP)\,/POP_{2000}]$;

$sr = 0.25 \cdot \ln(1 + SR/100) - \ln(CPI_{+1}/CPI)$;

$q = \ln(100 \cdot NER/NER_{2000}) - \ln(CPI)$;

$nfa = NFA/(YNC/NER)$;

$y_i^* = \sum_{j=0}^{N-1} w_{ij} y_j$;

$sr_i^* = \sum_{j=0}^{N-1} w_{ij} sr_j$;

$oil = \ln(100 \cdot OIL/CPI_{2000})$.

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Table 1: Trade weights

	Argentina	Bolivia	Brazil	Chile	Mexico	Peru	Euro Area	Japan	US
Argentina	0	0.158	0.178	0.126	0.003	0.033	0.026	0.004	0.012
Bolivia	0.011	0	0.008	0.010	0.000	0.023	0.001	0.000	0.001
Brazil	0.358	0.149	0	0.094	0.009	0.064	0.067	0.020	0.041
Chile	0.075	0.077	0.029	0	0.006	0.080	0.015	0.012	0.011
Mexico	0.025	0.020	0.028	0.054	0	0.041	0.031	0.020	0.283
Peru	0.010	0.093	0.008	0.026	0.002	0	0.005	0.002	0.006
Euro Area	0.273	0.077	0.334	0.248	0.060	0.219	0	0.272	0.342
Japan	0.042	0.091	0.081	0.149	0.027	0.083	0.224	0	0.305
US	0.207	0.335	0.334	0.293	0.894	0.458	0.631	0.670	0

Notes: Trade weights, computed as shares of exports and imports in 1995-2001, are displayed in column by country/region. Each column, but not row, sums to one. Source: Direction of Trade Statistics Yearbook, IMF, 2002.

Table 2: ADF unit root test statistics

Panel [A]. AIC order selection

	Argentina	Bolivia	Brazil	Chile	Mexico	Peru	Euro Area	Japan	US
y	-1.92	-1.33	-1.74	-2.57	-2.28	-1.67	-3.25	-1.49	-2.84
Δy	-3.90	-2.87	-9.44	-5.22	-4.86	-6.53	-2.30	-3.24	-4.80
sr	-1.69	-2.28	-4.13	-2.18	-2.68	-0.90	-2.38	-1.20	-2.27
Δsr	-8.05	-5.14	-7.61	-3.62	-8.89	-4.59	-5.33	-7.85	-4.27
q	-2.65	-1.19	-1.97	-1.53	-3.70	-1.66	-2.98	-2.30	-2.70
Δq	-4.54	-6.90	-8.35	-4.32	-4.33	-4.94	-6.55	-4.19	-3.40
nfa	-1.86	-2.71	-1.06	-4.41	-3.03	-3.90	-5.14	-1.20	-3.04
Δnfa	-7.82	-2.67	-4.88	-2.96	-5.02	-5.24	-3.45	-5.60	-3.18
y^*	-2.12	-2.80	-2.05	-3.64	-2.92	-3.19	-3.49	-4.32	-2.65
Δy^*	-9.30	-8.02	-5.44	-4.76	-4.74	-4.91	-3.70	-4.96	-5.42
sr^*	-2.04	-2.79	-6.02	-7.78	-2.62	-3.84	-3.27	-3.53	-2.53
Δsr^*	-2.70	-2.96	-4.98	-7.55	-6.32	-7.41	-4.61	-12.42	-6.57
oil	-	-	-	-	-	-	-	-	-1.85
Δoil	-	-	-	-	-	-	-	-	-5.87

Panel [B]. Modified AIC order selection

	Argentina	Bolivia	Brazil	Chile	Mexico	Peru	Euro Area	Japan	US
y	-1.92	-1.33	-1.74	-2.57	-2.28	-1.67	-1.96	-1.49	-2.88
Δy	-4.54	-2.79	-2.59	-3.24	-4.02	-2.56	-2.76	-3.24	-4.39
sr	-1.69	-2.32	-3.39	-1.25	-2.68	-0.90	-1.87	-1.20	-0.85
Δsr	-16.65	-11.40	-7.74	-5.30	-5.71	-5.20	-14.66	-18.48	-12.48
q	-2.65	-1.19	-1.48	-1.76	-4.07	-1.58	-2.47	-1.58	-2.31
Δq	-3.73	-1.98	-6.32	-1.86	-4.59	-3.58	-4.10	-4.19	-2.25
nfa	-1.15	-3.10	-1.06	-2.42	-1.61	-2.31	-3.78	-1.20	-3.19
Δnfa	-2.34	-1.72	-1.95	-1.61	-4.33	-4.85	-2.37	-4.02	-1.83
y^*	-2.12	-1.98	-1.51	-2.25	-2.92	-2.78	-2.24	-3.02	-1.84
Δy^*	-2.80	-5.03	-3.84	-4.90	-4.02	-5.02	-5.93	-3.22	-4.87
sr^*	-1.16	-2.11	-4.64	-1.49	-0.79	-2.61	-2.26	0.08	-2.06
Δsr^*	-2.37	-2.57	-19.04	-15.77	-12.60	-13.20	-18.86	-12.42	-4.53
oil	-	-	-	-	-	-	-	-	-1.85
Δoil	-	-	-	-	-	-	-	-	-6.27

Notes: The ADF statistics are based on univariate AR(p) models in the levels with p chosen according to the modified AIC, with a maximum lag order of 11. The sample period is 1980:1-2003:4. The regressions for all variables in the levels include an intercept and a linear trend with the exception of interest rates whose underlying regressions include only an intercept. The 95 percent critical value for regressions with trend is -3.46 and for regressions without trend -2.89.

Table 3: ADF unit root tests with breaks statistics

Panel [A]. Level variables

	y	*sr*	*q*	*nfa*	*y**	*sr**	*oil*
Argentina							
Suggested break date	1994 Q2	1991 Q2	1984 Q2	1984 Q4	1985 Q1	1990 Q3	-
Test statistic	-2.23 [8]	-3.61 [3]	-1.52 [2]	-1.83 [3]	-1.37 [0]	-2.58 [7]	-
Bolivia							
Suggested break date	1985 Q2	1991 Q1	1984 Q3	1988 Q4	1994 Q2	1994 Q2	-
Test statistic	-1.04 [10]	-1.07 [7]	-1.34 [2]	-3.52 [10]	-2.56 [1]	-5.83 [7]	-
Brazil							
Suggested break date	1995 Q1	1988 Q4	1994 Q4	1989 Q2	1991 Q2	1982 Q2	-
Test statistic	-1.88 [0]	-1.63 [1]	-2.03 [5]	-2.30 [5]	-1.87 [9]	-4.85 [4]	-
Chile							
Suggested break date	1995 Q1	1991 Q2	2003 Q1	1987 Q1	1985 Q1	1990 Q3	-
Test statistic	-1.11 [4]	-2.56 [10]	-2.29 [4]	-2.02 [3]	-2.70 [2]	-2.99 [0]	-
Mexico							
Suggested break date	1982 Q1	1988 Q4	1982 Q1	1982 Q2	1982 Q2	1986 Q2	-
Test statistic	-3.43 [2]	-3.79 [0]	-4.19 [3]	-2.84 [2]	-2.43 [3]	-2.82 [2]	-
Peru							
Suggested break date	1992 Q2	1984 Q4	1991 Q1	1989 Q1	1984 Q1	1990 Q3	-
Test statistic	-1.92 [1]	-0.90 [8]	-1.94 [3]	-3.45 [2]	-1.83 [1]	-1.80 [2]	-
Euro Area							
Suggested break date	1984 Q2	1993 Q2	1991 Q2	1999 Q4	1990 Q2	2002 Q1	-
Test statistic	-2.27 [6]	-2.64 [3]	-2.11 [1]	-2.86 [9]	-2.18 [7]	-3.34 [3]	-
Japan							
Suggested break date	2001 Q3	1986 Q4	1995 Q3	2000 Q2	1982 Q1	1986 Q4	-
Test statistic	-1.73 [3]	-1.70 [4]	-2.88 [3]	-1.67 [4]	-2.86 [3]	-3.93 [0]	-
US							
Suggested break date	1981 Q4	1986 Q4	1988 Q4	2000 Q3	1995 Q2	1991 Q4	2000 Q3
Test statistic	-2.34 [2]	-3.04 [2]	-2.72 [7]	-2.28 [9]	-2.21 [2]	-2.90 [4]	-2.33 [4]
Crit. value at 5% (1%)	-3.03 (-3.55)	-2.88 (-3.48)	-3.03 (-3.55)	-3.03 (-3.55)	-3.03 (-3.55)	-2.88 (-3.48)	-3.03 (-3.55)

Panel [B]. Differenced variables

	Δy	*Δsr*	*Δq*	*Δnfa*	*Δy**	*Δsr**	*Δoil*
Argentina							
Suggested break date	1991 Q3	1992 Q1	1988 Q3	1985 Q3	1991 Q2	1991 Q2	-
Test statistic	-2.19 [7]	-2.96 [5]	-3.04 [1]	-2.50 [2]	-3.37 [0]	-1.54 [3]	-
Bolivia							
Suggested break date	1984 Q1	1984 Q2	1983 Q1	2003 Q1	1994 Q2	1993 Q4	-
Test statistic	-3.42 [4]	-2.94 [6]	-3.60 [0]	-2.59 [4]	-2.06 [1]	-1.76 [10]	-
Brazil							
Suggested break date	1991 Q2	1989 Q2	1990 Q2	2003 Q1	2002 Q2	1988 Q4	-
Test statistic	-3.54 [0]	-2.30 [1]	-1.35 [4]	-2.59 [4]	-4.06 [7]	-3.11 [7]	-
Chile							
Suggested break date	1988 Q3	1991 Q1	1982 Q2	2002 Q4	2002 Q2	1982 Q3	-
Test statistic	-3.37 [0]	-1.03 [10]	-3.72 [2]	-2.97 [10]	-3.66 [7]	-6.45 [4]	-
Mexico							
Suggested break date	1987 Q1	1985 Q1	1982 Q1	1982 Q3	1983 Q1	1986 Q2	-
Test statistic	-4.12 [1]	-4.26 [0]	-4.30 [3]	-5.75 [4]	-5.79 [2]	-2.68 [5]	-
Peru							
Suggested break date	1989 Q2	1988 Q3	1990 Q2	1986 Q1	1985 Q3	1990 Q1	-
Test statistic	-2.47 [3]	-1.80 [7]	-1.80 [2]	-2.39 [3]	-6.05 [9]	-2.72 [4]	-
Euro Area							
Suggested break date	1984 Q3	1992 Q4	1988 Q4	1989 Q4	1990 Q2	1988 Q2	-
Test statistic	-3.89 [3]	-1.70 [7]	-3.38 [0]	-2.80 [9]	-2.75 [6]	-3.18 [3]	-
Japan							
Suggested break date	2002 Q2	1987 Q2	1995 Q3	2000 Q3	1990 Q2	1986 Q2	-
Test statistic	-2.50 [2]	-2.41 [3]	-1.57 [3]	-1.93 [5]	-3.49 [9]	-3.11 [10]	-
US							
Suggested break date	1981 Q3	1998 Q1	1988 Q3	1991 Q1	1995 Q1	1982 Q3	1986 Q3
Test statistic	-3.18 [2]	-2.29 [10]	-2.36 [3]	-3.23 [7]	-1.64 [2]	-4.88 [3]	-2.34 [3]
Crit. value at 5% (1%)	-2.88 (-3.48)	-2.88 (-3.48)	-2.88 (-3.48)	-2.88 (-3.48)	-2.88 (-3.48)	-2.88 (-3.48)	-2.88 (-3.48)

Notes: the regressions for all variables in the levels include an intercept and a linear trend with the exception of interest rates whose underlying regression include only an intercept. For differenced variables the regressions do not include an intercept and a linear trend. The lag order, selected according to the AIC with a maximum lag order of 10, is reported in square brackets.

Table 4: Test statistics for selecting the lag order of the endogenous (domestic) variables in the VARX*(pi,qi) model

Order (p_i)	AIC	SBC		Adjusted LR test
Argentina				
4	750.1	629.1		
3	760.7	659.8	χ2(16) =	8.0098[.949]
2	**761.8**	681.1	χ2(32) =	30.0748[.564]
1	757.3	**696.7**	χ2(48) =	**60.3741[.108]**
0	354.6	314.2	χ2(64) =	679.3204[.000]
Bolivia				
4	1108.0	987.0		
3	1111.5	1010.7	χ2(16) =	18.4464[.298]
2	**1118.8**	**1038.1**	χ2(32) =	**31.3951[.497]**
1	1072.1	1011.5	χ2(48) =	124.1005[.000]
0	529.1	488.8	χ2(64) =	950.3084[.000]
Brazil				
4	676.7	560.7		
3	682.5	586.6	χ2(16) =	15.3189[.501]
2	690.2	614.6	χ2(32) =	27.6889[.685]
1	**694.9**	**639.4**	χ2(48) =	**44.6904[.609]**
0	241.1	205.8	χ2(64) =	749.4294[.000]
Chile				
4	**970.4**	854.4		
3	970.2	874.3	χ2(16) =	**24.3738[.082]**
2	961.1	885.5	χ2(32) =	61.8960[.001]
1	942.6	**887.1**	χ2(48) =	113.7365[.000]
0	450.9	415.6	χ2(64) =	875.3154[.000]
Mexico				
4	**979.0**	868.1		
3	974.1	883.3	χ2(16) =	31.8997[.010]
2	973.4	**902.8**	χ2(32) =	57.2928[.004]
1	950.4	900.0	χ2(48) =	116.5151[.000]
0	552.1	521.9	χ2(64) =	747.0024[.000]
Peru				
4	814.2	693.1		
3	**820.8**	720.0	χ2(25) =	**13.8210[.612]**
2	797.7	717.0	χ2(50) =	71.6619[.000]
1	800.5	**740.0**	χ2(75) =	91.1393[.000]
0	291.1	250.7	χ2(100) =	867.8986[.000]
Euro Area				
4	**1423.5**	1307.5		
3	1423.4	1327.6	χ2(25) =	**24.1098[.087]**
2	1423.1	1347.5	χ2(50) =	48.5555[.031]
1	1408.5	**1353.1**	χ2(75) =	94.4301[.000]
0	846.9	811.6	χ2(100) =	960.8257[.000]
Japan				
4	1156.6	1040.6		
3	1155.6	1059.8	χ2(25) =	25.5334[.061]
2	**1164.0**	1088.3	χ2(50) =	**37.0023[.249]**
1	1155.6	**1100.1**	χ2(75) =	73.5455[.010]
0	801.8	766.5	χ2(100) =	628.2555[.000]
US				
4	1359.1	1253.2		
3	1361.7	1275.9	χ2(25) =	20.8059[.186]
2	**1367.4**	**1301.9**	χ2(50) =	**36.5831[.264]**
1	1305.6	1260.3	χ2(75) =	156.6580[.000]
0	797.0	771.8	χ2(100) =	966.4766[.000]

Notes: statistics in bold indicate the order selected by the relevant criterion/test. Unrestricted VARs are estimated with foreign variables treated as exogenous.

Table 5: Univariate specification tests statistics

	Δy	Δsr	Δq	Δnfa
Argentina				
Serial Correlation F(4,83)	1.87 [0.123]	2.39 [0.057]	2.27 [0.069]	1.58 [0.187]
Normality χ^2 (2)	67.18 [0.000]**	1.36 [0.506]	2.00 [0.369]	17.08 [0.000]**
Heteroscedasticity F(1,93)	0.14 [0.709]	5.44 [0.022]*	4.47 [0.037]*	1.55 [0.217]
Bolivia				
Serial Correlation F(4,82)	1.63 [0.174]	1.59 [0.184]	1.96 [0.108]	33.30 [0.000]**
Normality χ^2 (2)	0.00 [0.998]	0.64 [0.725]	0.88 [0.645]	2.02 [0.365]
Heteroscedasticity F(1,93)	5.36 [0.023]*	3.78 [0.055]	4.54 [0.036]*	2.63 [0.108]
Brazil				
Serial Correlation F(4,84)	0.41 [0.803]	1.38 [0.247]	0.61 [0.654]	1.84 [0.129]
Normality χ^2 (2)	1.48 [0.476]	2.36 [0.308]	0.64 [0.725]	0.19 [0.911]
Heteroscedasticity F(1,93)	0.65 [0.423]	4.16 [0.044]*	4.51 [0.036]*	0.58 [0.450]
Chile				
Serial Correlation F(4,83)	1.11 [0.357]	6.09 [0.000]**	3.60 [0.009]**	1.76 [0.145]
Normality χ^2 (2)	1.52 [0.468]	0.86 [0.652]	2.87 [0.238]	1.69 [0.430]
Heteroscedasticity F(1,93)	3.09 [0.082]	0.34 [0.559]	0.34 [0.559]	0.39 [0.535]
Mexico				
Serial Correlation F(4,85)	4.45 [0.003]**	0.79 [0.537]	0.73 [0.575]	0.90 [0.469]
Normality χ^2 (2)	0.98 [0.612]	1.01 [0.605]	35.25 [0.000]**	0.19 [0.909]
Heteroscedasticity F(1,93)	2.06 [0.155]	0.19 [0.668]	0.20 [0.658]	3.68 [0.058]
Peru				
Serial Correlation F(4,83)	0.75 [0.559]	1.16 [0.336]	0.42 [0.795]	1.67 [0.164]
Normality χ^2 (2)	0.75 [0.686]	1.25 [0.535]	2.22 [0.330]	1.14 [0.564]
Heteroscedasticity F(1,93)	1.16 [0.285]	1.95 [0.166]	0.25 [0.617]	0.79 [0.376]
Euro Area				
Serial Correlation F(4,83)	1.02 [0.401]	2.08 [0.091]	3.14 [0.019]*	1.57 [0.190]
Normality χ^2 (2)	3.22 [0.199]	2.77 [0.250]	2.01 [0.367]	3.73 [0.155]
Heteroscedasticity F(1,93)	2.09 [0.152]	0.17 [0.681]	2.37 [0.127]	0.10 [0.753]
Japan				
Serial Correlation F(4,84)	0.39 [0.812]	0.82 [0.514]	3.00 [0.023]*	1.28 [0.284]
Normality χ^2 (2)	0.49 [0.782]	0.39 [0.824]	0.46 [0.794]	0.03 [0.984]
Heteroscedasticity F(1,93)	7.12 [0.009]**	0.90 [0.345]	2.05 [0.155]	2.68 [0.105]
US				
Serial Correlation F(4,83)	3.55 [0.010]*	1.77 [0.142]	2.56 [0.045]*	16.18 [0.000]**
Normality χ^2 (2)	5.96 [0.051]	1.37 [0.503]	1.96 [0.375]	0.65 [0.721]
Heteroscedasticity F(1,93)	1.26 [0.265]	0.29 [0.592]	10.30 [0.002]**	0.03 [0.867]

Notes: the figures in square brackets are probability values associated with test statistics. The symbols "" and "**" denote statistical significance at the 5 percent and the 1 percent respectively.*

Table 6: Cointegration rank statistics

Maximum eigenvalue test						
H_0	**H_1**	**Argentina**	**Bolivia**	**Brazil**	**95%**	**90%**
r = 0	r = 1	277.51	111.90	85.90	40.98	38.04
r ≤ 1	r = 2	40.01	**31.34**	**22.60**	34.65	31.89
r ≤ 2	r = 3	**16.25**	24.98	10.52	27.80	25.28
r ≤ 3	r = 4	4.93	12.37	3.81	20.47	18.19
H_0	**H_1**	**Chile**	**Mexico**	**Peru**	**95%**	**90%**
r = 0	r = 1	147.11	91.07	94.82	40.98	38.04
r ≤ 1	r = 2	35.62	**19.69**	**16.64**	34.65	31.89
r ≤ 2	r = 3	**14.66**	16.69	10.23	27.80	25.28
r ≤ 3	r = 4	9.55	6.89	7.43	20.47	18.19
H_0	**H_1**	**Euro Area**	**Japan**	**US**	**95%**	**90%**
r = 0	r = 1	249.61	91.77	192.20	40.98	38.04
r ≤ 1	r = 2	76.30	**24.11**	50.44	34.65	31.89
r ≤ 2	r = 3	33.93	16.93	34.16	27.80	25.28
r ≤ 3	r = 4	**2.81**	3.79	28.39	20.47	18.19
Trace test						
H_0	**H_1**	**Argentina**	**Bolivia**	**Brazil**	**95%**	**90%**
r = 0	r = 1	338.70	180.60	122.84	90.02	85.59
r ≤ 1	r = 2	**61.19**	68.70	**36.94**	63.54	59.39
r ≤ 2	r = 3	21.18	**37.36**	14.33	40.37	37.07
r ≤ 3	r = 4	4.93	12.37	3.81	20.47	18.19
H_0	**H_1**	**Chile**	**Mexico**	**Peru**	**95%**	**90%**
r = 0	r = 1	206.94	134.33	129.12	90.02	85.59
r ≤ 1	r = 2	**59.83**	**43.26**	**34.30**	63.54	59.39
r ≤ 2	r = 3	24.21	23.58	17.66	40.37	37.07
r ≤ 3	r ≤ 3	9.55	6.89	7.43	20.47	18.19
H_0	**H_1**	**Euro Area**	**Japan**	**US**	**95%**	**90%**
r = 0	r = 1	362.64	136.60	305.18	90.02	85.59
r ≤ 1	r = 2	113.03	**44.83**	112.98	63.54	59.39
r ≤ 2	r = 3	**36.73**	20.72	62.55	40.37	37.07
r ≤ 3	r = 4	2.81	3.79	28.39	20.47	18.19

Notes: the last two columns report the critical values at the 95 percent and 90 percent significance level. Statistics in bold indicate acceptance of the null hypothesis at the 5 percent significance level.

Table 7: Average cross-section correlations of residuals

	Argentina	**Bolivia**	**Brazil**	**Chile**	**Mexico**	**Peru**	**Euro Area**	**Japan**	**US**
y	0.02	0.02	0.00	-0.03	-0.02	0.00	-0.04	-0.02	0.01
	[0.17]	[0.22]	[0.01]	[-0.28]	[-0.19]	[-0.01]	[-0.38]	[-0.24]	[0.07]
sr	0.04	-0.02	0.01	0.00	0.03	0.00	0.01	0.03	0.00
	[0.37]	[-0.19]	[0.13]	[-0.02]	[0.30]	[-0.01]	[0.12]	[0.30]	[0.04]
q	0.01	0.01	0.02	0.01	0.02	0.02	-0.01	-0.06	-0.03
	[0.09]	[0.13]	[0.16]	[0.14]	[0.21]	[0.19]	[-0.10]	[-0.53]	[-0.34]
nfa	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	[0.13]	[0.44]	[0.31]	[0.25]	[-0.05]	[-0.00]	[-0.15]	[0.13]	[-0.05]

Notes: each entry is the average correlation of the residual of the equation on the corresponding row for the country/region on the corresponding column with all other countries/regions endogenous variables residuals. Two-tailed t-test statistics with 93 d.f.are in square brackets. The null hypothesis is no correlation. The 5 percent critical value is 1.98.

Table 8: F statistics for testing the weak exogeneity of the country-specific foreign variables and oil prices

Country		Foreign variables and oil prices		
		*y**	*sr**	*oil*
Argentina	F(1,85)	0.58 [0.450]	1.11 [0.296]	0.08 [0.772]
Bolivia	F(2,84)	0.49 [0.613]	0.04 [0.965]	2.79 [0.067]
Brazil	F(1,85)	0.16 [0.693]	1.92 [0.170]	0.25 [0.618]
Chile	F(2,84)	1.47 [0.237]	2.20 [0.117]	0.09 [0.911]
Mexico	F(1,85)	6.47 [0.013]*	0.14 [0.706]	0.39 [0.534]
Peru	F(1,85)	0.07 [0.799]	16.44 [0.000]**	0.43 [0.512]
Euro Area	F(2,84)	1.07 [0.349]	0.40 [0.669]	5.36 [0.006]**
Japan	F(1,85)	0.05 [0.822]	3.78 [0.055]	0.66 [0.420]
US	F(4,82)	3.13 [0.019]*	0.91 [0.464]	2.39 [0.058]

Notes: the figures in square brackets are probability values associated with test statistics. The symbols "" and "**" denote statistical significance at the 5 percent and the 1 percent respectively.*

Table 9: Generalized variance decomposition of the forecast error of output

Horizon	Panel [A] Domestic factors				Panel [B] Regional factors	Industrial countries factors			Panel [C] All domestic factors	All foreign factors
	y	*sr*	*rer*	*nfa*		US	EA	JAP		
Argentina										
0	62.76	2.10	0.01	0.60	20.48	6.38	3.90	3.76	65.47	34.53
4	60.97	5.13	0.03	0.43	20.93	5.53	3.14	3.84	66.56	33.44
8	61.29	5.32	0.03	0.39	20.93	5.30	3.03	3.70	67.04	32.96
12	61.55	5.40	0.03	0.37	20.94	5.13	2.99	3.60	67.34	32.66
20	61.83	5.46	0.03	0.33	20.97	4.92	2.96	3.49	67.66	32.34
40	61.98	5.52	0.03	0.29	21.06	4.75	2.93	3.42	67.83	32.17
Bolivia										
0	69.16	6.44	0.68	0.33	19.73	0.80	0.98	1.89	76.61	23.39
4	53.71	22.71	1.81	0.06	15.48	1.69	2.19	2.35	78.30	21.70
8	41.11	30.35	5.76	0.02	15.56	1.83	3.21	2.17	77.23	22.77
12	33.42	32.58	10.33	0.01	16.18	1.74	3.85	1.90	76.34	23.66
20	24.34	29.79	20.55	0.09	17.51	1.80	4.30	1.61	74.77	25.23
40	12.00	14.31	42.63	1.22	19.79	4.32	2.92	2.83	70.15	29.86
Brazil										
0	75.54	0.26	0.65	5.24	9.05	3.55	0.74	4.96	81.69	18.31
4	76.18	0.25	1.35	4.46	9.58	3.54	0.67	3.98	82.23	17.77
8	75.99	0.15	2.18	3.78	10.19	3.56	0.77	3.38	82.10	17.90
12	75.48	0.12	2.97	3.26	10.71	3.59	0.91	2.96	81.83	18.17
20	74.28	0.15	4.28	2.56	11.49	3.66	1.16	2.42	81.27	18.73
40	72.19	0.28	6.13	1.75	12.52	3.74	1.57	1.81	80.35	19.65
Chile										
0	56.83	4.51	0.34	0.20	24.54	8.53	1.70	3.36	61.87	38.13
4	55.98	5.36	1.34	0.32	24.07	8.02	1.07	3.83	63.00	37.00
8	49.69	3.52	7.78	2.34	24.94	7.01	0.93	3.79	63.33	36.67
12	39.10	2.43	17.25	5.78	24.79	5.90	1.37	3.38	64.56	35.44
20	20.17	3.50	32.08	11.71	22.74	4.52	2.91	2.36	67.47	32.53
40	4.80	7.47	41.46	16.12	19.78	4.17	4.93	1.28	69.85	30.15
Mexico										
0	69.31	0.06	1.00	1.09	15.83	8.50	2.14	2.07	71.46	28.54
4	54.31	6.79	6.26	3.41	14.00	9.70	3.40	2.12	70.77	29.23
8	40.27	15.99	11.48	5.57	12.35	8.04	3.79	2.51	73.31	26.69
12	30.34	23.18	15.01	6.95	11.28	6.48	3.85	2.91	75.48	24.52
20	19.47	31.74	18.63	8.28	10.22	4.58	3.66	3.42	78.13	21.87
40	11.00	39.49	21.21	9.17	9.36	2.98	3.13	3.67	80.87	19.13
Peru										
0	58.42	4.21	0.03	18.06	13.29	2.40	1.67	1.91	80.72	19.28
4	55.27	1.87	0.36	20.83	14.45	4.30	1.01	1.91	78.33	21.67
8	45.75	3.84	1.39	20.33	20.21	5.45	1.14	1.88	71.31	28.69
12	35.71	7.66	2.54	18.33	26.73	5.54	1.60	1.89	64.24	35.76
20	22.36	14.12	4.25	14.69	35.52	4.61	2.57	1.88	55.41	44.59
40	10.92	20.55	6.26	11.29	41.88	3.84	3.55	1.71	49.01	50.99

Notes: share of the k-step ahead forecast error variance of domestic output explained by the shocks on the corresponding column. Entries have been normalized so that they sum to 100. Each entry in columns "All domestic factors" and "All foreign factors" are the sum of the corresponding percentages in columns 2, 3, 4, 5 and in columns 6, 7, 8, 9, respectively.