

## Common Factors in Latin America's Business Cycles

Marco Aiolfi  
Goldman Sachs  
Asset Management

Luis A. V. Catão<sup>1</sup>  
Research Department  
IADB and IMF

Allan Timmermann  
Rady School, UCSD  
and CREATES

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### Abstract

*We develop a common factor approach to reconstruct new business cycle indices for Argentina, Brazil, Chile, and Mexico (“LAC-4”) from a new dataset spanning 135 years. We establish the robustness of our indices through extensive testing and use them to explore business cycle properties in LAC-4 across outward- and inward-looking policy regimes. We find that output persistence in LAC-4 has been consistently high across regimes, whereas volatility has been markedly time-varying but without displaying a clear-cut relationship with openness. We also find a sizeable common regional factor driven by output and interest rates in advanced countries, including during inward-looking regimes.*

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<sup>1</sup> Corresponding Author. Address: Research Department, Inter-American Development Bank, 1300 New York Ave., Washington DC 20577. Phone: (202)6233587. E-mail: [lcatao@iadb.org](mailto:lcatao@iadb.org). We thank Ayhan Kose, Simon Johnson, Gian Maria Milesi-Ferretti, Adrian Pagan, Valerie Ramey, Luca Sala, Jeffrey Williamson, as well as two anonymous referees for extensive comments and suggestions on earlier drafts. We are also grateful to Nathan Balke and Christina Romer for generously sharing their data with us, and to seminar participants at the Fundação Getulio Vargas in Rio de Janeiro, IDB, IMF, PUC-RJ, UC San Diego, University of Manchester, the World Bank, and at the 2005 EHES and LACEA meetings. Timmermann acknowledges support from CREATES, funded by the Danish National Research Foundation. The views expressed in this paper are those of the authors alone and do not necessarily reflect the views of the institutions to which the authors are affiliated.

## I. INTRODUCTION

Business cycle volatility can arise from a variety of sources and may be exacerbated by distinct economic policy regimes, possibly reflecting slowly-evolving institutional factors (Acemoglu et al. (2003)) and different degrees of financial and trade openness (Kose, Prasad, and Terrones (2006)). This suggests that important insights can be gained from long-run data spanning a variety of policy regimes and institutional settings. Yet there is a striking dearth of systematic work along these lines for most countries outside North America and Western Europe.

A key constraint to this line of research has been lacking or patently unreliable GDP data for developing countries. While the work of Maddison (2003) has made important strides in filling some gaps and making long-run data more easily accessible to the profession, important deficiencies remain. For most developing countries, Maddison's pre-World War II data is either provided only for select benchmark years or compiled directly from secondary sources relying on annual data from a very limited set of macroeconomic variables and often using disparate methodologies to construct GDP estimates.

Partly due to such data constraints, one region that has been particularly under-researched from a historical business cycle perspective is Latin America. This gap is striking not only because the region is highly volatile and the question of what drives such volatility is of interest in its own right; it is also striking because the region comprises a large set of sovereign nations which historically have gone through dramatic changes in policy regimes and institutions relative to other developing countries in Africa and Asia (many of which only became independent nations in recent decades), thus providing a rich context for assessing business cycle theories. Indeed, Latin America is notoriously absent in the historical business cycle studies by Sheffrin (1988), Backus and Kehoe (1992), and A'Hearn and Woiteck (2001), and only Argentina is covered in more recent work (Basu and Taylor (1999)). Instead, existing work on business cycles covering Latin America has spanned much shorter time periods and/or focused on specific transmission mechanisms (Engle and Issler (1993); Mendoza (1995); Kydland and Zarazaga (1997); Agénor, McDermott and Prasad, (2000)). A corollary of this gap in the literature is the absence of any formal attempt to establish a reference cycle dating for these countries similar to that available elsewhere as well as to relate such a reference cycle to the world business cycle.

This paper seeks to fill some of this lacuna. Our contribution is threefold. First, we construct a new business cycle index for each of the four largest Latin American economies – Argentina, Brazil, Chile, and Mexico (“LAC-4”) – spanning 135 years and covering roughly 70 percent of Latin America’s GDP. Our data cover an extensive set of aggregate and sector variables compiled from a wide range of historical sources – both primary and secondary; as some of these series have been constructed from scratch, this has resulted in an unprecedentedly long and comprehensive database for each of the four countries. Moreover, our estimates are built on an econometric methodology that efficiently aggregates the business cycle content of the individual series, combining common factor extraction with “backcasting” procedures to build new country indices of aggregate economic activity. These new indices provide a measure that is germane to the business cycle concept employed in the work of Burns and Mitchell (1946) which underlies the widely used NBER reference cycle

indicator for the United States. To the best of our knowledge, this is the first time such a methodology is used in reconstructing historical business cycle indices for a single country as well as for a region.

The second and more central contribution of the paper lies in using the new data to formally characterize various stylized business cycle facts for each of these economies. We address three questions. First, how volatile has LAC-4 been relative to other countries during periods of greater trade and financial integration with the world economy (such as during the pre-1930 gold standard and the post-1970s period) as well as during the inward-looking regimes of the 1930s through the early 1970s? Second, how persistent have macroeconomic fluctuations been in those four countries? Since country risk and the gains from stabilization policy both rise when the underlying volatility and persistence of output shocks increase, it is important to have good measures of both. Third, since our business cycle index is built from various macro, financial and sector output indicators, our data also allows us to establish where such volatility and persistence come from. In doing so, we examine whether “stylized facts” for other economies regarding the pro- or counter-cyclicality of key variables such as the trade balance, fiscal policy, inflation and real wages also hold for LAC-4.

The third set of results focuses on the issues of international business cycle transmission and common cross-country factors. Using the classic Bry-Boschan algorithm for business dating and the Harding-Pagan (2002) concordance index, we measure the extent of business cycle synchronicity between the four countries. Then, we identify the common regional cycle through a dynamic common factor extraction from the pool of the individual country series – a novel approach that more fully utilizes information from existing country data. Having identified the common regional factor, we then examine how it is related to global factors such as fluctuations in world output, interest rates and commodity terms of trade. Finally, we use SURE regressions to orthogonalize the individual country cycles to these global factors so as to gauge the extent of country-specific shocks in accounting for national cycles.

The main findings are as follows. Our new index of economic activity is shown to very closely track existing real GDP data from the full set of national account estimates beginning after World War II (WWII henceforth). Our “backcasting” procedure also appears to be robust to structural change and the new indices closely track *qualitative* historical narratives of cyclical turning points in the four countries. This suggests that our business cycle indices provide reasonably accurate measures of pre-WWII cycles in Argentina, Brazil, Chile, and Mexico.

The new indices allow us to uncover the following stylized facts. The average business cycle volatility in all four countries has typically been much higher than in advanced economies and higher than in many emerging markets. Moreover, there were substantive differences across policy regimes. Latin American volatility was high during the openness regimes of the pre-1930 era, i.e., precisely during the formative years of key national institutions. With the exception of Chile, cyclical volatility then dropped during the four decades following the Great Depression, before bouncing back again in the 1970s and 1980s—when these economies again became more open to international capital markets—but then declined sharply, amidst continuing financial and trade openness. Throughout the past century and a half, output persistence has been consistently high, with large shocks giving rise to a striking

combination of high amplitude and long duration of output fluctuations relative to advanced country standards. Overall, this indicates no clear-cut unconditional relationship between openness on the one hand, and cyclical volatility and persistence on the other.

Some business cycle regularities are similar to those observed elsewhere while others differ. External terms of trade have been strongly procyclical, the trade balance counter-cyclical, and fixed investment has been several times more volatile than output. We also find that fiscal policy has been broadly procyclical and highly volatile in LAC-4—despite some dampening during the 1930-70 inward-looking regimes. In contrast, we find that inflation historically has been counter-cyclical and real wages broadly procyclical. Aggregate persistence is mainly accounted for by shocks to fixed investment, government spending, and broad money, with manufacturing and service output resulting to be far more persistent than agricultural output.

Finally, business cycles in the LAC-4 economies have been reasonably correlated throughout, including during the inward-looking policy regimes when trade and capital controls were very stringent. Global factors associated with commodity terms of trade, interest rates and output fluctuations in advanced countries account for much of such commonality, with the respective shares varying by country and period.

The remainder of the paper proceeds as follows. Section II sketches the econometric framework and Section III reports estimates and robustness checks on our methodology. Section IV presents the business cycle dating chronology for all four countries and stylized facts regarding persistence and volatility across policy regimes. Section V discusses cross-country synchronicity based on the common regional factor extraction, and the role of global and intra-regional factors therein. Section VI concludes.

## II. METHODOLOGY

A key ingredient of this paper is the construction of a consistent set of time series that permits more accurate inter-period and cross-country comparisons of business cycle dynamics in LAC-4. The absence of a full set of national income accounts for the pre-WWII period poses a major challenge. While previous researchers have tried to fill this gap by building “unofficial” GDP indicators for this early period, these suffer from the insufficient output coverage of the underlying series, as well as the use of disparate reconstruction methodologies. In the extended working paper version, we discuss in detail how these earlier reconstruction attempts produced series of uneven quality that often do not match the historical narrative of cyclical behavior in these economies (Aiolfi, Catão and Timmermann (2006)). Another difficulty is that the dramatic shift in both the output coverage and the construction methodology between pre- and post-WWII series could greatly undermine the accuracy of any inter-period comparisons between the two eras. This has been argued to be the case even for a country with a wealth of historical data such as the US (Romer (1989)).

The reconstruction procedure laid out here addresses both of these limitations. For each country we put together a broad set of indicators that are well-known to co-move closely with aggregate output and for which we have information spanning the pre- and post-WWII

periods. This potentially ensures greater consistency of inter-period comparisons since they are based on the same set of indicators per country. Our selection of variables (basically dictated by data availability) also facilitates inter-country comparisons within LAC-4 since it is quite similar across countries. These variables include capital formation, government revenue and expenditures, sector output series, as well as external trade and a host of financial variables. Since Latin American economies have historically been highly dependent on global capital markets and demand from outside trading partners, interest rates and cyclical output in advanced countries are also included. Our final data spans 20-25 variables per country between 1870 (1878 for Mexico) and 2004, with some variables being built from scratch based on research with primary data sources. Sources and specifics of the data construction are provided in Aiolfi, Catao and Timmermann (2006). To the extent that these variables correlate closely with aggregate economic activity, efficient aggregation of this information should yield a reasonably accurate measure of the national business cycles.

To efficiently aggregate the information content of this dataset, we use an information extraction methodology that builds on the idea – dating back at least to Burns and Mitchell’s (1946) seminal work – that any sufficiently broad cross-section of economic variables shares at least one common factor. This approach has two key advantages. First, it allows for the existence of strong linkages between economic activity across main sectors due to common productivity, preference and policy shocks, including across countries. Once we have a sufficiently wide and long panel of economic variables that are at least in part driven by these (typically unobservable) shocks, the common factor approach extracts information about macro shocks with minimal resort to an a priori theoretical structure.

The second advantage pertains to aggregation efficiency. The presence of errors in the measurement of activity levels in many sectors can make simple aggregation highly inaccurate. This is more likely to be the case with developing country data and with series going far back in time. In contrast, provided that such measurement errors are largely idiosyncratic, they are filtered out in the factor construction (Stock and Watson, (2002)). Thus, one should expect a common factor methodology to be particularly useful for the construction of a business cycle index when some of the constituent series adding up to a target variable (such as GDP) are lacking, or when those series are suspected to be seriously mis-measured. Both are true for LAC-4 pre-World War II data – with measurement problems also likely to plague at least some of the post-WWII data as well.

The final component of our reconstruction methodology consists of scaling these factors to a measure of aggregate economic activity over the period when this measure becomes available. This is done by regressing the extracted common factors on real GDP over the post-1950 period. The respective estimated coefficients are then used to “backcast” real GDP for the pre-1950 period, with the expected value of the respective country regressions being used as an indicator of the aggregate cycle for the post-1950 period as well. This ensures greater consistency of inter-period comparisons of business cycle dynamics.

We provide next a brief description of the mechanics of our approach.

### A. Dynamic Factor Extraction

Let  $\mathbf{X}_t$  be a vector of de-meaned and standardized time-series observations on  $N$  economic variables observed over the sample  $t = 1, \dots, T$ . Assuming that  $\mathbf{X}_t$  admits a common factor representation, we can write:

$$\mathbf{X}_t = \Lambda \mathbf{F}_t + \mathbf{e}_t \quad (1)$$

where  $\mathbf{F}_t = (\mathbf{f}_t, \dots, \mathbf{f}_{t-s})$  contains the current and lagged dynamic factors,  $\mathbf{f}_t$ , and  $\mathbf{e}_t$  comprises the idiosyncratic disturbances. In practice the factors are typically unobserved and extraction of them from the observables ( $\mathbf{X}_t$ ) requires making identifying econometric assumptions. As is typical in the literature, we assume that the errors  $\mathbf{e}_t$  are orthogonal with respect to the current factors,  $\mathbf{f}_t$ , although they can be correlated across series and through time. In addition the factors are only identified up to an arbitrary rotation.

In our application  $N$  is quite large so we adopt the non-parametric method based on static principal components (Stock and Watson (1999)). A principal component estimator of the factors emerges as the solution to the following least squares problem:

$$\min_{F, \Lambda} T^{-1} \sum_{t=1}^T (\mathbf{X}_t \Lambda \mathbf{F}_t - \mathbf{X}_t) (\Lambda \mathbf{F}_t - \mathbf{X}_t)$$

subject to the restriction  $\Lambda' \Lambda = I$ . The solution to this problem  $\{\hat{\Lambda}, \hat{\mathbf{F}}_t\}$  takes the form

$$\begin{aligned} \hat{\Lambda} &= v \\ \hat{\mathbf{F}}_t &= v' \mathbf{X}_t, \end{aligned} \quad (2)$$

where  $v$  comprises the eigenvectors corresponding to the largest eigenvalues of the variance-covariance matrix for the  $\mathbf{X}$  variables. The resulting estimator of the factors,  $\hat{\mathbf{F}}_t$ , contains the static principal components of  $\mathbf{X}_t$ .

This estimator requires that all variables entering the dynamic common factor specification are stationary. We are interested in the cyclical component of aggregate activity, so we employ two alternative approaches to ensure this. With the exception of the inflation rate, real interest rates, and the ratios of export to import value which are already stationary, we de-trend the remaining series by the standard Hodrick-Prescott filter, with a smoothing factor set to 100, as is common practice with annual data (e.g. Backus and Kehoe (1992); Kose and Reizman (2001)). The second approach to detrending considered here is the symmetric moving average band-pass filter advanced by Baxter and King (1999). Following common practice with annual data, we set the size of the symmetric moving average parameter to three but use a large bandwidth ranging from 2 to 20 years so as to avoid filtering out the longer (12–20 year) pre-war cycles first documented by Kuznets (1958) for the United States. As shown below, both detrending methods yield very similar results. Since we take natural

logs of the respective series, the resulting de-trended component or “cycle” measures percentage deviation of the actual series from trend. Letting  $y$  stand for aggregate output, this is equivalent to defining the cycle as  $\log(y_{actual}) - \log(y_{trend}) \approx (y_{actual} / y_{trend} - 1)$ , which is the so-called “output gap”, i.e., the percentage deviation of actual output from its trend.

## B. Backcasting Regressions

The common factors are of interest in their own right since they provide broad-based measures of economic activity. However, often particular interest lies in relating them to a specific economic variable such as real GDP. As discussed above, reliable data on this variable may only be available over the later part of the sample and, even then, the series may be subject to considerable measurement error and/or discontinuities in data collection and aggregation procedures in national income account construction.

To deal with this we use backcasting to create a new historical time-series of cyclical aggregate output. In particular, we estimate the following backcasting equation using contemporaneous factor values:

$$y_t = \alpha + \beta' \hat{F}_t + \varepsilon_t \quad (3)$$

Coefficient estimates are based on the post-1950 sample for which data of sufficient quality are available on  $y_t$ . Provided the parameters in (3) remain constant, we can then backcast cyclical output over the earlier sample for which estimates of the factors are available but data on aggregate output is missing.

## III. THE NEW BUSINESS CYCLE INDICES

### A. Estimates and Comparison with Previous Indices

Table 1 shows the estimated factor loadings for the first two factors extracted using the Stock and Watson (SW) procedure in equation (2). We report only the first two factors since the addition of further factors contributes only marginally to the total variance of the panel with the exception of one country (Brazil) for which the third factor turns out to be important. As discussed above, in all cases the factors are extracted from a panel where the series have been detrended by the HP-filter with exception of series that are known to be stationary (inflation rate, real interest rates, and the export to import ratio). To check for robustness we computed the same SW factors when the non-stationary underlying series were detrended using the Baxter-King (BK) band-pass filter. Figure 1 shows that these de-trending approaches yield very similar results. Given that the HP-detrending has been more extensively used in related studies (Backus and Kehoe (1992); Kydland and Zarazaga (1997); Kose and Reizman (2001); Neumeyer and Perri (2005)) and in light of some of its advantages relative to other methods that under-weigh low frequency components of the data (which are important during episodes of persistent growth accelerations/decelerations of the type described in

Hausmann, Pritchett, and Rodrick (2004)), we stick to HP-detrending through the remainder of the paper.

Factors extracted from a panel on a variety of variables are typically not straightforward to interpret and are only identified up to an arbitrary rotation. Yet, the estimated factor loadings do offer important clues in this respect. The first factor (labeled F1) can be interpreted as a broad measure of cyclical activity since it loads positively on indicators that are well-known to be procyclical, such as sectoral output, fixed capital formation, import quantum and real money, all measured in deviations from their respective long-term trends. Corroborating this interpretation, the first factor also bears a strong positive correlation with the GDP cycle during periods where official GDP data is available.

The interpretation of the second factor (F2) is less clear-cut. For Argentina, Brazil and Chile, this factor assigns large loadings to money, the domestic interest rate and the real exchange rate (also entered in deviations from trend). Thus, it can be broadly interpreted as an index of monetary conditions. In the case of Mexico, the largest loadings are observed on the variables capturing external linkages such as the terms of trade, the real exchange rate or import volume. This is suggestive of non-trivial differences between the economies regarding business cycle transmission—a point to which we return in Section V.

Ultimately our interest lies in reconstructing a measure of cyclical activity. To this end, Table 2 reports the  $\bar{R}^2$ 's of regressions of de-trended actual GDP on the factors across different factor model specifications. The results cover the period 1950–2004, when full national account estimates are available for all four countries. As with the bulk of the series entering the alternative factor specifications, actual GDP is also expressed in deviations from an HP trend. Correlations in Table 2 thus gauge the extent to which the various factor models span the real GDP cycle or “output gap”. To indicate the sensitivity of the results to the adopted econometric methodologies, we present results both for the all-regressor approach—which maximizes the  $R^2$  by projecting cyclical GDP on all variables—and for the Stock and Watson approach using between one and four common factors. As we shall see below, the high in-sample fit of the all-regressor, “kitchen sink” approach comes at the cost of overfitting the data and seemingly producing poor out-of-sample performance. Overall, linear projections of the GDP cycle on the various factors yield a tight fit for Argentina, Chile and Mexico, with 74–88 percent of the variance of the real GDP cycle explained by the first two factors alone. The fit for Brazil is relatively worse, but including the series on agricultural and manufacturing output (only available from 1900 onwards) raises it above 80 percent.

For each country, the left graphs in Figure 2 show our new indices and previously existing estimates of cyclical GDP over the period 1870–1950, while the right graphs compare our indices with the (HP-filter) de-trended real GDP taken from the most recently revised set of national accounts for 1950–2004. The close proximity between our new common factor-based indices and the detrended GDP derived from national accounts for the post-1950 period is clear from these plots –visual differences only emerge during rare and extremely large spikes such as in Brazil in 1961–62 and 1980. Thus, it is plain that our indices generally very closely track actual cyclical GDP whenever better quality estimates of the latter are available from official national accounts.



Figure 2 further shows that the factor-based estimates often differ substantially from estimates generated by the all-regressor (or “kitchen sink”) least squares regressions. Since the latter is the furthest away from the observations produced by better quality out-of-sample estimates (as for Argentina over 1935–49, Chile during 1940–49, and Mexico 1925–49), this strongly cautions against the use of a kitchen sink approach by researchers in the reconstruction of earlier GDP data. Moreover, the new indices differ substantially from previous authors’ estimates of pre-war GDP, including Maddison’s (2003). While such discrepancies are strikingly large for pre-1930 Brazil and Mexico during 1907–29, they are not negligible either for Argentina and Chile. Since our pre-WWII estimates are very robust to a variety of econometric tests as shown next, and also closely track descriptions of economic turning points from these countries’ historiography – something that previous indices do not (see section V) – this suggests such discrepancies between our indices and previous historical estimates are in all likelihood due to deficiencies in the latter.

### **B. Robustness to Structural Change**

Just as out-of-sample forecasts rely on an implicit assumption that certain relationships between predictor variables and the target variable remain constant over the forecasting period, backcast estimates of economic activity measures also require this assumption. Yet, widespread perception that Latin American economies have witnessed dramatic structural changes due to, e.g., economic liberalization cycles, high inflation bouts, and extensive time inconsistency in policy-making makes it particularly important to investigate whether the accuracy of our new business cycle index is compromised by the potential instability of the factor loadings and of the regression coefficients in (3).<sup>2</sup>

Stock and Watson (2002) provide both theoretical arguments and empirical evidence that principal component factor estimates are consistent even in the presence of temporal instability in the individual time-series used to construct the factors provided that this instability averages out in the construction of the common factors. This occurs if the instability is sufficiently idiosyncratic to the various series and the underlying panel is broad enough that the instability in the relationship between the factor and one or more of the underlying series (20 to 25 per country in our panel) is compensated elsewhere in the panel.

This has implications for the stability of the regression coefficients in (3). Suppose that the relationship between inflation and GDP changes over time as countries move through distinct monetary and exchange rate regimes. As discussed further later on, there are theoretical reasons why inflation is mostly counter-cyclical in these countries but can also be pro-

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<sup>2</sup> Latin American economies are often perceived to have been subject to far-reaching structural changes with major bearings on average growth as well as the cross-country heterogeneity thereof. However, Chumacero and Fuentes (2006) find that, after controlling for external shocks and a measure of distortions, the behavior of per capita GDP in much of the region has been reasonably stable. This is broadly consistent with the results presented in Section IV which show that common external factors have accounted for much of the cyclical variation in aggregate output in LAC-4 over the period 1870-2004.

cyclical at times. The net effect is a weakening of the relationship (and hence the magnitude of the loading) between inflation and the factor(s) which are pro-cyclical. As discussed above, since the first factor (F1) is strongly procyclical in our estimates, this implies that the loading of inflation on this factor will be weakened. This is precisely what the estimates in Table 1 suggest. To the extent that there is more than one factor (in our case we have two or three factors by country), the change may be absorbed by a stronger inflation coefficient in the remaining factors. Since the regression in (3) includes more than one factor (two for Argentina, Chile and Mexico and three for Brazil), this shift in the underlying relationship should be captured by the inclusion of extra factors. An analogous reasoning applies to changes in lead-lag relationships between the underlying variables: as emphasized by Stock and Watson (2002), the inclusion of extra factors can mitigate such structural change problems. In the limit, if a specific series bears too erratic a relationship to the target variable (real GDP in this case), then the respective series will have a small loading on the various extracted factors and hence the effects of such instability on the coefficients in the back-casting equation (3) will be quantitatively unimportant.

We buttress this conceptual discussion with an empirical evaluation of the robustness of our parameter stability assumption using four batteries of tests. First, we inspected the minimum and maximum value across different specifications of the back-casting equation, (3), that vary the number of static factors between two and three; used different samples for factor estimation, where a new sample is adopted if new time series become available (Argentina: 1870–2004, 1875–2004, 1900–2004; Brazil: 1870–2004, 1900–2004; Chile: 1870–2004; Mexico: 1878–2004); and adopted two different panels of data, one including external variables while the other excludes these. For each country this yields between 4 and 24 different specifications. However, with the exceptions of Brazil in 1890–91, 1986 and 1989, Chile in 1929–32 and Mexico in 1916, the range of estimates is very narrow; and even for those outlier observations, all estimates point in the same direction. As it turns out, all indications are that little has changed over time. This congruence is unlikely to hold if the factor loadings were subject to structural breaks.

Second, we also check for the stability of coefficients in the regression of the factors on the cyclical component of real GDP. This was done by re-estimating (3) for the period 1961–2004 (instead of 1950–2004) and recursively rolling back the estimation to the last point for which reasonably reliable data on real GDP exists.<sup>3</sup> Figure 3 shows that the back-casting coefficients are reasonably stable over the 1930–60 period (1940–60 for Chile). Only in the case of Mexico between 1921 and 1925 is there evidence of some instability. This should not be surprising since the real GDP figures used to compute the recursion over the early post-

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<sup>3</sup> Pre-war data on GDP for all the countries are considerably less reliable than official post-war data, but we thought it worthwhile to compare the stability of the back-casting regression coefficients against some of the existing pre-war data as a further robustness check. Given that data for Argentina, Brazil and Mexico from 1920 onwards appear to be of much better quality (albeit still relying on partial production data) than pre-1920 data, we extended the recursive stability test to 1920 using this data.

revolutionary period for Mexico are likely to be marred by measurement problems before the Banco de Mexico centralized the compilation of macroeconomic data in 1925.

Third, we check the sensitivity of our results to an arguably stricter test: we estimate the factor loadings over two different sub-samples – 1870-1950 and 1950-2004 (the latter being marked by various bouts of high- and hyper-inflation, as well as heavy government intervention). We then check how the first two factors of each estimation correlate with the corresponding pair over the other sub-sample, and re-estimate the back-casting equation swapping them. The correlations for the first factor (using the original versus the swapped loading coefficients) show that this makes little difference for three of the four countries. The differences are only sizeable for the second factor in Argentina and Chile. Since the coefficients on the projections of the second factor on GDP are generally very low, these differences only affect the fitted values in the back-casting equation (3) in a minor way.

Fourth and finally, in a Bai-Perron (1998) regression of growth rates of real GDP on our factors extracted from the HP-filtered series, we find little evidence of structural instability. In fact, there is only evidence of breaks for Chilean GDP growth for two years with extreme outliers in the pre-1950 sample, where the underlying level series (which we used to compute growth rates) are less reliable.<sup>4</sup>

Overall, the results above make an important point. Even when the common factors are extracted for countries where changes in economic structure are deemed to have been substantial, they track the real GDP cycle well. This may not be surprising since we selected variables that economic theory suggests are closely related to cyclical activity and a panel which is broad enough so that instability in the linear relationship between individual indicators and the aggregate cycle may be offset elsewhere in the panel.

#### **IV. POLICY REGIMES AND BUSINESS CYCLE FACTS**

##### **A. Dating LAC-4 Cycles**

Armed with business cycle indicators for the four countries, we now turn to the stylized facts, starting with the dating of turning points and thus establishing the typical cyclical lengths. A classic device to this end is the Bry and Boschan (1971) algorithm. It consists of a sequence of procedures starting with the search for extreme values in order to eliminate (near-) permanent jumps in the series associated with outliers, followed by the use of centered moving averages and the search for local maxima or minima within a particular window. Table 3 shows the peaks and troughs of the business cycles for the individual countries. To permit the identification of both shorter and longer cycles, Panels A and B of Table 4 report results based on two-year and six-year windows, respectively. As expected, the algorithm identifies peaks and troughs that are broadly consistent with a visual inspection of individual country plots (see Figure 2 as well as Figure 5 below). When the narrow window is used, the average duration of the cycle is shorter overall, and the more so during the post-WWII era.

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<sup>4</sup> These test results are not reported here but are available from the authors upon request.

Using a longer window, Panel B indicates that the pre-WWII cycle is dominated by the long swings of the type first analyzed by Kuznets and subsequently by Solomou (1987). This evidence of lengthy cycles is corroborated by spectral density function estimates below.

## B. Persistence Patterns

Further evidence that LAC-4 output fluctuations have been relatively protracted is provided by spectral analysis. Panel A in Table 4 reports peak values of the spectral density function of our business cycle index (standardized by scaling the respective series by their variance times  $\pi$ ) as well as the point in the frequency spectrum (the inverse of which thus being the cyclical length  $T$ ) where they occur. LAC-4 cycles were quite lengthy throughout 1870-2004. The average duration was even longer in the pre-WWII period, when the dominant cyclical length was 14 to 16 years.

The estimated spectral density function allows us to further address how the frequency ranges contribute to the total variability of our index, i.e., the extent to which shorter vs. longer fluctuations account for the total variability of de-trended output. Panel B in Table 4 shows that much of the aggregate output persistence in LAC-4 is accounted for by the lower range of the frequency spectrum: over the 1870-2004 period, shocks associated with the shorter cycles (3-6 years) accounted for between 12% and 20% of the total variability in de-trended output, whereas those related to longer cycles (7 to 12 years) accounted for between 43% and 53%. Consistent with the evidence on the shortened business cycle after WWII, the contribution of short-run fluctuations doubled post-1946. Yet, with the exception of one country (Argentina), the low frequency range of the spectrum continues to account for a higher share of the variability of de-trended output.

One benefit of having an index of aggregate activity built from a broad array of macro and sector output indicators is that it enables us to trace the sources of aggregate persistence in these economies. Table 5 reports standard ARIMA(p,I,q) measures of shock persistence (“P”) for the series in our country panels, with  $P = \frac{1 + \theta_1 + \dots + \theta_q}{1 - \rho_1 - \dots - \rho_p}$ , where  $\theta_q$  is the coefficient on the moving average (MA) component of order q and  $\rho_p$  is the coefficient on the autoregressive (AR) term of order p. I=0 for stationary series such as spreads, inflation, and real interest rates, and I=1 otherwise. Because maximum likelihood ARIMA estimates are sensitive to outlier specifications and standard model selection criteria yield disparate results, for each variable and country, four ARIMA specifications were estimated [(1,1,1), (2,1,2), (2,1,0), and (0,1,2)]. For each country and each variable the entries in the table refer to the median estimate across these model specifications. Combining these univariate estimates with the loading on the coefficients of each variable on the factors in Table 1, one can approximately gauge where much of the aggregate persistence comes from. Further, because these ARIMA-based persistence measures are not based on de-trended data, they provide an even broader measure of aggregate persistence than the spectral estimates above and the AR(1) measures presented below.

During 1870-2004, the sector breakdown in Table 5 indicates that manufacturing output and services (transportation and communication) typically have above-average persistence (often

higher than one). As these sectors generally load heavily on the economy-wide pro-cyclical factor and on GDP, they account for the high aggregate persistence in these countries. Agricultural output is typically the least persistent of all series. Much of the aggregate persistence is driven by fixed capital formation, government spending, terms of trade and real M2. Real wages and imports are also quite persistent. Some of the domestic output persistence is clearly imported, as foreign real GDP also has persistence above some domestic variables.

Limiting the sample to the post-WWII period reduces the precision of the maximum likelihood estimates of the MA components. Yet, the relative ranking remains largely robust. Notable differences pertain to the behavior of sovereign spreads, suggesting that country risk in the post-WWII period has become more persistent, and a decline in terms of trade persistence. Another advantage of looking at this sample is the availability of official GDP figures which enable us to report univariate measures for the overall persistence of GDP – something that we evaded for the pre-WWII period due to the low quality of estimates of trend GDP. Overall, real GDP persistence is on average above one and, in two of the four countries (Brazil and Mexico), it exceeds two.<sup>5</sup> Similar measures for the US over the same period yield  $P=1.01$ , whereas for the weighted real GDP of the largest advanced economies  $P=1.28$ . So, the various measures based on our business cycle index indicate that output persistence is high in LAC-4 and this conclusion is not overridden by overall (non-detrended) measures. In other words, the inference that output is highly persistent in LAC-4 does not depend on one's view of what is cycle and what is trend. This is in line with the findings of a recent and growing empirical literature on macroeconomic fluctuations (Aguilar and Gopinath (2007); Cerra and Saxena (2008)).

We refine these results by focusing on cyclical persistence across policy regimes and providing a broad international comparison in this context. We categorize the sample into three regimes. The first, which spans the early globalization in the 1870s era through the onset of the 1930s Great depression, was characterized by tight financial and trade integration with the world economy. There were no foreign exchange or capital controls, quantitative trade restrictions were virtually absent, with export and import shares in GDP at historical highs, and government size substantially lower than at any time since. This outward-looking regime was sharply reversed in the subsequent four decades through the early 1970s, starting with stringent capital controls in 1930-31 and followed by a complex system of trade restrictions. In the wake of the breakdown of the Bretton-Woods system in 1971 and the re-opening of world capital markets to developing country sovereign borrowing from the mid-1970s, financial openness in LAC-4 rose again. After some temporary set-back during the 1980s debt crisis, trade openness greatly intensified from the late 1980s. In light of these developments, we split the sample into pre- and post-1930 as well as pre- and post-1970 periods, including a further split from 1987. The latter is also instrumental in allowing us to address the recent debate on the existence of a “Great Moderation” in global business cycle volatility since the mid-1980s.

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<sup>5</sup> The fact that univariate measures of GDP persistence can yield higher figures than its component parts is well-known and explained by aggregation biases (Pesaran et al. (1993)).

Tables 6 and 7 report a classical measure of cyclical persistence – the slope coefficient of a regression of the business cycle index on its one-year lag (the so-called AR1 measure). Corroborating the earlier findings on the high output persistence in LAC-4, the respective AR(1) estimates of cyclical persistence are reasonably high throughout 1870-2004. Persistence was particularly high in LAC-4 in the pre-1930 era as well as during the 1970s and 1980s. Furthermore, if we discount major country-specific outliers (such as Argentina around the mid-1970s and Mexico’s unusually swift recovery from the 1994-95 crisis) and focus on the common regional factor (extracted as discussed in Section V), cyclical persistence has been even higher: the respective LAC-4 AR(1) coefficient is 0.74 for 1879-2004 as a whole, dropping to 0.60 over 1930-70 and then rising to 0.71 during 1971-2004. These regional averages are well above the benchmark values for several advanced countries and other emerging markets.

### C. Volatility

In addition to AR(1) measures, Tables 6 and 7 also report standard deviations of the cycle across periods and countries. These corroborate the perception that Latin America has been a more volatile region than countries deemed advanced by today's definition, as well as relative to Australia, Canada and Japan that were considered “emerging economies” in the pre-war world. However, this volatility gap between the two groups has changed significantly over time and across policy regimes. The four Latin American countries were clearly far more volatile than both advanced and new world (“NW”) countries in the pre-1930 period. Starting from the Great depression, however, this gap was reversed (See Table 7, panel A). In the wake of the 1929–32 world slump, World War II, and subsequent geopolitical dislocations, global volatility rose to historical highs. As noted above, it was precisely during this period that capital and trade controls were enacted leading to significant drops in trade shares and net capital inflows to GDP. So, our estimates indicate that such inward growth policies did succeed in fending these countries off from global instability. Interestingly, LAC-4 volatility declined not only relative to advanced countries but also relative to other developing countries such as India, Indonesia, Korea, Malaysia, Sri Lanka, South Africa, Taiwan Province of China, and Turkey. Interestingly, this lower volatility did not come at the expense of lower growth during that period, though a case has been made that price distortions due to inward-looking regimes impaired growth later on (Taylor (1998)).<sup>6</sup>

As output gap volatility came down in the advanced countries from the 1960s, cyclical volatility in Latin America rose again; only in the post-debt crisis period has LAC-4 cyclical volatility declined markedly compared to earlier levels. Despite being low relative to its historical record, business cycle volatility in Latin America has remained higher than in advanced countries as well as relative to Asian developing countries during 1988-2004. Rolling standard deviations of the output gap in Figure 4 summarize this broad overview of

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<sup>6</sup> The LAC-4 median of the ratio of growth volatility by mean growth (coefficient of variation) dropped to 1.0 during 1930-1970 (despite the Great Depression and WWII) from 1.66 before 1930, and up to 1.14 in 1971-2004. More recently, however, it dropped to 0.9 in 1988-2004. Similar inferences obtain using the un-weighted regional mean rather the median.

volatility trends in the region by plotting both individual country trends as well as that of the common regional cycle (extracted as discussed in Section V). Buttredding these descriptive statistics, more formal ARCH tests for each of the four countries generally reject the hypothesis of no time-series clustering of output volatility.

A key question from the viewpoint of business cycle transmission is what drives aggregate volatility. As with the previous analysis of persistence, the broad range of macro variables contained in our long dataset helps shed light on the volatility sources. As before, we break the sample down by policy regimes. Table 8 highlights some stylized facts that have been stressed in previous studies (Backus and Kehoe (1992); Mendoza (1995); Basu and Taylor (1999); Agénor, McDermott and Prasad (2000)). First, cyclical volatility in fixed investment is much higher than that of output. Second, government spending volatility is higher than output volatility. For all four countries and across all sub-periods, the magnitude of two simple gauges of government-induced volatility—the real government expenditure cycle and the ratio of public expenditure to revenues ( $G/T$ )—is strikingly high. Coupled with the positive loadings of the real government expenditure variable on the first (pro-cyclical) factor in Table 1, this provides prima facie evidence that changes in the fiscal stance have been important drivers of the business cycle in these countries. Our historical estimates thus further corroborate the post-1960's evidence on strong fiscal procyclicality in these countries (Gavin and Perrotti, 1997).

Our long data series also allow us to examine whether openness helps dampen or exacerbate such fiscally-induced volatility. On purely theoretical grounds, the effect is ambiguous: greater access to international capital markets can decouple real spending from revenues leading to potentially greater oscillations in the deficit ratio ( $G/T$ ). However, it can also help foster market discipline and thus restrain fiscal dominance, it turn dampening fiscal volatility. Table 8 indicates that neither effect wins out in the aggregate: while the volatility of both  $G/T$  and real spending dropped during the 1930s through the early 1970s, it did not bounce back again in three out of the four countries as financial and trade openness increased subsequently; indeed, the standard deviation of both real spending and  $G/T$  reached historical lows in Brazil, Chile, and Mexico during 1988-2004, only Argentina being an outlier in this respect, largely due to the 2001 default. This suggests that the relationship between openness and fiscal discipline is complex and mediated by other factors (cf. Fatás and Mihov (2003)).

As with fiscal variables, the volatility of monetary aggregates (expressed in real terms) has been much higher than for the advanced countries throughout the period. The post-1930 inward-looking regime succeeded in lowering the volatility of real money (both  $M0$  and  $M2$ ), but the subsequent monetary stability record has been more mixed as openness increased. Monetary volatility has clearly increased around major political transitions, reflecting bouts of high and hyper-inflation. Yet, the volatility of monetary aggregates remained reasonably high in Mexico after the 1980s stabilization and with greater trade and financial openness, while declining sharply in Chile. Overall, the historical record thus suggests that neither openness nor its converse – trade and financial account restrictions – readily translate into greater monetary stability; other factors are also at play.

Two other stylized facts contrast with those for advanced countries, namely the counter-cyclical behavior of inflation and pro-cyclicality of real wages, as indicated by the loadings

of these two variables on the pro-cyclical factor (F1) in Table 1. The former stands in stark contrast with the Phillips-curve trade-off which is usually deemed to hold among advanced countries. Evidence from our factor loadings is also suggestive as to why this is so: Consistent with a variety of models (Reinhart and Végh (1995)), cyclical upswings typically go in hand with real exchange rate appreciations (the factor loadings being 0.20 for Brazil, 0.1 for Chile and 0.14 for Mexico) as well as with buoyant imports (see the respective loadings in Table 1), both of which help keeping domestic price pressures at bay. The counter-cyclical behavior of inflation makes the apparent pro-cyclicality of real wages consistent both with models based on short-run nominal wage stickiness as well as with real business cycle models that emphasize the dominant role of technology shocks in shifting the labor demand schedule over business cycle frequencies.

Turning to external variables, terms of trade have been highly pro-cyclical and the trade balance mostly countercyclical, consistent with the relatively high and positive loadings of import volumes on the pro-cyclical factor (F1) in all four countries (see Table 1). The amplitude of the terms of trade cycle has been strikingly high throughout – albeit declining in Brazil, Chile and Mexico since the 1970s consistent with greater commodity diversification of exports in the three economies and the Great Moderation in advanced countries’ business cycles from the mid-1980s to 2004.

## **V. CYCLICAL SYNCHRONICITY**

### **A. Prima-Facie Evidence**

The business cycle reference dating reported in Table 3 highlights several cyclical turning points which occur around similar dates (plus/minus one-year) in all four countries. This begs the question of how these turning points relate to major events of domestic or external origin. In addition to providing some prima-facie evidence on the role of external vs. domestic shocks, relating the major turning points in our business cycle index to what the more narrative historiography says is a further test of the accuracy of our data.

Figure 5 relates the two. Most of the major cyclical turning points in each of the countries’ history have been associated with well-known global shocks. In the pre-WWII era, these include: the global stock market crash of the early 1870s, the European Banking crisis and global recession of 1884-85, the collapse of the Barings investment bank (1890-91) and the global recession of the early 1890s, the 1907 financial panic in the US, World War I, and the Great depression. In the post-WWII era, this includes the commodity price boom and collapse around the 1951 Korean war, the first global oil shock of 1973-4, the debt crisis of the early 1980s, and the emerging market financial crisis of 1997-98 associated with debt defaults in Asia and Russia.

A second spotlight in Figure 5 is that of some turning points being associated with country-specific shocks whose effects spread through the region. Intra-regional trade between these economies (as a share of their total trade) has been limited prior to the 1990s, so such regional contagion must largely stem from the financial channel and perceptions of a regional factor in country risk. Post-WWII instances include the Argentina debt rescheduling of 1962 and the political upheaval in Brazil around the same time, the Mexican financial crisis of



1994-95, the Brazilian currency crisis of 1999 and Argentina's 2001 sovereign default. Even in some of these cases, however, global factors can be argued to have played a role, such as the rise in US interest rates in the run-up to the 1994-95 Mexican crisis. Conversely, there were also cases in which a global shock was sparked by country-specific events within LAC-4 – notably the default on Argentine mortgage bonds which triggered the collapse of Barings in 1890-91 and the Mexican sovereign default of 1982, which weakened some large international banks and had domino effects on other emerging markets. So, the distinction between global and regional shocks is not always clear-cut. We return to this issue more formally below.

Third, Figure 5 also makes it plain that, despite common global factors and regional contagion, cyclical synchronicity has been far from perfect. First, some expansion and contraction phases were country-specific. This occurred for Chile in the aftermath of WWI and in the Brazil-specific booms of 1985-86 and 1994-95. Figure 5 also illustrates that imperfect synchronization across LAC-4 was sometimes due to contagion being limited to a subset of countries within the region. This was notably the case during 1994-95 when the Mexican financial crisis had far reaching adverse effects on Argentina but not on Brazil and Chile. Finally, imperfect synchronization also manifests itself in both distinct lags and amplitudes of the response of the national cycle to the same external shock.

The historiography for LAC-4 provides ample narrative evidence on two distinct sets of factors accounting for this imperfect synchronization. One is the considerable national differences in the commodity composition of exports. While all four countries have been mostly primary commodity exporters for much of the period, Argentina specialized in wheat, beef and other agricultural commodities, Brazil in coffee, Chile in copper, and Mexico in silver, oil and other metals. Since global shocks have often been associated with very different relative price shifts across commodity varieties, the impact of global shocks on the timing and amplitude of national cycles have differed according to these countries' stand in the "commodity lottery" (Diaz-Alejandro (1984); Blattman, Hwang, and Williamson (2006)). This explains the extreme amplitude of the 1931-32 depression in Chile following the strong collapse in copper prices relative to other commodities, for much the same reasons that coffee specialization in Brazil mitigated the effects of the 1890-91 Barings crisis on the economy (as coffee price boomed through 1893). In short, as the terms of trade across commodity varieties respond very differently to global financial and real shocks and such terms of trade have a major bearing on the national cycle, this explains some of the less-than-perfect cyclical concordance across LAC-4.

The other source of imperfect business cycle synchronization for which the country historiographies provide plenty of evidence is national policy – including differences in policy management and the role of political upheavals and revolutions which are well-known to have been non-trivial in Latin America. These differences appear to help explain both benign instances of limited vulnerability to regional contagion - as in Brazil and Chile during 1994-95– as well as instances of massive amplifications of external shock on the domestic economy. Striking instances of the latter which are clearly fleshed out by our indices include Mexico's severe downturn during WWI (exacerbated by chaotic monetary management and hyperinflation during the Mexican revolution), as well as the output collapses in Argentina and Chile around the military coups of 1973 and 1975.

To sum up, the proximate timing and amplitude of the output fluctuations portrayed by our 135-year long index closely match those of historiographical accounts and point to considerable cyclical commonality across LAC-4 and links with global shocks. This commonality is remarkable in light of structural differences in endowment and commodity specialization, limited intra-regional trade before the 1990s, as well as disparate national political and policy cycles. The remainder of this section provides formal measures of the common regional factor and the extent to which it is explained by fluctuations in global financial and real factors.

## **B. Concordance Measures**

The first formal measure of cyclical synchronicity we consider is the concordance index of Harding and Pagan (2002). This consists of a non-parametric measure of the relative frequency at which countries are jointly undergoing an expansion or a contraction phase gauged by a binary indicator. Table 9 reports this statistic which ranges from a minimum of zero (no concordance) to unity (perfect concordance). The results indicate that Latin American business cycles have displayed a reasonably high degree of synchronization throughout 1870–2004 and that this synchronization did not decline dramatically during the period from the early 1930s to the early 1970s. We return to this point below.

Our second metric uses the econometric methodology from Section II to extract common factors from a pooled data set that brings all four countries' data together.<sup>7</sup> Since the resulting regional factor jointly loads on a broad-based and reasonably homogeneous balanced panel of 20-25 series for each country, it is not unduly overweighting some country or sector relative to others. Corroborating the above results from the Harding and Pagan (2002) concordance metric, Table 10 shows that the regional factor has relatively high correlation coefficients (averaging around 0.7) with the main pro-cyclical factor (F1) for individual countries. Consistent with the concordance index, cross-country correlations in F1 declined only slightly in the 1930-70 closed economy regime. This approach does point, however, to some recent decoupling by Chile and Mexico, even though correlations with the regional F1 of 0.74 for Chile and 0.43 for Mexico remain far from negligible.

## **C. Global and Country Factors**

We now turn to two related albeit separate questions. The first is how important global factors are in explaining individual country cycles. The other is how much of the variance of the common regional factor are explained by those global factors. Since, as discussed in subsection A, there have been episodes of regional contagion stemming from country-specific shocks, global factors need not explain all – or even most – of the variance of the common regional factor. If we orthogonalize the domestic cycle to such external factors, a proximate measure of the role of domestic factors in individual country cycles can be obtained.

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<sup>7</sup> Our results hold irrespective of whether we exclude or include the foreign interest rate and advanced countries' GDP in the panel. The plot and correlations reported in this section exclude the advanced country interest rate and output to mitigate endogeneity biases.

Previous studies have highlighted the role of global interest rate shocks in “pushing” capital flows into (and hence driving business cycles in) Latin America. Calvo, Leiderman, and Reinhart (1993) and Fernandez-Arias (1994) find that US interest rate shocks account for up to one half of the variance of capital inflows, real exchange rates and international reserves – all highly procyclical variables – in Latin America. Izquierdo et al. (2008) repeats a similar exercise for average output for the seven largest Latin American countries. Using a structural VAR with post-1990 quarterly data, Canova (2005) estimates that US interest rate shocks account for some 25 percent of the average output variance in the region. This estimate is roughly similar to Uribe and Yue’s (2006) for a sample of seven emerging markets, five of which are Latin American.

We present two new pieces of evidence. First, we use SURE regressions to gauge the role of financial and real global factors for individual LAC-4 countries. In doing so, we account for a non-zero covariance between residuals and indicate that some of it reflects intra-regional contagion. Second, we use simple OLS regressions to gauge the share of fluctuations in our estimates of the common regional factor – which purportedly also capture intra-regional contagion – that is explained by global factors. We do so over a much longer sample than previous studies and distinguish between policy regimes.

Table 11 reports SURE results, with each country’s cyclical index as the dependent variable. These have been re-estimated excluding the foreign interest rate and foreign output variables to mitigate endogeneity issues. Global *real* factors are captured by the (HP-detrended) component of advanced countries’ real GDP as well as the global relative price of primary commodities, and global *financial* factors by the (GDP-weighted) average of short-term interest rates on government bonds in advanced countries. In addition, we include a world war dummy that is in effect for 1914-18 and 1940-45. With the exception of world output for Argentina and world interest rates for Mexico, world output and interest rates are statistically significant at conventional levels. Global terms of trade generally fall short of statistical significance (Mexico being the exception), as its effects are largely spanned by global output and interest rates.<sup>8</sup> Overall, the regressions explain between 52% and 71% of cyclical fluctuations in these countries. To gauge how much of this is ultimately due to global factors, rather than a combination of other shocks feeding output through lagged dependent variable dynamics, we experiment with two approaches. One is to drop the external variables altogether. The  $R^2$ s of these stripped-down regressions are reported at the bottom of Table 11 range from 0.42 for Argentina to 0.64 for Mexico. Subtracting those from the all-variable regression  $R^2$ s result in global factors accounting for some 10% of the total variance of national cycles. This is bound to be an underestimate, however, since global factors may be entering the stripped-down regressions indirectly through a combination of shocks to the residuals and lagged dependent variable dynamics. A second approach is to include only global factors (current and lagged) eliminating the lagged dependent variables altogether. In this case, the global variables explain between 14% (Argentina) to 40% (Chile) and 44%

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<sup>8</sup> We also experimented with two widely used indicators for global risk – the yield spread between AAA and BAA US corporate bonds and the intra-year standard deviation of monthly observations of US 3-month T-bill rates. None of them was significant.

(Mexico). These shares vary somewhat by regime (unreported), with the respective sub-period estimates averaging close to one-half. Despite some non-trivial discrepancies across these different measures of the role of domestic factors in driving cyclical volatility in LAC-4, all the above metrics accord with the findings of cross-country research that ranks Argentina well ahead of the other three countries in political and policy volatility (Scartascini et al., 2008).

In all cases, the matrix of residual co-variances points to significant cyclical inter-dependencies across LAC-4 even after controlling for global factors. This is corroborated by the Breuch-Pagan test which rejects cross-equation independence. We next examine whether this interdependence is mitigated once one allows for the role of shocks of a more intra-regional nature. We do this by adding a dummy to the regressions which is active in years where such shocks took place, often associated with sovereign default episodes.<sup>9</sup> Panel B of Table 11 shows that such a crisis dummy is statistically significant for all countries but Brazil. Importantly, its inclusion makes cross-equation residual correlation insignificant. This suggests that intra-regional “contagion” plays a non-trivial role in national cycles.

Finally, we take the alternative metrics of gauging how far the same global factors explain the dynamics of the common regional factor (F1). Table 12 reports the results. In the pre-1930 regime, a one percentage point change in the external output gap typically depressed the LAC-4 counterpart by some 0.23 percentage points, with rises in the real external interest rate having a similar depressing and statistically significant effect. Interestingly, this external interest rate effect retains its proximate magnitude through the post-1930 inward-looking regimes, perhaps suggesting that capital controls were not particularly effective in cutting off financial linkages with global markets. In contrast, and consistent with the role of protectionist trade policies and lower trade shares in GDP across LAC-4, the coefficient on external output drops by half to 0.12. This is sharply reversed post-1970, when the regional cycle becomes far more elastic to world output, with an estimated coefficient of 0.45. Given that output cycles in advanced countries witnessed a “Great Moderation” over the past two decades, this higher elasticity to world output implies that global business cycle moderation also helped dampen the common LAC-4 cycle. Finally, as with the SURE regressions, we also control for the global commodity terms of trade (panel B) and try to isolate the effects of global factors on the common regional factors by reporting the  $R^2$ 's of the respective regressions without lagged dependent variables, i.e., with global factors alone (current and lagged). These  $R^2$ 's suggest that global factors accounted for between 59-69% of the common regional factor before the 1970s and close to 40% (39% being the point estimate) thereafter, with output and interest rates in advanced economies being the main drivers.

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<sup>9</sup> A full list of these episodes is available from the authors upon request. The underlying database on credit events in the region has been derived from Catão, Fostel and Kapur (2009).

## VI. CONCLUSION

This paper has sought to fill some of the lacuna in the international business cycle literature stemming from the lack of good long-run data for emerging markets. Its main contribution is twofold. One is data reconstruction and computation of new business cycle indices for the four largest Latin American economies (LAC-4) spanning the early days of financial globalization in the late 19<sup>th</sup> century to the early 21<sup>st</sup> century. The underlying data work in the computation of the new indices was based on extensive research with both primary and secondary data sources, producing some new series that were unavailable to previous researchers. By combining these new data with a suitable approach to econometric backcasting, this paper has generated new business cycle indices that appear to be considerably superior to previous indicators of aggregate economic activity before World War II in these countries, as gauged by a variety of parameter stability tests and qualitative historical comparisons.

The second main contribution is to use these data to uncover stylized business cycle facts for LAC-4 across distinct policy regimes. Since our new business cycle indices are based on a consistent set of underlying data and the same construction methodology throughout, it is particularly suited to long-run historical comparisons.

Five sets of findings emerge. First, we have shown that LAC-4 business cycle volatility – both in absolute terms as well as relative to advanced countries and other emerging markets – varied markedly across policy regimes. It was highest during the “open economy” regime between the late 19th century and the eve of the 1930s world depression. While much has been made of the causality running from domestic institutions to macro volatility (Acemoglu et al. (2003)), this finding raises important questions on the reverse causality running from foreign-induced macro volatility to the quality of institutions, since the highest levels of foreign-induced volatility in Latin America coincided with the formative years of key national institutions. We believe this is an important issue for future research and one for which the historical dataset provided in this paper is instrumental.

Our findings are not, however, supportive of an *unconditional* relationship between openness and cyclical volatility. While cyclical volatility did fall in three out of the four countries (Chile being the exception) during the inward-looking regimes of the 1930s through the 1970s, and rose as LAC-4 opened up in the late 1970s and early 1980s, it actually reached all time lows during the post-1987 period, when a new wave of openness policies were implemented. Indeed, as our econometric results indicate, the decline in cyclical volatility during 1930-70 was not a result of reduced openness per se but simply indicates that inward-looking regimes can be instrumental in mitigating domestic output volatility when world volatility rises, as it did during that period. The fact that LAC-4 business cycle volatility declined to new historical lows during the more open regimes of the 1990s and early 2000s – when many advanced countries experienced the “Great Moderation” – further underscores this point. That is, openness can enhance or inhibit cyclical volatility depending on the volatility state of the world economy as well as on other factors.

Second, our new business cycle index allows us to probe into the much studied relationship between cyclical volatility and trend growth. As with the relationship between cyclical

volatility and openness, the relationship is not entirely clear-cut. In some cases (e.g. Argentina), cyclical volatility was above its historical average when trend growth was also above average (e.g., before 1930), while both cyclical volatility and trend growth declined between 1930 and 1970. In other cases (notably Brazil), however, volatility and trend growth have been negatively correlated in the longer run. So, clearly other factors seem to be intervening. This is consistent with what some recent studies cited above have shown using more post-1970 data.

Third and in contrast with the marked time-varying pattern of cyclical volatility, output persistence has been high in LAC-4 throughout the past one and a half century. Importantly, we have shown that this finding is not overly sensitive to cyclical vs. trend decompositions. Such high output persistence is an important feature of the data because, as discussed in a recent literature on country risk (Arellano (2008); Catão, Fostel and Kapur (2009)), higher cyclical persistence coupled with the likelihood of large shocks tend to raise sovereign spreads, the incidence of debt crises, and possibly drag down economic growth through this channel. We have also linked such high levels of aggregate persistence to fixed investment, government spending, and monetary shocks, and shown that it is propagated mostly through manufacturing and service sectors as opposed to agriculture and mining.

Fourth, our long-run data highlight some empirical similarities documented for other countries as well as some differences. One is the much higher cyclical amplitude of both fixed investment and real government spending relative to output and the greater pro-cyclicality of fiscal policy relative to that found in advanced countries. In contrast with stylized facts for advanced countries, inflation is typically counter-cyclical while real wages are pro-cyclical.

Fifth, and finally, there has been considerable commonality of cyclical fluctuations across LAC-4, stemming from a combination of global and intra-regional factors. We find that global factors explain no less than around 40% (post-1970) and 70% (pre-1930) of the common regional cycle, even though their shares in the variance of national cycles differ non-trivially at times. Evidence of such a sizeable external factor suggests that contentions often made in some country-specific studies emphasizing the role of domestic policies and related structural breaks on growth performance in Latin America should be qualified accordingly.

We finish by underscoring the usefulness of extending this paper's econometric methodology and data construction to other countries and regions. The finding that our estimates are robust even for countries that have gone through major structural changes, shows promise for taking our approach to other developing countries. Data collection efforts are bound to be considerable, but this should permit better identification of country-specific, region-specific, and world business cycle factors, as well as enhancing our understanding of business cycle propagation across a richer gamut of policy regimes and of the relationship between institutional quality and cyclical volatility more generally.

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Table 1: Factor Loadings on the First Two Factors

The table reports the eigenvectors associated with the first two common factors extracted from the panel of variables listed below for each country.

	A. 1870-2004						B. 1900-2004					
	Argentina		Brazil		Chile		Mexico		Argentina		Brazil	
	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
Agriculture	-	-	-	-	0.03	-0.21	0.25	-0.22	0.05	-0.05	0.07	0.24
Communication	-	-	0.29	-0.11	-	-	-	-	-	-	0.28	-0.1
Manufacturing	-	-	-	-	0.22	0.29	0.19	0.21	0.35	-0.13	0.31	-0.01
Mining	-	-	-	-	0.35	-0.16	0.26	0.05	-	-	-	-
Cement	0.30	-0.06	0.34	-0.07	-	-	0.21	0.24	0.32	0	0.33	-0.08
Transportation	0.35	-0.05	0.21	-0.26	-	-	0.26	-0.05	0.35	-0.03	0.24	-0.22
Fixed Investment	0.37	-0.09	0.42	0.02	0.34	-0.03	0.30	0.30	0.36	-0.15	0.39	0.03
Govt. Expenditures	0.30	0.31	0.21	0.36	0.30	0.08	0.24	-0.26	0.24	0.35	0.18	0.36
Govt. Revenues	0.31	-0.04	0.31	0.22	0.34	-0.03	0.27	-0.16	0.27	-0.04	0.3	0.21
NarrowMoney	0.19	0.39	0.11	0.18	0.11	0.45	0.34	-0.13	0.23	0.35	0.07	0.17
Broad Money	0.30	0.16	0.05	0.18	0.18	0.42	0.33	-0.14	0.24	0.17	0.01	0.17
Inflation	-0.08	0.30	-0.10	-0.04	-0.07	0.03	-0.18	-0.03	-0.09	0.3	-0.09	-0.03
Domestic Interest Rate	-0.05	-0.37	-0.07	-0.02	-0.00	-0.33	-	-	-0.04	-0.38	-0.06	-0.01
Mortgage Credit	-	-	-	-	0.05	-0.20	-	-	-	-	-	-
Terms of Trade	0.17	0.09	0.27	-0.31	0.19	0.06	0.09	0.28	0.11	0.16	0.25	-0.3
Real Exchange Rate	0.00	-0.43	0.20	-0.19	0.10	-0.43	0.14	0.43	0	-0.42	0.17	-0.19
Export Volume	0.04	-0.11	-0.05	0.17	0.31	-0.25	0.21	-0.12	0.06	-0.15	0	0.18
Import Volume	0.36	-0.26	0.43	-0.06	0.39	0.01	0.28	0.38	0.33	-0.23	0.42	-0.04
TradeBalance	-0.25	0.24	-0.30	-0.11	-0.06	-0.16	-0.08	-0.22	-0.23	0.21	-0.28	-0.1
External Spread	-	-	0.03	0.27	-	-	-	-	-	-	0.04	0.28
Foreign Capital Inflows	0.23	-0.17	-	-	-	-	-	-	0.17	-0.15	-	-
Foreign 3m-Tbill	0.08	-0.11	0.08	0.10	-0.06	0.13	0.17	-0.25	0.05	-0.07	0.06	0.13
Foreign Output	-0.01	0.11	0.02	-0.43	0.26	-0.00	0.09	0.16	-0.01	0.08	0.05	-0.4
Real Wage	0.20	0.25	0.02	0.40	0.29	-0.06	0.25	-0.24	0.22	0.22	0.02	0.41
Population	0.09	0.20	-0.10	-0.27	0.01	0.12	0.00	-0.10	0.11	0.22	-0.07	-0.24

Table 2: In-Sample Fit of Factor Models

The table reports adjusted R-squares of detrended official GDP on the extracted factors (backcasting equation (3)) for each country during 1950-2004. Factors were extracted over two alternative samples.

	A. 1870-2004				B. 1900-2004			
	Argentina	Brazil	Chile	Mexico	Argentina	Brazil	Chile	Mexico
All regressors	0.89	0.77	0.91	0.92	0.94	0.90	0.91	0.92
SW(1)	0.76	0.51	0.72	0.83	0.84	0.65	0.72	0.83
SW(2)	0.81	0.52	0.74	0.83	0.88	0.65	0.74	0.83
SW(3)	0.81	0.69	0.75	0.86	0.88	0.83	0.75	0.86
SW(4)	0.82	0.71	0.78	0.87	0.88	0.84	0.78	0.87

Table 3: Dating the Cycle

The table reports peak and trough dates selected by the Bry-Boschan algorithm. Results in Panel A impose a minimum of two years between peaks, while results in Panel B impose a minimum of six years between peaks.

A. Short Cycles						B. Long Cycles									
Argentina		Brazil		Chile		Mexico		Argentina		Brazil		Chile		Mexico	
Peaks	Troughs	Peaks	Troughs	Peaks	Troughs	Peaks	Troughs	Peaks	Troughs	Peaks	Troughs	Peaks	Troughs	Peaks	Troughs
1873	1880	1872	1876	1875	1877	1883	1886	1873	1880	1881	1876	1885	1890	1883	1886
1884	1887	1881	1886	1882	1885	1891	1894	1889	1891	1891	1886	1886	1912	1898	1916
1889	1891	1891	1893	1890	1894	1898	1902	1899	1902	1913	1901	1901	1929	1921	1927
1893	1895	1896	1901	1896	1897	1907	1909	1913	1918	1927	1915	1915	1943	1936	1938
1899	1902	1907	1908	1898	1902	1912	1916	1930	1933	1938	1931	1931	1952	1947	1951
1913	1918	1912	1915	1907	1909	1921	1927	1948	1953	1951	1942	1942	1980	1965	1971
1923	1926	1927	1931	1912	1915	1928	1932	1961	1971	1962	1956	1956	1997	1981	1995
1930	1933	1938	1942	1918	1919	1936	1938	1980	1985	1979	1967	-	-	-	-
1938	1945	1946	1948	1926	1927	1941	1942	1997	-	1997	1992	-	-	-	-
1948	1953	1951	1956	1929	1932	1945	1947	-	-	-	-	-	-	-	-
1958	1959	1962	1967	1937	1942	1951	1953	-	-	-	-	-	-	-	-
1961	1963	1974	1976	1943	1947	1956	1959	-	-	-	-	-	-	-	-
1965	1968	1979	1983	1952	1954	1960	1962	-	-	-	-	-	-	-	-
1970	1971	1986	1988	1957	1958	1965	1971	-	-	-	-	-	-	-	-
1974	1978	1990	1992	1962	1965	1974	1977	-	-	-	-	-	-	-	-
1980	1985	1997	1999	1966	1970	1981	1988	-	-	-	-	-	-	-	-
1987	1990	2002	-	1972	1975	1994	1995	-	-	-	-	-	-	-	-
1994	1995	-	-	1980	1983	2000	2002	-	-	-	-	-	-	-	-
1997	2002	-	-	1989	1990	-	-	-	-	-	-	-	-	-	-
-	-	-	-	1997	2002	-	-	-	-	-	-	-	-	-	-

Table 4: Spectral Density Estimates of the Business Cycle Index

Panel A reports global peak values of the spectral density function of de-trended output for each country/period using a Bartlett window and a bandwidth set at twice the squared number of observations. Panel B reports the relative masses of lower (longer cycle) and higher (shorter-cycle) frequency ranges under the spectral density function normalized by the variance of the de-trended output.

	A. Global Peaks				B. Relative Contributions to Total Output Variance					
	1870-1929		1930-1970		1870-2004		1947-2004			
	Estimate	T	Estimate	T	Short cycle (3-6 years)	Long cycle (7-12 years)	Short cycle (3-6 years)	Long cycle (7-12 years)		
Argentina	4.64 (1.96)	16	3.36 (1.48)	12	2.11 (1.02)	12	19.45% (7-12 years)	43.64% (3-6 years)	44.53% (7-12 years)	39.21%
Brazil	4.57	16	3.90	12	2.35	12	12.18%	48.45%	23.01%	42.31%
Chile	(1.92) 2.18	16	(1.72) 2.05	12	(1.13) 3.79	8	19.95%	48.00%	33.79%	61.78%
Mexico	(0.92) 3.75	14	(0.90) 2.35	8	(1.90) 3.14	12	11.71%	52.62%	34.40%	50.08%
	(1.59)		(1.04)		(1.52)					

Table 5: Disaggregated Persistence Measures

The table reports the values of  $P = (1 + \theta_1 + \theta_p..)/(1 - \rho_1 - ..\rho_q)$  where  $\theta$  and  $\rho$  are the moving average and auto-correlation coefficients of an ARIMA (p,1,q) over the full period (1870-2004) and post-war sample (1947-2004).

**A: 1870-2004**

	Argentina	Brazil	Chile	Mexico	LAC-4 Median
agriculture output	0.48	0.53	0.50	1.09	0.50
manufacturing output	1.04	1.36	1.02	1.04	1.04
mining output	-	-	0.71	1.65	0.71
cement output	0.96	1.00	.	1.31	0.98
transportation output	2.53	1.60	-	1.77	2.07
communications output	-	1.53	-	-	1.53
export volume	0.64	0.71	0.64	0.97	0.64
import volume	0.96	1.12	1.11	0.88	1.11
terms of trade	0.82	0.87	0.94	0.79	0.87
fixed investment	1.30	1.15	0.93	1.19	1.15
real gov. spending	0.85	0.88	0.76	1.14	0.85
real gov. revenues	0.64	1.01	0.66	1.27	0.66
real wage	0.91	1.05	0.84	1.00	0.91
real exchange rate	0.47	0.44	0.70	0.81	0.47
Mo/CPI	0.97	0.19	0.65	0.99	0.65
M2/CPI	1.06	0.30	1.04	0.96	1.04
real domestic interest rate	0.00	0.00	0.50	-	0.00
Inflation	0.55	0.80	1.09	0.00	0.80
Sovereign spread	0.36	0.33	1.00	-	0.36
foreign capital flows	0.35	-	-	-	0.35
foreign real GDP	1.41	1.41	1.41	1.31	1.41
foreign real TB-bill rate	0.23	0.23	0.23	0.23	0.23
Overall Median	0.73	0.80	0.84	0.97	0.80

**B: 1947-2004**

	Argentina	Brazil	Chile	Mexico	LAC-4 Median
agriculture output	0.26	0.60	0.78	1.48	0.60
manufacturing output	0.93	2.18	1.08	1.44	1.08
mining output	-	-	0.93	1.24	0.93
cement output	0.69	1.97	-	0.92	1.33
transportation output	0.83	2.38	-	1.44	1.61
communications output	-	3.85	-	-	3.85
export volume	0.79	0.98	0.52	0.87	0.79
import volume	0.79	1.17	0.94	0.87	0.94
terms of trade	0.56	0.43	0.86	0.70	0.56
fixed investment	0.77	1.07	1.06	0.94	1.06
real gov. spending	0.49	0.91	1.02	1.04	0.91
real gov. revenues	0.34	1.09	0.96	1.00	0.96
real wage	0.80	1.60	0.43	1.38	0.80
real exchange rate	0.25	0.37	0.89	0.23	0.37
Mo/CPI	0.26	0.00	0.31	0.88	0.26
M2/CPI	0.94	0.60	0.92	0.79	0.92
real domestic interest rate	0.66	0.60	0.89	.	0.66
Inflation	0.74	3.01	3.09	0.69	3.01
Sovereign spread	1.05	0.45	0.74	0.44	0.74
foreign capital flows	0.30	-	-	-	0.30
foreign real GDP	1.26	1.26	1.26	1.03	1.26
foreign real TB-bill rate	0.27	0.27	0.27	0.27	0.27
Overall Median	0.71	1.03	0.91	0.92	0.92
Real GDP Persistence	0.97	2.86	1.30	2.38	1.84

Table 6: Persistence and Volatility of the Cycle

The table reports autocorrelation and standard deviation estimates of our new business cycle indices in Panel A. Panel B reports the corresponding estimates of the HP-filtered detrended real GDP data from these countries' national accounts.

**A: Backcasted Data**

	1870-1929			1930-1970				
	Arg	Bra	Chi	Mex	Arg	Bra	Chi	Mex
AR(1)	0.728	0.727	0.640	0.767	0.617	0.616	0.554	0.573
Std	0.065	0.048	0.063	0.066	0.046	0.032	0.078	0.029
	1971-1987			1988-2004				
	Arg	Bra	Chi	Mex	Arg	Bra	Chi	Mex
AR(1)	0.059	0.659	0.614	0.654	0.579	0.482	0.562	0.472
Std	0.029	0.037	0.071	0.039	0.065	0.020	0.020	0.024

**B: Actual GDP Data**

	1971-1987			1988-2004				
	Arg	Bra	Chi	Mex	Arg	Bra	Chi	Mex
AR(1)	0.168	0.624	0.590	0.644	0.590	0.622	0.687	0.383
Std	0.034	0.043	0.081	0.039	0.068	0.021	0.033	0.030

Table 7: International Comparisons on Cyclical Persistence and Volatility

The table compares autocorrelation (AR(1)) and unconditional standard deviation (Std) estimates of the new LAC-4 business cycle indices with HP-filter detrended real GDP to those in other countries. Panel A shows median regional values for LAC-4, EU-4 (France, Germany, Italy and the UK), NW-3 (USA, Canada and Australia) and Japan (JP). Panel B includes a broad LDC group (India, Indonesia, Korea, Malaysia, Taiwan, South Africa, and Turkey), as well as Africa (41 countries), Asia (11 countries), and the Middle East (18 countries) using Maddison data before 1950 and official data thereafter.

**A: Advanced Countries**

	1870-1929			1930-1970				
	LA-4	EU-4	NW-3	JP	LA-4	EU-4	NW-3	JP
AR(1)	0.728	0.507	0.517	0.032	0.595	0.697	0.706	0.599
Std	0.064	0.051	0.050	0.035	0.039	0.101	0.066	0.128
	1971-1987			1988-2004				
	LA-4	EU-4	NW-3	JP	LA-4	EU-4	NW-3	JP
AR(1)	0.634	0.526	0.477	0.683	0.522	0.619	0.501	0.417
Std	0.038	0.017	0.021	0.027	0.022	0.015	0.022	0.018

**B: Developing Countries**

	1930-1950				1950-1970					
	LA-4	Other LDCs	Africa	Asia	Middle East	LA-4	Other LDCs	Africa	Asia	Middle East
AR(1)	0.560	0.617	-	-	-	0.273	0.051	0.502	0.416	0.402
Std	0.040	0.078	-	-	-	0.031	0.030	0.038	0.028	0.043
	1971-1987				1988-2004					
	LA-4	Other LDCs	Africa	Asia	Middle East	LA-4	Other LDCs	Africa	Asia	Middle East
AR(1)	0.607	0.551	0.563	0.486	0.447	0.606	0.531	0.481	0.547	0.572
Std	0.041	0.038	0.051	0.033	0.031	0.031	0.028	0.035	0.028	0.057

Table 8: Disaggregated Measures of Cyclical Volatility

The table reports standard deviations (in percent) for selected variables and different sample periods. Monetary variables are expressed in real terms (CPI deflated). All variables are measured as deviations from their HP-filtered trends with the exception of expenditure to revenue ratios and real interest rates.

	1870-1929			1930-1970			1971-2004			
	Argentina	Brazil	Chile	Argentina	Brazil	Chile	Argentina	Brazil	Chile	Mexico
Foreign Interest Rate	5.34	5.34	5.34	4.68	4.68	4.68	2.20	2.20	2.20	2.20
Foreign Output	3.46	3.46	3.46	7.08	7.08	7.08	2.97	2.97	2.97	2.97
Domestic Output	6.49	4.84	6.25	4.56	3.25	7.69	5.01	2.94	5.35	3.30
Terms of Trade	14.99	21.79	33.05	12.20	20.27	26.66	29.37	12.24	16.45	22.20
Export Volume	13.20	10.21	17.61	13.59	9.95	16.89	9.52	12.94	8.11	6.87
Fixed Investment	45.30	34.96	30.45	34.04	29.56	34.67	13.43	16.64	15.32	20.94
Government Spending	14.79	10.51	15.88	11.43	13.82	14.05	8.53	11.76	10.33	9.44
Expenditure/Revenue	28.41	20.82	28.83	10.70	23.36	16.21	13.83	19.64	22.53	9.05
Narrow Money	14.94	15.32	16.64	35.07	10.20	11.01	19.90	15.43	16.84	15.81
Broad Money	14.82	14.62	11.39	35.83	12.33	10.84	13.46	13.62	20.32	22.82
Real Wage	12.33	9.14	8.69	32.73	6.99	13.07	18.22	12.44	5.72	12.30
										15.13

Table 9: Synchronization of the Latin American Cycles

The table reports the Harding-Pagan (2002) concordance statistic. Values close to one show evidence of a stronger degree of synchronicity.

	1878-1929			1930-1970		
	Arg	Bra	Chi	Arg	Bra	Chi
Arg	1.00	0.48	0.54	0.62	1.00	0.54
Bra	-	1.00	0.79	0.71	-	1.00
Chi	-	-	1.00	0.77	-	1.00
Mex	-	-	-	1.00	-	1.00

	1971-1987			1988-2004		
	Arg	Bra	Chi	Arg	Bra	Chi
Arg	1.00	0.59	0.53	0.76	1.00	0.41
Bra	-	1.00	0.71	0.59	-	1.00
Chi	-	-	1.00	0.41	-	1.00
Mex	-	-	-	1.00	-	1.00

Table 10: Individual Country Correlations with the Regional Common Factor

The table reports correlation coefficients of the regional common factors with the respective country-specific counterparts. The regional common factors were extracted by pooling all individual country series together and using principal components factor analysis.

	1878-1929		1930-1970		1971-1987		1988-2004	
	Regional F1	Regional F2	Regional F1	Regional F2	Regional F1	Regional F2	Regional F1	Regional F2
Argentina	0.68	0.51	0.56	-0.07	0.79	0.79	0.80	0.31
Brazil	0.80	0.18	0.66	-0.40	0.63	0.30	0.60	0.27
Chile	0.70	0.55	0.82	0.56	0.84	0.57	0.74	-0.44
Mexico	0.86	0.06	0.75	-0.06	0.83	0.60	0.43	0.41
Median	0.75	0.35	0.71	-0.07	0.73	0.59	0.67	0.29

Table 11: SURE Regressions of Domestic Cycles on Global Factors

The table reports SURE regressions of global variables on the business cycle index (domestic cycle) for each country. Country indices were extracted from the panel of variables in Table 1, excluding the foreign interest rate and output variables. t-statistics are reported in parentheses.

	<b>A. Baseline Specification</b>				<b>B. Including LA crisis Dummy</b>				
	Argentina	Brazil	Chile	Mexico	Argentina	Brazil	Chile	Mexico	
World Output	0.100 (1.23)	0.150 (2.77)	0.583 (6.35)	0.150 (3.58)	0.050 (0.68)	0.152 (2.77)	0.520 (5.90)	0.140 (3.30)	
World real interest rate	-0.160 (-1.93)	-0.140 (2.41)	-0.230 (2.58)	-0.010 (-0.35)	-0.150 (-1.95)	-0.140 (-2.42)	-0.210 (-2.56)	-0.010 (-0.38)	
World commodity TOT	0.006 (0.48)	0.002 (0.22)	0.015 (1.09)	0.017 (1.87)	-0.003 (-0.32)	0.002 (0.24)	0.006 (0.45)	0.014 (1.49)	
World War dummy	-0.070 (-4.51)	-0.054 (-4.88)	-0.059 (-3.59)	-0.053 (-4.94)	-0.068 (-4.83)	-0.054 (-4.90)	-0.059 (-3.71)	-0.055 (-5.01)	
LA crises dummy	-	-	-	-	-0.056 (5.18)	-0.001 (-0.1)	-0.047 (-3.81)	-0.020 (-2.34)	
Lagged cycle(t-1)	0.610 (9.74)	0.740 (8.83)	0.600 (8.24)	0.930 (12.96)	0.670 (11.44)	0.730 (8.76)	0.610 (8.65)	0.930 (13.22)	
Lagged cycle (t-2)	-	-0.160 (-1.90)	-0.309 (-4.55)	-0.478 (-6.90)	-	-0.150 (-1.87)	-0.260 (-3.77)	-0.460 (-6.74)	
Observations	125	125	125	125	125	125	125	125	
R2	0.52	0.61	0.58	0.71	0.6	0.61	0.63	0.73	
		Co-variance Matrix of Residuals:				Co-variance Matrix of Residuals:			
Argentina	1				1				
Brazil	-0.04	1.00			-0.05	1.00			
Chile	0.25	0.06	1.00		0.10	0.08	1.00		
Mexico	0.10	0.10	0.22	1	0.02	0.10	0.19	1.00	
Breusch-Pagan test of independence: $\chi^2(6) = 17.32$ , Pr = 0.01				Breusch-Pagan test of independence: $\chi^2(6) = 8.21$ , Pr = 0.22					
Other statistics:									
R2 exc. foreign series	0.42	0.53	0.45	0.64					
R2 global factors only	0.14	0.25	0.4	0.44					
R2 global & Dcrisis only	0.18	0.26	0.44	0.45					

Table 12: External Determinants of the Common Latin American Cycle

This table reports OLS regressions of the common component LAC-4 regional factor (F1) on short-term (3-month Treasury bills) interest rates deflated by CPI inflation and the weighted real GDP cycle in the G-8 advanced countries (G-7 advanced economies plus Australia). All regressions include an intercept. Panel B adds the logarithm of a global index of the US\$ price of commodities relative to manufacturing. t-statistics are reported in parentheses.

**A: World Commodity Prices Excluded**

	<b>1880-1929</b>	<b>1930-1970</b>	<b>1971-2004</b>
Foreign Real Interest Rate	-0.19 (-2.47)	-0.20 (-3.75)	-0.23 (-1.87)
Foreign Output	0.23 (2.71)	0.12 (2.43)	0.42 (2.50)
World War Dummy	-0.07 (-6.31)	-0.04 (-3.2)	- -
Lagged cycle(t-1)	0.68 (7.57)	0.80 (6.86)	0.77 (6.92)
Lagged cycle(t-2)	- -	-0.45 (-3.85)	- -
R2 all	0.82	0.78	0.67
R2 exc. lagged cycle	0.65	0.57	0.34
DW	1.26	2.08	1.63
Observations	50	41	34

**B: World Commodity Prices Included**

	<b>1880-1929</b>	<b>1930-1970</b>	<b>1971-2004</b>
Foreign Real Interest Rate	-0.22 (-1.93)	-0.14 (-2.13)	-0.22 (-1.88)
Foreign Output	0.23 (2.72)	0.11 (2.33)	0.43 (2.58)
World Commodity TOT	-0.02 (-0.47)	0.04 (1.91)	0.06 (-0.67)
World War Dummy	-0.07 (-5.67)	-0.03 (-3.1)	- -
Lagged cycle(t-1)	0.70 (7.34)	0.79 (6.96)	0.79 (6.81)
Lagged cycle(t-2)	- -	-0.44 (-4.17)	- -
R2 all	0.82	0.80	0.68
R2 exc. lagged cycle	0.69	0.59	0.39
DW	1.47	2.04	1.72
Observations	50	41	34



Figure 1: Common Factors

Comparison of the first two common factors (F1, F2) extracted from series detrended with the Hodrick-Prescott (HP), and the Baxter-King (BK) filters.

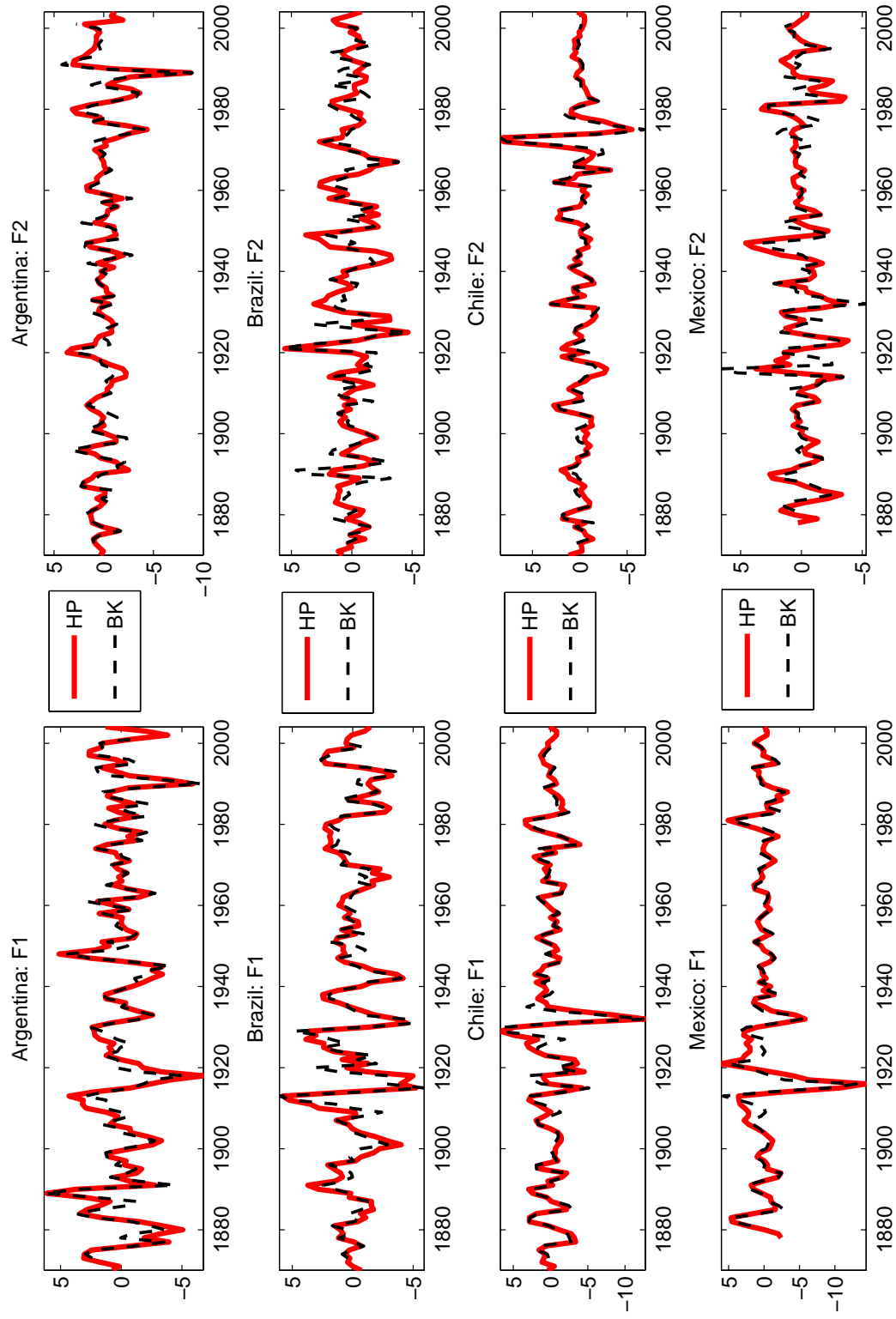


Figure 2: Actual and Backcasted Values of Cyclical Growth

Comparison between backcasted values, previous estimates and national income accounts data for Argentina, Brazil, Chile, and Mexico. All reg. denotes backcasted values that use all available regressors. The series  $SW(r)$  denotes our new business cycle index extracted using the Stock and Watson (SW) approach with  $r$  static factors.

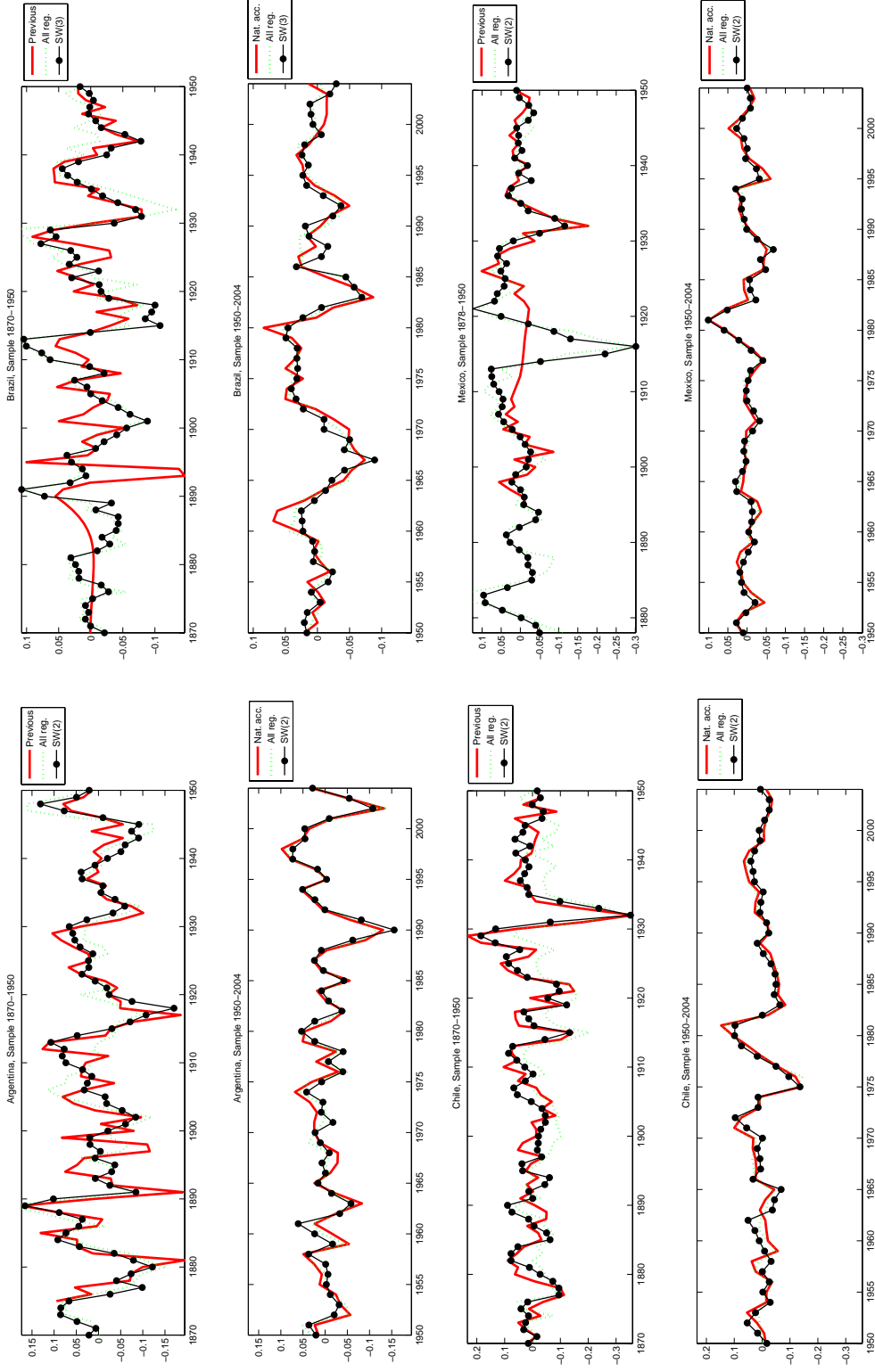


Figure 3: Recursive Parameter Estimates

Recursive estimates of the coefficients in backcasting regression(3).  $c$  is the intercept of that regression while  $b_1, b_2$ , and  $b_3$  are the slope coefficients for the first three common factors.

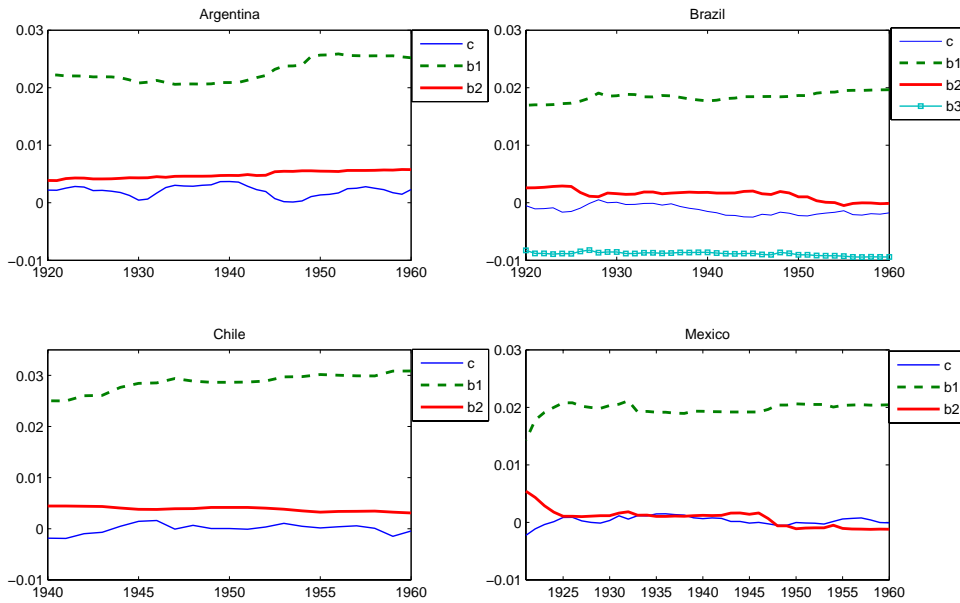


Figure 4: Volatility

The figure reports 10-Year rolling window estimates of standard deviations of the backcasted business cycle. The top panel reports estimates for Argentina, Brazil, Chile, and Mexico. The backcasted values are based on a model using two common static factors (three for Brazil). The bottom panel reports estimates for the LAC-4 region.

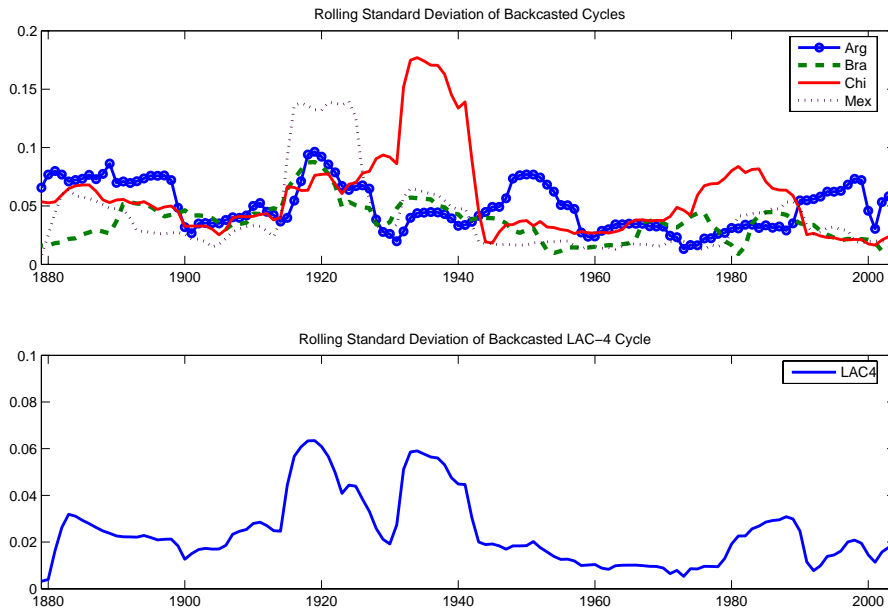
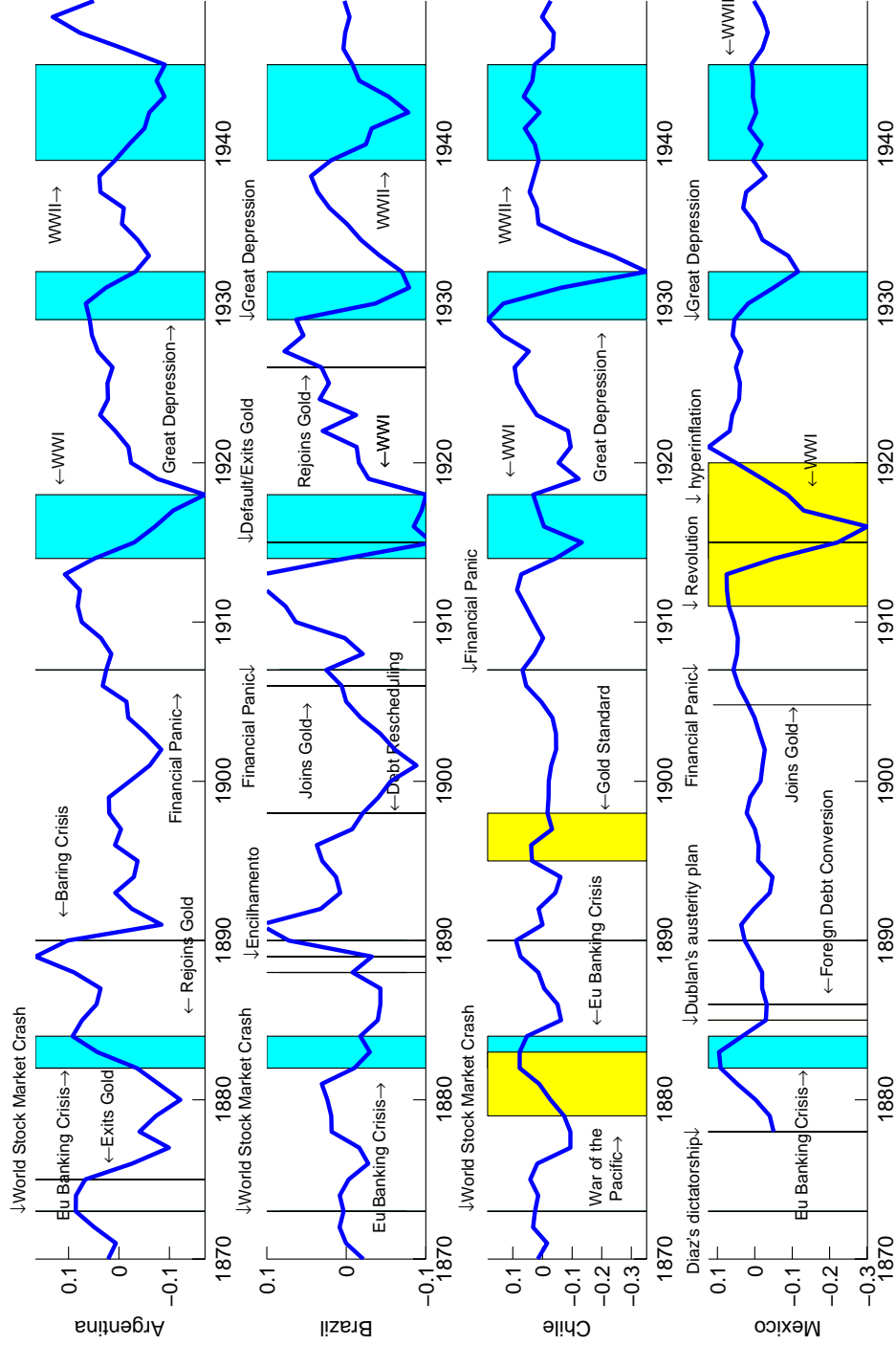


Figure 5: Historical Event Charts

The panels report the backcasted business cycle for Argentina, Brazil, Chile and Mexico against world economic events (dark shaded area) and country-specific events (light shaded area).

**A: 1870-1949**



## B: 1950-2004

