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business cycles

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Data: 19/08/2005 (Sexta-feira)

Horário: 12 h 15 min

FGV

EPGE

Local:

Praia de Botafogo, 190 – 11º andar
Auditório nº 1

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Common Factors in Latin America's Business Cycles

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This Draft: 15 August 2005

Abstract

This paper constructs new business cycle indices for Argentina, Brazil, Chile, and Mexico based on common dynamic factors extracted from a comprehensive set of sectoral output, external trade, fiscal and financial variables. The analysis spans the 135 years since the insertion of these economies into the global economy in the 1870s. The constructed indices are used to derive a business cycle chronology for these countries and characterize a set of new stylized facts. In particular, we show that all four countries have historically displayed a striking combination of high business cycle volatility and persistence relative to advanced country benchmarks. Volatility changed considerably over time, however, being very high during early formative decades through the Great Depression, and again during the 1970s and early 1980s, before declining sharply in three of the four countries. We also identify a sizeable common factor across the four economies which variance decompositions ascribe mostly to foreign interest rates and shocks to commodity terms of trade.

Keywords: Business Cycles, Factor Models, Latin America

JEL classification: E32, N10

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1 Introduction

What gives rise to the business cycle and how it evolves over time is a key question in macroeconomics. Since business cycle volatility can arise from various sources and be exacerbated by distinct economic policy regimes, slowly-evolving institutional factors (Acemoglu et al. 2003) and degrees of financial and trade openness (Kose et al. 2005), a better understanding of it requires taking a long view at the phenomenon so as to cover a range of distinct policy and trade 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.

One region that is particularly under-researched is Latin America. This gap is somewhat surprising not only because the region is deemed as highly volatile and the question of what drives such volatility is of interest in its own right; it is also surprising because the region comprises a large set of sovereign nations which have gone through a number of dramatic changes in policy regimes and institutions over a long period of time and 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 well-known historical business cycle studies by Sheffrin (1988) and Backus and Kehoe (1992), and only Argentina is covered in more recent work along similar lines (Basu and Taylor, 1999). Instead, recent research on Latin American business cycles has been either country-specific and covered only short periods of time (e.g. Kydland and Zarazaga, 1997) or focused on specific transmission mechanisms and limited to post-1980 data (Hoffmaister and Roldos, 1997; Neumeyer and Perri, 2005).¹ 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 those available for others—such as the United States and the Euro area—on the basis of a variety of coincident and leading indicators (Moore, 1983; Gordon, 1986; Artis et al., 1997; Stock and Watson, 1999).

This paper seeks to fill some of this lacuna. Unlike previous work, we go back as

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¹ A notable exception is Engle and Issler (1993) who use a multivariate version of the Beveridge-Nelson trend-cycle decomposition to test for the existence of common trends and common cycles in the real GDP of Argentina, Brazil, and Mexico during 1948-86. They do not provide evidence, however, of what drives the common regional cycle they extract, nor do they look at key variables such as terms of trade or fiscal and monetary shocks that might help explain the observed country-specific movements. Furthermore, their analysis is entirely univariate and is conducted at the country level.

far as available macroeconomic data permits and jointly focus on four of the largest Latin American economies - Argentina, Brazil, Chile, and Mexico. Together, these countries have accounted for some 70 percent of the region's GDP over the past half century (Maddison, 2003, pp.134-140), thus clearly setting the tone for the region's overall macroeconomic performance. At the same time, data availability for this subset of countries permits us to provide a long-run characterization of the business cycle in these economies similar to that conducted for advanced countries.

The construction of new indices of economic activity and the identification of volatility sources over such long period allows us to address four main questions. First, how volatile has Latin America been relative to other countries? In particular, has economic activity in Latin America been more or less stable in periods of greater trade and financial integration with the world economy, such as during the pre-1930 gold standard and the post-1980 period? Second, has this volatility been the result of small and frequent shocks, giving rise to smooth patterns of output fluctuations around trend, or has it been dominated by large and infrequent but persistent shocks? Third, do we observe similar stylized facts as those documented for other economies that feature in the existing business cycle literature? Finally, is there an identifiable regional business cycle and, if so, what drives it?

As discussed further below, a key requirement for answering these questions is to obtain a measure of economic activity that is expected to be reasonably accurate and consistent over such a long period. We provide this by constructing a new index of economic activity for each of the four countries using a dynamic common factor methodology which, to the best to our knowledge, is for the first time applied to build a business cycle index for this set of countries. This methodology is applied to a uniquely large set of macroeconomic variables compiled from a wide range of historical sources. The data span key sectors such as agricultural, manufacturing, mining and cement production, fiscal expenditures and revenues, external variables such as terms of trade, the real exchange rate and import and export volume, as well as a host of financial indicators including interest rates and monetary aggregates. Our index of economic activity is shown to track very closely the existing real GDP data from the full set of national account estimates beginning in the early post-World War II period. Since this index of economic activity is constructed as the common factor that underlies a wide set of macroeconomic and sectorial indicators - thus filtering out idiosyncratic components

(including possible measurement errors) - it provides a measure that is germane to the very concept of the business cycle as defined in the work of Burns and Mitchell (1946) - which still forms the backbone of the widely used NBER reference cycle indicator for the United States.

The paper's main findings are as follows. Over the full sample 1870-2004, the average business cycle volatility in all four countries has been considerably higher than in the advanced economies—albeit with important differences over sub-periods. Latin American volatility was highest in the pre-1930 era, during the formative years of key national institutions. It then dropped sharply during the four decades following the Great Depression - an apparent significant pay-off of the inward-looking growth and highly interventionist policy regimes at a time when volatility in advanced countries rose to all-time highs. Cyclical instability in Latin America bounced back again in the 1970s and 1980s - when it was more than twice as high as the advanced country average - before declining sharply more recently to unprecedented low levels. Throughout the period, cyclical persistence has been high, with large shocks giving rise to a striking combination of high cyclical volatility and long business cycle durations relative to advanced country standards.

We also find evidence of a number of regularities highlighted in the existing business cycle literature. In particular, external terms of trade have been strongly procyclical, the trade balance counter-cyclical, and fixed investment has been several times more volatile than output. Using the simple gauge proposed in Kaminsky, Reinhart, and Végh (2004), we also find that fiscal policy has been strongly procyclical in these countries. In contrast with evidence more directly supportive of Phillips curve trade-offs among advanced countries, we find that inflation has been historically counter-cyclical in all four Latin American economies. Compared with the more mixed cross-country evidence in other regions, real wages have also been broadly procyclical. Once again, a main contrast with advanced economies lies in the strikingly large volatility of these individual variables.

Concordance indices along the lines of Artis et al (1997) and Harding and Pagan (2002) indicate that business cycles in these economies have been reasonably correlated. This raises the question of whether there has been a common Latin American business cycle and, if so, what drives it? Pooling data from all four countries, the common factor methodology we employ permits the identification of a common regional factor.

This provides the basis for a more robust test of the hypothesis that global shocks (notably shocks to key foreign interest rates such as UK and US Treasury bond rates) have been important in driving capital flows and business cycles in Latin America - an issue with salient practical implications that has previously been addressed using more restrictive empirical approaches and limited data (Calvo et al. 1993; Fernandez-Arias, 1994; Agénor et al., 2000; Neumeyer and Perri, 2005). Using a VAR framework that also allows for the roles of world primary commodity terms of trade and foreign output shocks and using generalized variance decompositions, we show that shocks to global interest rates, terms of trade, and foreign output account for between 40 to 70 percent of forecast error variance in the regional common component across the various sub-periods and policy regimes.

The remainder of the paper is divided into four sections as follows. Section 2 lays out the econometric framework and discusses the main estimation issues. Section 3 provides a brief description of the variables and presents initial estimates. Section 4 places our results in an economic context and presents a business cycle chronology for the four countries. Section 5 examines the extent of regional co-movements and the role of common shocks. Section 6 concludes.

2 Econometric Framework

The idea that a cross-section of economic variables share a common factor structure has a long tradition in economics, dating back at least to the attempt by Burns and Mitchell (1946) to construct an aggregate measure of economic activity. There are two chief motivations for common factor models. One is that economic theory suggests strong linkages between economic activity across different sectors due to common productivity, preference, policy shocks but since some of these shocks unobservable, information about them can only be extracted once one has access to a sufficiently large cross-section of economic variables that are at least in part driven by these shocks. Hence, a critical requirement that needs to be met in our analysis is the availability of broad and a diverse enough set of variables that bear sufficiently close relation to aggregate business cycle behavior. Natural candidates include capital formation, government revenue and expenditures, sectorial output series, as well as a external trade figures and a host of financial variables. The fact that the Latin American economies have historically been

highly dependent on global capital markets and demand from outside trading partners suggests that interest rates and cyclical output in advanced countries also be included in the analysis.

The second motivation for using dynamic factor analysis is related to the presence of measurement errors. Activity levels in many sectors are measured with considerable error. Provided that measurement errors are largely idiosyncratic, cross-sectional information can be used to construct more robust common factors that are not similarly sensitive to the impact of such errors. Here one has to make assumptions on the exposure of such observable variables to common shocks in order to identify the underlying driving factors.

Stock and Watson (1989, 2002) and Forni, Hallin, Lippi and Reichlin (2000) have shown that the application of dynamic common factor models to a sufficiently representative set of macroeconomic and sectorial indicator provides superior forecasting performance for a target variable such as real GDP or indeed any broad index of economic activity. This methodology turns out to be particularly useful when some of the constituent series that add up to a target variable (such as monthly GDP) are lacking, or when such series are suspected to be mismeasured (as commonly deemed to be the case for certain service activities). An important requirement is that such measurement errors are sufficiently idiosyncratic or that the cross-section of available time series be sufficiently large and/or representative. This methodology is clearly suitable when interest lies in reconstructing (backcasting) historical measures of the cycle.

2.1 Dynamic Factor Models

In the following we explain how information on the unobserved factors can be extracted. Let $\mathbf{X}_t$ be a vector of de-meaned time series observations on N economic variables observed over the sample $t = 1, \dots, T$. Assuming that $\mathbf{X}$ admits a dynamic factor representation we can write

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

$$= [\Lambda_0, \dots, \Lambda_s] \begin{bmatrix} \mathbf{f}_t \\ \dots \\ \mathbf{f}_{t-s} \end{bmatrix} + \mathbf{e}_t = \Lambda \mathbf{F}_t + \mathbf{e}_t, \quad (2)$$

where $\mathbf{f}_t = (f_{1t}, \dots, f_{qt})'$ is a vector of q common dynamic factors, $\Lambda(L)$ is an $N \times q$ matrix of filters of length s , $\mathbf{e}_t$ is an $N \times 1$ vector of idiosyncratic disturbances, $\mathbf{F}_t = (\mathbf{f}'_t, \dots, \mathbf{f}'_{t-s})$ is an $r \times 1$ vector of stacked factors with $r = q \times (s + 1)$. Notice that while q identifies the number of common shocks, the dimension of $\mathbf{F}_t(r)$ depends on the lag structure of the propagation mechanism of those shocks. We refer to (1) as the dynamic representation and to (2) as the static representation. Similarly, $\mathbf{f}_t$ is the vector of q dynamic factors and $\mathbf{F}_t$ the vector of r static factors, while the Λ matrices contain the factor loadings.

In practice the factors are typically unobserved and extraction of them from the observables ($\mathbf{X}_t$) requires making identifying econometric assumptions. It is common to assume that the errors, $\mathbf{e}_t$, are mutually orthogonal with respect to $\mathbf{f}_t$ although they can be correlated across series and through time. In addition the factors are only identified up to an arbitrary rotation—we explain in the empirical section how we choose a particular rotation using the idea that the factors are only identified indirectly via the factor loadings.

When applied to a broad cross-section of economic variables, this model is ideally suited to extract information on common components of economic activity. The extent to which information in the q common factors provides a broad-based measure of economic activity depends crucially on the quality and representativeness of the underlying economic variables, so successful implementation of the approach must be preceded by careful construction of a data base comprising information on sectorial output variables, government activity, external trade, financial variables and so forth.

2.2 Factor Estimation

The standard estimation method of dynamic factor models involves maximizing the likelihood function by means of the Kalman filter. This technique has been employed for low-dimensional systems by Stock and Watson (1991) and for higher dimensional systems ($N=60$) where the maximization is undertaken using the EM algorithm. When N is large, non-parametric methods such as static principal components (Stock and Watson (2002)), weighted static principal components (Boivin and Ng (2003)) and dynamic generalized principal components (Forni, Hallin, Lippi and Reichlin (2000)) are available for consistent estimation of the factors in approximate dynamic factor models.

Under the assumed orthogonality between the dynamic factors and the idiosyncratic disturbances, we can consider a spectral density matrix or covariance matrix of the $\mathbf{X}_t$ decomposition and the common component can be approximated by projecting either on the first r static principal components of the covariance matrix (Stock and Watson, 2002) or the first q dynamic principal components (Forni, Hallin Lippi and Reichlin, 2000), possibly after scaling the data by the covariance matrix (Boivin and Ng (2003)). In the following we briefly describe these approaches.

Stock and Watson (2002) proposed a principal component estimator of the factors as the solution to the following least squares problem:

$$\min_{\mathbf{F}_t, \Lambda} T^{-1} \sum_{t=1}^T (\mathbf{X}_t - \Lambda \mathbf{F}_t)' (\mathbf{X}_t - \Lambda \mathbf{F}_t)$$

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

$$\begin{aligned} \hat{\Lambda} &= \nu \\ \hat{\mathbf{F}}_t^{SW} &= \nu' \mathbf{X}_t, \end{aligned} \tag{3}$$

where ν is an $r \times 1$ vector of eigenvectors corresponding to the r largest eigenvalues of the variance-covariance matrix of the $\mathbf{X}$ -variables, Σ_{xx} . The resulting estimator of the factors, $\hat{\mathbf{F}}_t^{SW}$, is the first r static principal components of $\mathbf{X}_t$.

Forni et al (2000) exploit dynamic structure in the factors by extracting principal components from the frequency domain. Their approach permits efficient aggregation of variables that may be out of phase. In this case the common component is estimated by projecting the $\mathbf{X}$ -variables on present, past and future dynamic principal components. The factors and their loadings are the solution to the following non-linear least squares problem that weights the idiosyncratic errors by their variance covariance matrix, $\Omega = E[(\mathbf{X}_t - \Lambda \mathbf{F}_t) (\mathbf{X}_t - \Lambda \mathbf{F}_t)']$:

$$\min_{\mathbf{F}_t, \Lambda} T^{-1} \sum_{t=1}^T (\mathbf{X}_t - \Lambda \mathbf{F}_t)' \Omega^{-1} (\mathbf{X}_t - \Lambda \mathbf{F}_t),$$

again subject to $\Lambda' \Lambda = \mathbf{I}$. Forni et al (2003b) consider a two-step weighted principal components analysis where they estimate Ω as the difference between the sample co-

variance matrix, $\hat{\Sigma}_{xx}$, and the dynamic principal components estimator of the spectral density matrix of the common components.²

The resulting estimators of the loadings and common factors are

$$\begin{aligned}\hat{\Lambda} &= \nu_g \\ \hat{\mathbf{F}}_t^{FHLR} &= \nu'_g \mathbf{X}_t = \nu' \tilde{\mathbf{X}}_t,\end{aligned}\tag{4}$$

where ν_g are the generalized eigenvectors associated with the largest generalized eigenvalues of the estimated covariance matrices of common and idiosyncratic components and the resulting estimator of the factors is the vector consisting of the first r generalized principal components of $\mathbf{X}_t$. This can be seen as the first r static principal components of the transformed data $\tilde{\mathbf{X}}_t = (\hat{\Omega})^{-1/2} \mathbf{X}_t$. An advantage of this approach is that it exploits the dynamic structure in the variance covariance matrix of the data, accounting for leading or lagging relationships among variables which can be out of phase by deriving an estimate of Ω through dynamic principal components methods.³

An important requirement when applying these estimators is that all the variables entering the dynamic common factor specification are stationary. With the exception of the inflation rate, real interest rates, and the ratios of export to import value which are stationary by construction, we employ two alternative approaches to ensure stationarity. One is the standard Hodrick-Prescott filter, with the smoothing factor (λ) set to 100, as is common practice with annual data (c.f. Backus and Kehoe, 1992). 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 $K=3$ but use a larger-

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²Specifically, let $\mathbf{x}_t$ denote the standardized values of $\mathbf{X}_t$. The estimated spectrum of $\mathbf{x}_t$, $\mathbf{S}_{xx}(\omega)$, is computed at 101 equally spaced ordinates using a Bartlett kernel applied to $p = T^{1/2}$ sample autocovariances. The estimated spectrum of the dynamic factor components, $\mathbf{S}_{ff}(\omega)$, is computed for each of the 101 frequencies using q dynamic principal components of $\mathbf{S}_{xx}(\omega)$. The estimated value of Ω is computed as $\Omega = \Sigma_{xx} - \Sigma_{ff}$, where Σ_{xx} is the sample second moment matrix of x and Σ_{ff} is the inverse fourier transform of $\mathbf{S}_{ff}(\omega)$.

³In their empirical forecasting comparison D'Agostino and Giannone (2004) find that weighted procedures generally produce better forecasting performance. Similarly, Boivin and Ng (2003) find that weighted principal components improve on the forecasts of the standard principal components methods applied to the static factor model. Stock and Watson (2005) report that forecasts based on factors estimated with static principal components and those estimated with weighted principal components tend to be highly correlated.

than-usual 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 (1956) for the United States and found to be present in several advanced countries (Solomou, 1987). As shown below, both detrending methods yield very similar results. Finally, since we are concerned with a real economic aggregate, all variables are measured in real terms (deflated by the consumer price index or by the GDP deflator) with the obvious exceptions of inflation, the ratios of exports to imports, and country spreads (as measured by the difference between the yield on a sovereign foreign-currency denominated bond and the respective UK or US yields). We employ the commonly used of defining the real interest rate as the difference between the nominal interest rate and current inflation. Since all interest rate series used in the estimation refer to short-term instruments, discrepancies arising from possible mismatches between current and expected inflation are less critical than in the case of long bonds.⁴

2.3 Backcasting Historical Activity Measures with Dynamic Factors Model

The common factors derived above, $\hat{\mathbf{F}}_t^{SW}$ or $\hat{\mathbf{F}}_t^{FHLR}$, are of interest in their own right since they provide broad-based measures of economic activity. However, often particular interest lies in analyzing a particular time-series such as GDP growth over long periods of time. This immediately poses two problems. First, data on this variable may only be available over a more recent sample. Second, even when available, the series may be subject to considerable measurement error.

The common factor approach is ideally suited to handle these problems provided that the variable of interest lends itself to a similar dynamic factor representation as assumed above. In particular, let GDP growth be represented by the variable y_t . Under the assumption that y_t is driven by the common factors $\mathbf{f}_t = (f_{1t}, \dots, f_{qt})'$ derived above, we have

$$y_t = c + \mathbf{b}(L) \mathbf{f}_t + \epsilon_t. \quad (5)$$

Our interest lies in backcasting values to create a new historical time-series of output growth so we estimate the following backcasting equation using contemporaneous factor

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⁴We also checked the robustness of our results to the use of the US 10-year bond yield and found that this did not have any effect on inferences made in the paper.

values:

$$y_t = \alpha + \beta' \hat{\mathbf{F}}_t + \epsilon_t.$$

Data of sufficient quality on y_t is only available over a much shorter (recent) sample than data on the variables used to construct estimates of the factors. However, under the maintained model (5), we can estimate the parameters $\theta = \{\alpha, \beta\}$ over a (recent) sample period for which quality data is available on output growth, y . We can then backcast output growth over the longer sample for which estimates of the factors are available. In the following we explain details of how we set up the data and implement these ideas.

3 Reconstructing Broad Measures of Economic Activity in Latin America

A full set of national income account data for Argentina, Brazil, Chile and Mexico is only available from the mid-1930s (Argentina) or starting at some point in the 1940s for the other three countries.⁵ Previous researchers have tried to overcome this limitation by constructing proxy measures of economic activity for the earlier period. The quality of these constructs is, however, very uneven due to the lack and/or the very poor quality of output data for broad sectors of the economy. In the case of Argentina and Brazil, for instance, official output data in agriculture, manufacturing, construction, and services only become available from 1900 onwards and, even then, with serious gaps particularly in the case of Brazil (c.f. Haddad, 1978). With regard to Chile and Mexico, sectorial output data stretching back to the 19th century are more readily available but, again, often spanning a small subset of the universe of firms and of questionable quality (see the Appendix). Insofar as previous researchers tried to derive an aggregate measure of economic activity from averages of these production data (resorting to linear interpolation to fill gaps in some discontinuous annual series), the resulting indices are bound to be highly inaccurate. While two other attempts have been made to overcome these problems, they have clear drawbacks. One is that of

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⁵Even for Argentina, full-fledged information underpinning national account estimates is not available before 1950 (see Banco Central de Argentina, 1976). In the case of Mexico, a GDP series constructed solely on the basis of sectoral output information—and not based on expenditure and income data—has been reported by Banco de Mexico since 1921.

backcasting Argentine GDP based on a handful of production and trade variables by means of linear OLS regressions (della Paolera, 1988, p.189); the other is the use of static common components to backcast 19th century Brazilian GDP on the basis of foreign trade data (Contador and Haddad, 1975).⁶ Despite this very limited variable span, the latter series has been (misleadingly) compiled by Maddison (1995, 2003) and Mitchell (2003) as a reliable indicator of pre-war Brazilian GDP.

Our paper addresses these data limitations by substantially broadening the number of variables from which one can derive valuable information on the pace of aggregate economic activity. We take into account not only production or foreign trade variables, but also monetary and financial indicators that economic theory suggests should be correlated with the business cycle. As discussed in the Appendix, the data was obtained from an extensive compilation of both primary and secondary data sources. In some cases this resulted in entirely new series being created; once combined with their counterparts from the later 20th century, these series span the entire 1870-2004 period. Still, as one might expect from country specific idiosyncrasies in data collection (especially before the standardization of national account and balance of payments methodologies), the availability of macroeconomic and financial indicators varies somewhat across countries. For example, for Mexico very few variables were measured prior to 1877, so our business cycle index for that country only starts in 1878. Likewise, it proved impossible to obtain any meaningful series for manufacturing and agriculture output in Brazil before 1900, although we were successful in filling the gap regarding domestic cement consumption (a proxy for construction activity) as well as output in the transportation and communication sectors. A similar gap was filled for pre-1900 Argentina which also benefitted from the use of a new proxy indicator of manufacturing activity starting in 1875 and recently compiled by della Paolera and Taylor (2003). Overall, we were able to put together a panel of between 20 to 25 time series per country which, as shown below, appears to provide an excellent gauge of the respective national business cycles. The Appendix provides a detailed discussion of measurement issues underlying the various series and the respective data sources.

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⁶ A cruder attempt of reconstructing 19th century Brazilian GDP can be found in Goldsmith (1986), who derives a GDP growth series based on an unweighted average of government expenditure, revenues, wages, exports and imports.

3.1 Empirical Results

Factors extracted from a dataset comprising information on a variety of variables are not typically straightforward to interpret. Nevertheless, the estimated eigenvectors do offer important clues in this respect. While factors are only identified up to an arbitrary rotation, it becomes clear from the individual factor loadings that the first factor bears a strong positive correlation with the GDP cycle during periods for which actual GDP data is available.

Table 1 shows the estimated factor loadings for the first two factors extracted using the Stock and Watson procedure and the HP-detrending since the results using other methods yield very similar estimates, as shown below. We report only the first two factors since the addition of further factors only contributes marginally to the total variance of the panel with the exception of one country (Brazil) for which the third factor is important (more on this below). 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 sectorial output, fixed capital formation, import quantum and real money, all measured in deviations from their respective long-term trends. 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 term of trade, the real exchange rate or import volume. This is suggestive of an important difference between the economies, possibly indicating that Mexico's linkage to the US economy is of special relevance - a hypothesis that is corroborated by further evidence presented below.

Figure 1 plots the two SW factors for each of the countries using the HP detrending as reported in Table 1. For comparison, we also plot the same factors using band-pass filter detrending. Since the two approaches yield very similar results, and given that the HP-detrending does not entail losing three annual observations on each extremes of the sample and has been more extensively used in related studies (Backus and Kehoe, 1992; Kydland and Zarazaga, 1997; Neumeyer and Perri, 2005), we maintain this detrending method through the remainder of the paper.

While the factors are of interest in their own right, ultimately our interest lies in reconstructing a measure of cyclical activity in the Latin American economies. To this end, Table 2 reports the $\bar{R}$ -value of regressions of de-trended actual GDP on the factors across a range of factor model specifications. The results cover the period 1950-2002, 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 - a widely used measure of the output gap. Correlations in Table 2 thus gauge the extent to which the various factor models span the real GDP cycle. 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 a range of alternative factor approaches such as the Stock and Watson approach using between one and four common factors and the Forni et al (2000) approach estimated with up to two dynamic factors and up to four static factors. As we shall see later, the high in-sample fit of the all-regressor, 'kitchen sink' approach comes at the cost of overfitting the data and producing poor out-of-sample performance.

Over the period 1870-2004, the linear projections of GDP growth on the various factors yield a tight fit for Argentina, with $\bar{R}^2$ -values varying from 0.89 for the all-regressor approach to around 0.80 for the two factor approaches. Correlations are also generally high for Chile and Mexico, with 75-85 percent of the variance of the real GDP cycle explained by the first two factors. The fit for Brazil is relatively worse, as indicated by $\bar{R}^2$ -values in the 0.50-0.70 range. Only by including the series on agricultural and manufacturing output (both of which are only available from 1900 onwards), can one raise the fit of the regressions for Brazil to above 70 percent using the SW and the FHLR approaches, c.f. panel B of Table 2.

Further evidence that the various approaches tell a similar story can be gleaned from Figures 2-5, which show the backcast estimates of cyclical GDP in the four economies. In each case the upper panel plots the estimates and (where available) actual values of cyclical GDP over the period 1870-1949, while the bottom panel shows the corresponding values for the remaining part of the sample. The close proximity between the fitted and actual values for the post-war period is clear from these plots—visual differences only emerge during rare and extremely large spikes such as in Brazil in 1961-62 and

1980.⁷ Overall, however, it is plain that: (i) the estimated values closely track actual cyclical GDP whenever this is available; (ii) the various factor approaches generate quite similar estimates of the cycle and (iii) factor estimates often differ substantially from estimates based on the all-regressor least squares approach which in turn is furthest away from the actual value. This strongly cautions against the use of "kitchen sink" approach by previous researchers in the reconstruction of earlier GDP data.⁸

3.2 Robustness Analysis: Parameter Instability and Factor Specification

It is important to investigate whether our estimates are robust to potential instability of the factor loadings and to changes in the factor specification. The common factor projections were built under the assumption that factor loadings remain constant over time. In the same way that 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, backcasting economic activity measures without this assumption is infeasible.

An advantage of our approach is that the use of common factors can be expected to be reasonably robust against the structural instability that plagues low-dimensional forecasting regressions. 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.

To evaluate the robustness of our results for the backcasted GDP values, Figure 6 plots the minimum and maximum value across different specifications of the backcasting

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⁷The gaps between the "actual" values and our backcast estimates for Brazil before 1930 should not be seen as misses since what is denoted as actual is the Haddad (1978) estimate which, as noted above, is constructed with incomplete sectoral data and relies extensively on interpolation and use of regression analysis to fill gaps in the actual output series. Given the reasonably tight fit between our index and the official GDP data after 1950, we suspect that such apparent misses reflect the inaccuracies of the Haddad index rather than of our index, which relies on information across a wider spectrum of variables.

⁸As mentioned above, this approach has been used by della Paolera (1988) to backcast Argentine GDP during 1884-1899. It has also been used by Braun et al. (2000, p.20) to backcast Chilean GDP for much of the 19th century.

equation. In particular we consider:

- Two different estimation samples for the backcasting equation, 1915-2004 and 1950-2004 (GDP data for Chile and Mexico are available only after 1940 so for these countries the backcasting equation is estimated only over the sample 1950-2004.)
- Six different factor specifications: SW(2), SW(3), FHLR(2,1), FHLR(3,1), FHLR(2,2), FHLR(2,3).
- Different samples for factor estimation, where a new sample occurs if new time series become available (Argentina: 1870-2004, 1875-2004, 1900-2004; Brazil: 1870-2004, 1900-2004; Chile 1870-2004; Mexico: 1878-2004).
- Two different panels of data, one including the external variables while the other excludes these.

The sensitivity analysis produces 72 specifications for Argentina, 36 for Brazil and 12 for Chile and Mexico. With the exceptions of Brazil in 1890-91, 1986 and 1989, and Chile in 1929-32 and Mexico in 1916, the range is very narrow; and even at 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 would be unlikely to hold if the factor loadings were subject to structural breaks or considerable instability.

Overall, the results above make a simple but important point. Even when the common factors are extracted from a dataset containing limited information on output growth, they track the real GDP cycle well. This may not be overly surprising since we selected variables that economic theory suggests should be closely related to cyclical activity. Yet, this evidence underscores the robustness of backcasting inferences on the aggregate output cycle using simple combinations of a cross-section of fiscal, financial, sectorial and external variables.

3.3 Gains from Using Extended Data Set

Although our results do not appear to be sensitive to the particular choice of factor estimation methodology, number of factors or sample period used to estimate the factor loadings, one might ask what the 'value-added' is of using as wide a set of variables as

that adopted here when constructing the common factors. To answer this, we compare in Figure 7 plots of the first common factor constructed using our extensive data set vs. that using only sectoral output variables. This comparison shows the value from including information on financial, fiscal and trade variables. The differences are not negligible. Common factors based exclusively on sectoral output data are far smoother than those based on the wider set of variables. This shows up in a failure of the more narrowly constructed common factors in fully accounting for the depth of the crises in Argentina in 1918 and 1990, in Brazil and Mexico following World War I and in Chile following the Great Depression. In addition many of the smaller peaks and troughs - such as the cycle around 1900 in Argentina - are entirely missed by the common factor based on sectoral output information.

Notice also that this limitation of the smaller set is not exclusive to Argentina for which we have only two sectoral variables going back to 1870. Adding industrial output for Argentina (a series that becomes available from 1875) does not overturn this conclusion. Significant gaps also arise for Brazil, Chile, and even Mexico which has a wider sectoral output data coverage all the way back to the 1870s. Further, the discrepancies between the two series are not exclusive to the pre-war period, and hence do not seem entirely attributable the poorer quality of earlier data; large gaps emerge, for instance, for post-1960 Brazil.

These plots vividly demonstrate the importance to the construction of broad measures of economic activity of using a wide and varied set of economic variables representing not just a few sectoral output series. As one might expect, fiscal, financial and external trade variables have a non-negligible role in filling the gap.

4 Tracking History

We next ask how well the backcasted series square with qualitative historical evidence on events deemed to be major economic turning points in these countries. Figure 8 relates the two. Starting with pre-war Argentina, the index picks up all economic downturns associated with well-known world events - notably the stock market crashes in Europe and the US in 1873 and the ensuing global economic depression, the 1890 Barings crisis, the 1907 financial panic, the two world wars, and the Great Depression of the 1930s. Likewise, major post-WWII shocks are also conspicuously picked up as turning points

in our index, notably the boom and bust in world commodity prices associated with the Korean War in the early 1950s, the oil price shocks of the 1970s, the early 1982-83 debt crisis, as well as the emerging market crises of the 1990s (the 1994-95 "Tequila" crisis and the Asia and Russia crises of 1997-98). A glance at Figure 8 also indicates that such a juxtaposition of cyclical turning points in country indices with major world economic events is broadly corroborated for Brazil, Chile, and Mexico.⁹

In addition, the portrait of history provided by our index is consistent with narrative evidence about the macroeconomic repercussions of key country-specific events. In the case of Brazil, the index picks up the mini downturn associated with the 1888 political unrest (end of Slavery and the republican transition) as well as the subsequent boom (the "Encilhamento") stemming from a liberal monetary reform that brought about an unprecedented boom in domestic credit and asset valuations in 1889-90 (see Trinner, 2000). The Brazil index tracks equally well what is deemed to have been one of Brazil's most protracted recessions which culminated in the country's first sovereign default and the debt rescheduling arrangements under the auspices of the Rothchilds in 1898 (see Fritsch, 1988).¹⁰ As for Chile, our index highlights the upturn of 1879-82 associated with the "War of the Pacific" (against Peru), the downturn around the country's exit from the gold standard in 1898 (Llona Rodriguez, 2000), as well as the severity of the 1929-32 depression in Chile due to plummeting terms of trade (Diaz-Alejandro, 1984). Both in Argentina and Chile as well as (to a lesser extent) Brazil, the index identifies clear turning points around the military coups of the 1960s and 1970s.

Finally, the Mexico index yields a picture of economic fluctuations that is remarkably consistent with that depicted by Mexican historiography starting with the 1879-82 upturn that is typically associated with the onset of the new regime headed by General Porfirio Diaz (Cardenas, 1997). Likewise, the subsequent recession is clearly depicted; with the 1885 trough coinciding precisely with the well-documented austerity plan im-

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⁹In contrast with Argentina, Brazil and Chile were little affected by the 1994-95 Mexican crisis partly due to offsetting domestic developments. In the case of Brazil, a singularly successful stabilization plan in 1994 and renewed political stability set off a domestic demand boom in the following year. In the case of Chile, stronger trade linkages with Asia, low public debt, and a significant improvement in external terms of trade limited the disruptive effects of Tequila crisis on the domestic economy (see Singh et al., 2005).

¹⁰Unlike several Latin American countries which defaulted on their external debts (and some also on their domestic debts) more than once throughout the 19th century, Brazil copiously serviced its sovereign debt obligations until then (Summerhill, 2004).

posed by Diaz's finance minister Manuel Dublan that involved a temporary suspension of payments on domestic public debt; this was followed by an upswing that coincided with Mexico's renewed access to international capital markets in the wake of the 1886-87 external debt settlement and the resumption of strong capital inflows in the late 1880s (c.f. Marichal, 2002). This strong upswing was brought to a halt by a sharp worldwide fall in silver prices (Mexico's main export item) coupled with a sudden stop in capital flows to emerging markets in the early 1890s (c.f. Catão and Solomou, 2005). Finally, our business cycle index also provides a new measure of the severity of the economic downturn associated with the Mexican Revolution of 1911-20 identifying a trough around 1915-16—these were the years when the revolutionary conflict peaked and chaotic monetary conditions triggered a hyperinflation (Cardenas and Manns, 1988).

4.1 Business Cycle Dating

Armed with the business cycle indicators for the four countries, we turn to the task of formally dating the respective turning points. A classic device to this end, which is also consistent with our definition of the business cycle as output deviations from a stochastic or deterministic trend, is the Bry and Boschan (1971) algorithm.¹¹ 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 say with outliers, followed by the use of centered moving averages of the series and the search for local maxima or minima within a chosen window length.¹² Panels A and B of Table 3 report results based on two-year and three-year windows, respectively. As expected, the algorithm identifies peaks and troughs that are broadly consistent with a visual inspection of Figures 2-8. When the narrower window is used, the average duration of the cycle is

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¹¹ A recent alternative dating procedure which also builds on the Bry and Boschan approach has been advanced by Harding and Pagan (2004). Their procedure has been designed for use with quarterly data and growth cycles rather than with measures of the output gap. As discussed in Marcellino (2005), measuring the cycle as deviations from trend as we do is a more suitable procedure in contexts where absolute declines in output are not so rare, as in our group of countries over the past century. Conversely, the concept of a growth cycle is more analytically relevant when absolute declines in output are very rare and growth rates are reasonably persistent, as in Western Europe in the early post-war decades. Most of the recent empirical literature on business cycle identification and measurement has focused on the classical cycle defined in terms of deviations from trend (stochastic or deterministic).

¹² See King and Plosser (1984) and Watson (1994) for further details and application to US data, for which the algorithm closely replicates the dating by the NBER's panel of experts.

shorter overall, and the more so when one focuses on the post-war era. This finding is consistent with evidence of the shortening business cycle length among advanced countries (see, e.g., Gordon, 1986). Using a longer window, Panel B indicates that the pre-cycle is dominated by the Kuznets or long swings, with similar turning points as those identified in the literature on Anglo-saxon economies (Solomou, 1987). This evidence is further reinforced by spectral density function estimates of the individual country indices, which point to a dominant cyclical length around 14 to 16 years during the 1870-1930 period (a typical Kuznets-swing length), followed by a 10-12 year cycle in post-war data (Table 4).

In sum, both the Bry and Bosham algorithm and the spectral density function estimates point to a reasonably long average cyclical duration in all four countries. The dominant cyclical pattern was generally longer in the pre-1930 era, but even in the post-World War II period, cycles in Latin America were substantially more protracted than in the United States and other advanced countries.¹³

Against this background, Tables 5 and 6 report a set of descriptive statistics that help characterize other stylized facts about Latin America's business cycles. First, standard deviations corroborate the perception that Latin America has been a more cyclically volatile region than both countries deemed advanced by today's definition as well as countries such as Australia, Canada and Japan that were considered "emerging economies" in the pre-war world. This volatility gap between the two groups has changed over time, however. The four Latin countries were clearly far more volatile in the early globalization period before the 1930s - characterized as it was by free capital mobility and very limited quantitative restrictions on trade. Conversely, there is *prima facie* evidence that the inward growth policies did succeed in fending these countries off global instability in the 1930-70 sub-period, when global volatility generally rose, partly due to the recovery from the 1929-32 depression and war shocks, which appear reflected in the higher standard deviation of the output gap among advanced countries during the period. But as output gap volatility came down in advanced countries in the post-1960s period (notwithstanding two oil shocks and dramatic changes in economic policies), cyclical volatility in Latin America remained relatively high; only in the post-

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¹³To the extent that the combination of large shocks and high cyclical persistence make the task of stabilization policies more difficult, this finding has interesting implications for the interpretation of the history of stabilization policies in Latin America.

debt crisis period has Latin American cyclical volatility declined markedly compared to earlier levels. Yet, despite being low relative to its earlier historical record, business cycle volatility in Latin America still remains higher than in advanced countries.

Table 6 focuses on the key drivers of aggregate business cycles in the four economies, once again broken down by sub-periods. The table clearly highlights some stylized facts that have been stressed in previous studies (Backus and Kehoe, 1992; Mendoza, 1995; Basu and Taylor, 1999; Agénor et al. 2000). First, cyclical volatility in fixed investment is much higher than that of output. Second, and consistent with the findings of Backus and Kehoe (1992) for advanced countries, 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—is staggering. Coupled with the positive loadings of the real government expenditure variable on the first (pro-cyclical) factor in Table 1—and with all the caveats about some inevitable endogeneity of this or indeed of any measure of the fiscal stance—this provides a *prima facie* case that changes in fiscal stances have been important drivers of the business cycle in these countries. This finding squares well with the post-1960 evidence on strong fiscal procyclicality in these countries provided in Kaminsky, Reinhart and Végh (2004) who use the cyclical component of real government spending as their main gauge.

Third, the volatility of monetary aggregates (expressed in real terms) is smaller than that of the fiscal variables with the exception of Argentina and Brazil over the past two decades and Chile in the 1970s reflecting bouts of high- and hyper-inflation in these countries. Interestingly, however, inflation has been broadly counter-cyclical (see Table 1), in stark contrast with the Phillips-curve trade-off which is usually deemed to hold at least among advanced countries. The counter-cyclical behavior of inflation makes the apparent procyclicality of real wages (see Table 1) consistent both with models based on short-run nominal wage stickiness as well as with real business cycle models which emphasize the dominant role of technology shocks in shifting the labor demand schedule over business cycle frequencies. Finally, terms of trade fluctuations are highly procyclical and, consistent with earlier work (Mendoza, 1995), emerge as an important (and more clearly exogenous) source of output volatility. While this may not be particularly surprising given that all four countries have mainly been primary commodity exporters for much of the period (the manufacturing share of Brazil's and

Mexico's exports only became prominent over the past couple of decades), it is still instructive to observe the sheer magnitude of the phenomenon. To the extent that terms of trade volatility has important welfare implications and is usually associated with poorer long-term growth performance (Blattman, Hwang, and Williamson, 2004), this emerges as an important feature of the data.

To sum up, our business cycle index indicates that not only in recent decades but also historically Latin America has displayed high cyclical volatility compared to advanced country benchmarks. While the decline in volatility under the inward-looking policy regimes of the 1930s through the early 1970s suggests a positive association between aggregate output volatility and trade and capital account openness, this association does not square with fact that volatility in Latin America has greatly declined since the 1980s alongside with increasing openness. On balance, a comparison between the volatility of external aggregates such as the output gap in the G-7 countries and external interest rates, and the volatility of domestic aggregates such as public expenditures and revenues as well as, to a lesser extent, real money indicate, if anything, that domestic amplification mechanisms have played a key role. As discussed in the next section, this does not mean that external shocks are unimportant, but simply that domestic propagation mechanisms seem to deserve more systematic scrutiny by future research on business cycles in these countries.

5 Is there a Common Latin American Cycle?

A glance at Figure 8 suggests that several major business cycle turning points—such as those of the early 1890s, World War I, the early 1930s and the early 1980s—are common to all or most of the four countries. However, it is important to consider a more formal measure of the extent to which a common business cycle characterized these countries during the sample. A useful metric in this regard is the concordance index proposed by 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 7 reports the respective 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 through the 1870-2004 period. This is especially striking

in light of the fact that there has been very little intra-regional trade between these economies until the past twenty years or so, and that such synchronization did not decline dramatically during the period from the early 1930s to the early 70s marked by strong trade restrictions and capital controls.

These results indicate the presence of a common regional factor superimposed on the distinct country-specific business cycle drivers. To gauge this hypothesis more formally we use the econometric methodology from Section 2 to extract common factors from a pooled data set that brings all four countries' data together.¹⁴ The resulting regional factor jointly loads on the various country specific business cycle indicators. Corroborating the concordance metric of Table 7, the regional factor generates correlation coefficients between 0.6 and 0.75 with the procyclical factor (F1) of the business cycle indices in the four individual countries.

Given the limited trade and financial linkages across these economies during much of the period, this begs the question of what is driving such a common regional factor. An obvious clue comes from the loadings on the two external indicators—foreign interest rates and cyclical output in the advanced economies—reported in Table 1. Since both variables are common to all four countries they are likely to account for at least some of the co-movement. Some support for this hypothesis is provided in Calvo, Leiderman, and Reinhart (1993) who, in a sample spanning the late 1980s and early 1990s, find that a combination of foreign output and monetary shocks (which they deemed to be largely captured by changes in real US interest rates) account for about 50 percent of the variance of foreign reserves and real exchange rates - two highly procyclical variables in those countries.¹⁵

A third common variable which, although not explicitly considered in the above studies' econometric evidence, has long been emphasized in a large strand of the business cycle and developing country literatures is primary commodity terms of trade (see Blattman, Hwang, and Williamson, 2004 for a broad overview of the literature). As

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¹⁴In this analysis we exclude the foreign interest rate and GDP cycle for reasons that are discussed below.

¹⁵In a sample of 13 countries (seven of which are Latin American) Fernandez-Arias (1994) finds that fluctuations in external interest rates account for some 63 percent of the variance of capital inflows - another well-known key driver of domestic business cycles in Latin American countries. More recently, Neumeyer and Perri (2005) find that shocks to foreign interest rate and output can go a long-way toward explaining output cycles in a real business cycle model calibrated with parameters deemed suitable to Latin American emerging markets.

documented by Diaz-Alejandro (1984) and Fishlow (1989) among others, major business cycle downturns in Latin America such as those in the early 1890s, 1929-32 and 1982-83 have been associated with dramatic worldwide declines in the relative price of primary commodities. By reducing profitability of domestic ventures and/or making it harder to continue servicing external debt and triggering disruptive defaults, shocks to primary commodity terms of trade are expected to be broadly correlated with domestic business cycle conditions. To the extent that for a small open economy the world primary commodity terms of trade is an exogenous common factor affecting all other country-specific terms of trade indicators, it is another potentially important driver behind the cyclical synchronicity across the four countries documented above.

Our much longer dataset and new index of common regional economic activity allows us to revisit this issue. Following Calvo, Leiderman, and Reinhart (1993), we use a VAR framework. Unlike them, however, we use the regional common index factor (constructed so as to exclude the external interest rate and output variables that we seek to shock) and do not impose untested restrictions on the variance-covariance matrix.¹⁶ Instead, we allow for possible contemporary correlations in the shocks to the three external variables we consider - foreign interest rates, cyclical output in advanced countries, and world commodity terms of trade). This is important since there are theoretical and empirical reasons to expect these variables to be contemporaneously correlated especially when working with annual data.¹⁷

To allow for the possibility of a variance-covariance matrix which is not necessarily lower triangular and ensure that results are invariant to the ordering of the variables, we use the generalized variance decomposition advanced in Koop et al (1997) and extended to linear systems by Pesaran and Shin (1998). Let $\mathbf{z}_t$ be a $m \times 1$ vector of jointly

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¹⁶This unrestricted two-step approach whereby a latent variable (the common factor) is included in the VAR is also used by Bernanke et al (2005) in their study of output and price effects of US monetary policy shocks. They also consider a distinct estimation strategy which does away with the second-step at the cost of imposing a priori restrictions on the variance-covariance matrices, but find that the two-step approach yields very similar and more precise estimates.

¹⁷A possible mechanism through which interest rate changes in advanced countries may affect negatively primary commodity terms of trade has been proposed by Triffin (1968). He argued that, as stock piling costs rise following higher interest rates, this poses an incentive for the unloading of stocks of bulky primary commodities into world markets thereby depressing prices. Conversely, periods of rapid economic growth in advanced countries may have been historically associated with rising commodity terms of trade through a demand-pull effect (Rostow, 1980). Either way, one would expect world commodity prices to be dependent on both variables.

determined dependent variables and $\mathbf{u}_t$ a $m \times 1$ vector of shocks with $E(\mathbf{u}_t \mathbf{u}_t') = \Sigma_{uu}$. Starting from the standard moving average representation of a VAR

$$\mathbf{z}_t = \sum_{j=0}^{\infty} \mathbf{A}_j \mathbf{u}_{t-j}, \quad (6)$$

the error in predicting $\mathbf{z}_{t+h}$ conditional on information at time $t-1$ is given by

$$\boldsymbol{\xi}_{t,h} = \sum_{l=0}^h \mathbf{A}_l \mathbf{u}_{t+h-l}, \quad (7)$$

while the covariance matrix of the forecast errors is given by

$$Cov(\boldsymbol{\xi}_{t,h}) = \sum_{l=0}^{\infty} \mathbf{A}_l \Sigma_{uu} \mathbf{A}_l'. \quad (8)$$

It follows that the generalized h -step forecast error variance of variable i following a shock to variable j can be decomposed into

$$\psi_{ij}(h) = \frac{\sigma_{ii}^{-1} \sum_{l=0}^h (\mathbf{e}_i' \mathbf{A}_l \Sigma_{uu} \mathbf{e}_j)^2}{\sum_{l=0}^h \mathbf{e}_i' \mathbf{A}_l \Sigma_{uu} \mathbf{A}_l' \mathbf{e}_i}, \quad i, j = 1, \dots, m \quad (9)$$

where σ_{ii} is the standard deviation of the i -th variable, and $\mathbf{e}_i$ is a vector of zeros except for the i -th element which is unity.¹⁸

Results from this procedure are reported in Table 8.¹⁹ All estimates are based on a VAR with two lags—this proved to be the most consensual choice using the Schwartz and Akaike information criteria—and include, for the pre-1946 period, a war dummy on the slope of the external interest rate variable to capture changes in the asset market transmission mechanism associated with war disruptions. Such a dummy turns out to

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¹⁸It is straightforward to see that $\psi_{ij}(h)$ yields identical results as the standard Cholesky decomposition when the variable shocked is ordered first in the VAR or when Σ_{uu} is a lower triangular matrix, so the generalized variance decomposition nests the Cholesky identification scheme. Unlike the latter, however, the sum of the various contributions will not generally add up to one because of the non-zero covariance between the original (non-orthogonalized) shocks.

¹⁹To allow for the possibility that predictable changes in the external variables were also significant in explaining the common regional cycle, we also performed block Granger-causality tests, both over the entire period and during the various sub-periods of interest (pre-1930s, post-1945, 1930-70, and 1970-2004). These clearly support the hypothesis that external shocks Granger-caused movements in the Latin American common cycle.

be highly significant and take on the expected negative sign. To allow for the possibility that the importance of the distinct transmission mechanisms changes over time, we also split the sample into pre- and post-WWII halves as well as into two other sub-periods of interest - before and after widespread capital controls and trade restrictions enacted from the 1930s which prevailed through the early 1980s.²⁰

In the pre-WWII era shocks to the foreign interest rate account for up to 11 percent of the forecast error variance of the common regional cycle, whereas shocks to cyclical output in the advanced economies account for up to 48 percent and shocks to the world commodity terms of trade for another 14 percent. Thus a large share of the forecast error variance of the common regional cycle is accounted for by such global shocks.²¹ The contribution of interest rate and terms of trade shocks rises further in the post-WWII period to up to 15 and 19 percent, respectively whereas the contribution of cyclical output in foreign countries drops sharply to low single digit levels. This is consistent with evidence that capital market linkages gradually became more important as Latin American economies became more closed to foreign trade and their trade gradually diversified away from the core advanced economies. Similar conclusions emerge once we consider an alternative break-down between 1878-1930 and 1930-82. Overall, therefore, it is clear that global shocks to interest rates, foreign output, and terms of trade go a long way towards explaining the regional business cycle in Latin America.

6 Conclusions

The combination of long-spanning country data, rich variety of policy regimes, and high historical volatility make Latin America an interesting region for business cycle analysis. From a pure policy perspective, a better understanding of the sources of business cycle volatility in the region is also important because such volatility is deemed to have sizeable welfare costs which could in principle be mitigated by sensible policies (see

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²⁰To be precise, while trade and capital account restrictions remained high in Brazil and Mexico through the early to mid-1980s, both Argentina and Chile experienced economic liberalization reforms around the mid-1970s, when some of the capital restrictions were dramatically relaxed. However, including or excluding those years for the two countries does not alter the broad thrust of the results.

²¹We also performed generalized impulse-responses to these shocks and found that positive shocks to foreign interest rates impart a negative impulse to the Latin America business cycle, whereas positive shocks to advanced country cyclical output and commodity terms of trade have an expansionary effects.

Aizenman and Pinto, 2005 for further discussion).²²

This paper has sought to fill some of the lacuna in the international business cycle literature. Taking a century long view of the Latin American business cycle allowed us to characterize a host of stylized facts, compare them with existing evidence for other countries, and identify important differences in business cycle behavior across distinct policy and developmental regimes. Business volatility in Latin America was highest during the early globalization era of the late 19th and early 20th century—precisely during the formative years of key national institutions—then declined markedly over the four decades since the great depression. Yet, we have also shown that after bouncing back in the 1970s and early 1980s, business cycle volatility in Latin America subsequently declined to unprecedented historical lows. Since this coincides with greater trade and financial openness, a causal link between business cycle volatility and openness seems unwarranted looking at the period as a whole. More stable domestic policies and lower external volatility over the past twenty years are likely factors at play.

We have also shown that several empirical regularities highlighted in the existing business cycle literature readily apply to the four countries included in our study. One set of regularities pertains to the countercyclicality of trade balances and the much higher cyclical amplitude of both fixed investment and real government spending relative to output. Indeed, using the simple yardstick of the co-movement between real government expenditures and the output cycle employed elsewhere (Kaminsky, Reinhart and Vegh, 2004), we find that fiscal policy has been procyclical in all four countries. Overall, the most distinctive feature of the business cycle in all four countries has been its striking combination of high volatility and persistence.

Our common factor framework also allowed us to identify a sizeable regional common component in Latin American business cycles. Since trade linkages between these economies have been small well into the 1980s and as capital market linkages remain so,

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²² While estimates of the welfare cost of macroeconomic fluctuations in advanced countries differ markedly, they are supposed to be much larger in financially less developed economies. Pallage and Robe (2003) estimate that the cost of eliminating business cycle fluctuations amounts to more than 1 percent of yearly consumption growth in general equilibrium models with parameter calibrations akin to those generally thought as appropriate for developing countries. Their estimates, however, do not take into account the evidence volatility detracts from welfare not only through income uncertainty but also via lower trend output growth (Ramey and Ramey, 1995). On both counts, the task of dampening business cycle fluctuations thus emerges as an overriding policy goal, since trading-off volatility for growth is no longer a viable option

this raises the question of what drives such a common cyclical factor. Using VAR-based generalized variance decompositions on the regional common component, foreign interest rates, cyclical output and world primary commodity terms of trade, we find that these three external variables account for up to 40 to 70 percent of the medium-term forecast error variance of the common regional cycle. These results highlight the importance of global shocks to the region and are broadly consistent with earlier evidence (Calvo, Leiderman and Reinhart, 1993, Engle and Issler, 1993; Fernandez-Arias, 1994). The main qualification is that the relative importance of the distinct types of external shocks changed considerably over time. World terms of trade shocks and cyclical output in advanced countries have been overwhelmingly important in the pre-1930 period and much less so since. In contrast, interest rate shocks have become more prominent in the post-war. This is consistent with the fact that the four economies became more closed to foreign trade in the decades following the Great Depression through the debt crisis in the 1980s which reduced the scope for international business cycle transmission through trade channels and augmented the importance of the capital account channel.

By highlighting the role of global factors in driving a common business cycle component across Latin American countries, the evidence presented in this paper speaks directly to a recent literature that points towards the role of global factors in individual countries' business cycles (Kose, Otrok, Whiteman, 2004; Canova 2004). In extending these findings to Latin America based on wider time series evidence and in a broader historical context, the findings of this paper also point to two other salient implications: they help explain why the scope for effective risk-sharing across these countries has been historically limited and why several apparent "contagion" episodes have taken place in the absence of substantial trade or capital account linkages between them.

A Data Construction and Sources

A.1 Argentina

Agricultural Output

1900-1960: Banco Central de Argentina (1976)

1961-2004: World Bank, World Development Database.

Industrial Output

1875-1960: della Paolera and Taylor (2003)

1961-2004: World Bank, World Development Database.

Transport Output

1870-1960: Geometric weighted average of passengers and tons of freight per kilometers times total railway road extension; then spliced in 1913 with the index provided in Carlos F. Diaz-Alejandro, 1970, *Essays on the Economic History of the Argentine Republic*. Yale.

Cement Consumption

1870-1913: Total cement imports in tons from the United Kingdom and the United States, which together accounted for no less than between 60 to 70 percent of Argentina's total cement imports. The sources are the United Kingdom, Board of Trade, *Annual Statements of the Trade of the United Kingdom with Foreign Countries and British Possessions*. London: HMSO. Commerce and Navigation, several issues; and the United States, *Foreign Commerce, Navigation and Tonnage of the United States*, Washington, DC: Department of Labor, several issues. Because a local cement industry was non-existing before World War I, all domestic consumption of cement was then met by imports. So this newly constructed series for the period should be expected to a good proxy for domestic construction activity.

1913-2000: Oxford Latin American Economic History database, available at <http://oxlad.qeh.ox.ac.uk/>.

2001-2004: Instituto Nacional de Estadísticas y Censos de la Republica Argentina, available at: www.indec.mecon.ar/.

Fixed Investment

1870-1884: Capital goods imports from the United Kingdom and the United States (converted into equivalent pounds sterling) and deflated by the UK capital good deflator taken from Charles H. Feinstein, 1972, *Statistical Tables of National Income, Expenditure and Output of the United Kingdom, 1855-1965*, Cambridge. Since the domestic capital goods industry was virtually non-existent in Argentina before World War I (being in fact relatively negligible before WWII – see Diaz-Alejandro, 1970), and because the UK and the US were the two most important suppliers of capital goods to Argentina, such imported capital goods series should be expected proxy very well aggregate fixed capital formation in the country in those early decades.

1885-1960: della Paolera and Taylor (2003).

1961-2004: International Financial Statistics (IFS), International Monetary Fund.

Central Government Expenditures and Revenues

1870-1960: Brian M. Mitchell, 1998, *International Historical Statistics: The Americas*, London.

1961-2004: Luis A. V. Catão and Marco E. Terrones, 2005, “Fiscal Deficits and Inflation,” *Journal of Monetary Economics*, 52, 529-554. Both series are expressed in real terms by deflating them by the consumer price index (CPI).

Narrow (M0) and Broad Money (M2)

1870-1960: Mitchell, op cit.

1961-2004: IFS. Both series expressed in real terms by deflating them by the CPI.

Consumer Price Index (CPI)

1870-1913: Catão and Solomou (2005).

1914-1960: della Paolera and Taylor (2003)

1961-2004: IFS.

Average Interest Rate on Domestic Public Bonds

1870-1913: 'Monetary and Banking Experiments in Argentina: 1861-1930', Paper presented at the conference, 'Economic Growth in the Long Run: Argentina, Brazil and Mexico, 1870-1950' at the Institute of Latin American Studies, University of London, March, 1992.

1914-1993: della Paolera and Javier Ortiz, 1995, Dinero, Intermediación Financiera y niveles de actividad en 110 años de historia económica Argentina. Documentos de Trabajo 36 (December), Universidad Torcuato di Tella.

1993-2004: IFS (line 60p). Real interest rate series obtained by deflating annual nominal yields by current period CPI inflation.

Export and Import volumes and Net Barter Terms of Trade

1870-1913: Catão and Solomou (2005).

1914-1960: Oxford Latin American Economic History database, available at <http://oxlad.qeh.ox.ac.uk/>.

1961-2004: IFS.

Real Effective Exchange Rate

1870-1913: Catão and Solomou (2005).

1914-2004: CPI-based geometric weighted averages of Argentina's real bilateral exchange rates with its eight largest trading partners (covering between 67 and 80 percent of visible trade).²³ Fisher ideal indices were derived for the sub-periods 1914-1946 and 1946-2004 (based on 1913 and 1938, and 1960 and 2000 weights respectively), and then spliced at 1946. Nominal exchange rates for the entire post-war period are market rates underlying Carmen M. and Kenneth S. Rogoff, 2004, "The Modern History of Exchange Rate Arrangements: A Reinterpretation," *Quarterly Journal of Economics*, CXIX, No.1, pp.1-48.

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²³The choice of GDP deflator rather than a CPI-based index was determined by the deficiencies of the existing CPI series during the period 1870-1913, compared to an existing series based on production weights (therefore mimicking a GDP deflator) which covers a much extensive range of products and constructed based on weights from national production censuses.

Net Foreign Capital Inflows

1870-1960: Obtained by splicing the series on UK capital flows to Argentina provided in Stone, Irving. 1999, *The Global Export of Capital from Great Britain, 1865-1914: A Statistical Survey*, New York, with a post-1884 series on net capital inflows constructed as changes in end-year net international reserves expressed in US\$ million (obtained from Gerardo della Paolera, 1988, "How the Argentine Economy Performed During the International Gold Standard: A Re-examination", PhD thesis, University of Chicago for 1870-1913 then with the Cavallo-Mundlak series, as kindly supplied by Alan Taylor) minus the current account balance (also expressed in US\$ millions) provided in della Paolera and Taylor (2003). The splicing of the two series is warranted by the fact that the UK was by far the most important source of foreign capital flows to Argentina before World War I (and particularly prior to 1890), and evidence that the two series co-move tightly together in the 1884-1913 period, with a correlation coefficient of 0.81.

1961-2004: Also obtained as the difference between changes in international reserves and the current account balance, both as reported by the IFS. The resulting nominal series in US dollars was then deflated by the US Wholesale price index (WPI) obtained from Global Financial Database for the period 1870-1947 and the IFS for 1948-2004.

Wages

1870-1913: Jeffrey G. Williamson, "The Evolution of Global Labor Markets Since 1830", *Explorations in Economic History*, 32 (2), 1995, pp. 141-96.

1914-1980: della Paolera and Taylor (2003).

1981-2004: IMF's WEO database. This series was then deflated by CPI to obtain the real wage index.

Foreign 3-month bill rate

1870-1920: Annual average yields of 3-month bills on the London market provided in Sidney Holmer and Richard Sillas, 1996, *A History of Interest Rates*, Rutgers.

1921-2004: Annual average yields of the US 3-month Treasury Bill provided in the same source. The choice of 1920 as the splicing point was due to the unavailability of the US instrument prior to 1920. Both series were deflated by the respective countries' CPI inflation, obtained from Catao and Solomou (2005) for 1870-1913, Mitchell, op cit (1914-1960) and the IFS (1961-2004).

Foreign Output

Sum of France's, Germany's, UK's and US's GDP, all expressed in 1990 PPP constant dollars from Maddison (2003).

Population at mid-year

1870-1960: Maddison (2003).

1961-2004: IFS (2003).

A.2 Brazil

Agricultural and Manufacturing Output

1900-1946: Haddad (1978).

1947-2004: Instituto Brasileiro de Geografia e Estatística, available at <http://www.IBGE.gov.br>.

Transport Output

1870-1907: Average of freight and passenger transported in railways, using 1908 weights provided in Haddad (1978).

1908-1946: Haddad (1978).

1947-2004: Instituto Brasileiro de Geografia e Estatística, available at <http://www.IBGE.gov.br>.

Communications Output

1870-1907: Average of mail and telegraph traffic in the national postal system, weighted according to current 1889 values provided in Instituto Brasileiro de Geografia e Estatística, 1987. Estatísticas Históricas do Brasil, Rio de Janeiro, IBGE.

1908-1946: Haddad (1978).

1947-2004: Instituto Brasileiro de Geografia e Estatística, available at <http://www.IBGE.gov.br>.

Cement Consumption

1870-1901: Cement imports from the France, Germany, the UK, and the US, obtained from these countries' own trade statement data (see above). Since these four countries accounted for between 75 and 85 percent of total Brazilian imports (see IBGE, op.cit., pp. 545-49) and all cement consumed in Brazil at the time was imported, this newly constructed series is very representative of aggregate cement consumption and hence a good proxy for domestic construction activity.

1902-1945: Anibal V. Villela and Wilson Suzigan, 1975, *Politica do Governo e Crescimento da Economia Brasileira 1889-1945*, p.423.

1945-2004: Instituto Brasileiro de Geografia e Estatística, available at <http://www.IBGE.gov.br>; and IPEA database.

Machinery Investment

1870-1913: Wilson Suzigan, *Industria Brasileira. Origens e Desenvolvimento*, São Paulo, 1986.

1913-2004: Instituto Brasileiro de Geografia e Estatística, available at <http://www.IBGE.gov.br>.

Central Government Expenditures and Revenues

1870-1960: IBGE, op. cit.

1961-2004: Luis A.V. Catão and Marco E. Terrones, 2005, "Fiscal Deficits and Inflation," *Journal of Monetary Economics*, 52, 529-554. Both series are expressed in real terms by deflating them by the GDP deflator.

Narrow (M1) and Broad Money (M2)

1870-1960: IBGE, op. cit.

1961-2004: IFS. Both series expressed in real terms by deflating them by the GDP deflator.

GDP deflator

1870-1913: Catão and Solomou (2005).

1914-1960: IBGE, op cit.

1961-2004: IFS.

Domestic Interest Rate

1870-1961: yields on government perpetuities (“apolices”). Pre-1930 data kindly provided by Bill Summerhill and Gail Trinner based on their research with Brazilian historical archives. Post-1930 data from Claudio Contador, 1975, *O Mercado de Ativos Financeiros no Brasil. Perspectiva historica e comportamento recente*. Rio de Janeiro.

1965-1980: Equivalent nominal yield on inflation indexed public bonds (ORTNs), from Goldsmith, op. cit. The gap between the apolice series and the ORTN series was bridged by linear interpolation.

1981-2004: Money market interest rate from IFS. Real interest rate series obtained by deflating annual nominal yields by current annual percentage changes in the GDP deflator.

External Interest Rate Spread

1870-1913: Mauro, Paolo, N. Sussman and Y. Yafeh, 2002, “Emerging Market Spreads: Then versus Now,” *Quarterly Journal of Economics*, CXVII.

1914-1956: Global Financial Data.

1968-1986: Eliana Cardoso and Albert Fishlow, “The Macroeconomics of Brazilian External Debt,” in J. Sachs (ed.), *Developing Country Debt and Economic Performance*. Chicago, 269-391

1987-1993: Estimated as the one-year libor interest rate plus a 400 basis points spread minus the US 10-year bond interest rate.

1993-2004: IMF’s global data source database. Real interest rate series obtained by deflating annual nominal yields by current period CPI inflation.

Export and Import volumes and Net Barter Terms of Trade

1870-1913: Catão and Solomou (2005).

1914-1960: Instituto Brasileiro de Geografia e Estatística, available at <http://www.IBGE.gov.br>

1961-2004: IFS.

Real Effective Exchange Rate

1870-1913: Catão and Solomou (2005).

1914-2004: GDP deflator-based geometric weighted averages of Brazil's real bilateral exchange rates with its eight largest trading partners (covering between 64 and 75 percent of visible trade). Fisher ideal indices were derived for the sub-periods 1914-1946 and 1946-2004 (based on 1913 and 1938, and 1960 and 2000 weights respectively), and then spliced at 1946. Nominal exchange rates for the whole post-WWII period are market rates underlying Carmen M. and Kenneth S. Rogoff, 2004, "The Modern History of Exchange Rate Arrangements: A Reinterpretation," *Quarterly Journal of Economics*, CXIX, No.1, pp.1-48.

Wages

1870-1940: Jeffrey G. Williamson, "The Evolution of Global Labor Markets Since 1830", *Explorations in Economic History*, 32 (2), 1995, pp. 141-96.

1940-1955: IBGE, op cit..

1955-1976: Raymond Goldsmith, 1986, *O Desenvolvimento Financeiro do Brasil*, Sao Paulo.

1977-2004: IBGE, op cit..

Foreign 3-month bill rate and Foreign Output

The same as for Argentina.

Population at mid-year

1870-1960: Maddison (2003).

1961-2004: IFS (2003).

A.3 Chile

Agriculture, Manufacturing and Mining Output

1870-1960: Juan Braun, Matías Braun, Ignacio Briones, José Díaz, Rolf Luders and Gert Wagner, 2000, "Economía Chilena 1810-1995: Estadísticas Históricas", Documento de Trabajo No. 187, Catholic University of Chile, Instituto de Economía.

1961-2004: World Development database, World Bank, and Central Bank of Chile.

Machinery Investment

1870-1900: Capital goods imports from the United Kingdom and the United States (converted into equivalent pounds sterling) and deflated by the UK capital good deflator taken from Charles H. Feinstein, 1972, Statistical Tables of National Income, Expenditure and Output of the United Kingdom, 1855-1965, Cambridge.

1901-1990: Andre Hoffman, 2000, The Economic Development of Latin America in the Twentieth Century, Cheltenham (pp. 190-91, Table D2).

1991-2004: Central Bank of Chile, *ibid.*

Central Government Expenditures and Revenues

1870-1960: Brian M. Mitchell, 1998, International Historical Statistics: The Americas, London.

1961-2004: Luis A.V. Catão and Marco E. Terrones, 2005, "Fiscal Deficits and Inflation," *Journal of Monetary Economics*, 52, 529-554. Both series are expressed in real terms by deflating them by the consumer price index (CPI).

Narrow Money (M0) and Broad Money (M2)

1870-1878: M0 calculated as paper money issued minus banks' cash-in-vault, both taken from Llona Rodriguez, Agustin, *Chilean Monetary Policy 1870-1925*, PhD thesis, Boston University; M2 from Braun et al, *op.cit.*

1879-1960: M0 from Mitchell, *op.cit.*; M2 from Braun et al. *op.cit.*

1961-2004: IFS. Both series expressed in real terms by deflating them by the CPI.

Mortgage Credit

1870-1995: Braun et al. (1995).

1995-2004: Central Bank of Chile.

Consumer Price Index (CPI)

1870-1913: Catão and Solomou (2005).

1914-1960: Mitchell, op cit.

1961-2004: IFS.

Domestic Interest Rate

1870-1993: Bank lending rate from Braun et al, op cit.

1993-2004: IFS (line 60p). Real interest rate series obtained by deflating annual nominal yields by current period CPI inflation.

Export and Import volumes and Net Barter Terms of Trade

1870-1913: Catão and Solomou (2005).

1914-1960: Braun et al, op.cit.

1961-2004: IFS.

Real Effective Exchange Rate

1870-1913: Catão and Solomou (2005).

1914-2004: CPI-based geometric weighted averages of real bilateral exchange rates with up to Chile's twenty largest trading partners (covering between 79 and 93 percent of visible trade). Fisher ideal indices were derived for the sub-periods 1914-1946 and 1946-2004 (based on 1913 and 1938, and 1960 and 2000 weights respectively), and then spliced at 1946. Nominal exchange rates for the whole post-WWII period are market rates underlying Carmen M. and Kenneth S. Rogoff, 2004, "The Modern History of Exchange Rate Arrangements: A Reinterpretation," Quarterly Journal of Economics, CXIX, No.1, pp.1-48.

Wages

1870-1995: Real wage index from Braun et al, op.cit.

1995-2004: Average nominal wage index from IMF's WEO database, deflated by CPI.

Population at mid-year

1870-1960: Maddison (2003).

1961-2004: IFS (2003).

A.4 Mexico

Agricultural Output

1878-1910: Colégio de México, 1960, Estadísticas Economicas del Porfiriato, p.61. Refers to export crop sub-index. Converted from a fiscal to calendar year basis by the averaging of two successive years.

1911-1921: Index constructed as a weighted average of the output of ten main crops (beans, corn (maiz), cotton, coffee, garbanzo, rice, sisal, sugar, and tomatoes) weighted by their 1900 (normalized) share in total value of agricultural production. The information on individual crop output was taken from INEGI, 1992, Estadísticas Historicas de Mexico, Mexico.

1921-1960: Leopoldo Solis, 1975, La Realidade Económica Mexicana. Retrovision y Perspectivas. Mexico.

1961-2004: World Development database, World Bank, and INEGI, available at <http://www.inegi.gob.mx/>

Manufacturing Output

1878-1910: Colégio de México, op. cit, p.105. Prior to 1892, the series reflects solely changes in the index of domestic textile production taken from Haber, Stephen, Armando Razo and Noel Maurer, 2003, The politics of property rights: Political instability, credible commitments, and economic growth in Mexico, 1876-1929. Cambridge. Figures for 1879-1882, 1884-87, and 1890 derived by linear interpolation due to the gaps in the original source.

1910-1921: INDEC, op.cit.

1921-1960: Solis, 1975, op.cit.

1961-2004: World Development database, World Bank, and INEGI, available at <http://www.inegi.gob.mx>

Mining Output

1878-1910: Colégio de México, op. cit, p.135.

1911-1921: Weighted average of the output of ten main domestically produced metals (silver, gold, iron, graphite, lead, mercury, copper, zinc, antimony, and lead) as well as oil, weighted according to their 1900 value share in total mining output provided in the same source (pp.136-43).

1921-1960: Solis, 1975, op.cit.

1961-2004: World Development database, World Bank, and INEGI, available at <http://www.inegi.gob.mx>

Transportation and Communications Output

1870-1921: Weighted average of railway freight and passenger traffic (taken from John Coatsworth, *Growth Against Development – The Economic Impact of Railways in Porfirian Mexico*, Illinois) and postal service traffic, taken from Mitchell, op.cit.

1921-1960: Solis, 1975, op.cit.

1961-2004: World Development database, World Bank, and INEGI, available at <http://www.inegi.gob.mx>

Cement Consumption

1870-1931: Cement imports from the UK and the US (by far the two main foreign suppliers), obtained from these countries' own trade statement data (see above). From 1906 onwards, when the first plants of domestic cement production began operations, we add their output (taken from the Oxford Latin American Economic History database, see above) to imports.

1932-2000: Oxford Latin American Economic History database, available at <http://oxlad.queh.ox.ac.uk/>.

2001-2004: INEGI, op.cit.

Machinery Investment

1870-1925: Luis Catão, 2005, "Exchange Rate and Machinery Investment in Early Development: The Cases of Brazil and Mexico." International Monetary Fund. Mimeo,.

1925-1940: Enrique Cardenas, 1987, Mexico's Industrialization during the Great Depression: Public Policy and Private Response, PhD thesis, Yale University. The index is based on the volume of imported capital goods.

1941-1993: Hoffman, op.cit.

1994-2004: INEGI, op.cit.

Central Government Expenditures and Revenues

1870-1960: IBGE, op. cit.

1961-2004: Luis A.V. Catão and Marco E. Terrones, 2005, "Fiscal Deficits and Inflation," Journal of Monetary Economics, 52, 529-554. Both series are expressed in real terms by deflating them by the CPI deflator.

Narrow (M0) and Broad Money (M2)

1870-1925: Catão, op. cit.

1926-1960: INEGI, op.cit.

1961-2004: IFS. Resulting real series was obtained by CPI deflation.

CPI

1870-1913: Catão and Solomou (2005).

1914-1917: Interpolated assuming relative PPP, given that no domestic data seems available for the hyperinflation period. Assuming PPP is probably not very inaccurate since those years were characterizing by soaring inflation and a hyperinflation (see main text) which typically tends to align domestic price movements with the exchange rate.

1918-1940: Williamson, op.cit.

1941-1960: Mitchell, op.cit.

1961-2004: IFS.

Export and Import volumes and Net Barter Terms of Trade:

1870-1925: Catão (2005), op.cit.

1926-1940: Cardenas, op.cit.

1941-1960: INEGI, op.cit.

1961-2004: IFS.

Real Effective Exchange Rate

1870-1913: Catão and Solomou (2005).

1914-2004: CPI-based geometric weighted averages of Mexico's real bilateral exchange rates with its six largest trading partners (covering over 90 percent of visible trade). Fisher ideal indices were derived for the sub-periods 1914-1946 and 1946-2004 (based on 1913 and 1938, and 1960 and 2000 weights respectively), and then spliced at 1946. Nominal exchange rates for the whole post-WWII period are market rates underlying Carmen M. and Kenneth S. Rogoff, 2004, "The Modern History of Exchange Rate Arrangements: A Reinterpretation," *Quarterly Journal of Economics*, CXIX, No.1, pp.1-48.

Wages

1870-1940: Jeffrey G. Williamson, "The Evolution of Global Labor Markets Since 1830", *Explorations in Economic History*, 32 (2), 1995, pp. 141-96.

1940-1974: Mitchell, op cit..

1974-2004: WEO and IFS databases.

Foreign 3-month bill rate

1870-1920: Annual average yields of 3-month bills on the London market provided in Sidney Holmer and Richard Sillas, 1996, *A History of Interest Rates*, Rutgers.

1921-2004: Annual average yields of the US 3-month Treasury Bill provided in the same source. The choice of 1920 as the splicing point was due to the unavailability of the US instrument prior to 1920. Both series were deflated by the respective countries' CPI inflation, obtained from Catao and Solomou (2005) for 1870-1913, Mitchell, op cit (1914-1960) and the IFS (1961-2004).

Foreign Output

US real GDP in 1990 PPP constant dollars from Maddison (2003).

Population at mid-year

1870-1960: Maddison (2003).

1961-2004: IFS (2003).

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Table 1: **Factors Composition** Loadings of eigenvectors associated with the first two common factors constructed on the data sample covering the period 1870-2004.

	Argentina		Brazil		Chile		Mexico	
	F1	F2	F1	F2	F1	F2	F1	F2
Agriculture	-	-	-	-	0.03	-0.21	0.25	-0.22
Communication	-	-	0.29	-0.11	-	-	-	-
Manufacturing	-	-	-	-	0.22	0.29	0.19	0.21
Mining	-	-	-	-	0.35	-0.16	0.26	0.05
Cement	0.30	-0.06	0.34	-0.07	-	-	0.21	0.24
Transportation	0.35	-0.05	0.21	-0.26	-	-	0.26	-0.05
Fixed Investment	0.37	-0.09	0.42	0.02	0.34	-0.03	0.30	0.30
Govt. Expenditures	0.30	0.31	0.21	0.36	0.30	0.08	0.24	-0.26
Govt. Revenues	0.31	-0.04	0.31	0.22	0.34	-0.03	0.27	-0.16
Narrow Money	0.19	0.39	0.11	0.18	0.11	0.45	0.34	-0.13
Broad Money	0.30	0.16	0.05	0.18	0.18	0.42	0.33	-0.14
Inflation	-0.08	0.30	-0.10	-0.04	-0.07	0.03	-0.18	-0.03
Domestic Interest Rate	-0.05	-0.37	-0.07	-0.02	-0.00	-0.33	-	-
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
Real Exchange Rate	0.00	-0.43	0.20	-0.19	0.10	-0.43	0.14	0.43
Export Volume	0.04	-0.11	-0.05	0.17	0.31	-0.25	0.21	-0.12
Import Volume	0.36	-0.26	0.43	-0.06	0.39	0.01	0.28	0.38
Trade Balance	-0.25	0.24	-0.30	-0.11	-0.06	-0.16	-0.08	-0.22
External Spread	-	-	0.03	0.27	-	-	-	-
Foreign Capital Inflows	0.23	-0.17	-	-	-	-	-	-
Foreign 3m-Tbill	0.08	-0.11	0.08	0.10	-0.06	0.13	0.17	-0.25
Foreign Output	-0.01	0.11	0.02	-0.43	0.26	-0.00	0.09	0.16
Real wage	0.20	0.25	0.02	0.40	0.29	-0.06	0.25	-0.24
Population	0.09	0.20	-0.10	-0.27	0.01	0.12	0.00	-0.10

Table 2: **In Sample Fit(R-squared)** for the backcasting equation estimated over the post-war sample (1950-2004). Panel A reports results when the factors are extracted from a panel spanning the period 1870-2004 (1878-2004 for Mexico), while in panel B the factors are extracted from a larger cross-section of variables available during the sample 1900-2004. All regressors denotes results from the backcasting equation that includes all available variables. The remaining backcasting equations estimate the factors using either the Stock and Watson (2002) approach with r static factors (SW(r)) or the Forni et al (2000) dynamic factor approach with q , r dynamic and static factors, respectively (FHLR(q,r))

Panel A: Sample 1870-2004				
	Argentina	Brazil	Chile	Mexico
All regressors	0.89	0.77	0.91	0.92
SW(1)	0.76	0.51	0.72	0.83
SW(2)	0.81	0.52	0.74	0.83
SW(3)	0.81	0.69	0.75	0.86
SW(4)	0.82	0.71	0.78	0.87
FHLR(1,1)	0.79	0.47	0.71	0.75
FHLR(1,2)	0.82	0.67	0.71	0.76
FHLR(1,3)	0.81	0.68	0.71	0.87
FHLR(1,4)	0.81	0.67	0.80	0.86
FHLR(2,1)	0.80	0.46	0.67	0.77
FHLR(2,2)	0.81	0.54	0.74	0.76
FHLR(2,3)	0.80	0.56	0.74	0.84
FHLR(2,4)	0.80	0.68	0.80	0.85
Panel B: Sample 1900-2004				
	Argentina	Brazil	Chile	Mexico
All regressors	0.94	0.90	0.91	0.92
SW(1)	0.84	0.65	0.72	0.83
SW(2)	0.88	0.65	0.74	0.83
SW(3)	0.88	0.83	0.75	0.86
SW(4)	0.88	0.84	0.78	0.87
FHLR(1,1)	0.85	0.61	0.71	0.75
FHLR(1,2)	0.87	0.79	0.71	0.76
FHLR(1,3)	0.88	0.80	0.71	0.87
FHLR(1,4)	0.88	0.80	0.80	0.86
FHLR(2,1)	0.86	0.60	0.67	0.77
FHLR(2,2)	0.88	0.66	0.74	0.76
FHLR(2,3)	0.88	0.70	0.74	0.84
FHLR(2,4)	0.88	0.81	0.80	0.85

Table 3: **Dating the cycle.** This 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 panel B imposes a minimum of three years between peaks.

Panel A							
Argentina		Brazil		Chile		Mexico	
Peaks	Troughs	Peaks	Troughs	Peaks	Troughs	Peaks	Troughs
1873	1880	1872	1876	1875	1877	1883	1886
1884	1887	1881	1885	1882	1885	1891	1894
1889	1891	1891	1893	1890	1894	1898	1902
1893	1895	1896	1901	1896	1897	1907	1909
1899	1902	1907	1908	1898	1902	1912	1916
1913	1918	1912	1918	1907	1909	1921	1927
1923	1926	1922	1923	1912	1915	1928	1932
1930	1933	1927	1931	1918	1919	1936	1938
1938	1945	1938	1942	1926	1927	1941	1942
1948	1953	1949	1956	1929	1932	1945	1947
1958	1959	1961	1967	1937	1942	1951	1953
1961	1963	1974	1978	1943	1947	1956	1959
1965	1968	1980	1984	1952	1954	1960	1962
1970	1971	1986	1988	1957	1958	1965	1971
1974	1978	1990	1992	1962	1965	1974	1977
1980	1985	1995	1999	1966	1970	1981	1988
1987	1990	2001	-	1972	1975	1994	1995
1994	1995	-	-	1980	1983	2000	2002
1997	2002	-	-	1989	1990	-	-
-	-	-	-	1997	2002	-	-
Panel B							
Argentina		Brazil		Chile		Mexico	
Peaks	Troughs	Peaks	Troughs	Peaks	Troughs	Peaks	Troughs
1873	1880	1881	1876	1890	1885	1883	1886
1889	1891	1891	1885	1912	1909	1898	1916
1899	1902	1913	1901	1929	1919	1921	1927
1913	1918	1927	1918	1943	1932	1936	1938
1930	1933	1938	1931	1952	1947	1951	1959
1948	1953	1949	1942	1980	1958	1965	1971
1961	1971	1961	1956	1997	1983	1981	1995
1980	1985	1974	1967	-	-	-	-
1997	-	1986	1978	-	-	-	-
-	-	1995	1992	-	-	-	-

Table 4: **Spectral Density Function Estimates of Cyclical Durations.** Estimates refer to the peak value of a Bartlett lag window estimate using a bandwidth set at twice the number of sample observations.

	1870-1929		1930-1970		1971-2002	
	Estimate	T	Estimate	T	Estimate	T
Argentina	4.64	16	3.36	12	2.11	12
	(1.96)		(1.48)		(1.02)	
Brazil	4.57	16	3.90	12	2.35	12
	(1.92)		(1.72)		(1.13)	
Chile	2.18	16	2.05	12	3.79	8
	(0.92)		(0.90)		(1.90)	
Mexico	3.75	14	2.35	8	3.14	12
	(1.59)		(1.04)		(1.52)	

Table 5: **Descriptive Statistics:** Autocorrelation and standard deviation estimates of the cycle obtained from a static two-factor model. Panel A shows results for the backcasted data used in this paper while panel B reports results for actual cycle measures and panel C compares median regional values for Latin America (Argentina, Brazil, Chile and Mexico), European countries (France, Germany, Italy and the UK), new world countries (USA, Canada and Australia) and Japan.

Panel A: Backcasted Data								
	1870-1929				1930-1970			
	Arg	Bra	Chi	Mex	Arg	Bra	Chi	Mex
AR(1)	0.721	0.706	0.549	0.739	0.593	0.763	0.538	0.573
Std	0.065	0.048	0.063	0.066	0.046	0.032	0.078	0.029
	1971-2004				1982-2004			
	Arg	Bra	Chi	Mex	Arg	Bra	Chi	Mex
AR(1)	0.501	0.628	0.611	0.588	0.547	0.452	0.689	0.379
Std	0.050	0.030	0.051	0.032	0.057	0.028	0.028	0.027
Panel B: Actual Data								
	1971-2004				1982-2004			
	Arg	Bra	Chi	Mex	Arg	Bra	Chi	Mex
AR(1)	0.497	0.625	0.614	0.605	0.528	0.632	0.785	0.419
Std	0.053	0.034	0.061	0.034	0.060	0.029	0.040	0.031
Panel C: Comparison with Advanced Countries								
	1870-1929				1930-1970			
	LA	EU-4	NW-3	Jap	LA	EU-4	NW-3	Jap
AR(1)	0.714	0.507	0.517	0.032	0.58	0.697	0.706	0.599
Std	0.064	0.051	0.05	0.035	0.039	0.101	0.066	0.128
	1971-2004				1982-2004			
	LA	EU-4	NW-3	Jap	LA	EU-4	NW-3	Jap
AR(1)	0.595	0.533	0.515	0.594	0.58	0.692	0.542	0.539
Std	0.041	0.015	0.021	0.023	0.028	0.015	0.022	0.02

Table 6: Cyclical Volatility Estimates of Selected Variables. (standard deviations in percent)

	1870-1929			
	Argentina	Brazil	Chile	Mexico
Foreign Interest Rate	5.34	5.34	5.34	5.34
Foreign Output	3.46	3.46	3.46	3.46
Domestic Output	6.49	4.84	6.25	7.29
Terms of Trade	14.99	21.79	33.05	29.00
Export Volume	13.20	10.21	17.61	10.34
Fixed Investment	107.80	37.16	76.05	79.00
Government Spending	66.23	47.85	39.33	33.71
Expenditure/Revenue	28.41	20.82	28.83	10.70
Narrow Money	14.94	15.32	16.64	35.07
Broad Money	14.82	14.62	11.39	35.83
Real Wage	12.33	9.14	8.69	32.73
	1930-1970			
	Argentina	Brazil	Chile	Mexico
Foreign Interest Rate	4.68	4.68	4.68	4.68
Foreign Output	7.08	7.08	7.08	7.08
Domestic Output	4.56	3.25	7.69	2.90
Terms of Trade	12.20	20.27	26.66	29.37
Export Volume	13.59	9.95	16.89	9.52
Fixed Investment	67.96	29.56	64.60	102.36
Government Spending	14.09	13.27	13.69	16.73
Expenditure/Revenue	23.36	16.21	13.83	19.64
Narrow Money	10.20	11.01	19.90	15.43
Broad Money	12.33	10.84	13.46	13.62
Real Wage	6.99	6.54	13.07	18.22
	1971-2004			
	Argentina	Brazil	Chile	Mexico
Foreign Interest Rate	2.20	2.20	2.20	2.20
Foreign Output	2.97	2.97	2.97	2.97
Domestic Output	5.01	2.94	5.35	3.30
Terms of Trade	27.14	12.24	16.45	22.20
Export Volume	12.94	8.11	6.87	9.61
Fixed Investment	16.39	15.82	16.10	14.93
Government Spending	8.14	66.37	44.21	40.33
Expenditure/Revenue	22.53	9.05	12.15	18.05
Narrow Money	16.84	15.81	21.89	10.48
Broad Money	20.32	22.82	17.31	19.00
Real Wage	12.44	5.72	12.30	15.13

Table 7: Synchronization of the Cycles. The table reports the Harding-Pagan concordance statistic. Values closes to one show evidence of a stronger degree of synchronicity.

	1878-1929				1930-1970			
	Arg	Bra	Chi	Mex	Arg	Bra	Chi	Mex
Arg	1.00	0.50	0.54	0.62	1.00	0.66	0.54	0.49
Bra	-	1.00	0.73	0.69	-	1.00	0.59	0.44
Chi	-	-	1.00	0.77	-	-	1.00	0.61
Mex	-	-	-	1.00	-	-	-	1.00
	1971-2004				1982-2004			
	Arg	Bra	Chi	Mex	Arg	Bra	Chi	Mex
Arg	1.00	0.59	0.68	0.74	1.00	0.43	0.78	0.70
Bra	-	1.00	0.50	0.56	-	1.00	0.48	0.48
Chi	-	-	1.00	0.53	-	-	1.00	0.57
Mex	-	-	-	1.00	-	-	-	1.00

Table 8: **Variance Decomposition of Common the Latin American Business Cycle.** The results are obtained from a variance decomposition using a second-order VAR with an intercept and a slope dummy on the foreign interest rate during World War I and II. i^* is the foreign interest rate, y^* is the foreign real GDP growth and tot^* is the world commodity terms of trade.

<i>year</i>	1878-1939			1946-2004		
	i^*	y^*	tot^*	i^*	y^*	tot^*
0	0.026	0.444	0.142	0.109	0.002	0.012
1	0.055	0.472	0.145	0.086	0.004	0.020
2	0.060	0.482	0.142	0.091	0.012	0.028
3	0.081	0.480	0.139	0.107	0.011	0.121
4	0.098	0.474	0.138	0.126	0.012	0.174
5	0.107	0.469	0.140	0.142	0.012	0.175
6	0.109	0.468	0.143	0.150	0.015	0.182
7	0.109	0.468	0.145	0.152	0.022	0.191
8	0.109	0.468	0.146	0.152	0.029	0.195
9	0.111	0.468	0.145	0.152	0.030	0.195
10	0.112	0.468	0.146	0.154	0.030	0.195
<i>year</i>	1878-1930			1930-1982		
	i^*	y^*	tot^*	i^*	y^*	tot^*
0	0.048	0.444	0.167	0.304	0.091	0.211
1	0.056	0.427	0.149	0.308	0.077	0.223
2	0.050	0.425	0.127	0.288	0.075	0.227
3	0.084	0.435	0.151	0.345	0.073	0.200
4	0.089	0.447	0.191	0.391	0.071	0.192
5	0.089	0.452	0.204	0.399	0.071	0.196
6	0.090	0.452	0.206	0.387	0.071	0.204
7	0.090	0.452	0.205	0.381	0.071	0.208
8	0.090	0.451	0.205	0.386	0.071	0.207
9	0.090	0.451	0.205	0.388	0.071	0.208
10	0.090	0.451	0.205	0.386	0.071	0.210

Figure 1: Comparison of common factors extracted from series detrended with the Hodrick-Prescott or the Baxter-King filters.

Figure 2: Argentina. Comparison of actual and backcasted values of cyclical growth. All reg. denotes backcasted values that use all available regressors. The backcasting equation estimates the factors using either the Stock and Watson (2002) approach with r static factors (SW(r)) or the Forni et al (2000) dynamic factor approach with q , r dynamic and static factors, respectively (FHLR(q,r)). Each backcasting equation includes a constant term. The backcasting sample is 1870-1950.

Figure 3: Brazil. Comparison of actual and backcasted values of cyclical growth. All reg. denotes backcasted values that use all available regressors. The backcasting equation estimates the factors using either the Stock and Watson (2002) approach with K static factors ($SW(r)$) or the Forni et al (2000) dynamic factor approach with q, r dynamic and static factors, respectively ($FHLR(q,r)$). Each backcasting equation includes a constant term. The backcasting sample is 1870-1950.

Figure 4: Chile. Comparison of actual and backcasted values of cyclical growth. All reg. denotes backcasted values that use all available regressors. The backcasting equation estimates the factors using either the Stock and Watson (2002) approach with K static factors ($SW(r)$) or the Forni et al (2000) dynamic factor approach with q, r dynamic and static factors, respectively ($FHLR(q,r)$). Each backcasting equation includes a constant term. The backcasting sample is 1870-1950.

Figure 5: Mexico. Comparison of actual and backcasted values of cyclical growth. All reg. denotes backcasted values that use all available regressors. The backcasting equation estimates the factors using either the Stock and Watson (2002) approach with K static factors ($SW(r)$) or the Forni et al (2000) dynamic factor approach with q, r dynamic and static factors, respectively ($FHLR(q,r)$). Each backcasting equation includes a constant term. The backcasting sample is 1878-1950.

Figure 6: Comparison of actual and backcasted values of cyclical growth. For each year the figures show the minimum and maximum backcasted value of cyclical output growth across models estimated using different numbers of factors and different data samples used to estimate the backcasting equation or to extract common factors.

Figure 6: Continued. Comparison of actual and backcasted values of cyclical growth. For each year the figures show the minimum and maximum backcasted value of cyclical output growth across models estimated using different numbers of factors and different data samples used to estimate the backcasting equation or to extract common factors.

Figure 7: Comparison of the first common factor constructed either on the basis of our extensive data set or solely on the basis of the sectoral output variables.

Figure 8: Historical event charts, Part 1: 1870-1949. The panels report the backcasted cycle for Argentina, Brazil, Chile and Mexico against world economic events (dark shaded area) and country-specific events (light shaded area).

Figure 8: Continued. Part 2: 1950 - 2004.

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Título: Common factors in Latin America's business

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Nº Pat.:370835