LATIN AMERICAN GROWTH CYCLES. EMPIRICAL EVIDENCE 1960-2000

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Abstract

This paper measures and explains to what extent Latin American countries' growth cycles experienced co-movement in the last forty years, using different methodologies. We find that short lasting cycles showed a great dispersion among cyclical correlation, while long lasting ones displayed considerable co-movement. From the structural VAR approach, the results imply a very low degree of co-movement among the shocks affecting these economies. There exist important differences regarding the speed of adjustment and the excess volatility of demand shocks. Processes of integration among Latin-American countries need more policy coordination prior to any attempt to go further in an economic integration process.

Resumen

Este artículo cuantifica y explica la extensión de los ciclos de crecimiento de América Latina, y los comovimientos experimentados en los últimos cuarenta años, usando diferentes metodologías. Se encuentra que los últimos ciclos cortos muestran una gran dispersión entre las correlaciones cíclicas, mientras que los grandes ciclos evidencian un considerable comovimiento. A través de un VAR estructural los resultados implican un bajo grado de comovimiento entre los shocks que afectan a estas economías. Existen importantes diferencias respecto a la velocidad de ajuste y al exceso de volatilidad de los shocks de demanda. Los procesos de integración al interior de América Latina necesitan mayor coordinación de política antes de cualquier intento de ir más allá en el proceso de integración.

Keywords: *Trend-cycle decomposition, Common cycles, Cointegration.*

JEL Classification: E3, F3.

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1. Introduction

This paper intends to measure and explain to what extent Latin American countries' growth cycles have experienced co-movement in the last forty years. We use two different methodologies. First, we analyze short run dynamics by looking at the correlation matrix in the cyclical part of the series using the Hodrick and Prescott filter. As Baxter and Stock (1989) pointed out, this methodology has a static way of approaching the problem since only contemporaneous correlations are analyzed and not simultaneous persistence of the disturbances and co-movement.

The second methodology corrects for this problem and recognizes that although countries may be subject to common or highly correlated shocks, their cycles may exhibit different persistence properties. We investigate jointly trend and cycle dynamics in the real GDP using time series techniques that exploits common features in the series. More specifically, a feature is said to be common if a linear combination of the series fails to have the feature even though individually each series has the feature. There might exist long run or/and short run common features. An indicator of co-movement among non-stationary variables is cointegration, since the variables share some common stochastic trends that drive their long run swings, and at least a combination of them is stationary. An indicator of co-movement among stationary variables is codependence, since there exist a linear combination of the variables that eliminates all correlation with the past and is completely unpredictable with respect to the past information set. The methodology used is described in Vahid and Engle (1993), which follow Engle and Kozicki (1993). It decomposes a multivariate series in a common trend and cycle component. To measure the long-run co-movement, we estimate vector cointegration and cofeature vectors to determine the short run co-movement.

Domestic authority may respond differently to common shocks given country-specific characteristics. In order to take this into consideration we focus on shocks as the source of co-movement and *not* on the co-movement of the outcomes. If we just look at the variables and not at the series of innovation processes that affected them, differences in policies might result in co-movement of less degree among countries.

The rest of paper is organized as follows: In section 2, we begin with the empirical estimations, contemporaneous correlations are carried out using Hodrick and Prescott filter. In section 3, we do the common trend and common cycles analysis following Vahid and Engle methodology. In section 4 we implement the Structural Vector Autoregression models (SVAR) à la Blanchard and Quah (1989) to determine the causes of the co-movement that was identified in the previous section. Finally, in section 5 we present some conclusions and final remarks.

2. Empirical Estimations

The data used to test for the presence of co-movement among countries was real GDP spanned in the period 1960-2000 quarterly. The countries included are Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Paraguay, Peru, Uruguay and Venezuela. As a benchmark for comparison, data for developed countries are considered.

Quarterly GDP was not available for the whole period, excepting Argentina. Two different ways of interpolating annual to quarterly data were used. The first method consists in running the program EZX11 of the NBER. The second one, based on related series, was proposed by Chow and An-loh Lin (1971), and generalized afterwards by Fernandez (1981) and Litterman (1983). We used import[1], as related quarterly series to 'transfer' the quarterly structure to the GDP. Both methods gave us similar results, R-squared between the series obtained from the two methods is always higher than 90%, so we used the method based on related series, since we can give it a more intuitive economic justification.

The variable considered was logarithm of GDP at constant prices. Most of the data were obtained from IFS database and for recent periods from Central Banks of each country.

Hodrick and Prescott filter is applied to decompose the series into trend and cyclical component (Graphs in Appendix). The correlation matrix of the cyclical component of the eleven countries in the sample is presented in Table 1. This table shows a great dispersion among cyclical correlation. According to correlations we can set a group of seven countries that share certain degree of co-movement (superior to 0.5). These countries are Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru and Venezuela. The biggest Latin American economies Argentina, Brazil and Mexico[2], are not highly correlated either among themselves or among the others eight smallest countries. On the other hand, Brazil and Mexico have the lowest standard deviation among the countries considered.

The structure of correlation among decades changed from country to country. When considering the four decades separately, the correlation between countries changed among periods. The empirical evidence showed that the correlation was the highest, on average, in the 70s', the second highest the 60s' and finally in the 90s' and 80s'. (see Table 1).

For the sake of comparison, the correlation matrix of seven developed countries is presented in Table 2. Based on correlations, we can identify two groups of countries: Belgium, France, Spain and Netherlands, and United Kingdom, USA and Canada. We can highlight that standard deviations are considerable lower than in Latin American countries. This is an indicator that developed countries growth cycles are less volatile than Latin American cycles.

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1 Imports and GDP are coincident series.

2 The GDP of the three countries amount to 75% of the aggregate GDP of the eleven countries.

TABLE 1
SIMPLE CORRELATIONS OF 11 LATIN AMERICANS GDP CYCLES (HODRICK-PRESCOTT). 1960-2000 QUARTERLY DATA

	Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	Mexico	Paraguay	Peru	Uruguay	Venezuela	Std. Dev.
1960-2000												
Argentina	1											0.048
Bolivia	0.091	1										0.049
Brazil	0.079	-0.126	1									0.029
Chile	0.065	0.421	0.001	1								0.052
Colombia	0.164	0.558	-0.065	0.488	1							0.039
Ecuador	0.117	0.580	-0.055	0.421	0.628	1						0.058
Mexico	0.023	-0.178	0.071	-0.065	-0.340	-0.127	1					0.025
Paraguay	0.047	0.737	-0.148	0.602	0.771	0.687	-0.169					0.046
Peru	0.251	0.520	0.054	0.423	0.561	0.454	-0.157	0.579	1			0.055
Uruguay	0.120	0.280	0.042	0.374	0.366	0.272	0.040	0.387	0.349	1		0.069
1960-1970												
Argentina	1											0.048
Bolivia	-0.019	1										0.075
Brazil	0.040	-0.207	1									0.023
Chile	-0.116	0.849	-0.286	1								0.058
Colombia	0.196	0.803	-0.282	0.687	1							0.065
Ecuador	0.074	0.902	-0.182	0.810	0.830	1						0.082
Mexico	0.109	-0.674	0.512	-0.711	-0.724	-0.663	1					0.023
Paraguay	0.086	0.930	-0.271	0.836	0.885	0.958	-0.781					0.080
Peru	0.117	0.876	-0.319	0.855	0.842	0.901	-0.756	0.922	1			0.066
Uruguay	0.153	0.479	-0.084	0.455	0.567	0.510	-0.411	0.546	0.517	1		0.084
Venezuela	0.065	0.880	-0.171	0.786	0.836	0.876	-0.610	0.882	0.862	0.602	1	0.059
1970-1980												
Argentina	1											0.036
Bolivia	0.171	1										0.042
Brazil	-0.085	-0.209	1									0.030
Chile	0.479	0.033	-0.022	1								0.065
Colombia	0.246	-0.078	0.143	0.345	1							0.023
Ecuador	0.112	-0.023	0.151	-0.081	0.243	1						0.037
Mexico	0.338	-0.081	0.123	0.136	0.396	0.409	1					0.019
Paraguay	0.615	0.120	0.034	0.563	0.512	0.106	0.682	1				0.020
Peru	0.440	0.204	-0.223	0.021	0.076	0.093	0.389	0.270	1			0.033
Uruguay	0.188	-0.027	-0.019	0.249	0.039	-0.085	0.129	0.169	0.006	1		0.080
Venezuela	0.150	0.291	-0.052	0.050	-0.177	-0.141	-0.465	-0.190	-0.167	0.223	1	0.025
1980-1990												
Argentina	1											0.059
Bolivia	0.085	1										0.030
Brazil	0.194	-0.021	1									0.035
Chile	0.080	0.445	0.313	1								0.049
Colombia	0.291	0.125	0.126	0.482	1							0.018
Ecuador	-0.097	0.154	0.236	0.398	0.061	1						0.027
Mexico	-0.258	0.521	-0.027	0.605	0.018	0.373	1					0.029
Paraguay	-0.053	0.540	-0.150	0.687	0.364	0.438	0.729	1				0.031
Peru	0.370	0.188	0.310	0.415	0.411	0.020	0.174	0.144	1			0.071
Uruguay	-0.055	-0.053	0.315	0.498	0.340	0.068	0.260	0.312	0.429	1		0.063
Venezuela	0.471	-0.020	0.035	-0.011	0.236	0.239	-0.104	0.101	0.485	0.072	1	0.041
1990-2000												
Argentina	1											0.054
Bolivia	0.412	1										0.032
Brazil	-0.046	-0.160	1									0.024
Chile	-0.013	-0.309	-0.056	1								0.027
Colombia	0.036	0.125	-0.046	0.420	1							0.024
Ecuador	0.324	0.286	-0.198	0.435	0.423	1						0.065
Mexico	0.228	0.050	-0.145	-0.327	-0.431	-0.011	1					0.027
Paraguay	0.020	0.390	-0.295	-0.208	0.352	0.162	-0.296	1				0.017
Peru	0.210	0.282	0.349	0.133	0.341	0.210	-0.192	0.147	1			0.043
Uruguay	0.252	0.231	-0.059	0.048	0.090	0.244	0.377	-0.069	0.143	1		0.043
Venezuela	0.647	0.298	-0.284	0.310	0.142	0.524	0.104	0.049	-0.008	0.102	1	0.033

TABLE 2
CORRELATIONS OF 7 DEVELOPED COUNTRIES GDP CYCLES
(HODRICK-PRESCOTT). 1960-2000 QUARTERLY DATA

	Belgium	Spain	France	Netherlands	UK	USA	Canada	Std. Deviation
Belgium	1,000							0.0136
Spain	0,418	1,000						0.0256
France	0.402	0,383	1,000					0.0111
Netherlands	0,703	0,574	0,435	1,000				0.0175
UK	0,024	0,247	0,103	0,048	1,000			0.0155
USA	0,056	0,343	-0,083	0,120	0,585	1		0.0161
Canada	0,169	0,192	-0,074	0,121	0,501	0,767	1	0.0151

3. Estimating common trends and common cycles Engle and Vahid Approximation

3.1. Methodological notes

This methodology decomposes a series into trend and cycle component. Following Vahid and Issler (1992), an y_t is an n-vector of I(1) variables. This implies that Δy_t is I(0) and it admits a Wold representation in innovation form:

(1) $$\Delta y_t = u + C(L)\varepsilon_t$$

Such that $C(0) = I_n$ and $\sum_{j=1}^{\infty} j\left|C_j\right| < \infty$

Where *C(L)* is a matrix polynomial in the lag operator and ε_t is a *nx1* vector of stationary errors in y_t given information on lagged values of y_t. (We will assume $\mu=0$, which will imply no time trend in levels).

Note that $C(L) = C(1) + (1-L)C^*(L) \;=\; C(1) + \Delta C^*(L)$

Where $\sum_{j>i} -C_j$ for all *i* and $C^*(0) = I_n - C(1)$

Then we can rewrite equation (1) as

(2) $$\Delta y_t = C(1)\varepsilon_t + \Delta C^*(L)\varepsilon_t$$

Integrating both sides of the equation (2)

(3) $$y_t = C(1)\sum_{s=0}^{\infty}\varepsilon_{t-s} + C^*(L)\varepsilon_t$$
$$y_t = T_t + C_t$$

Equation (3) is the multivariate decomposition of the Beveridge-Nelson (1981) trend-cycle representation. The importance of this decomposition is that we can represent the series y_t as a sum of a random walk part T_t (trend) and a stationary part C_t (cycle).

Following Stock and Watson (1988) we can represent the system in terms of n-r random walks by decomposing *C(1)* into product of *nx(n-r)* matrix of rank *n-r(A)* with a *(n-r)xn* matrix of rank *n-r (B)*, which is known as "common trend representation". So the Beveridge-Nelson-Stock-Watson (BNSW) representation is

$$y_t = AB\sum_{s=0}^{\infty}\varepsilon_{t-s} + C^*(L)\varepsilon_t \tag{4}$$
$$y_t = AZ_t + C_t$$

Where Z_t is a *n-r vector* of random walk components and *A* is a *nx(n-r)* matrix of factor loadings with full column rank. Let α be the cointegration vectors that form a basis for the left null-space of *A*.

Now C_t is linear combinations of a reduced number of common cycles, so we can write

$$y_t = AZ_t + Fc_t \tag{5}$$

Where c_t is a *n-s vector* of stationary components and the matrix of factor loading *F* is a *nx(n-s)* matrix of rank *n-s*. In this case there will be *s* independent linear combination of y_t which will not have any cycles and will be pure random walks. The vectors representing such combinations are the cofeature vectors and denote the *nxs* matrix of cofeature α^*.[3]

If we stack the cofeature and cointegration combinations:

$$\begin{bmatrix} \alpha^{*'} y_t \\ \alpha' y_t \end{bmatrix} = \begin{bmatrix} \alpha^{*'} T_t \\ \alpha' C_t \end{bmatrix} \tag{6}$$

$A = \begin{bmatrix} \alpha^{*'} \\ \alpha' \end{bmatrix}$. The nxn matrix *A* has full rank and is invertible

So

We can recover the common trend-common cycle decomposition

$$y_t = A^{-1}Ay_t = \alpha^{*-1}(\alpha^{*'} y_t) + \alpha^{-1}(\alpha' y_t) \tag{7}$$
$$A^{-1} = [\alpha^{*-1} / \alpha^{-1}]$$

3 Proietti (1997) develops a methodology, based on Beveridge and Nelson (1981) and Gonzalo and Granger (1995), where this decomposition can be done even is the matrix A does not have full rank.

Implying that the trend component is given by the first term, while the cycle component by the second term.

Test for common trend and common cycles

It is possible to use Johansen procedure to determine the dimension of the cointegration space and estimate the vector of cointegration, procedure that is available in econometrics programs. A test for common cycles and a statistical method for determining the dimension of the cofeature space is proposed by Vahid and Engle (1992). Both procedures are based on canonical correlation analysis.

$$\Delta y_t = \Gamma_1 \Delta y_{t-1} + ... + \Gamma_{p-1} \Delta y_{t-p-1} + \Gamma_p y_{t-p} + \varepsilon_t \tag{8}$$

The number of non zero canonical correlation between Δy_t and $y_{t\text{-}p}$ controlling for all lags differences, yields the dimension of cointegration and the corresponding canonical variates give the cointegration combinations. The likelihood ratio statistic for the test of significance of the canonical correlation does not have a $\chi 2$ distribution.

Common cycles imply a restriction on all of the parameter matrices in equation (8). Having estimated the cointegration vector (a), we can rewrite eq(8) as

$$\Delta y_t = \Gamma_1 \Delta y_{t-1} + ... + \Gamma_p \Delta y_{t-p} + Ba' \, y_{t-1} + \varepsilon_t \tag{9}$$

The common cycle test will then be a test for zero canonical correlations between Δy_t and $\Delta y_{t\text{-}1}, \ldots, \Delta y_{t\text{-}p}$ and $a' y_{t\text{-}1}$. Now all variables are stationary and the likelihood test for the null of s cofeature vectors will be asymptotically $\chi 2$ with $s(np + r)\text{-}sn + s2$ degree of freedom.

This can be clearly seen rewriting equation (9)

$$\begin{bmatrix} I_s & \alpha^{**'} \\ 0_{(n-s)xs} & I_{n-s} \end{bmatrix} \Delta y_t = \begin{bmatrix} 0_{sx(np+r)} \\ \Gamma_1^* ... \Gamma_p^* \beta^* \end{bmatrix} \begin{bmatrix} \Delta y_{t-1} \\ . \\ . \\ \Delta y_{t-p} \\ a' \, y_{t-1} \end{bmatrix} + v_t \tag{10}$$

where Γ_i^* and β^* are partitions of Γ_i and β corresponding to the bottom n-s reduced-form VECM equations and v_t is given by

$$v_t = \begin{bmatrix} I_s & \alpha^{**'} \\ 0_{(n-s)xs} & I_{n-s} \end{bmatrix} \varepsilon_t$$

Inverting the coefficient matrix on Δy_t in equation (10) and multiplying through yields a reduced-form VECM model that contains the common feature and cointegration information:

$$\Delta y_t = \Gamma_1^{**} \Delta y_{t-1} + ... + \Gamma_p^{**} \Delta y_{t-p} + \beta^{**} y_{t-1} + \varepsilon_t^* \tag{11}$$

This reduced-form representation allows us to gain to common cycles, in addition to the gains due to common trends.

3.2. Empirical estimations

This method was carried out for eleven Latin American countries: Argentina, Bolivia, Brazil, Chile Colombia, Ecuador, Mexico, Paraguay, Peru, Uruguay and Venezuela. The variable used is log of real GDP. The analysis was performed jointly for the eleven countries. First of all we determined the optimum lag order of the VAR according to the Akaike Information Criterion (AIC). This criterion showed that the optimal lag order is 2.

Unit Root test was performed using Augmented Dickey Fuller Test. The null hypothesis of unit root is accepted, independently on the specification of the test. First differences are stationary, which lead us to conclude that the log of the real GDP is I(1). (See Table 3).

TABLE 3
AUGMENTED DICKEY FULLER TEST

	ADF(p)	Intercept	
		Level	First Difference
Argentina	4	-2,631	-5,667
Bolivia	4	-0,949	-7,640
Brazil	4	-2,301	-4,904
Chile	4	1,191	-5,595
Colombia	4	-1,874	-9,161
Ecuador*	4	-0,233	-5,717
Mexico	4	-2,521	-4,680
Paraguay	4	-2,195	-6,430
Peru	4	-1,486	-6,156
Uruguay	4	-0,091	-8,047
Venezuela	4	-2,326	-6,059

Variables are log real per capita GDP, quarterly data 1960-2000. 160 observations per country. MacKinnon critical values for rejection of hypothesis of a unit root are for the intercept at 1% -3.47, for intercept plus trend -4.02

* Intercept plus trend

Tests for cointegration were performed using Johansen's technique. We first reject the null hypothesis that there is at most zero cointegration vectors. Then we reject that there is at most 1, 2, and 3 cointegration vectors, concluding that the cointegration rank ***r*** is 4. This implies the presence of seven common stochastic trends for the eleven Latin American countries. The results of the cointegration test are presented in Table 4.

The next step was to examine the presence of common cycles in the data. For the common cycle test we built a VECM, with only one lag, since variables are in first difference, but conditional to the estimated values of the four cointegration vectors. A canonical correlation analysis was performed. The results of the tests are given in Table 5. The results of common cycle tests pointed out the eleven Latin American countries share four independent cycles. The system was characterized by seven canonical correlations that were not significantly different from zero, suggesting that the system has four common cycles.

Then, the results implied that these eleven Latin American countries have $s = n\text{-}r = 7$ common stochastic trend and $r = n\text{-}s = 4$ common cycles. The number of cointegrating vectors and cofeature vectors added up to the number of variables, which allows the decomposition of GDP in trend and cycle. In this special case both methodologies (Beveridge Nelson –BN- and Proietti's –GG) give the same results. The correlation between cycles from different methods are presented in Table 6.

TABLE 4

JOHANSEN COINTEGRATION TEST

Hypothesized N° of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None**	0.568	448.54	277.7	293.4
At most 1**	0.414	314.06	233.1	247.2
At most 2**	0.305	228.59	192.9	205.0
At most 3**	0.268	170.29	156.0	168.4
At most 4	0.215	120.32	124.2	133.6
At most 5	0.157	81.65	94.2	103.2
At most 6	0.138	54.32	68.5	76.1
At most 7	0.077	30.54	47.2	54.5
At most 8	0.059	17.79	29.7	35.7
At most 9	0.042	8.00	15.4	20.0
At most 10	0.008	1.21	3.8	6.7

*(**) denotes rejection of the hypothesis at the 5%(1 %) level. Trace test indicates 4 cointegrating equation(s) at both 5% and 1 % levels.

TABLE 5

COMMON CYCLE TEST

Canonical Correlations	chi-squared Statistic	Degrees of Freedom	Significance Level
0.8734	749.05	297	0.0000
0.7519	520.25	260	0.0000
0.7291	387.77	225	0.0000
0.6366	267.18	192	0.0003
0.6113	184.56	161	0.0984
0.5144	110.16	132	0.9169
0.3825	61.30	105	0.9998
0.3386	36.14	80	1.0000
0.2378	16.78	57	1.0000
0.1717	7.53	36	1.0000
0.1314	2.77	17	1.0000

Chi squared test is a trace test. Degrees of freedom es given by: s*(h*k+r+s), where s: nº of VECM canonicel correlation, h: nº of lags in the VECM, k is the dimension of vector y(t), r: nº of cointegrating relations.

TABLE 6
CORRELATION BETWEEN BN AND GG METHODS AND SENSITIVITY ANALYSIS TO THE NUMBER OF COINTEGRATION VECTORS

Correlation	Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	Mexico	Paraguay	Peru	Uruguay	Venezuela
BN(5)-GG(5)	0.992	0.980	0.989	0.950	0.984	0.985	0.975	0.988	0.983	0.997	0.992
BN(4)-GG(4)	0.994	0.984	0.961	0.760	0.980	0.979	0.958	0.985	0.963	0.996	0.967
BN(5)-BN(4)	0.955	0.936	0.642	0.504	0.988	0.970	0.849	0.991	0.450	0.991	0.739
GG(S)-GG(4)	0.952	0.930	0.619	0.525	0.987	0.967	0.849	0.990	0.421	0.990	0.714

Number in parenthesis stands for the number of cointegration vectors.

As expected correlation was very high. We performed a sensitivity analysis to the number of cointegration vectors since four or five vectors can be found under different specifications. We finally chose four vectors according either to Schwarz or AIC criteria. Correlation between cycles under five and four cointegration vectors is presented in Table 6. We see that the correlation is high for almost all countries considered, being the exception Peru and Chile. In all other cases correlation is considerable higher than 50%. This analysis makes our cyclical estimations more reliable, since the results do not change much whether we use four or five cointegration vectors.

3.2.1. Trend and cycle component

The matrix composed by cointegration and cofeature vectors is used to decompose GDP into trend and cycle component. This decomposition is carried out for each one of the eleven Latin-American countries. Graphs of each country with trend and cyclical component are reported in Graph 1.

Literature on business cycle let us identify cycles of different duration. The cycles we identified in the first part of the paper (with Hodrick and Prescott filter) have a duration of approximately 3 years, while the cycles we identified with BN and GG are long lasting cycles of approximately 10 years. It looks as if those long lasting cycles are common to Latin American countries, excepting Chile and Mexico.

Chile does not show to share common cycles with the rest of Latin American countries (probably because it had a more open economy during the period considered), excepting with Bolivia, with which Chile has common commodities, especially copper.

Another exception is Mexico, whose economy is more related to North American economies. The only country that has a high correlation with Mexico is Argentina. It is not easy to find an explanation for that since they neither share common commodities nor they have important trade links. A possible explanation may be found in Kaminsky and Reinhart (2000), who find important financial links between those countries and between those countries with a third financial center.

GRAPH 1
BEVERIDGE NELSON AND GONZALO-GRANGER TREND-CYCLE DECOMPOSITION

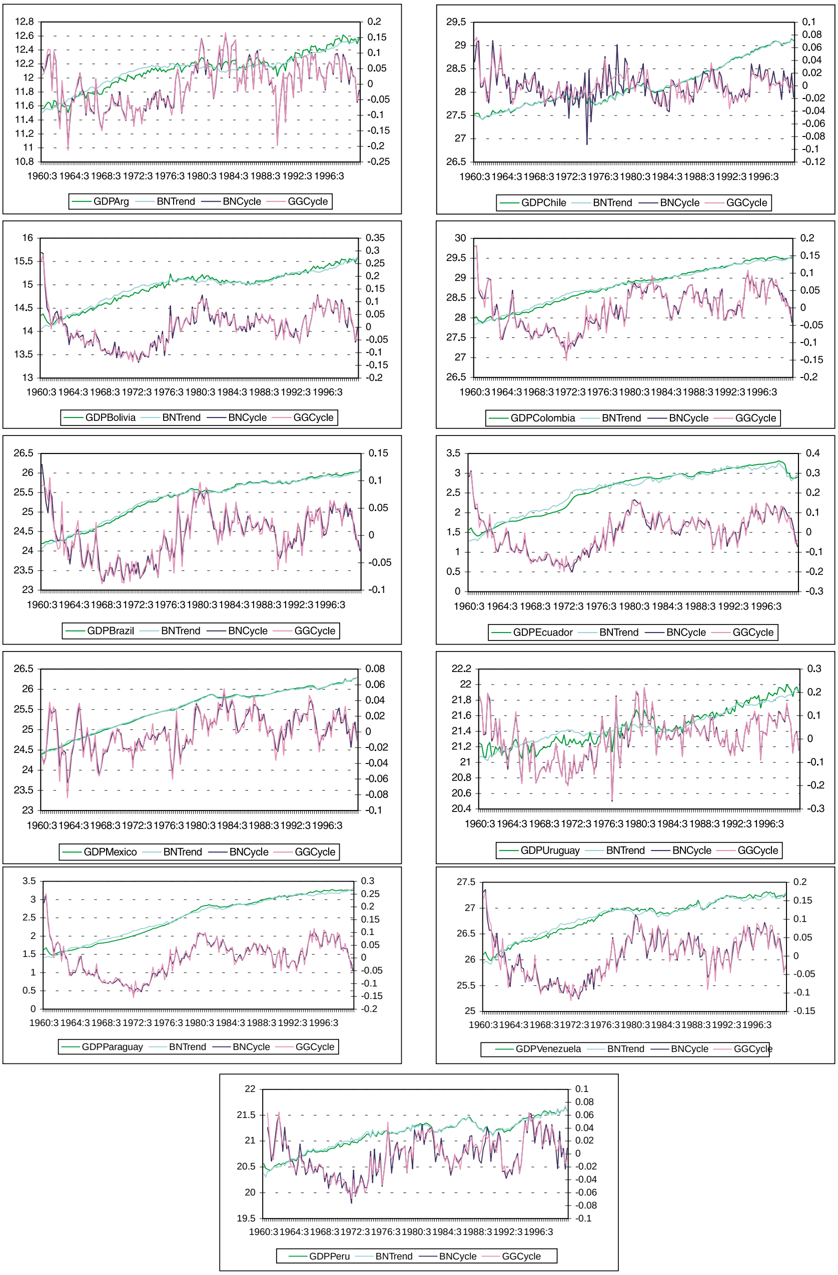

TABLE 7
CYCLICAL CORRELATION. BN DECOMPOSITION

	Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	Mexico	Paraguay	Peru	Uruguay	Venezuela
1960-2000											
Argentina	1										
Bolivia	0.652	1									
Brazil	0.755	0.847	1								
Chile	-0.138	0.421	0.299	1							
Colombia	0.717	0,859	0.781	0.204	1						
Ecuador	0.761	0.932	0.945	0.347	0.906	1					
Mexico	0.756	0.263	0.514	-0.379	0.561	0.458	1				
Paraguay	0.729	0.948	0.881	0.334	0.952	0.977	0.439	1			
Peru	9,399	0.868	0.601	0.322	0.817	0.761	0.091	0.836	1		
Uruguay	0.545	0.694	0.839	0.284	0.739	0.795	0.570	0.748	0.536	1	
Venezuela	0.826	0.924	0.928	0.268	0.895	0.976	0.499	0.961	0.747	0.723	1
1960-1970											
Argentina	1										
Bolivia	0.561	1									
Brazil	0.702	-0.806	1								
Chile	-0.131	0.586	0.417	1							
Colombia	0.693	0.877	0.818	0.280	1						
Ecuador	0.711	0.955	0.953	0.486	0.912	1					
Mexioo	0.664	-0.017	0.272	-0.582	0.365	0.198	1				
Paraguay	0.680	0.969	0.907	0.493	0.940	0.990	0.165	1			
Peru	0.410	0.930	0.733	0.512	0.886	0.851	-0.069	0.896	1		
Uruguay	0.589	0.692	0.883	0.286	0.754	0.807	0.451	0.761	0.584	1	
Venezuela	0.733	0.946	0.939	0.422	0.918	0.983	0.233	0.976	0.859	0.768	1
1970-1980											
Argentina	1										
Bolivia	0.706	1									
Brazil	0.842	0.823	1								
Chile	0.317	0.506	0.486	1							
Colombia	0.677	0.787	0.709	0.340	1						
Ecuador	0.838	0.904	0.947	0.511	0.869	1					
Mexico	0.424	-0.035	0.303	-0.125	0.342	0.224	1				
Paraguay	0.774	0,918	0.872	0.438	0.919	0.976	0.156	1			
Peru	0.415	0.782	0.513	0.077	0.788	0.688	-0.074	0.798	1		
Uruguay	0.622	0.656	0.784	0.389	0.701	0.752	0.577	0.688	0.452	1	
Venezuela	0.883	0.902	0.938	0.519	0.823	0.980	0.199	0.954	0.642	0.684	1
1980-1990											
Argentina	1										
Bolivia	0.410	1									
Brazil	0.389	0.607	1								
Chile	-0.612	0.181	0.159	1							
Colombia	0.407	0.569	0.157	-0.230	1						
Ecuador	O.487	0.823	0.832	0.113	0.591	1					
Mexico	0.683	0.047	0.240	-0.719	0.408	0.239	1				
Paraguay	0.462	0.815	0.531	-0,036	0.864	0.862	0.280	1			
Peru	0.081	0.619	0.101	0.064	0.689	0.469	-0.111	0.705	1		
Uruguay	-0.220	0.311	0.612	0.388	0.187	0.494	0.107	0.340	0.195	1	
Venezuela	0.764	0.734	0.705	-0.253	0.579	0.859	0.420	0.795	0.417	0.134	1
1990-2000											
Argentina	1										
Bolivia	0.556	1									
Brazil	0.660	0.727	1								
Chile	-0.447	0.280	0.078	1							
Colombia	0.419	0.796	0.632	0.294	1						
Ecuador	0.612	0.864	0.885	0.198	0.848	1					
Mexico	0.622	0.057	0.431	-0,546	0.211	0.235	1				
Paraguay	0.514	0.919	0.782	0.353	0.931	0.942	0.152	1			
Peru	0.165	0.826	0.356	0.386	0.772	0.632	-0.200	0.774	1		
Uruguay	0.279	0.544	0.689	0.185	0.623	0.656	0.418	0.595	0.397	1	
Venezuela	0.755	0.892	0.872	0.075	0.785	0.954	0.292	0.913	0.623	0.522	1

3.3.2. Cyclical correlation

The BN and GG decompositions showed that the correlation among countries in different decades changed a lot being higher in the first two decades than in the last two. In Table 7 we report cyclical correlation for the whole period and for sub-periods.

As Table 7 shows cyclical correlation changed from decade to decade. Also this degree of cyclical co-movement has been neither constant nor symmetric through time. It was higher during the 60's and 70s, considerable smaller during the 80s, and it partially recovered (increases) during the 90s. Members of the Andean Community of Nations have a higher degree of co-movement than those of the MERCOSUR.

3.3.3. Variance decomposition of real GDP innovations

We performed the variance decomposition of innovation to examine the relative importance of trends and cycles of each country. We also determined the relative importance of innovations to the transitory and permanent component for the total variation of income. The decomposition was based on bivarite VARs of the log differences of the permanent and transitory components. Lag order changed from country to country and was chosen according to AIC criterion. Results of the trend-cycle decomposition are reported in Table 8. We placed trend innovation firstly in the orthogonalization procedure, as suggested by Engle and Issler (1995), since innovations in productivity cause both trend and cycle movements in real business cycle model. The results obtained suggest that the trend component makes, by large, the greatest contribution to GDP forecast variances although at higher horizons the cyclical component increases in its importance.

TABLE 8

VARIANCE DECOMPOSITION OF REAL GDP INNOVATIONS

Proportion of the Variance of real GDP innovations Attributed to Trend and Cyclical Shocks at Horizon (h). BN Decomposition

	h=2		h=6		h=10		h=16	
	Tendencia	Ciclo	Tendencia	Ciclo	Tendencia	Ciclo	Tendencia	Ciclo
Argentina	99.996	0.004	98.93063	1.069366	98.135	1.865	97.616	2.384
Bolivia	99.850	0.150	92.93433	7.065671	90.623	9.377	90.122	9.878
Brazil	98.906	1.094	97.61731	2.382686	97.370	2.630	97.351	2.649
Chile	99.985	0.015	99.67795	0.322053	99.565	0.435	99.540	0.460
Colombia	99.857	0.143	99.47472	0.525279	99.462	0.538	99.462	0.538
Ecuador	98.874	1.126	87.26732	12.73268	86.312	13.688	86.221	13.779
Mexico	99.906	0.094	94.74013	5.259872	94.696	5.304	94.695	5.305
Paraguay	99.807	0.193	92.57978	7.420224	91.886	8.114	91.297	8.703
Peru	99.999	0.001	99.18653	0.813473	99.185	0.815	99.185	0.815
Uruguay	99.780	0.220	97.88826	2.11174	97.379	2.621	97.284	2.716
Venezuela	99.995	0.005	97.15887	2.84113	94.869	-5.131	93.180	6.820

4. Common Shocks

In this section we implemented the Eichengreen and Bayoumi (1994) methodology of Structural Vector Autoregression models (SVAR) developed by Blanchard and Quah (1989) to identify the causes of the co-movement that was identified in the last section. The SVAR methodology allowed us to identify the temporary and permanent impact of different shocks through the imposition of restrictions on the shock structure of the model. One advantage of SVAR à la Blanchard and Quah is that it does not impose restrictions in the short run dynamics that is generated by the permanent component of output. In addition it does not suffer the “end point” problem that is present in the more mechanic techniques to filter the data (as it is the case of the Hodrick and Prescott filter).

4.1. Impulse-response function

In this section we made special emphasis on the qualitative aspects of the results that stems from the impact of the supply and demand shocks on output growth and inflation, as well as the speed of adjustment.

In Table 9 we can see the behavior of GDP growth and inflation in Latin American countries. Argentina had the poorest perform in the four decades: its growth rate was the lowest (jointly with Uruguay) and its inflation rate the highest. The results obtained below (Argentina behaved always as an outlier) may be understood when we see its behaviour during these years.

TABLE 9

MEAN OF INFLATION AND GROWTH PER COUNTRY

	Period	Argentina	Bolivia	Brazil	Chile	Colombia	Ecuador	Mexico	Paraguay	Peru	Uruguay	Venezuela	Mean
Inflation	**1960-2000**	**0.683**	**0.363**	**1.24***	**0.329**	**0.171**	**0.208**	**0.209**	**0.120**	**0.522**	**0.400**	**0.164**	**0317**
	1960-1970	0.192	0.057		0.221	0.108	0.043	0.027	0.042	0.088	0.376	0.000	**0.115**
	1970-1980	0.752	0.149		0.839	0.179	0.112	0.140	0.114	0.238	0.470	0.071	**0.307**
	1980-1990	1.484	1.189	1.281	0.187	0.209	0.293	0.501	0.183	1.137	0.448	0.202	**0.647**
	1990-2000	0.336	0.085	1.202	0.095	0.186	0.362	0.170	0.136	0.605	0.317	0.348	**0.349**
Growth	**1960-2000**	**0.023**	**0.033**	**0.046**	**0.040**	**0.043**	**0.049**	**0.047**	**0.045**	**0.032**	**0.020**	**0.032**	**0.037**
	1960-1970	0.030	0.052	0.058	0.041	0.053	0.060	0.068	0.046	0.052	0.015	0.059	**0.049**
	1970-1980	0.025	0.044	0.083	0.025	0.054	0.087	0.064	0.084	0.038	0.029	0.040	**0.052**
	1980-1990	-0.012	0.002	0.022	0.031	0.034	0.022	0.019	0.030	-0.008	0.005	0.010	**0.014**
	1990-2000	0.041	0.035	0.026	0.061	0.027	-0.007	0.035	0.019	0.041	0.029	0.018	**0.030**

We expect that a supply shock have a permanent positive effect on output and a permanent negative effect on inflation, while a demand shock is expected to have a temporary positive effect on output and a permanent positive effect on inflation.

Results for the eleven Latin-American countries showed that there exist permanent positive effects of supply shocks on output. However when considering the effect of supply shocks on prices, we did not obtain results as homogeneous as in the previous case. Contrary to what we expected, Argentina, Uruguay and Paraguay experimented permanent positive effect of supply shocks on prices.

With respect to demand shocks, we verified the existence of a permanent positive effect on inflation as well as a transitory positive effect on output. But in the case of Argentina, Bolivia, Paraguay and Uruguay the initial effect of demand shocks on output was contractionary. Even worse for the cases of Argentina and Bolivia the effects of demand shocks dissipated very slowly. For practical purposes these effects appeared as "permanent" which could impose important costs to any coordinated adjustment to its commercial partners.

The results from the variance decomposition of growth and inflation in most of the cases were as expected, that is, in the long run the supply shocks have a larger weight on output variation and the demand shocks have a larger weight on prices variation. But there exists two types of anomalies in the results for the variance decomposition of output. First, in the Argentinean case demand shocks had a very large weight even at a 25 years horizon. Second there are four countries (Chile, Mexico, Peru and Venezuela) in which, even though the relative weights stabilized very quickly, the weight that demand shocks have on output variations looks relatively high (between 35% and 50%) in the long run. In the same way, there are five countries (Chile, Ecuador, Mexico, Peru and Venezuela) in which the weight of supply shocks on the variation of prices in the long run looks also very high (between 40% and 60%).

These observed asymmetries could be a very strong difficulty for any monetary integration among these countries, since the size and direction of the adjustments needed could be very different for each country even if the shocks (supply and demand) were correlated. A possible explanation of this result could be found in the instability of demand policies in those countries, since these policies could produce a very large weight of this type of shocks on output even in large horizons.

Finally, we study the degree of co-movement between supply and demand shocks among the eleven Latin-American countries. The results show a very low degree of co-movement for both supply and demand shocks, higher for the former and in many cases negative correlations for the later (see Appendix)

The results show that any process of integration (specially monetary) among the Latin-American countries could have important obstacles, which implies that these economies need more policy coordination prior to any attempt to go further in an economic integration process.

5. Conclusions

The results show a great dispersion among cyclical correlation between the eleven Latin American countries when we analyze **short lasting cycles**. The most representative countries of the region, Argentina, Brazil and Mexico show a very low correlation among themselves and among the other Latin American countries.

In the decade analysis we found that the correlation were the highest in the 60's and 70s', the second highest in the 90s' and finally in the 80s'. Contrary to what we expected, the cyclical co-movements observed among the three biggest economies in Latin America, Argentina, Brazil and Mexico were quite low in the whole period and in the decades considered. We expected higher correlation, especially in the 90's from the fact that their financial markets were relatively more developed and integrated to the international markets, and in that decade Argentina and Brazil jointed a trade union: Mercosur.

The common trend common cycle analysis for the eleven Latin American countries, carried out by using cointegration estimations and canonical correlations, shows four cointegration vectors, and seven cofeature vectors, which implies the presence of seven common stochastic trends and four common cycles for the eleven Latin American countries.

For the BN and GG decomposition we identified **long lasting cycles** of approximately 10 years in contrast to the cycles we identified in the first part of the paper (with Hodrick and Prescott filter) that had a duration of approximately 3 years. It seems as if those long lasting cycles are common to Latin American countries, excepting Chile and Mexico. Also, the correlation among countries in different decades has changed a lot, observing a higher correlation in the first two decades than in the last two.

In order to identify aggregate supply and demand disturbances (both domestic and external), and to distinguish them from policy responses, we implemented the Eichengreen and Bayoumi (1994) methodology of Structural Vector Autoregression models (SVAR) developed by Blanchard and Quah (1989)

From this methodology, given the decomposition of shocks (supply and demand), the results imply a very low degree of co-movement among the shocks affecting these economies. Also there exists important differences regarding the speed of adjustment and the excess volatility of demand shocks. That motivated us to say that any process of integration (specially monetary) among the Latin-American countries could suffer from important obstacles, which implies that these economies need more policy coordination prior to any attempt to go further in an economic integration process.

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